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FOREWORD FROM THE IQAC DESK

Research work adds to the information base of a country and various industries can use this to take forward a nation economically or for general all-over development. One common requirement of "developing a research culture" is to move from a few isolated individual researcher projects to an environment where research is so pervasive that it appears to be the activity of a large number of interconnected colleagues.

Education administrators in India look at Research in many different ways, such as, (i) building research culture involves incorporating research into an organisational culture that has not previously considered that activity as part of its culture; (ii) implanting a research sub-culture within an organisational culture currently having a distinctive teaching sub-culture; (iii) having a 'petri-dish' culture - an environment into which we toss research and expect it to grow, just as we expect bacteria to grow in a petri dish (Subrata Chakraborthy, Hindu Business Line).

Science in India is on a great momentum in the last few decades, thanks to the talent and the infrastructure. Our achievements in fields ranging from astronomy to biology, to chemistry and agriculture, there are so many to be proud about (Arati Halbe, India's year in Science, 2017).

ISRO has now established its ability to launch satellites on a commercial scale with multiple multi-satellite launches. Determining factors that influence the onset of monsoon, and understanding extreme rainfall events and their influence on the overall rainfall patterns in the country are some research challenges our scientists seem to have cracked.

Named Saraswati, after the Indian goddess of music, art and knowledge, the supercluster is estimated to contain billions of stars, planets, gases, dark matter and other bodies. This would also help astronomers understand much about the composition of our universe and its mysterious past.

In a pathbreaking seismological study, researchers have examined the Indian Ocean Geoid Low (IOGL), a point of abnormally low gravity, caused by the deficit in the mass of Earth below IOGL. While there were a few theories in the past explaining the cause, none of them were convincing. Scientists from India and Germany seem to have finally succeeded in their attempt to explain the phenomenon of the gory face of climate change. Melting glaciers in the Himalayas is a significant threat posing the country.

Indian researchers contributed a significant share in the fight against cancer with research spanning across fields of genetics, computational biology, nanotechnology and bioinformatics. Scientists in the country also indigenously developed an anti-cancer drug called disarib, which is now ready for pre-clinical trials. A major challenge in fighting TB is the emergence of drug resistant strains of the TB bacteria, which are now immune to most antibiotics. In a pathbreaking study this year, our scientists attempt to answer how TB bacteria develop resistance to most antibiotics, and try to find ways to reverse this drug resistance.

Researchers at the Indian Institute of Technology Bombay (IITB), in a collaborative effort with ISRO's Semi-Conductor Labs (SCL), Chandigarh, have developed a completely indigenous Bipolar Junction Transistor (BJT) that can work with the other type of transistor, called BiCMOS.

The IQAC of Nirmala College for women is elated to have launched the 3rd volume of the Nirmala Annual Research Congress – 2018.

Dr Pawlin Vasanthi Joseph
IQAC Co-ordinator

From the Organizer's Desk

Warm Greetings!!

The annual research congress is a prime event in Nirmala's calendar besides other National and State level seminars and workshops organized by the Departments. It is a gathering of our research scholars and is a regional platform for them to present and discuss their research findings. It also helps to imbibe good values, practices and ethics early on in our young researchers starting at the undergraduate level.

NARC combines an inspiring keynote speech for our budding researchers with research presentations and discussions in a friendly, informal and lively atmosphere. This congress depends on contributions of our research scholars and I would like to acknowledge the efforts of research supervisors for their invaluable support in sending research articles.

Original research articles were invited from all the departments. 12 Departments actively sent their research findings which are of high quality, original and not published elsewhere or submitted for publication. This year, we received 99 full research articles out of which 32 are from Mathematics, 23 from Chemistry, 11 from English Literature, 9 from Commerce, 7 from Zoology, 4 from History, 4 from Tamil, 3 each from Botany and Economics and 1 each from French, Hindi and Bio-informatics Departments.

All accepted papers will be presented orally and included in the congress proceedings. I hope our researchers will enrich their knowledge and benefit from NARC'18.

Dr. C. Subha,
Organizing Secretary.

PRINCIPAL'S MESSAGE

The purpose of quality education apart from setting good standards in academics should be of value to individuals. Education should help them to grow in self-mastery, skills, personal depth, to be fair minded and generous in all the human resources and to delight in the adventures of research which kindles their intellectual curiosity. Knowledge is power, Information is Liberation and Research the premise of progress. A blend of all these with values has been the spirit of Nirmala College for Women.

Knowledge is power and schools of learning are called temples of knowledge. Research is the key that opens doors of knowledge. There are many rooms in a mansion. It is not enough if one stays outside and stands impressed with the big stately structure. One has to walk through every chamber that is locked to see and enjoy the treasures of immense value. This is not possible without the key of Research.

NARC has played a very important role in helping scholars, to know the certainty of the path chosen and direction taken in Research. Research at Nirmala has seen phenomenal growth in all dimensions. Nirmala Annual Research Congress which has completed 4 years is organized by the IQAC of the college with a great purpose to enable research scholars to understand and appreciate various intellectual works in research in the college. NARC has helped in showing the direction to the scholars who wish to explore research more systematically and gain in the process a deeper insight into the rich diversity of areas of their subject and life itself.

Over the years it has helped them to share their progress in research and learn from the experiences of other scholars. NARC has not only helped to sharpen their thinking but to expediate their thesis preparation.

Congratulating Dr. Pawlin Vasanthi Joseph, Coordinator – IQAC, and the members of IQAC, Research Guides and Scholars for all the efforts taken. I wish NARC 2018 all success and pray that Research at Nirmala takes greater strides towards a wonderful contribution for the future.

Dr. Sr. Helen
Principal
Nirmala college for women

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A STUDY ON DOMINATOR COLORING OF MYCIELSKIAN OF SOME GRAPHS

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A dominator coloring of a graph G is a proper coloring of G in which every vertex should dominate every vertex of at least one color class. The dominator chromatic number $\chi_d(G)$ is the minimum number of color classes in a dominator coloring of G. In this paper we study the dominator chromatic number ofmycielskian some graphs.

Keywords: Coloring, Domination, Dominator coloring.

AMS Classification Numbers: 05C15, 05C69.

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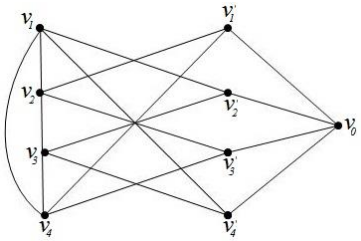
1 Introduction

For general notations and concepts of graphs we refer to [2][5][8]. For definitions of coloring and domination refer to [3][4][9][10][11][12]. Unless mentioned otherwise, all the graphs mentioned in this paper are simple, finite and connected undirected graphs. A graph coloring is an assignment of colors to the vertices of G. The vertex coloring is said to be proper if no two adjacent vertices of G receive the same color. Various coloring derivatives are found in the literature, one such problem is dominator coloring.

Dominator colorings were introduced in [7] and they were motivated by [6].The aim in this paper is to study about the dominator coloring of mycielskian of certain graphs such as Path, Cycle, Complete graph, Star graph, etc.,.

1.1 Definitions

Definition 1.1.1. [1] For a graph $G=(V,E)$, $V=\{v_1,v_2,...,v_n\}$, the ***mycielskian*** of G is the graph $\mu(G)$ with vertex set $V\cup V'\cup v_0$, where $V'=\{v_i' : v_i \in V\}$ and is disjoint from V, and $E'=E\cup\{v_iv_j' : v_iv_j \in E\}\cup\{v_i'v_0 : v_i' \in V'\}$. The vertices v_i and v_i' are called twins of each other and v_0 is called the *root*of $\mu(G)$.



Mycielskian of C_4

Theorem1.1.8. [1] For any graph G, $\chi_d(G)+1 \le \chi_d(\mu(G)) \le \chi_d(G)+2$. Further if there exists a χ_d-coloring C of G in which every vertex v dominates a color class V_i with $v \notin V_i$, then $\chi_d(\mu(G)) = \chi_d(G)+1$.

2 DOMINATION AND COLORING

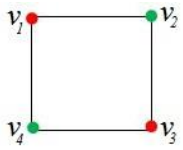
Theorem 2.1. If $\gamma(G)=1$ then $\chi_d(G)=\chi(G)$.

*Proof:*Let G be a graph of order n. Given $\gamma(G)=1$. Let $D=v_0$ be the dominating set of G. Then the vertex v_0 dominate every vertex of G. If $f(v_0)=1$ then $f(v_i)\neq 1$ for $1\le i\le n-1$ and every vertex of G dominates the color class of 1. Hence for color the remaining vertices we need $\chi_d(G)-1$ colors. Hence $\chi_d(G)=\chi(G)$.

Converse need not be true.

Example 2.2.

Consider the cycle C_4, $\chi_d(C_4)=\chi(C_4)=2$ but $\gamma(C_4)=2$.



Dominator Coloring of C_4

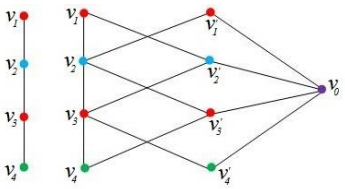
Theorem 2.3. If $\gamma(G)=1$ then $\chi_d(\mu(G))=\chi_d(G)+1$.

*Proof:*Let G be a graph of order n. Given $\gamma(G)=1$. Let $D=v_1$ be the dominating set of G. Then the vertex v_1 dominate every vertex of G. Hence the vertices v_1 and v_1' is adjacent to every vertex of $\mu(G)$ except v_0. If $f(v_1)=f(v_1')=1$ then every vertex v_i of $\mu(G)$ dominates the color class of 1. Now color the remaining v_i and v_i' in $\mu(G)$ by $\chi_d(G)-1$ colors and v_0 by the color $\chi_d(G)+1$. Then the vertices v_i' dominates color class $\chi_d(G)+1$. Hence $\chi_d(\mu(G))=\chi_d(G)+1$.

Converse need not be true.

Example 2.4.

Consider the path P_4, $\chi_d(P_4)=3$ $\chi(\mu(P_4))=4=\chi_d(P_4)+1$ but $\gamma(P_4)=2$.



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Dominator coloring of P_4 and $\mu(P_4)$.

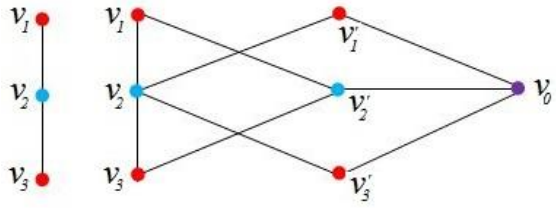
Theorem 2.5. If $\gamma(G)=2$ such that $D=\{u,v\}$ be any minimal dominating set of G and $d(u,v)=1$then $\chi_d(\mu(G))=\chi_d(G)+1$.

*Proof:*Let G be a graph of order n. Given $\gamma(G)=2$. Let $D=\{v_1,v_2\}$ be the dominating set of G such that $d(v_1,v_2)=1$. That is $v_1 \sim v_2$ in G. Now partition the vertex set of G into two sets V_1 and V_2 such that, $V_1=\{x\in V(G): x\sim v_1\}$ and $V_2=\{x\in V(G): x\sim v_2\}$. Consider $\mu(G)$ and let $f(v_1)=f(v_1')=1$ and $f(v_1)=f(v_1')=2$ then all the vertices of V_1 dominate the color class of 1 and all the vertices of V_2 dominate the color class of 2. Now color the remaining v_i and v_i' in $\mu(G)$ by $\chi_d(G)-1$ colors and v_0 by the color $\chi_d(G)+1$. Then the vertices v_i' dominates color class $\chi_d(G)+1$. Hence $\chi_d(\mu(G))=\chi_d(G)+1$.

Converse need not be true.

Example 2.4.

Consider the path P_3, $\chi_d(P_3)=2$, $\chi(\mu(P_3))=3=\chi_d(P_3)+1$ but $\gamma(P_3)=1$.



Dominator coloring of P_3 and $\mu(P_3)$

3 DOMINATOR COLORING OF MYCIELSKIAN SOME SIMPLE GRAPHS

Theorem 3.1. For any path $P_n, \chi_d(\mu(P_n))=\begin{cases}\chi_d(P_n)+1 & 2\le n\le 4\\ \chi_d(P_n)+2 & otherwise\end{cases}$.

*Proof:*Consider the path $P_n, 2\le n\le 4$. Consider the n vertices v_i of P_n in $\mu(P_n)$ and color them by $\chi_d(P_n)$ colors. And define the coloring function for v_i' as, $f(v_i)=f(v_i')$ for $1\le i\le n$ and $f(v_0)=\chi_d(P_n)+1$. Hence $\chi_d(\mu(P_n))=\chi_d(P_n)+1$.

Consider the path $P_n, n\ge 5$.Consider the n vertices v_i of P_n in $\mu(P_n)$ and color them by $\chi_d(P_n)$ colors. And define the coloring function for v_i' as follows: If $f(v_i)=f(v_i')$ then no vertices will dominate any of the color classes. Hence $f(v_i')=\chi_d(P_n)+1$ for $1\le i\le n$ and $f(v_0)=\chi_d(P_n)+2$. Hence $\chi_d(\mu(P_n))=\chi_d(P_n)+2$.

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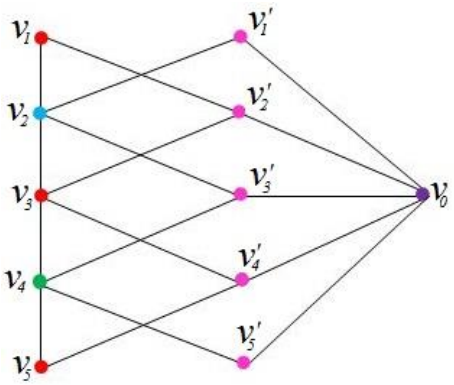

Dominator Coloring of $\mu(P_5)$.

Theorem 3.2. For any cycle C_n, $\chi_d(\mu(C_n)) = \begin{cases} \chi_d(C_n)+1 & 3 \le n \le 4 \\ \chi_d(C_n)+2 & otherwise \end{cases}$.

*Proof:*Consider thecycle $C_n, 3 \le n \le 4$.Consider the n vertices v_i of C_n in $\mu(C_n)$ and color them by $\chi_d(C_n)$ colors. And define the coloring function for v_i' as, $f(v_i) = f(v_i')$ for $1 \le i \le n$ and $f(v_0) = \chi_d(C_n)+1$. Hence $\chi_d(\mu(C_n)) = \chi_d(C_n)+1$.

Consider the path $C_n, n \ge 5$. Consider the n vertices v_i of C_n in $\mu(C_n)$ and color them by $\chi_d(C_n)$ colors. And define the coloring function for v_i' as follows: If $f(v_i) = f(v_i')$ then no vertices will dominate any of the color classes. Hence $f(v_i') = \chi_d(C_n)+1$ for $1 \le i \le n$ and $f(v_0) = \chi_d(C_n)+2$. Hence $\chi_d(\mu(C_n)) = \chi_d(C_n)+2$.

Theorem 3.3. For any complete graph K_n, $\chi_d(\mu(K_n)) = \chi_d(K_n)+1$.

*Proof:*Consider the graph K_n for $n \ge 1$. Clearly $\gamma(K_n) = 1$. Hence by theorem 2.3, $\chi_d(\mu(K_n)) = \chi_d(K_n)+1$.

Theorem 3.4. For any star graph $K_{1,n}$, $\chi_d(\mu(K_{1,n})) = \chi_d(K_{1,n})+1$.

*Proof:*Consider the graph $K_{1,n}$ for $n \ge 3$ Clearly $\gamma(K_{1,n}) = 1$. Hence by theorem 2.3, $\chi_d(\mu(K_{1,n})) = \chi_d(K_{1,n})+1$.

Theorem 3.4. For any wheel graph $W_{1,n}$, $\chi_d(\mu(W_{1,n})) = \chi_d(W_{1,n})+1$.

*Proof:*Consider the graph $W_{1,n}$ for $n \ge 3$ Clearly $\gamma(W_{1,n}) = 1$. Hence by theorem 2.3, $\chi_d(\mu(W_{1,n})) = \chi_d(W_{1,n})+1$.

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Theorem 3.4. For any complete bipartite graph $K_{m,n}$, $\chi_d(\mu(K_{m,n})) = \chi_d(K_{m,n}) + 1$.

*Proof:*Consider the graph $K_{m,n}$ for $n, m \geq 1$ and let X, Y be the bipartite sets. Clearly $\gamma(K_{m,n}) = 2$, choose $D = \{x, y\}$ where $x \in X$ and $y \in Y$. Then $x \sim y$. Hence by theorem 2.5, $\chi_d(\mu(K_{m,n})) = \chi_d(K_{m,n}) + 1$.

CONCLUSION

In this paper, we have seen the affect of domination number $\gamma(G)$ in coloring numbers $\chi(G)$ \$and $\chi_d(G)$. Also we discuss dominator coloring number of Mycielskian of common graphs such as $P_n C_n, K_n, K_{1,n}, W_{1,n}, K_{m,n}$. There are many interesting graphs to which this study can be extended.

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b- COLORING OF MIDDLE GRAPH OFCERTAIN SNAKE GRAPHS

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Abstract :A b- coloring of a graph is a coloring of the vertices where each color class contains a vertex that has a neighbor in all other color classes. The b-chromatic number of G is the greatest integer k such that G admits a b-coloring. In this paper b- coloring of certain snake graphs are studied. Some structural properties of them are discussed and their*b*- chromatic number were obtained .

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Keywords :b- chromatic number,b- coloring, Double triangular snake graph, Graph coloring, Middle graph and Triangular snake graph

Classification number: 05C15, 05C76

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1. Introduction

Let G be a finite, undirected graph with no loops and multiple edges. The graph G has the vertex set V (G) and the edge set E (G).Graph coloring is coloring of G such that no two adjacent vertices share the same color.

A b - coloring of a graph is a coloring of the vertices where each color class contains a vertex that has a neighbor in all other color classes.

The b-chromatic number of G is the largest b(G) positive integer that the graph has a b-coloring with φ(G) number of colors.

The middle graph of G denoted by M(G), is defined as follows :

The vertex set of M(G) is V(G)∪E(G) in which two elements are adjacent in M(G) if the following conditions hold.

(i) x,y∈E(G) and x, y are adjacent in G.
(ii) x∈V(G), y ∈ E(G) and y is incident on x in G.

A triangular snake graph has 2n+1 vertices and 3n edges, where n is the number of blocks in the triangular snake. It is denoted by T_n .

A double triangular snake graph is obtained from a path v_1, v_2, v_3,…….v_{n+1} by joining v_i and v_{i+1} to a new vertex w_i to another new vertex u_i .It has 3n+1 vertices and 5n edges.

2.Structural properties of middle graph of Triangular snake and Double Triangular snake graphs

- Number of vertices in$M(T_n)$, p= 5n+1
- Number of vertices in M[D(T_n)] ,p=8n+1
- Maximum degree in $M(T_n)$,Δ=6
- Maximum degree in $M[D(T_n)]$,Δ=7
- Minimum degree in M(T_n),δ=2
- Minimum degree in M[D(T_n)],δ = 3

3. b - coloring of M (T_n) and M [D(T_n)]

Theorem 3.1 : For the middle graph of triangular graph M(T_n), the b-chromatic number is 5

$$(i.e)\varphi_b[M(T_n)] = \Delta[M(T_n)] - 1 \ , n \geq 2$$

Proof:

Let T_n be the triangular snake graphwith 2n+1 vertices and 3n edges

Let {v_1,v_2……v_{n+1} ,u_1,u_2……u_n } be the vertices of the triangular snake graph T_n.

Now by definition of middle graph, each edge of graph is sub-divided by a new vertex.

Assume that each edge (v_i,v_{i+1}) and the line joiningv_i and v_{i+1} to a vertex u_i ,i=1,2,3,….n are sub-divided by the vertices w_i, e_{jj} and e_{jj+1},j=1,2,3,….n respectively.

Now the coloring assignment are as follows

Color the vertices $v_1,v_2\ldots\ldots\ldots v_{n+1}$,$u_1,u_2\ldots\ldots\ldots u_n$ with c_1.

Color alternatively the sub-divided vertices $e_{11},e_{12}\ldots\ldots e_{j,j+1}$ with $c_2$and c_3.

Color alternatively the sub-divided vertices $w_1,w_2\ldots\ldots w_n$ with $c_4$and c_5.

$c(v_i) = 1$ for $1 \leq i \leq n+1$,

$c(u_i) = 1$ for $1 \leq i \leq n$,

$c(w_i) = 4$ for $1 \leq i \leq n$, if i is odd and

$c(w_i) = 5$ for $1 \leq i \leq n$, if i is even

$c(e_{jj}) = 2$ for $1 \leq j \leq n$,

$c(e_{jj+1}) = 3$ for $1 \leq j \leq n$,

It follows that, $\varphi_b[M(T_n)] = \Delta[M(T_n)] = 5$

Hence the b-chromatic number of $M(T_n)$ *is* 5.

Figure 1: Triangular snake graph

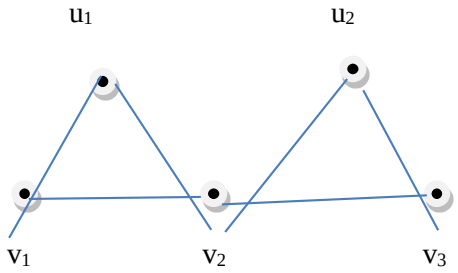

Figure 2: Middle graph of Triangular snake graph

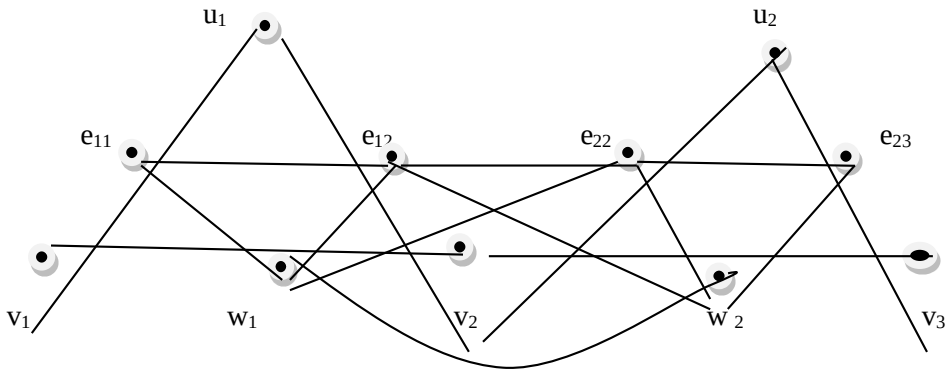

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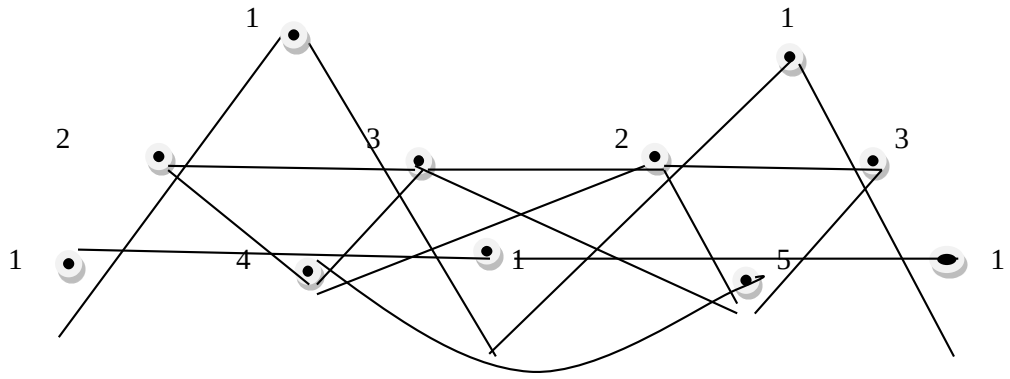
Figure 3: Middle graph of Triangular snake graph T_2



$\varphi_b[M(T_2)] = \Delta[M(T_2)] - 1 = 5$

Theorem 3.2 : If $n \geq 2$,then theb- chromatic number of middle graph of double triangular snake graph is 6. ($i.e$)$\varphi_b[M(D(T_n))] = \Delta[M(T_n)] - 1$, $n \geq 2$

Proof:

Let $D(T_n)$ be the double triangular snake graph with 3n+1 vertices and 5n edges

Let $\{v_1, v_2 \ldots\ldots\ldots v_{n+1}, u_1, u_2 \ldots\ldots\ldots u_n, w_1, w_2 \ldots\ldots w_n\}$ be the vertices of the double triangular snake graph $D(T_n)$

Assume that each edge (v_i, v_{i+1}) $(u_i, v_j)$and (v_j, w_i) ,i=1,2,3,….n and j=1,2,3…n+1 is sub-divided by the vertices x_i, $e_{ij}$and f_{ij} for ,i=1,2,3,….n and j=1,2,3…n+1 respectively.

Now the coloring assignment are as follows,

Color the vertices $v_1, v_2 \ldots\ldots\ldots v_{n+1}, u_1, u_2 \ldots\ldots\ldots u_n$ and $w_1, w_2 \ldots\ldots w_n$with c_1.

Color alternatively the sub-divided vertices $e_{11}, e_{12} \ldots\ldots e_{j,j+1}$ with $c_2$and c_3.

Color the vertices $f_{11}, f_{12} \ldots\ldots f_{j,j+1}$ with $c_3$and c_4

AtlastColor alternatively the sub-divided vertices $x_1, x_2 \ldots\ldots x_n$ with $c_5$and c_6.

$C(v_i) = 1$ for $1 \leq i \leq n+1$,

$c(u_i) = 1$ for $1 \leq i \leq n$,

$c(w_i) = 1$ for $1 \leq i \leq n$,

$c(x_i) = 5$,if i is odd and

$c(x_i) = 6$ if i is evenfor $1 \leq i \leq n$,

$c(e_{jj}) = 2$ for $1 \leq j \leq n$,

$c(e_{jj+1}) = 3$ for $1 \leq j \leq n$,

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$c(f_{jj}) = 3$ for $1 \leq j \leq n$,

$c(f_{j,j+1}) = 4$ for $1 \leq j \leq n$,

Hence the maximum number of colors in a b-coloring for $M[(D(T_n))]$ is 6

(i. e) $\varphi_b[M(T_n)] = \Delta[M(D(T_n))] - 1 = 6$

Figure 4: Double Triangular snake graph $D(T_2)$

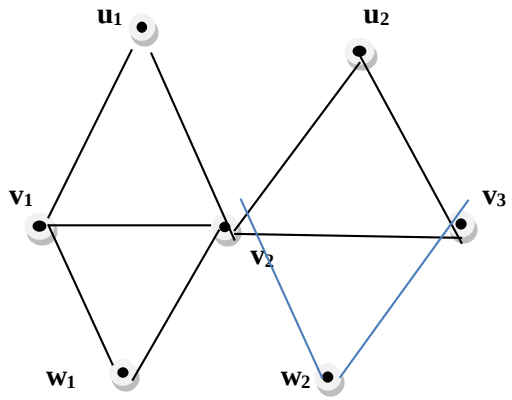


Figure 5: Middle graph of Double Triangular snake graph

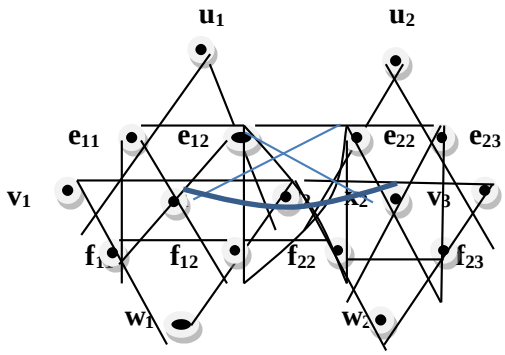
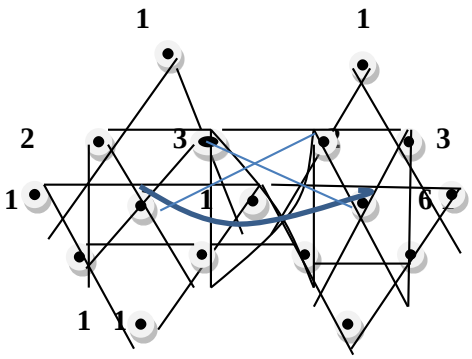


Figure6: Middle graph of Double Triangular snake graph $D(T_2)$



4. Conclusion

b -coloring play an important role in clustering ,automatic reading system and distributed system. We have investigated b-chromatic number of middle graph of triangular snake graph and double triangular snake graph .The investigation of similar results for different graphs as well in the context of various graph coloring problems is an open area of research.

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b-Colouringof Flower Graph and Line Graph of Flower Graph

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Abstract:

The b-chromatic number $\varphi(G)$, parameter of a graph G is the maximum number of colours for which G has a proper colouring such that every colour class contain a vertex adjacent to every other colour. In this paper, we examine the b-chromatic number of Line graphof Flower graph.

Keywords:b-chromatic number, b-colouring ,Flower graph, Line graph, Proper colouring

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1 Introduction:

In this paper, we consider a simple, finite, connected and undirected graph with vertex set $V(G)$ and edgeset $E(G)$. The b-chromatic number [2], parameter of a graph G is the maximum number of colors for which G has a proper coloring such that every color class contain a vertex adjacent to every other color. The concept of b-coloring was introduced by Irving and Manlove [3] in 1999 and showed that the problem of determining b-chromatic number is NP-hard for general graphs but it is polynomial for trees. The upper bounds for the b-chromatic number were investigated in the work of Kouider M and Maheo M [5]. The b-chromatic number for Perterson graph and power of a cycle was discussed by Chandrakumar and Nicholous[8]. Balakrishanan R [11] and Francis Raj ,Kavaskar T were find out the b-chromatic number of Cartesian product of some families of graph. Vaidya S K and Shukla M S [10] were find the b-chromatic number of some wheel graphs. In this paper we examine the the b-chromatic number of line graphof Flower graph.

2 Preliminaries

2.1 Line Graph

The line graph $L(G)$ [10] of a graph G is the graph whose vertex set is $E(G)$ and two vertices are adjacent in $L(G)$ whenever they are incident in G.

2.2 Flower Graph

A Flower graph [10] F_n is the graph from a helm graph by joining each pendent vertex to the central vertex of the helm.

2.3Proposition [3]

If G admits a b-coloring with m colors, G must have at least m vertices with degree at least $m-1$. It is obvious that $\chi(G) \le \varphi(G) \le \Delta(G)+1$, where $\Delta(G)$ is the maximum degree of G.

2.4Proposition[3]

If the graph G contains K_n as a sub graph, $\chi(G) \ge n$.

3 Main Results

3.1Theorem

For the Flower graph F_n, $\varphi(F_n) = \begin{cases} 4, n = 3 \\ 5, n = 4 \\ 4, n = 5 \\ 5, n > 5 \end{cases}$.

Proof:

For $n = 3$, the vertex set of flower graph be $V(F_3) = \{u_1, u_2, ..., u_7\}$. The cardinality of vertices $|V(F_3)| = 7$, and out of these seven vertices, three vertices having degree 4 and apex vertex has

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degree 6. Assign the colours $f(u_1)=1, f(u_2)=2, f(u_3)=3$ and $f(u_4)=4$ in clockwise direction. Furthermore no new colours can be introduced in the graph. Therefore it results in a proper b-colouring. Hence $\varphi(F_3)=4.$ For $n=4$, the vertex set of flower graph be $V(F_4)=\{u_1,u_2,...,u_9\}$. The cardinality of vertices in $|V(F_4)|=9$, and out of these nine vertices, four vertices having degree 4 and apex vertex has degree 8. Assign the colours $f(u_1)=1, f(u_2)=2, f(u_3)=3, f(u_4)=4, f(u_5)=5$ in clockwise direction. Furthermore no new colours can be introduced in the graph. Therefore it results in a proper b-colouring. Hence $\varphi(F_4)=5.$ For $n=5$, the vertex set of flower graph be $V(F_5)=\{u_1,u_2,...,u_{11}\}$. The cardinality of vertices in $|V(F_5)|=11$, and out of these eleven vertices, five vertices are of the degree 4 and apex vertex has degree 10. Assign the colours $f(u_1)=1, f(u_2)=2, f(u_3)=3, f(u_4)=4, f(u_5)=5$ in clockwise direction. The vertex u_6 is adjacent with u_2 and $u_5.$ If we assign a colour 5 or 2 to the vertex u_6, vertex u_6 cannot receives the colour 5 or 2. Hence $\varphi(F_4)=4.$ For $n=6$, the vertex set of flower graph be $V(F_6)=\{u_1,u_2,...,u_{13}\}$. the cardinality of vertices in $|V(F_6)|=13$, out of these 13 vertices, six vertices having degree 4 and apex vertex has degree 12. Assign the colours $f(u_1)=1, f(u_2)=2, f(u_3)=3, f(u_4)=4, f(u_5)=5$ in clockwise direction. Furthermore no new colours can be introduced in the graph. Therefore it results in a proper b-colouring. Hence $\varphi(F_n)=5, n\geq 6.$

3.2 Theorem

If $L(F_n)$ be the Line graph of flower graph F_n ,then $\varphi[L(F_n)]=2n, n>3.$

Proof:

The Flower graph F_n , is the graph obtained from the helm H_n , by joining each pendent vertex to the apex of the helm, and n be the number of vertices in the outer cycle of helm. Consider the line graph of flower graph $L(F_n)$, and the vertex set of $L(F_n)$ can be partitioned in to the complete graph with $2n$ vertices denoted by $\{u_1,u_2,u_3,...,u_{2n}\}$, the outer cycle with n vertices denoted by $\{v_1,v_2,v_3,....v_n\}$ andthe vertices introduced in the pendent edges of helm denoted by $\{w_1,w_2,w_3,...,w_n\}$. The vertex v_1 is adjacent with v_2, v_n and w_1, w_n ,and also share a common vertex in the complete graph. The vertex v_n is adjacent with v_1, v_{n-1} and w_n, w_{n-1} , and also share a common vertex in the complete graph. Vertex v_i is adjacent with v_{i-1}, v_{i+1} and w_i, w_{i-1} , for $i=2,3,4,...,n-1$, andalso share a common vertex with the complete graph. Assign the colours $\{1,2,3,...,2n\}$ inclockwise direction to the complete graph as follows $f(u_1)=1, f(u_2)=2, f(u_3)=3,..., f(u_{2n})=2n$. Next, If we introduce a new colour $2n+1$ to any one of the vertices u_i and w_i for $i=1,2,3,4,...,n$, these vertices cannot harmonises the colour $2n+1$. Since $m(v_i)=6$ and $m(w_i)=4$ for $i=1,2,3,4,...,n.$ Hence the b-chromatic number line graph of flower graph is $2n, n>3.$

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3.3 Corollary

For the Flower graph F_3, $\varphi[L(F_3)] = 7$.

Proof:

For $n = 3$, the vertex set of flower graph be $V[L(F_3)] = \{u_1, u_2, ..., u_{12}\}$ .The cardinality of vertices in $|V[L(F_3)]| = 12$ and assign the colours $\{1,2,3,...,6\}$ in clockwise direction to the complete graph as follows $f(u_1) = 1$, $f(u_2) = 2$, $f(u_3) = 3$,..., $f(u_6) = 6$. Next we assign a colour 7 to any one of the vertices in the outer cycle $\{v_1, v_2, v_3\}$. The maximum degree of any vertex in the outer cycle is 6. So it receives the new colour 7 and it is a b-colouring. Hence $\varphi[L(F_3)] = 7$.

4. Conclusion

In this paper we find the b-chromatic number of flower graph and its line graph.

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Computation of F index using python program for Bridge molecular Graphs

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Abstract:

In this paper, we investigate F-Index for Bridge molecular graphs using Python Program.

Keywords:

Bridge graph, Topological index

Mathematical Subject Classification(2010) ***:05C12.***

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Introduction

Chemical graph theory is a branch of Mathematical Chemistry in which different tools from graph theory are used to model Chemical phenomena mathematically. Molecules and molecular compounds are modelled as molecular graphs, in which the vertices correspond to the atoms and the edges correspond to the chemical bonds between the atoms. A topological index is a numeric value that is graph invariant and correlates the physico-chemical properties of a molecular graph. Topological indices are used for studying quantitative structure-activity relationships (QSAR) and quantitative structure property relationships (QSPR) for predicting different properties of chemical compounds and their biological activities. In chemistry, biochemistry and nanotechnology, different topological indices are found to be useful in isomer discrimination, QSAR, QSPR and pharmaceutical drug design. There are several studies regarding different topological indices of special molecular graphs, a few of which we mention [3-10].

We present the F-topological index of several widely used chemical structures which often appear in drug molecular graphs[5], molecule and communication background of neurons and nervous system.

Python is easy to use and interpret comparing with others. Python is strongly but dynamically typed. This makes Python very easy to write and not too bad to read, running time of the programme is few seconds with respect to both vertices and edges. In this paper, we use Python program to compute the F- index of a bridge molecular graph with respect to vertices**.** Interested readers can visit https://repl.it/@Manimekalai/K-to-D for more details.

Definition:

1.1 F- Index[12]:

The F index is given by $F(G) = \sum_{v \in V(G)} d_G(v)^3$ or $F(G) = \sum_{vu \in E(G)} [d_G(u)^2 + d_G(v)^2]$

where $d_G(v)$ is the degree of vertex v in G.

1.2 Bridge Molecular Graph[25] :

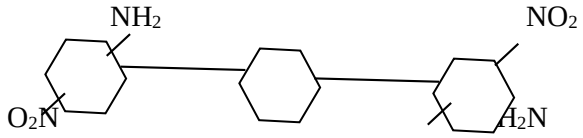
Let $\{G_i\}_{i=1}^{d}$ be a set of finite molecular graphs with vertices $v_i \in V(G_i)$. The bridge molecular graph

$B(G_1, G_2 \ldots G_d, v_1, v_2, \ldots v_d)$ of $\{G_i\}_{i=1}^{d}$ with respect to the vertices $\{v_i\}_{i=1}^{d}$ is yielded from the molecular graphs $G_1, G_2 \ldots G_d$ in which the vertices v_i and v_{i+1} are connected by an edge for i=1,2...d-1.

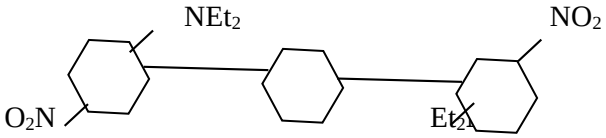
Let $\{G_i\}^d$ be a set of finite molecular graphs with vertices v_i.

1.3 Examples:

Molecular structure of PNA and PDNA, with possible π-delocalization of the two p-nitroaniline NLO subunits through the organic bridge.



PNA



PDNA

1.4 Theorem:

For the bridge molecular graph $G_d(C_n,v)$ the F - index is given by

$F(G_d(C_n,v))=[a+(n-2)\times 16]+[b+(n-3)\times 8](d-2)$

where $n \geq 3$, a=70 and b=80, d is number of copies of C_n.

Proof:

When n=3 and d=3 we get $F(G_2(C_3,v))=166$.

d=4 we get $F(G_3(C_3,v))=246$.

d=5 we get $F(G_4(C_3,v))=326$ and so on.

When n=4 and d=3 we get $F(G_2(C_4,v))=190$.

d=4 we get $F(G_3(C_4,v))=278$.

d=5 we get $F(G_4(C_4,v))=366$ and so on.

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When n=5 and d=3 we get $F(G_2(C_5,v))=214$.

d=4 we get $F(G_3(C_5,v))=310$.

d=5 we get $F(G_4(C_5,v))=406$ and so on.

When n=6 and d=3 we get $F(G_2(C_6,v))=238$.

d=4 we get $F(G_3(C_6,v))=342$.

d=5 we get $F(G_4(C_6,v))=446$ and so on.

Proceeding like this we will get F index for bridge molecular graph is

$F(G_d(C_n,v))=[a+(n-2)\times16]+[b+(n-3)\times8](d-2)$.

1.5 Program:

The following is the **Python** program to calculate F-index for bridge molecular graph $\mathbf{G_d(C_n,v)}$**:**

```
start = 70
increment = 80
k = int(input("Enter K value : "))
value = start + ((k-2) * 16 )
increment = increment + ((k-3) * 8)
n = int(input("Enter number of digits"))
for i in range(0,n):
  print(value,end=",")
  value = value + increment
```

In this program we have chosen for our convenience a= 70 and increment = 80 so we can get F index for bridge molecular graph with any number of cycles.

2.1 Bridge Molecular graph $G_d(C_n, v_1,v_2,....v_d)$[25]:

Let C_n be the cycle with n vertices. Then $G_d(C_n,v_1,v_2,....v_d)$ is a bridge molecular graph in which d copies of C_n are present in such a way that successive C_n 's are connected by an edge.

2.2 Table for F - Index of Bridge Molecular Graph $G_d(C_3,v)$

S.No	Number of $G_d(C_3,v)$	The F- Index	Number of $G_d(C_3,v)$	The F- Index
1	d=2	F(G)=86	d=7	F(G)=486
2	d=3	F(G)=166	d=8	F(G)=566
3	d=4	F (G)=246	d=9	F(G)=646
4	d=5	F(G)=326	d=10	F(G)=726
5	d=6	F(G)=406	d=11	F(G)=806

2.3 Table for F - Index of Bridge Molecular Graph $G_d(C_7,v)$

S.No	Number of $G_d(C_7,v)$	The F- Index	Number of $G_d(C_7,v)$	The F- Index
1	d=2	F(G)=150	d=7	F(G)=710
2	d=3	F(G)=262	d=8	F(G)=822
3	d=4	F (G)=374	d=9	F(G)=934
4	d=5	F(G)=486	d=10	F(G)=1046
5	d=6	F(G)=598	d=11	F(G)=1158

2.4 Table for F - Index of Bridge Molecular Graph $G_d(C_9,v)$

S.No	Number of $G_d(C_9,v)$	The F- Index	Number of $G_d(C_9,v)$	The F- Index
1	d=2	F(G)=182	d=7	F(G)=822
2	d=3	F(G)=310	d=8	F(G)=950
3	d=4	F (G)=438	d=9	F(G)=1078
4	d=5	F(G)=566	d=10	F(G)=1206
5	d=6	F(G)=694	d=11	F(G)=1334

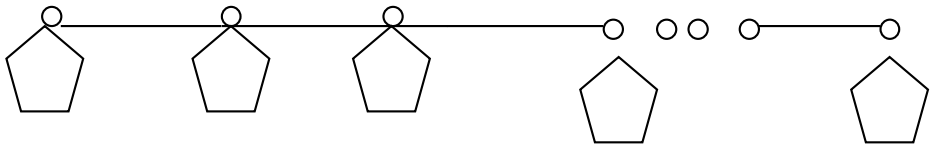

Figure : Bridge Molecular Graph $G_d(C_5,v_1,v_2,...v_d)$

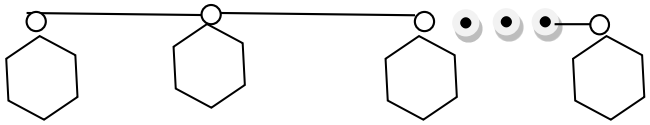

Figure : Bridge Molecular Graph $G_d(C_6,v_1,v_2,...v_d)$

Conclusion

The F –index could be established to the bridge molecular graph for cyclic graphs with three vertices connected by a path, cyclic graph with four vertices and cyclic graph with any number of vertices connected by a path.

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On $\mathcal{J}$-Chromatic Core Subgraph Of Cartesian Product Of Graphs

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Abstract

If distinct colours represent distinct technology types that are placed at the vertices of a simple graph in accordance to a minimum proper colouring, a disaster recovery strategy could rely on an answer to the question:"What is the maximum destruction, if any, the graph (a network) can undergo whilst ensuring that at least one of each technology type remain, in accordance to a minimum proper colouring of the remaining induced subgraph." In this paper we introduce the notion of a chromatic core sub graph H of a given simple graph G in answer to the stated problem. Since for any subgraph H of G it holds that, $\chi(H) \leq \chi(G)$ the problem is well defined.

Keywords: $\mathcal{J}$-chromatic colouring, $\mathcal{J}$-chromatic core subgraph,structural size, structure index,Cartesian product

AMS Classification Numbers: 05C15, 05C38, 05C75, 05C85

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1 Introduction

For general notation and concepts in graphs and digraphs see [1,3, 8]. We will write that a graph G has order ν(G) = n ≥ 1 and size ε(G) = p ≥ 0 with minimum and maximum degree δ(G) and Δ(G), respectively. The degree of a vertex v ∈ V (G) is denoted dG(v) or when the context is clear, simply as d(v). Also, as a collective hence, without distinction, the vertices and the edges of a graph are called the elements of a graph. Unless mentioned otherwise all graphs G are finite, undirectedsimple graphs.

We recall that if C = {c_1,c_2,c_3,...,c_n} and ` sufficiently large, is a set of distinct colours, a proper vertex colouring of a graph G denoted φ : V (G) →C is a vertex colouring such that no two distinct adjacent vertices have the same colour. The cardinality of a minimum set of colours which allows a proper vertex colouring of G is called the chromatic number of G and is denoted χ(G). When a vertex colouring is considered with colours of minimum subscripts the colouring is called a minimum parameter colouring. Unless stated otherwise we consider minimum parameter colour sets throughout this paper.

2. Chromatic Core Subgraph

We introduce the notion of a chromatic core subgraph H of a given simple graph G in answer to the stated problem.For a graph G its structural size is measured by its structor index denoted and defined as, si(G) = ν(G) + ε(G). We say that the smaller of graphs G and H is the graph satisfying the condition, min{si(G),si(H)}. If si(G) = si(H) the graphs are of equal structural size but not necessarily isomorphic. A straight forward example is the path, P_4 and the star graph, S_3.

Definition 1.1. A $\mathcal{J}$ **-coloring** of a graph G is a maximal proper coloring such that each vertex in G yields a rainbow neighborhood. Equally important is that not all graphs permit a rainbow neighborhood. See [5].

Definition 1.2. For a finite, undirected simple graph G of order $(G) = n \geq 1$ a chromatic core subgraph H is a smallest induced subgraph H (smallest in respect of si(H)) such that, $\chi(H) = \chi(G)$ See [4].

2 $\mathcal{J}$ -Chromatic core Sub graph of Cartesian product of Graphs

The subsection begins with the results of Cartesian product of graphs G□H. For the Cartesian product the vertex set will be $V(G) \times V(H)$). Let $V(G) = \{u_i : 1 \leq i \leq m\}$ and $V(H) = \{v_j : 1 \leq j \leq m\}$. Recall that the Cartesian product of vertices (u_i, v_j) and (u_m, v_n) are adjacent (adj) if and only if, $u_i = u_m$and$v_j \; adj \; v_n$ or $v_j = v_n$and$u_i \; adj \; u_m$.

Theorem 2.1: Let the graph*G* and *H* beany pairwise combination of path or even cycle or K_1 then the$\mathcal{J}$ -CCS G□H is K_2 .

Proof: Let*G* and *H* be anypairwise combination of path or an even cycle. Let $V(G) = (u_1, u_2, u_3, \cdots, u_m)$ and $V(H) = (v_1, v_2, v_3, \cdots, v_n)$. Now V(G□H) $= V(G) \times V(H)$. Then draw an edge between (u_i, v_j) and (u_m, v_n) if the following condition holds, (i.e) if $u_i = u_m$and$v_j \; adj \; v_n$ or $v_j = v_n$and$u_i \; adj \; u_m$. The Cartesian graph G□Hadmits Johan colouring and its $\mathcal{J}$ - number is 2. Also there exist a subgraph K_2 with $\mathcal{J}$ -number as 2. Hence, the $\mathcal{J}$ -CCS is K_2

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Theorem 2.2: Let K_m and K_n be a complete graph, then the $\mathcal{J}$-CCS of $K_m \square K_n$ is given by J-CCS ($K_m \square K_n$) = $\begin{cases} K_m & \text{if } n \leq m-1 \\ K_n & \text{if } n > m-1 \end{cases}$

Proof: Let K_m and K_n be both complete graph with m and n vertices respectively.

Case (i) $\boldsymbol{n \leq m-1}$ Let $V(K_m) = (u_1, u_2, u_3, \cdots u_m)$ and $V(K_n) = (v_1, v_2, v_3, \cdots v_n)$, Now $V(K_m \square K_n) = V(K_m) \times V(K_n)$, then draw an edge between (u_i, v_j) and (u_m, v_n) if the following condition holds,(i.e) if $u_i = u_m$ and $v_j adj v_n$ or $v_j = v_n$ and $u_i adj u_m$ .The Cartesian graph $K_m \square K_n$ admits Johan colouring and its $\mathcal{J}$- number is *m*. Also, there exist a subgraph K_m with J-number as m. Hence, the $\mathcal{J}$ -CCS of $K_m \square K_n$ is K_m , The Chromatic core sub graph of $K_m \square K_n$ is K_m, for any complete graph of $n \leq m-1$.

Case (ii) $n > m-1$ then the proof is similar, but here the $\mathcal{J}$ -number is n. Also, there exist a subgraph K_n with $\mathcal{J}$-number as n. Hence, the $\mathcal{J}$ -CCS of $K_m \square K_n$ is K_n.

Theorem 2.3: Let C_m and C_3 be the cycle graphs, then the $\mathcal{J}$ -CCS of $C_m \square C_3$ is K_3.

Proof: Let C_m and C_3 be cycle graphs. Let, $V(C_m) = (u_1, u_2, u_3, \cdots u_m)$ and $V(C_3) = (v_1, v_2, v_3)$ Now, $V(C_m \square C_3) = V(C_m) \times V(C_3)$, then draw an edge between (u_i, v_j) and (u_m, v_3) if the following condition holds,(i.e) if $u_i = u_m$ and $v_j adj v_3$ or $v_j = v_3$ and $u_i adj u_m$ .The Cartesian graph $K_m \square K_n$ admits Johan colouring and its $\mathcal{J}$- number is 3. Also, there exist a subgraph K_3 with $\mathcal{J}$ -number as 3. Hence, the $\mathcal{J}$ -CCS of $C_m \square C_3$ is K_3.

Theorem 2.4: Let, the graph *G* be any pairwise combination of path P_m or even cycle C_m or complete graph $K_n : n > 1$ then, the $\mathcal{J}$ -CCS of $G \square K_n$ is K_n.

Proof: Let *G* be any pairwise combination of path or even cycle graph or complete graph $K_n : n > 1$ and Let $V(G) = (u_1, u_2, u_3, \cdots, u_m)$ and $V(K_n) = (v_1, v_2, v_3, \cdots v_n)$, Now, $V(G \square K_n) = V(G) \times V(K_n)$, Now draw an edge between (u_i, v_j) and (u_m, v_n) if the following condition holds,(i.e) if $u_i = u_m$ and $v_j adj v_n$ or $v_j = v_n$ and $u_i adj u_m$ .The Cartesian graph $G \square K_n$ admits Johan colouring and its $\mathcal{J}$- number is *n*. Also, there exist a subgraph K_n with $\mathcal{J}$ -number as n. Hence, the $\mathcal{J}$ -CCS of $G \square K_n$ is K_n.

Remark 2.6: Let *G* be a any pairwise combination of P_m or even cycle C_m then for $n > 1$ the $\mathcal{J}$ -CCS of $K_n \square G$ is K_n..

Conclusion

The paper introduced the notion of achromatic core sub graph of Cartesian product of some simple graph in respect of Johan colouring. The field of research can be developed by generalizing the notion to edge colouring and other colorings such as local colouring, dynamic colouring, co-colouring, Grundy colouring, harmonious colouring, complete colouring, exact colouring, star colouring and etc., offers a wide scope**.**

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COMPUTATION OF TOPOLOGICAL INDICES OF LINE GRAPH OF DUTCH WINDMILL GRAPH D_3^m

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Abstract: In this paper,we compute ABC index ,ABC_4 index, Sum connectivity index,Randic connectivity index, GA index and GA_5 index of line graph of Dutch windmill graph D_3^m.

Keywords: ABC index, ABC_4 index, GA index and GA_5 index, Line graph,Randic connectivity index, Sum connectivity index.

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1. *Introduction*:

All graphs considered here are finite, connected, loopless and without multiple edges. Let G=(V,E) be a graph with n vertices and m edges. Here d_u represents the degree of a vertex u∈V(G) and uv represents the edge connecting by the vertices u and v.Thedutchwind-mill graph D_3^m is also called friendship graph which is a graph obtained by taking m copies of the cycle C_3 with avertex in common whereas [4] explains more about dutchwind-mill graph .L(G) denotes the line graph[3] of G,i.e., the vertices of L(G) are the edges of G and two vertices of L(G) are adjacent if the corresponding edges of G are adjacent. The work in computation of topological indices of dutchwind-mill graph and windmill graphs are reported in [2,4]. A topological index also known as a connectivity index is a type of a molecular descriptor that is calculated based on the molecular graph.Topological indices are numerical parameter of a graph which characterize its topology and are usually graph invariant. Further results about some topological indices are explained in [6,7,8].Using these findings we have proved the following results.

Definition 1.1. Let G=(V,E) be a molecular graph and d_u is the degree of the vertex u,then ABC index of G is defined as, ABC(G)=$\sum_{uv\in E(G)}\sqrt{\frac{d_u+d_v-2}{d_u d_v}}$.

Definition 1.2. Let G be a graph then its fourth ABC index is defined as $ABC_4(G) = \sum_{uv\in E(G)}\sqrt{\frac{s_u+s_v-2}{s_u s_v}}$ where s_u is the sum of the degrees of all neighbours of vertex u in G. i.e.,$s_u=\sum_{uv\in E(G)} d_v$,similarly for s_v.

Definition 1.3. For the graph G ,Randic index is defined as $\chi(G) = \sum_{uv\in E(G)}\frac{1}{\sqrt{d_u d_v}}$. It gives a quantitative assessment of branching of molecules.

Definition 1.4. For a simple connected graph G,its sum connectivity index S(G) is defined as $S(G) = \sum_{uv\in E(G)}\frac{1}{\sqrt{d_u+d_v}}$.This index belongs to a family of Randic like Indices and it was introduced by Zhou and Trinajstic.

Definition 1.5. Let G be a graph and e= uv be an edge of G then Geometric Arithmetic index is defined as GA(G) = $\sum_{uv\in E(G)}\frac{2\sqrt{d_u d_v}}{d_u d_v}$ and it was introduced by D.Vukicevic.

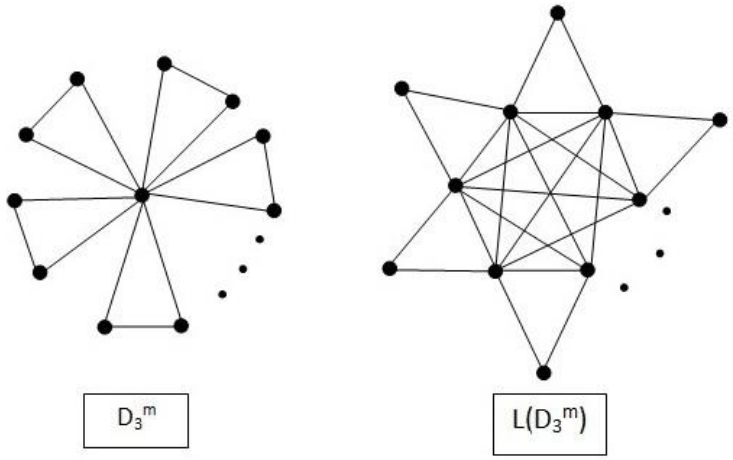
Definition 1.6. For a Graph G the Fifth Geometric arithmetic index is defined as $GA_5(G) = \sum_{uv\in E(G)}\frac{2\sqrt{s_u s_v}}{s_u+s_v}$ where S_u is the sum of the degrees of all neighbors of the vertex u in G.

2.Structural properties of $L(D_3^m)$

The Line graph of D_3^m, $L(D_3^m)$ has

(i) The number of vertices = 3m
(ii) The number of edges = m(2m+1)
(iii) m number of vertices of degree 2
(iv) 2m number of vertices of degree 2m.

The following are the figures of Dutch-windmill graph and line graph of Dutch-windmill graph



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3.Some topological indices of line graph of D_3^m

Theorem:3.1. The atom bond connectivity index of line graph of dutch windmill graph is ABC ($L(D_3^m)$)=$\sqrt{2}[m+\frac{1}{2}(2m-1)^{\frac{3}{2}}]$.

Proof: We partition the edges of $L(D_3^m)$ into edges of the type $E(d_u,d_v)$.The number of edges of the type E(2,2m) is 2m and E(2m,2m) is m(2m-1).

Now ABC(G)=$\sum_{uv\in E(G)}\sqrt{\frac{d_u+d_v-2}{d_u d_v}}$.

i.e.,ABC($L(D_3^m)$)=$|E_{2,2m}|\sum_{uv\in E(2,2m)}\sqrt{\frac{d_u+d_v-2}{d_u d_v}}+|E_{2m,2m}|\sum_{uv\in E(2m,2m)}\sqrt{\frac{d_u+d_v-2}{d_u d_v}}$

=2m $\sqrt{\frac{2+2m-2}{2(2m)}}$ +m(2m-1) $\sqrt{\frac{2m+2m-2}{2m(2m)}}$

∴ABC($L(D_3^m)$) =$\sqrt{2}[m+\frac{1}{2}(2m-1)^{\frac{3}{2}}]$.

Theorem 3.2. The Randic index of line graph of dutch windmill graph is $\chi(L(D_3^m))=\frac{2m+2\sqrt{m}-1}{2}$.

Proof: We know that $\chi(G)=\sum_{uv\in E(G)}\frac{1}{\sqrt{d_u d_v}}$

i.e., $\chi(L(D_3^m))=|E_{2,2m}|\sum_{uv\in E(2,2m)}\sqrt{\frac{1}{2(2m)}}+|E_{2m,2m}|\sum_{uv\in E(2m,2m)}\sqrt{\frac{1}{2m(2m)}}$

$=\frac{2m}{\sqrt{2(2m)}}+\frac{m(2m-1)}{\sqrt{2m(2m)}}=\frac{2m+2\sqrt{m}-1}{2}$.

Theorem:3.3. The Sum connectivity index of line graph of dutch windmill graph is

S($L(D_3^m)$)=$m\left[\sqrt{\frac{2}{1+m}}-\frac{1}{2\sqrt{m}}+\sqrt{m}\right]$.

Proof: We know that $S(G)=\sum_{uv\in E(G)}\frac{1}{\sqrt{d_u+d_v}}$

i.e., S($L(D_3^m)$)=$|E_{2,2m}|\sum_{uv\in E(2,2m)}\sqrt{\frac{1}{2+2m}}+|E_{2m,2m}|\sum_{uv\in E(2m,2m)}\sqrt{\frac{1}{2m+2m}}$

$=\frac{2m}{\sqrt{2+2m}}+\frac{m(2m-1)}{\sqrt{2m+2m}}=m\sqrt{\frac{2}{1+m}}+\frac{m(2m-1)}{2\sqrt{m}}$

∴S($L(D_3^m)$)=$m\left[\sqrt{\frac{2}{1+m}}-\frac{1}{2\sqrt{m}}+\sqrt{m}\right]$.

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Theorem:3.4. The Geometric arithmetic index of line graph of dutch windmill graph is

$GA(L(D_3^m))=2m+2\sqrt{m}-1$.

Proof: We know that $GA(G)=\sum_{uv\in E(G)}\frac{2\sqrt{d_u d_v}}{d_u d_v}$

i.e., $GA(L(D_3^m))=\left|E_{2,2m}\right|\sum_{uv\in E(2,2m)}\frac{2\sqrt{2(2m)}}{2(2m)}+\left|E_{2m,2m}\right|\sum_{uv\in E(2m,2m)}\frac{2\sqrt{2m(2m)}}{2m(2m)}$

$=2m.\frac{2\sqrt{2(2m)}}{2(2m)}+m(2m-1).\frac{2\sqrt{2m(2m)}}{2m(2m)}$

$\therefore GA(L(D_3^m))=2m+2\sqrt{m}-1$.

For finding the fourth atom bond connectivity index and fifth geometric arithmetic index for line graph of dutch windmill graph we take edge partition of $(L(D_3^m))$ into edges of the type$E^*_{s_u s_v}$ where uv is an edge and S_u is the sum of the degrees of all neighbours of vertex u in G. i.e.,$s_u=\sum_{uv\in E(G)}d_v$.similarly for S_v.The following is an edge partition based on degree sum of neighbours of end vertices of each edge of $(L(D_3^m)$.

$E^*_{(2+(2m-1)2m,2(2m))}=2m$; $E^*_{(2+(2m-1)2m,2+(2m-1)2m)}=m(2m-1)$.

Theorem:3.5.The fifth Geometric arithmetic index of line graph of dutch windmill graph is $GA_5(L(D_3^m))=m(2m-1)+4\sqrt{2}m^{\frac{3}{2}}\frac{\sqrt{2m^2-m+1}}{2m^2+m+1}$.

Proof: We know that $GA_5(G)=\sum_{uv\in E(G)}\frac{2\sqrt{s_u s_v}}{s_{u+}s_v}$

$GA_5(L(D_3^m))=\left|E^*_{(2+(2m-1)2m,2(2m))}\right|\sum_{uv\in E^*_{(2+(2m-1)2m,2(2m))}}\frac{2\sqrt{s_u s_v}}{s_{u+}s_v}+$
$\left|E^*_{(2+(2m-1)2m,2+(2m-1)2m)}\right|\sum_{uv\in E^*_{(2+(2m-1)2m,2+(2m-1)2m)}}\frac{2\sqrt{s_u s_v}}{s_{u+}s_v}$

$=2m\frac{2\sqrt{(2+(2m-1)2m)(2(2m))}}{2+(2m-1)2m+2(2m)}+m(2m-1)\frac{2\sqrt{(2+(2m-1)2m)(2+(2m-1)2m)}}{2+(2m-1)2m+2+(2m-1)2m}$

$=4m\frac{\sqrt{2m(2m^2-m+1)}}{2m^2+m+1}+m(2m-1)$

$\therefore GA_5(L(D_3^m))=m(2m-1)+4\sqrt{2}m^{\frac{3}{2}}\frac{\sqrt{2m^2-m+1}}{2m^2+m+1}$.

Theorem:3.6. The fourth atom bond connectivity index of Line graph of dutch windmill graph is $ABC_4\left(L(D_3^m)\right)=\frac{m}{2m^2-m+1}\left[\sqrt{4m^3+m+1}+\left(m-\frac{1}{2}\right)\sqrt{2(4m^2-2m+1)}\right]$.

Proof: We know that $ABC_5(G) = \sum_{uv\in E(G)} \sqrt{\frac{s_u+s_v-2}{s_u s_v}}$

$ABC_5(L(D_3^m))=\left|E^*_{(2+(2m-1)2m,2(2m))}\right| \sum_{uv\in E^*_{(2+(2m-1)2m,2(2m))}} \sqrt{\frac{s_u+s_v-2}{s_u s_v}}+$

$\left|E^*_{(2+(2m-1)2m,2+(2m-1)2m)}\right| \sum_{uv\in E^*_{(2+(2m-1)2m,2+(2m-1)2m)}} \sqrt{\frac{s_u+s_v-2}{s_u s_v}}$

$$=2m\sqrt{\frac{(2+(2m-1)2m)+(2(2m))-2}{(2+(2m-1)2m)(2(2m))}} + m(2m-1)\sqrt{\frac{(2+(2m-1)2m)+(2+(2m-1)2m)-2}{(2+(2m-1)2m)(2+(2m-1)2m)}}$$

$$=m\sqrt{\frac{4m^2+2m}{4m^3-2m^2+2m}} + \frac{m(2m-1)}{4m^2-2m+2}\sqrt{8m^2-4m+2}$$

$$\therefore\ ABC_4\left(L(D_3^m)\right) = \frac{m}{2m^2-m+1}\left[\sqrt{4m^3+m+1}+\left(m-\frac{1}{2}\right)\sqrt{2(4m^2-2m+1)}\right].$$

Conclusion:

We found the analytic formula for ABC index,ABC_4 index, Sum connectivity index, Randic connectivity index, GA index and GA_5 index for line graph of dutch windmill graph.

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Johan Colouring for Parallel and Series Composition Graphs, Rooted and Zig-Zag Product Graphs

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Abstract: In this paper, a new type of colouring called J-colouring is introduced. We discuss johan colouring for path, cycle, complete graph, fan graph, friendship graph, graph power and their complement graphs and dual of tree, cycle, friendship graph and their complement graph and johan colouring for rooted product, series and parallel composition, zig-zag product on some simple graphs.

Key words: Cycle, Fan graph, Friendship graph, Johan Colouring, Rooted product, Series and Parallel composition,andZig-Zag product.

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1. Introduction: For general notations and concepts, we refer to [1].For definitions of colouring we refer [4][5 . Unless specified, all graphs mentioned in this paper are simple, connected graphs.A colouring of a graph is an assignment of colors to its vertices so that no two adjacent vertices have the same colour. The chromatic number χ (G) of a graph G is the minimum number of distinct colours that allow a proper colouring of G. Such a colouring is called chromatic colouring. In this paper, we study the graphs admitting chromatic colourings subject to certain conditions.

2. Some basic definitions:

2.1: Rainbow neighbourhood: [5] A rainbow neighbourhood of a graph G, which admits a chromatic colouring, is the closed neighbourhood N[v] of a vertex v ϵ V(G) which contains atleast one coloured vertex of each colour in the chromatic colouring of G. The number of vertices in G yielding rainbow neighbourhood is called the rainbow neighbourhood number of the graph G, denoted by $\gamma_{\chi(G)}$.

2.2: Johan Colouring: [4] A proper k- colouring of a graph G is called the Johan Colouring or the J-colouring of G if C is the maximal colouring such that every vertex of G belongs to a rainbow neighbourhood of G.

2.3: Fan Graph: [8] A fan graph $F_{m,n}$ is defined as the graph join $K\overline{\ }_m+P_n$, where $K\overline{\ }_m$ is the empty graph on m nodes and P_n is the path graph on n nodes.

2.4: Friendship Graph: [7] The friendship graph F_n is a planar undirected graph with 2n+1 vertices and 3n edges. The friendship graph F_n can be constructed by joining n copies of the cycle graph C_3 with a common vertex.

2.5: Parallel Composition: [2] The parallel composition $P_c = P_c(X,Y)$ of two TTGs X and Y is a TTG created from the disjoint union of graphs X and Y by merging the sources of X and Y to create the source of P_c and merging the sinks of X and Y to create the sink of P_c.

2.6: Series Composition: [2] The series composition $S_c = S_c(X,Y)$ of two TTGs X and Y is a TTG created from the disjoint union of graphs X and Y by merging the sink of X with the source of Y. The source of X becomes the source of S_c and the sink of Y becomes the sink of S_c.

2.7: Rooted Product: [3]Let H be a labelled graph on n vertices. Let G be a sequence of n rooted graphs $G_1, G_2, \ldots G_n$. Then by H(G) we denote the graph obtained by identifying the root of G_i with the i^{th} vertex of H. We call H(G) the rooted product of H by G.

2.8: Zig-Zag Product: [6] The Zig-Zag product of regular graphs G,H denoted by GoH, takes a large graph (G) and small graph (H), and produces a graph that approximately inherits the size of the large one but the degree of the small one. An important property of the Zig-Zag product is that if H is a good expander, then the expansion of the resulting graph is only slightly worse than the expansion of G.

3. Johan Colouring for some simple graphs and their Complement graphs

Remark 3.1: Path$P_n$is Johan Colourable and $P\square_n$ be the complement of path P_n , $n \geq 3$. Then $P\square_n$ is johan colourable when n is even, and not johan colourable when n is odd.

Remark 3.2: Let C_n be the Cycle graph with $n \geq 4$ vertices. The graphs C_n and $C\square_n$ are Johan colourable when n is even, and they are not Johan colourable when n is odd.

Remark3.3: Complete graph K_m is Johan colourable andthe complement graph of K_m has isolated vertices in which we can not discuss johan colouring.

Remark3.4: Fan Graph is Johan colourable and Complement Graph of Fan graph is not Johan colourable.

Theorem 3.5: Friendship graph F_n is Johan colourable and $F\square_n$ is not Johan colourable, for $n \geq 2$.

Proof: The friendship graph F_n is a planar undirected graph with 2n+1 vertices and 3n edges. The friendship graph F_n can be constructed by joining n copies of the cycle graph C_3 with a common vertex. Since, common vertex is adjacent to the remaining vertices, we assign propercolours to F_n. We conclude $\chi(F_n) = 3$. Exactly one vertex in $F\square_n$, that is the common vertex in F_n is not adjacent to the remaining vertices. Therefore, $F\square_n$ is disconnected. Isolated vertex do not satisfy the rainbow neighbourhood, hence $F\square_n$ is not johan colourable.

Result 3.6: Let T_n* be the dual of tree T_n, then T_n* is not Johan Colourable and the Complement graph of T_n* has isolated vertex in which we can not discuss Johan Colouring.

Result 3.7: Let C_n* bethe dual of cycle C_n, then C_n* is Johan Colourable and the complement graph of C_n* has isolated vertices in which we can not discuss Johan Colourable.

4. Johan Colouring for Rooted, Zig-Zag product and Series and Parallel composition Graphs

Theorem 4.1: Let C_n be the cycle graph, with n even and T_m be the tree graph. Then Rooted product $G = C_n \odot T_m$ is Johan Colourable.

Proof: We know that graph C_n is johan colourable when n is even and graph T_m is johan colourable. We can construct rooted product of C_n and T_m , therefore the graph G is a graph with (nm) vertices and (nm) edges, We assign proper colours to the vertices of G. We conclude that the chromatic number of G is two. $\chi(G)=2$. Every vertex in G belongs to a rainbow neighbourhood, hence graph G is johan colourable.

Remark 4.2: Let C_n be the cycle graph, with n odd and T_m be the tree graph. Then Rooted product $G = C_n \odot T_m$ is not Johan Colourable.

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Theorem 4.3: Let F_n be the friendship graph and T_m be the tree graph. Then Rooted product $G = F_n \odot T_m$ is not Johan Colourable.

Proof: We know that graph F_n is johan colourable and graph T_m is johan colourable. We can construct rooted product G of F_n and T_m , therefore the graph G has (2n+1)(m) vertices and (2nm+n+m-1) edges. $\chi(G)=3$. Every vertex in G does not belong to a rainbow neighbourhood, hence graph G is not johan colourable.

Theorem 4.4: Let G be a 2 regular graph and H be a P_2. Then Zig-Zag Product of Z = G ® H is Johan Colourable.

Proof: Let G be a 2 regular graph with n vertices and degree of each vertex is two, H be a P_2 graph with 2 vertices. We can construct Zig-Zag product. As a first stage, we replace every vertex of G by a copy of H. $\chi(Z) = 2$. Every vertex in Z belongs to a rainbow neighbourhood, hence graph Z is johan colourable.

Theorem 4.5: Let C_n be the cycle graph and T_m be the tree graph. Then Series Composition$S_c = S_c(C_n,T_m)$ is Johan Colourable when n is even, and not Johan Colourable when n is odd.

Proof: Case 1: Let n be even. We choose two different vertices s and t called source and sink in C_n and T_m. We can construct Series composition of C_n and T_m. The disjoint union of graphs C_n and T_m is obtained by merging the sink of C_n with the source of T_m. The source of C_n becomes the source of S_c and sink of T_m becomes the sink of Sc. Therefore the graph S_c has (n+m-1) vertices and (n+m-1) edges. $\chi(S_c) = 2$. Every vertex in $S_c$belongs to a rainbow neighbourhood, hence graph S_c is johan colourable.

Case 2: Let n be odd. The graph S_c has (n+m-1) vertices and (n+m-1) edges. $\chi(S_c) = 3$. The graph S_c containatleast one pendent vertex. That pendent vertex does not satisfy rainbow neighbourhood, therefore every vertex in S_c does not belong to a rainbow neighbourhood. Hence graph S_c is not johan colourable.

Result 4.6: Let F_n and F_m be friendship graphs. Then Series Composition $S_c=S_c(F_n,F_m)$ is Johan Colourable.

Theorem 4.7: Let F_n and F_m be Friendship graphs. Then Parallel Composition $P_c = P_c(F_n,F_m)$is Johan Colourable.

Proof: We know that Friendship graph is johancolourable. The disjoint union of graphs Fn and F_m is obtained by merging the sources of F_n and F_m to create the source of P_c and merging the sinks of F_n and F_m to create the sink of P_c. We know that $\chi(P_c) = 3$. Every vertex in P_c belongs to a rainbow neighbourhood, hence graph $P_c$is johan colourable.

Result 4.8: Let K_n be the Complete graph and P_m be the path graph. Then Parallel Composition $P_c=P_c(K_n,P_m)$ is not Johan colourable, when $n\geq4$ and $m\geq3$.

Conclusion: In this paper, the Johan colouring of graphs and their complement graphs, johan colouring for graph operations on some simple graphs have been found out . This can be extended to many other graph classes. Such as digraphs, Euler graphs, Hamiltonian graphs etc...

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The Minimum Dominating Energy of Friendship graph

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ABSTRACT

Motivated by the concept of Minimum Covering energy $E_C(G)$ of a graph [2], emerged the idea of minimum dominating energy $E_D(G)$ of a graph and the authors have computed minimum dominating energies of a star graph, complete graph, crown graph and cocktail graphs in [3]. In this article we applied the concept of the Minimum dominating energy to Friendship graph.

KEYWORDS

Minimum dominating set, Minimum dominating matrix, Minimum dominating eigenvalues, Minimum dominating energy of a graph

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1. INTRODUCTION

The concept of energy of a graph was introduced by I. Gutman [1] in the year 1978. Let G be a graph of order n with vertex set V= $\{v_1, v_2, \dots, v_n\}$ and edge set E. The adjacency matrix of G is the n × n matrix $A(G)$, whose entries a_{ij} (real values) takes the value as ; a_{ij} = 1 if v_i and v_j are adjacent and a_{ij} = 0 otherwise. The eigenvalues of $A(G)$ are the eigenvalues of G whose sum is equal to zero. Since matrix of $A(G)$ is real and symmetric, its eigenvalues are real numbers and are labeled as $\lambda_1 > \lambda_2 > \cdots > \lambda_r, r \leq n$. Then the Energy of the graph G is defined as:

$$E(G) = \sum_{i=1}^{n} |\lambda_i|$$

C.Adiga, Bayad, Gutman, Srinivas in the year 2012 [2] presented the topic "Minimum covering energy of a graph", where the concept of minimum covering eigenvalues was introduced and the energy was given by $E_C(G)= \sum_{i=1}^{n} |\lambda_i|$.

Motivated by the above paper, M. R. Rajesh Kanna, B.N. Dharmendra, G. Sridhara(2013)[3] came up with the concept of "Minimum dominating energy of a graph".

2. DEFINITIONS

2.1THE MINIMUM DOMINATING ENERGY

Let G be a simple graph of order n with vertex set V = $\{v_1, v_2, \dots, v_n\}$ and edgeset E. A subset D of V is called a dominating set of G if every vertex of V- D isadjacent to some vertex in D. Any dominating set with minimum cardinalityis called a minimum dominating set. Let D be a minimum dominating set ofa graph G. The minimum dominating matrix of G is the n × n matrix definedby $A_D(G) = a_{ij}$, where

$$a_{ij} = \begin{cases} 1 \text{ if } v_i v_j \in E \\ 1 \text{ if } i = j \text{ and } v_i \in D \\ 0 \quad \text{otherwise.} \end{cases}$$

The characteristic polynomial of $A_D(G)$ is denoted by $\det(\lambda I - A_D(G))$. The minimum dominating eigenvalues of the graph G are the eigenvalues of $A_D(G)$. Since $A_D(G)$ is real and symmetric, its eigenvalues are realnumbers and we label them in non-increasing order$\lambda_1 > \lambda_2 > \cdots > \lambda_r$, $r \leq n$. Theminimum dominating energy of G is defined as

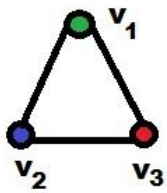
$$E_D(G) = \sum_{i=1}^{n} |\lambda_i| .$$

Note that the trace of $A_D(G)$ = Domination Number = k.

EXAMPLE

Consider the following graph G with vertices v_1, v_2, v_3.

Let the Minimum Dominating set D= $\{v_1\}$.



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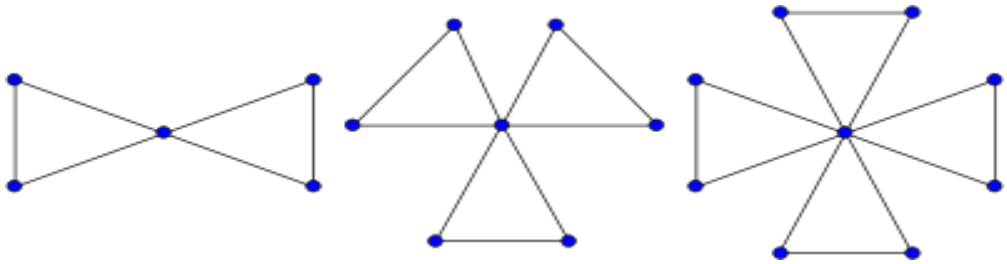
Then $A_D(G)=\begin{bmatrix}1 & 1 & 1\\ 1 & 0 & 1\\ 1 & 1 & 0\end{bmatrix}$. Characteristic equation is $\lambda^3-\lambda^2-3\lambda-1=0$.

Minimum dominating eigenvalues are $\lambda = -1, 1+\sqrt{2} and\ 1-\sqrt{2}$

Minimum dominating Energy , $E_D(G) = 1+1+\sqrt{2}+1+\sqrt{2} = 3+2\sqrt{2}$.

2.2 FRIENDSHIP GRAPH

The Friendship graph (or Dutch windmill graph or *n*-fan) F_n is a planar undirected graphconstructed by joining *n* copies of the cycle graph C_3 with a common vertex.



$F_2F_3F_4$

3. THE MINIMUM DOMINATING ENERGY OF FRIENDSHIP GRAPH

Theorem 3.1

For $n \geq 2$, the minimum dominating energy of the Friendship graph of order $2n+1$ is $E_D(F_n) = (2n+1) + \sqrt{2n}$

Proof.

Let F_n be thecolored Friendship graph with with Vertex set V= $\{v_1, v_2, \dots, v_{2n+1}\}$

The minimum dominating set is D= $\{v_1\}$. Then the minimum dominating matrix is

$$A_D(F_n) = \begin{pmatrix} 1 & 1 & 1 & \cdots & 1 & 1 \\ 1 & 0 & 1 & & 0 & 0 \\ & \vdots & & \ddots & \vdots & \\ 1 & 0 & 0 & \cdots & 0 & 1 \\ 1 & 0 & 0 & & 1 & 0 \end{pmatrix}_{(2n+1 \times 2n+1)}$$

The Characteristic polynomial is $[\lambda+1]^n[\lambda-1]^{n-1}\left[\lambda-(1\pm\sqrt{2n})\right]$

The Minimum dominating eigenvalues are

$\lambda = (1 \pm \sqrt{2n})$

λ = -1[$n\ times$]

λ = 1[$(n-1) times$]

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The Minimum dominating energy is ,

$$E_D(F_n) = \sum_{i=1}^{n} |\lambda_i|$$

$$= \left|1 + \sqrt{2n}\right| 1 + \left|1 - \sqrt{2n}\right| + |-1|\, n + |1|\,(n-1)$$

$$= 2 + \sqrt{2n} + n + n - 1$$

$$= 2 + \sqrt{2n} + 2n - 1$$

∴ The Minimum dominating energy of the Friendship graph is $(2n + 1) + \sqrt{2n}$

CONCLUSION

In this article, the Minimum dominating energy of Friendship graph is determined.It can be concluded thatMinimum dominating energy depends on the minimumdominating set and it can be applied to other graphs and the values can be determined provided they satisfy their corresponding mathematical aspects.

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◆

TRANSIENT SOLUTION TO THE M/M/c QUEUING MODEL FOR HOMOGENOUS SERVER WITH FINITE CAPASITY

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ABSTRACT:

In this paper we study the markovian queuing system with homogenous servers. The arrival process follows Poisson and service process follows exponential distribution. There are c servers with uniform service rate and each arriving customer requires exactly one server for its service.

The model is analyzed under finite capacity N where the queue discipline followed in this model is FCFS. Thus an effective time-dependent transient solution for M/M/c/N queuing model is derived by using generating function technique and thereby solving simple difference differential equations.

KEYWORDS:

Difference differential equation, Modified Bessel function, Laplace transforms, System size.

INTRODUCTION:

"A common situation occurring in everyday life is that of queuing or waiting line. A.K Erlang who is called the father of Queuing theory has published his articles relating to the study of congestion in telephone traffic. Philippe Nain [6] explained the stochastic birth–death Markov process which turned to be a highly suitable modeling tool for many queuing process. Harrison Peter & Patel [1] discussed about the M/M/c queue. Kendall [3] explained for c servers which are exponentially distributed. It is a generalization of the M/M/1 queue which considers only a single server. Parthasarathy [4] analyzed the transient solution for the number of customers in the system with single server. Furthermore Parthasarathy [5] also simplified the transient solutions for the infinite server in M/M/c queue and deduced the steady state probabilities. In this paper we obtain the elegant expressions for the transient solution for M/M/c/N model.

The difference differential equations for the system are,

$$\frac{d}{dt}P_0(t) = \lambda P_1(t) - \lambda P_0(t) \quad \text{(1)}$$

$$\frac{d}{dt}P_N(t) = (N+1)\mu P_{N+1}(t) - (\lambda + n\mu)P_N(t) + \lambda P_{N-1}(t) \quad 1 \le n \le c \quad \text{(2)}$$

$$\frac{d}{dt}P_N(t) = c\mu P_{N+1}(t) - (\lambda + c\mu)P_N(t) + \lambda P_{N-1}(t) \quad c \le n \le N \quad \text{(3)}$$

With $P_n(0) = \delta_{in}$, the Kronecker symbol λ & μ represents the arrival and service rates respectively. If we define

$$P(z,t) = r_{c-1}(t) + \sum_{n=0}^{N} P_{c+n}(t) z^{n+1} \quad \text{(4)}$$

$P(z,0) = z^{\phi(i)}$ with

$$r_{c-1}(t) = \sum_{j=0}^{c-1} P_j(t) \quad \text{(5)}$$

$$\phi(i) = (i+1-c)\left[1 - \sum_{j=0}^{c-1} \delta_{ij}\right]$$

Equation (4) is differentiated partially with respect to't'.

$$\frac{\partial}{\partial z}P(z,t) = r'_{c-1}(t) + \sum_{n=0}^{N} P'_{c+n}(t) z^{n+1}$$

using eqn (5) we get

$$\frac{\partial}{\partial z}P(z,t) = \sum_{i=0}^{c-1} P'_j(t) + \left[P'_c(t)z + P'_{c+1}(t)z^2 + P'_{c+2}(t)z^3 + \ldots\ldots\ldots + P'_{c+N}(t)z^N\right]$$

Applying some algebra simplifications, then the above eqn becomes,

$$\frac{\partial}{\partial z}P(z,t) = [\lambda z + \frac{c\mu}{z} - (\lambda + c\mu)]\,[P(z,t) - r_{c-1}(t)] + \lambda(z-1)P_{c-1}(t) \quad \text{\_\_\_\_\_(6)}$$

The solution of partial differential equation (6) becomes

$$P(z,t) = \quad P(z,0)e^{-(\lambda+c\mu-\lambda z-\frac{c\mu}{z})t} + \int_0^t [\lambda(z-1)P_{c-1}(u) + ((\lambda+c\mu) - \lambda z - \frac{c\mu}{z})r_{c-1}(u)]e^{-(\lambda+c\mu-\lambda z-\frac{c\mu}{z})(t-u)}du. \quad \text{\_\_\_\_(7)}$$

Modified Bessel function:

Clearly known that $\alpha = 2\sqrt{\lambda c\mu}$, $\beta = \sqrt{\frac{\lambda}{c\mu}}$ then

$$e^{t[\lambda z + \frac{c\mu}{z}]} = \sum_{n=-\infty}^{\infty} (\beta z)^n I_n(\alpha t)$$

Here $I_n(.)$ is the modified Bessel function. Using this in eqn (7) and comparing the coefficients of z^n on both sides, we get for n=1,2…

$$\beta^{-n+1}P_{n+c-1}(t) = e^{-(\lambda+c\mu)t}\beta^{1-\phi(i)}I_{n-\phi(i)}(\alpha t) + \int_0^t e^{-(\lambda+c\mu)(t-u)}\{[\lambda I_{n-1}\alpha(t-u) - \lambda\beta I_n\alpha(t-u)]P_{c-1}(u) + [(\lambda+c\mu)\beta I_n\alpha(t-u) - \lambda I_{n+1}\alpha(t-u) - \lambda I_{n-1}\alpha(t-u)]r_{c-1}(u)\}du \quad \text{\_\_\_\_\_(8)}$$

By Substituting $n = 0$ in eqn (8) and applying Bessel function we get,

$$\beta P_{c-1}(t) = e^{-(\lambda+c\mu)t}\beta^{1-\phi(i)} I_{\phi(i)}(\alpha t) + \int_0^t e^{-(\lambda+c\mu)(t-u)}\{[\lambda I_1\alpha(t-u) - \lambda\beta I_0\alpha(t-u)\,]P_{c-1}(u) + [(\lambda+c\mu)\beta I_0\alpha(t-u) - 2\lambda I_1\alpha(t-u)]r_{c-1}(u)\}du$$

_____(9)

Since the left hand side of eqn (8) does not contain any negative powers of z then, sub n=-n in the right hand side of (8), and using the Bessel inequality, it equates with zero yields,

$$e^{-(\lambda+c\mu)t}\beta^{1-\phi(i)} I_{n+\phi(i)}(\alpha t) + \int_0^t e^{-(\lambda+c\mu)(t-u)}\{[\lambda I_{n+1}\alpha(t-u) - \lambda\beta\, I_n\alpha(t-u)\,]P_{c-1}(u) + [(\lambda+c\mu)\beta\, I_n\alpha(t-u) - \lambda[I_{n-1}\alpha(t-u) + \lambda I_{n+1}\alpha(t-u)]r_{c-1}(u)\}du = 0.$$

_____(10)

By using (8) & (10) applying Bessel inequality we get

$$P_{n+c-1}(t) = e^{-(\lambda+c\mu)t}\beta^{n-\phi(i)}[I_{n-\phi(i)}(\alpha t) - I_{n+\phi(i)}(\alpha t)] + \int_0^t e^{-(\lambda+c\mu)(t-u)}[\frac{n\beta^n I_n\alpha(t-u)}{(t-u)}]P_{c-1}(u)du.$$

_____(11)

For solving the probabilities we consider the system of equation as

$$\frac{d}{dt}P(t) = DP + (c-1)\mu P_{c-1}(t)\, I_{c-1} \qquad \text{_____(12)}$$

$$P(t) = [P_0(t), P_1(t)\ \ldots\ P_{c-2}(t)]^T \qquad D = (d_{kj})_{(c-1)\times(c-1)}$$

$$d_{kj} = \begin{cases} \lambda & j = k-1,\ k = 1,2\ldots c-2 \\ -(\lambda+k\mu) & j = k,\ k = 0,1,2\ldots c-2 \\ (k+1)\mu & j = k+1, k = 0,1,2\ldots c-3. \end{cases} \qquad \text{_____(13)}$$

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I_{c-1} is a column vector of order c-1 which have 1 in the last place and zero in the remaining places. Eqn (12) becomes

$$\hat{P}(s) = (sI - D)^{-1}[(c-1)\mu \hat{P}_{c-1}(s) I_{c-1} + P(0)] \quad \text{\_\_\_\_\_(14)}$$

and $I^T \hat{P}(s) + \hat{P}_{c-1}(s) = \hat{r}_{c-1}(s)$, $P(0) = (\delta_{i0,}\, \delta_{i1,}\, \delta_{i2,} \ldots \delta_{ic-2,})^T$ _____(15)

Here $\hat{r}_{c-1}(s) = \sum_{j=0}^{c-1} P_j(s)$, then the equation (15) implies that

$$\hat{P}_{c-1}(s) = \frac{\hat{r}_{c-1}(s) - (sI - D)^{-1} P(0)}{1 + (sI - D)^{-1}(c-1)\mu I_{c-1}} \quad ,$$

Taking Laplace transforms of (9) and using (14) simplifies that,

$$\hat{P}_{c-1}(s) = \frac{[\frac{p - \sqrt{p^2 - \alpha^2}}{\alpha\beta}]^{\phi(i)} - s e^T (sI - D)^{-1} P(0)}{\lambda + s - [\frac{p - \sqrt{p^2 - \alpha^2}}{2}] + (sI - D)^{-1} e^T (c-1)\mu s\, I_{c-1}} \quad \text{\_\_\_\_\_(16)}$$

Since $(sI - D)^{-1} = (\tilde{d}_{kj}(s))_{(c-1)\times(c-1)}$ is a matrix of order c-1

$$\hat{P}_{c-1}(s) = \frac{[\frac{p - \sqrt{p^2 - \alpha^2}}{\alpha\beta}]^{\phi(i)} - s\delta_{ij} \sum_{j=0}^{c-2} \sum_{k=0}^{c-2} \tilde{d}_{kj}(s)}{\lambda + s - \frac{p - \sqrt{p^2 - \alpha^2}}{2} + (c-1)\mu s \sum_{k=0}^{c-2} d_{k\,c-2}(s)} \quad k = 0,1,2,\ldots c-2 \quad \text{\_\_\_\_\_(17)}$$

$$\hat{P}_k(s) = \sum_{j=0}^{c-2} \delta_{ij}\, \tilde{d}_{kj}(s) + (c-1)\mu\, \tilde{d}_{k\,c-2}(s)\, \hat{P}_{c-1}(s) \quad \text{\_\_\_\_\_(18)}$$

We see that $\tilde{d}_{kj}(s)$ are all rational algebra functions in s. In particular the leading coefficient equal to 1 and cofactors of the diagonal are polynomials in s of degree c-2. Hence the inverse transform can be found out by using partial fraction decomposition method.

Let S_m be the characteristic roots of the matrix D also using the partial fraction method we get

$$\tilde{d}_{kj}(s) = \sum_{m=0}^{c-2} \frac{P_{kj}^{(m)}}{s - s_m} \quad \text{\_\_\_\_\_(19)}$$

where $P_{kj}^{(m)} = \lim_{s \to s_m} [(s - s_m)\, \tilde{d}_{kj}(s)$ _____(20)

Thus $\hat{d}_{kj}(t) = \sum_{m=0}^{c-2} P_{kj}^{(m)} e^{smt}$ _____(21)

Similarly $\sum_{k=0}^{c-2}(c-1)s\,\tilde{\tilde{d}}_{kj}(s) = c-1+\hat{b}_j(s)\ \ j = 0,1,2...c-2$ _____(22)

where $\hat{b}_j(s) = \sum_{m=0}^{c-2} \frac{B_j^{(m)}}{s-s_m}$ _____(23)

$B_j^{(m)} = \lim_{s \to s_m} [(s-s_m)(c-1)\sum_{k=0}^{c-2} s\,\tilde{\tilde{d}}_{kj}(s)]$ _____(24)

Inverse of $\hat{b}_j(s)$ can be written as

$b_j(t) = \sum_{m=0}^{c-2} B_j^{(m)} e^{smt}$ where

$b_j(t)$ is the inverse of $\hat{b}_j(s)$

Thus eqn(17) yields,

$$\hat{p}_{c-1}(s) = \frac{2}{\alpha}\left(\frac{p-\sqrt{p^2-\alpha^2}}{\alpha}\right)\left[\left(\frac{p-\sqrt{p^2-\alpha^2}}{\alpha\beta}\right)^{\phi(i)} - (c-1)^{-1}\sum_{j=0}^{c-2}\delta_{ij}(c-1+\hat{b}_j(s)\right].$$
$$\left[1-\sqrt{\frac{\mu}{c\lambda}}\left(\frac{p-\sqrt{p^2-\alpha^2}}{\alpha}\right)\left(1-\hat{b}_{c-2}(s)\right)\right]^{-1}$$

By taking Laplace inverse of the above equation we obtain the time dependent probability of the model.

CONCLUSION:

We obtained the time dependent solutions for the M/M/c model with finite capacity using generating functions. By applying this model we examined the relationship between Insulin and Insulin receptors in Adipose tissue [2]. We plan to extend our work for obtaining some performance measures for M/M/c/N.

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MEASURES OF PERFORMANCE OF THE ALLOPATHIC MEDICATIONS IN CURING THE THYROID HORMONE DISORDERS USING M/M/4 TRANSIENT QUEUEING MODEL

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The thyroid gland is an endocrine gland in neck. It secretes two hormones and these hormones are necessary for all the cells in body to work normally. The over secretion or under secretion of the hormones causes change in metabolism of the body cells. In this paper, we consider M/M/4 queueing system with heterogeneous servers subject to catastrophes as our base model and with the aid of our model, we are analyzing allopathic-medication which will balance the hormonal level and thereby find the best drug to cure the disorders in transient-state.

Keywords: Thyroid hormones, Hypothyroidism, Hyperthyroidism, Thyroid hormone receptors, Thyroid-Stimulating Hormone (TSH), Allopathic-Medicine and Transient-state solution.

Introduction

The thyroid gland secretes two hormones that are released into blood: *Thyroxine*(*T4*) and *Triiodothyronine*(*T3*). The hormone releases from the thyroid gland is maintained by *thyroid-stimulating hormone*(*TSH*) which is regulated from the *Anterior Pituitary Gland*, which itself is controlled by *thyrotropin-releasing hormone*(*TRH*) produced by the *Hypothalamus*. These hormones which is biologically active and govern the metabolism of the body cells. In other words, it controls the speed with which body cells work. If the hormones are secreted more than normal subsequently the body cells works faster than normal, which shows *Hyperthyroidism*. If too little of the thyroid hormones are produced, then the cells and organs of body slow down its activity, which indicates *Hypothyroidism.*

Receptors, function as *hormone-activated transcription factors*. Mammalian thyroid hormone receptors are encoded by two gene, designated alpha and beta. Further, the primary transcript for each gene can be alternatively spliced, generating different alpha and beta receptor isoforms. Currently, four different thyroid hormone receptors are recognized: *alpha-1, alpha-2, beta-1, and beta-2*.

Numerical Solution

Models in Queueing System, are developed by differential equations with respect to time in case of Transient Analysis and differential equations with independent on time(time=0) in case of Steady-State Analysis. In order to find numerical solutions to ordinary differential equations, few numerical methodologies can be utilized to obtain values. For example, *Runge-Kutta method*, Euler's method and Boundary Value method.

The relationship between insulin level and number of insulin receptors has studied with application of queueing theory logic by C.Kandemir and L.Cavas(2007). From a textbook of receptor pharmacology, drug- receptor interaction has detailed by Jenkinson.D.H(1996) in classical view. In 1997, Kenakin.T analyzed the interaction of drug and receptor in pharmacologic view-point. A numerical approach to queueing system has discussed by A.Nellai Murugan and S.Vijayakumari Saradha in 2015.

Relating the *four different thyroid hormone receptors with four heterogeneous servers* of the considered queueing model, the rate of behavior of drugs in the receptors can be analyzed. *Runge-Kutta 4th order methodology* is utilized to calculate the required numerical values to the data. Further, in this paper we examine Allopathic treatment and moreover we are analyzing which drug is the best one for thyroid disorders.

Basic Elements

The Queueing model, "Transient Solution Of A M/M/4 Queue With Heterogeneous Servers Subject To Catastrophes" is considered as a basic concept for this paper. The idea is to replace the four heterogeneous servers of the queueing model to be the four thyroid hormone receptors bind DNA. Thyroid gland failure or malfunctions of brain or heart or etc., are subject to be the catastrophes. The arrival in the system is nothing but the drugs which is consumed to deal with thyroid hormone disorders. The basic elements of the performance measures of our queueing system is considered as follows,

$L_q \rightarrow$ Expected level of drug absorbed by the receptors.

$L_s \rightarrow$ Expected level of TSH absorbed in DNA.

$W_q \rightarrow$ Expected level of drug linger by the receptor.

$W_s \rightarrow$ Expected level of TSH required in DNA after the reaction of drug.

Transient-State Solution

The performance measures of transient-state equations of finite servers are considered and by taking c=4 for our model. Thus, various performance measures are

$$L_q = \sum_{n=c+1}^{\infty}(n-c)\mathrm{P}_n \qquad L_s = L_q + \frac{\lambda}{\mu} \qquad W_q = \frac{L_q}{\lambda}$$

$$W_s = \frac{L_s}{\lambda}$$

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The value of Expected level of drugs absorbed by the receptors and Expected level of TSH absorbed in DNA are expected to be higher will produce good improvement in health. Then the values of Expected level of drug linger by the receptors and Expected level of TSH required in DNA after the reaction of drug should be low in level for the best result.

Allopathic Medication

Allopathic Medication is one of the system of medical practice. It aims to cure disease with the remedies(as drugs or surgery). The Expression "Allopathic" was coined in 19th century by Samuel Hahnemann(1755-1843), who was the creator of Homeopathy also. This medication was based on balancing four "humors"(a system of medicine detailing the makeup and workings of human body), i.e., blood, phlegm, yellow bile and black bile, where diseases caused by excess of one humor and which should be thus treated with its opposite. This description continued to be used to describe anything that was not homeopathy. The following are most prescribed drugs.

Hypothyroidism-Drugs	Hyperthyroidism-Drugs
Levothyroxine	Methimazole
Armour Thyroid	Carbimazole
Liothyronine	Propylthiouracil
Liotrix	Potassium Iodide

Numerical Solution-Hypothyroidism

The drug contains synthetic hormones which brings the hormonal level to normal condition. In case of hypothyroidism, the man-made hormones in the drug should increase the hormonal level. We are assuming that the level of drugs accepted by the four receptors are taken as service rates, the level of drug actually intake by the patient is considered as arrival rate and the occurrence level of catastrophes and the value of initial probability[$P_0(0)$] are always constant. Using Runge-Kutta 4th order, the numerical values of the reaction of receptors towards the drugs is calculated for each drug separately and the values are tabulated below.

Drugs	Armour Thyroid	Levothyroxine	Liothyronine	Liotrix
$P_0(0.1)$	0.567142	0.571681	0.573141	0.592327
$P_1(0.1)$	0.321923	0.308779	0.315695	0.303269
$P_2(0.1)$	0.093111	0.085096	0.089806	0.078353
$P_3(0.1)$	0.017892	0.015984	0.016993	0.014093
$P_4(0.1)$	0.002924	0.002804	0.002989	0.002449
$P_5(0.1)$	0.002838	0.002734	0.002303	0.001155
$P_6(0.1)$	0.002782	0.002529	0.002075	0.000946
$P_7(0.1)$	0.002627	0.002359	0.002491	0.000937
$P_8(0.1)$	0.002525	0.002358	0.002489	0.000936

Table-1

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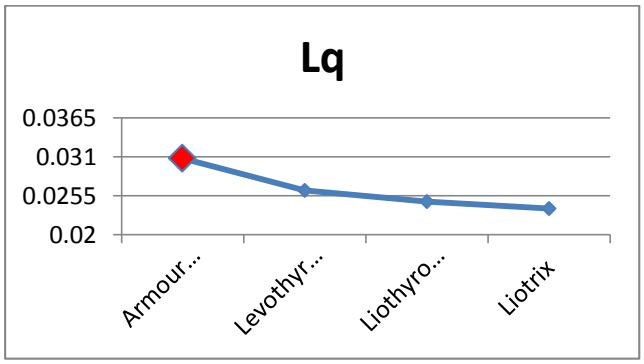
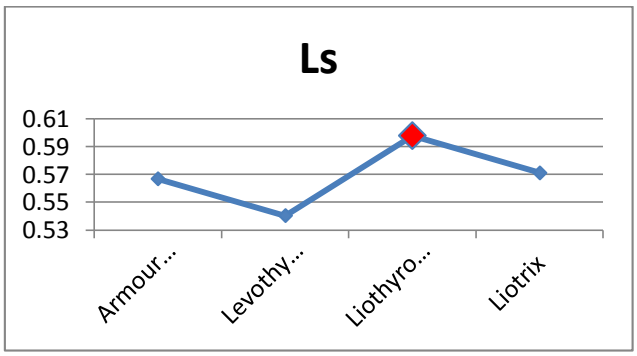
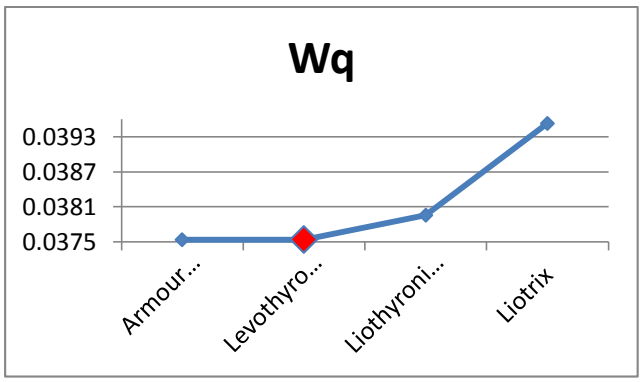
Transient-State Solution: Transient-state(Dependent on time) values are calculated with the help of Table-1 and the values are tabulated. The calculated values of L_q, L_s, W_q and W_s for each drug represents the behavior of drug towards the thyroid hormone receptors.

Drugs	L_q	L_s	W_q	W_s
Armour Thyroid	0.0307808	0.566728	0.0375376	0.6911323
Levothyroxine	0.0262716	0.540422	0.0375309	0.7717452
Liothyronine	0.0246734	0.597866	0.0379591	0.9197933
Liotrix	0.0237195	0.571165	0.0395320	0.9519412







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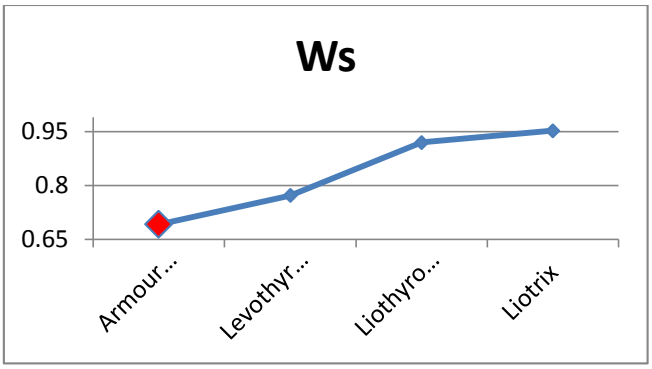

The level of absorption of the drug increases with time in transient-state. If more the absorption level by the receptors and in DNA(L_q and L_s respectively), thereby we observe that there is good improvement in balancing the hormones and when the absorption is high the requirement of drug for balancing hormones and the drug reminds unabsorbed by the receptor (W_s and W_q respectively) should decrease. Here the drug Armour Thyroid shows the high in the absorption level(L_q) and also the least value of requirement of hormones(W_s). Even though its absorption level is low in L_s, it satisfies the requirement of hormones and thereby show lower value in W_s and second lower value in W_q . Thus, the drug Armour Thyroid is the better one to cure hypothyroidism in transient-state.

Numerical Solution-Hyperthyroidism

In case of hyperthyroidism, the drug should reduced the production of excess thyroid hormones and thus to control the hormone level in equilibrium. The service rates, arrival value, catastrophes, initial probability, transient-state probabilities and steady-state probabilities are considered as same as in case of hypothyroidism. Numerical values are also found in same methodology and the values are tabulated.

Drugs	**Methimazole**	**Propylthiouracil**	**Potassium Iodide**	**Carbimazole**
$P_0(0.1)$	0.567142	0.571681	0.573141	0.592327
$P_1(0.1)$	0.321923	0.308779	0.315694	0.303269
$P_2(0.1)$	0.093111	0.085096	0.089806	0.078353
$P_3(0.1)$	0.017892	0.015984	0.016993	0.014093
$P_4(0.1)$	0.002924	0.002804	0.002989	0.002449
$P_5(0.1)$	0.002838	0.002734	0.002303	0.001155
$P_6(0.1)$	0.002782	0.002529	0.002075	0.000946
$P_7(0.1)$	0.002627	0.002359	0.002491	0.000937
$P_8(0.1)$	0.002525	0.002358	0.002489	0.000936

Table-2

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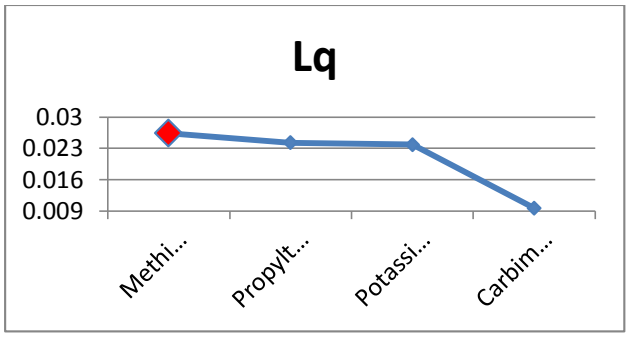
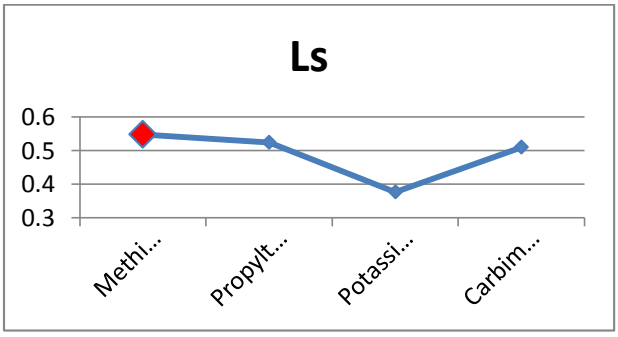
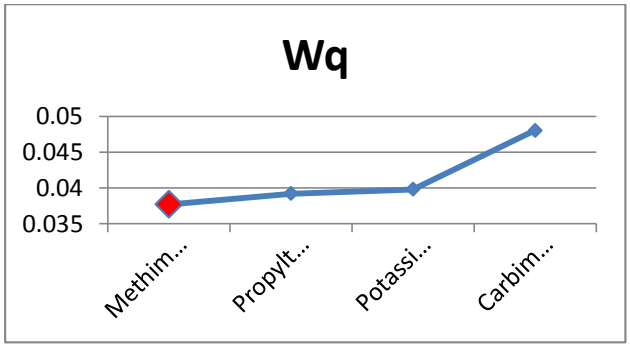
Transient-State Solution: the following table values are calculated with the aid of table-2.

Drugs	L_q	L_s	W_q	W_s
Methimazole	0.026383	0.546828	0.037689	0.781184
Propylthiouracil	0.024299	0.524299	0.039192	0.845644
Potassium Iodide	0.023882	0.376823	0.039803	0.628039
Carbimazole	0.009605	0.509605	0.048024	2.548024







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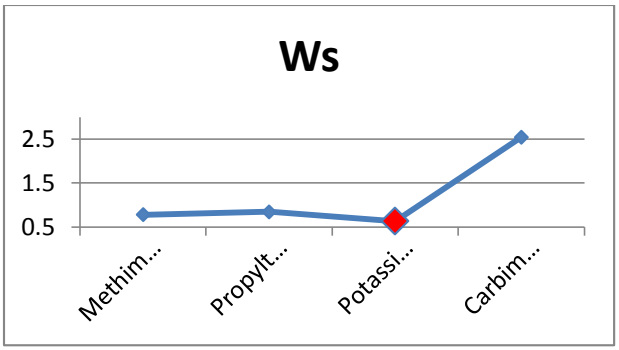

Thus, from the Table-2 and graph above, for time dependent factor, the drug methimazole shows high range in L_q and L_s, very low in W_q and then second lower in W_s. Hence, moreover the drug Methimazole is seem to be the best and it reduce the excess thyroid hormones secretion in the Hyperthyroidism disorder in transient-state condition.

Conculsion

Therefore, our considered queueing model is being the base for the current paper in analyzing the performance of drugs in curing both hypo and hyper thyroid disorders using allopathic medication. Numerical values are found using runge-kutta 4th order method and line graphs are drawn for the calculated performance measures values for transient-state equations. Then, the best medicines for curing thyroid disease is established.

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TRANSIENT SOLUTION OF M/M/c HETEROGENOUS SERVER WITH INFINITE MODEL

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Abstract*:*

In this paper c parallel servers markovian queuing model is taken into consideration. The arrival in this model are allowed to join the queue according to a Poisson distribution and the service rate takes place according to an exponential distribution. For this model we find a transient solution of multiple server heterogeneous queuing system in which there are infinite number of c servers with different service rate and each arriving customer requires one server for its service. The explicit time dependant probabilities of system size are obtained and the numerical illustration are calculated using Runga-kutta method.

Keywords:

Transient Analysis, Laplace transform, Runga-kutta method

Introduction:

Queuing theory is the mathematical study of waiting lines, or queues. The first paper on queuing theory was published in 1909 by A.K.Erlang. Parthasarathy [3] solved a time-dependant for the number in a single server queuing system with poission arrival and exponent service time. Shyam sundar [5] in his paper deals with the erlangian queuing system with time dependant framework. Vijayashree and Janani [6]obtained an explicit expressions for the time dependent system size probabilities using Laplace transform and generating function techniques. Dharmaraja and Rakesh Kumar [1] studied the markovian queuing system with heterogeneous servers and catastrophes. Krishna kumar and Arivudainambi [2] discussed the asymptotic behavior of the probability of the server being idle and obtained the steady state probabilities for the same .Sherif I Ammar [4] derived an explicit solution for M/M/1 queue where the server is allowed to take vacation whenever the system is empty for a random period of time.

Model description

We consider a multi-server heterogeneous queuing system in which the arrival occurs according to the Poisson process. There are infinite number of servers in the system with different service rate μ_i.The transient state time dependant probabilities are calculated and the numerical illustration are carried out for different values of λ and μ.The cost function corresponding to numerical analysis are tabulated.

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By standard methods, the system of Kolmogorov differential difference equations governing the process is given by

$$P_0^{'}(t) = -\lambda P_0(t) + \mu P_1(t) \tag{1}$$

$$P_n^{'}(t) = -(\lambda + \sum_{i=1}^{n} \mu_i) P_n(t) + \lambda P_{n-1}(t) + \sum_{i=1}^{n+1} \mu_i P_{n+1}(t), \quad n = 1,2,.....c-1 \tag{2}$$

$$P_c^{'}(t) = -(\lambda + \sum_{i=1}^{c} \mu_i) P_c(t) + \lambda P_{c-1}(t) + \sum_{i=1}^{c} \mu_i P_{c+1}(t) \tag{3}$$

$$P_n^{'}(t) = -(\lambda + \sum_{i=1}^{c} \mu_i) P_n(t) + \lambda P_{n-1}(t) + \sum_{i=1}^{c} \mu_i P_{n+1}(t), \quad n = c+1 \tag{4}$$

Define

$$P(Z,t) = q_c(t) + \sum_{i=1}^{c} P_{n+c}(t) z^n \quad , P(s,0) = 1 \tag{5}$$

$$q_c(t) = \sum_{n=0}^{c} P_n(t) \tag{6}$$

$$\frac{dq_c(t)}{dt} = -\lambda P_c(t) + \sum_{i=1}^{c} \mu_i P_{c+1}(t) \tag{7}$$

Now, multiplying equ.4 by z^n summing over the corresponding limit values

$$\frac{d[\sum_{n=1}^{\infty} P_{n+c}(t) z^n]}{dt} = [-(\lambda + \sum_{i=1}^{c} \mu_i + \lambda z + \sum_{i=1}^{c} \frac{\mu_i}{z}] \sum_{n=1}^{\infty} P_{n+c}(t) z^n + \lambda z P_c(t) - \sum_{i=1}^{c} \mu_i P_{c+1}(t)] \tag{8}$$

Adding equs. 7 & 8 and using equ 5 we get

$$\frac{\partial P(z,t)}{\partial t} = \left[(\lambda z + \sum_{i=1}^{c} \frac{\mu_i}{z}) - (\lambda + \sum_{i=1}^{c} \mu_i) \right] P(z,t) + \lambda (z-1) P_c(t) - \left[(\lambda z + \sum_{i=1}^{c} \frac{\mu_i}{z}) - (\lambda + \sum_{i=1}^{c} \mu_i \right] q_c(t) \tag{9}$$

By solving partial differential equ .9 using integrating factor, yields,

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$$P(z,t)=\exp\left\{\left[\left(\lambda z+\sum_{i=1}^{c}\frac{\mu_i}{z}\right)-\left(\lambda+\sum_{i=1}^{c}\mu_i\right)\right]t\right\}+\int_0^t\left\{\lambda(z-1)P_c(u)-\left[\left(\lambda z+\sum_{i=1}^{c}\frac{\mu_i}{z}\right)-\left(\lambda+\sum_{i=1}^{c}\mu_i\right)\right]q_c(u)\right\}$$
$$\exp\left\{\left[\left(\lambda z+\sum_{i=1}^{c}\frac{\mu_i}{z}\right)-\left(\lambda+\sum_{i=1}^{c}\mu_i\right)\right](t-u)\right\}du \quad (10)$$

Using modified Bessel function ,

If $\alpha=2\sqrt{\lambda\mu}$ and $\beta=\sqrt{\frac{\lambda}{\mu}}$ we get,

$$\exp\left\{\left(\lambda z+\frac{\mu}{z}\right)t\right\}=\sum_{n=-\infty}^{\infty}(\beta z)^n I_n(\alpha t) \quad (11)$$

Using equ 11 in equ 10 we get

$$P(z,t)=\exp\{[-(\lambda+\gamma)]t\}\sum_{n=-\infty}^{\infty}(\beta z)^n I_n(\alpha t)+\lambda\int_0^t\exp[-(\lambda+\gamma)(t-u)]P_c(u)$$
$$*\left[\sum_{n=-\infty}^{\infty}(\beta z)^n\left[\beta^{-1}I_{n-1}(\alpha(t-u))-I_n(\alpha(t-u))\right]\right]du$$
$$+\int_0^t q_c(u)\exp\{[-(\lambda+\gamma)(t-u)]\}\sum_{n=-\infty}^{\infty}(\beta z)^n$$
$$*\left[-\lambda\beta^{-1}I_{n-1}(\alpha(t-u))+(\lambda+\gamma)I_n(\alpha(t-u))-\gamma\beta I_{n+1}(\alpha(t-u))\right]du \quad (12)$$

Comparing the coefficients of z^n we get,

$$P_{n+c}(t)=\exp\{-(\lambda+\gamma)t\}\beta^n I_n(\alpha t)$$
$$+\lambda\int_0^t P_c(u)\exp\left\{-(\lambda+\gamma)(t-u)\left[I_{n-1}(\alpha(t-u))\beta^{n-1}-I_n(\alpha(t-u))\beta^n\right]\right\}du$$
$$-\int_0^t q_c(u)\exp\{-(\lambda+\gamma)(t-u)\}$$
$$*\left[\lambda\beta^{n-1}I_{n-1}(\alpha(t-u))-(\lambda+\gamma)\beta^n I_n(\alpha(t-u))+\gamma\beta^{n+1}I_{n+1}(\alpha(t-u))\right]du \quad (13)$$

Comparing the terms free from z on either side of equ. (12),we get

$$q_c(t)=\exp\{-(\lambda+\gamma)t\}I_0(\alpha t)+\lambda\int_0^t exp\{-(\lambda+\gamma)(t-u)\}P_c(u)\left[\beta^{-1}I_1(\alpha(t-u))-I_0(\alpha(t-u))\right]du$$
$$+\int_0^t\exp\{-(\lambda+\gamma)(t-u)\}q_c(u)\left[-\alpha I_1(\alpha(t-u))+(\lambda+\gamma)I_0(\alpha(t-u))\right]du \quad (14)$$

As P(z,t) does not contain terms with negative power of z, replacing the right side of equ.13 by -n, we get

$$\exp\{-(\lambda+\gamma)t\}I_n(\alpha t)\beta^n + \lambda\int_0^t \exp\{-(\lambda+\gamma)(t-u)\}P_c(u)$$
$$*\left[\beta^{n-1}I_{n+1}(\alpha(t-u)) - I_n(\alpha(t-u))\beta^n\right]du + \int_0^t \exp\{-(\lambda+\gamma)(t-u)\}q_c(u)$$
$$*\left[-\lambda I_{n+1}(\alpha(t-u))\beta^{n-1} + (\lambda+\gamma)I_n(\alpha(t-u))\beta^n - \gamma I_{n-1}(\alpha(t-u))\beta^{n+1}\right]du \quad (15)$$

On simplifying equ.15 we get

$$P_{n+c}(t) = n\beta^n\int_0^t \exp\{-(\lambda+\gamma)(t-u)\}\left[\frac{I_n(\alpha(t-u))}{(t-u)}\right]P_c(u) \quad (16)$$

$$\frac{dP(t)}{dt} = BP(t) + \gamma P_c(t)I_1 \quad (17)$$

where the matrix $A=a_{ij}$ is given as:

$$A = \begin{bmatrix} -\lambda & \mu_1 & 0 & 0 \\ \lambda & -(\lambda+\mu_1) & 0 & 0 \\ 0 & 0 & 0 & \sum\mu_i \\ . & & & \\ 0 & & & -(\lambda+\sum_{i=1}^{c-1}\mu_i) \end{bmatrix}$$

$$P(t) = (P_0(t)\ \ P_1(t), \ldots\ldots\ldots\ldots P_{c-1}(t))^T \quad \textit{and} \quad I_1 = (0\ 0\ 0 \qquad 1)^T$$

Let $P_*(s) = (P_0^*(s)\ldots\ldots\ldots\ldots P_{c-1}^*(s))^T$ denote the Laplace transform of P(t).Taking Laplace transform of equation (17) ,we get

$$P^*(s) = (sI - B)^{-1}\left[\gamma P_c^*(s)I_1 + P(0)\right] \quad (18)$$

$$e^T P^*(s) + P_c^*(s) = q_c^*(s) \quad (19)$$

Define

$$f(s) = \left[(s+\lambda+\gamma) - \sqrt{(s+\lambda+\gamma)^2 - \alpha^2}\right]$$

Taking Laplace transform of equation 14, we obtain

$$P_c^*(s) = \frac{\left[1 - e^T sP(0)(sI - B)^{-1}\right]}{1 - \frac{1}{2} f(s) - \lambda + e^T s\gamma I_1 (sI - B)^{-1}} \tag{21}$$

Numerical Illustration:

For the purpose of numerical illustration we take into consideration a special case of homogenous transient c server infinite model and use the method of Runge kutta by varying the values of λ and μ in equations (1) and (4).

COST EQUATION :

Here optimum cost value is taken as energy value which can be written as $C(t) = C_h L(t) + C_0 B(t) - C_r(N)$ where,

C_h : Holding cost per unit time for each customer present in the system

C_0 : Cost per unit time for keeping the server on and in operation

C_r : Reward per unit time as the server is doing secondary work.

Table 1: Cost calculation with respect to λ and μ

Cost - varying time	**λ=0.30**	**λ= 0.31**	**λ= 0.32**
C(.1)	259.4021	273.6007	288.5660
C(.2)	271.0545	285.4512	302.7119
C(.3)	294.4680	301.2638	317.0571
C(.4)	317.0072	315.2325	333.3889
C(.5)	333.9777	328.9461	347.4858

From Table 1, we find that the calculated cost values increases as the probability values increases from 0.1 to 0.5. This calculation is done for different arrival rates by varying the values of λ from 0.3 to 0.32 by keeping service rate as μ as 0.5 . The above table gives clear description that the energy values keeps on increasing with increase in time.

Discussion:

Most of the heterogeneous server queuing system dealt in the literature have analyzed steady state probabilities ,very few papers have discussed about the transient behavior. Those papers that have discussed the transient behavior have dealt with the single server queuing model ,but in this paper we have discussed a c server infinite model with heterogeneous server where the server behavior changes from time to time. A numerical illustration gives a clear picture about the model description.

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Transient Solution of an M/M/3 ueue With Heterogeneous Servers Subject to Catastrophes

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Abstract

A transient solution of an M/M/3 queue with heterogeneous servers subject to catastrophes is considered. Expressions are derived for the time-dependent system size probabilities in terms of the Modofied Bessel function are obtained.

Keywords

System size, Heterogeneous Servers, Catastrophes, Steady State Probability, Performance Measures.

1. Introduction

Three – server queueing systems emerge in congestion problems of computer networks and telephone systems. Moreover, now - a – days in medical field it is very essential. In Diabetic treatments, patients inject the insulin to control the sugar level. The sugar level may vary from time to time and hence they inject the insulin according to the level needed to control. For example, if the patient sugar level is only few points higher than the normal level, they can inject the short acting insulin(with the level of medicine according to the calories of food taken)

"Lavenberg [1988], describes the situation of queueing analysis in computer systems." Making customers to undergo different quality of service we introduce an invaluable scheduling method called heterogeneous service mechanism. It is clearly an important feature of operation in all the manufacturing system. "Singh [1970], discussed about the Markovian queueing system with balking and two heterogeneous servers. " "Liu and Kumar [1984], introduced A control model for a machine center with two heterogeneous servers." Almost in all the application of

queueing theory, the users needs to know how long the system will be functioning. For this case, we used the transient behavior in the queuing system.

"Transient probabilities of single and batch service queueing system have been studied by Baburaj [2000]." "The time-dependent solution of single server Markovian queueing system with service in batches of variable size has been investigated by Garg[2003]".

Now-a-days we use catastrophes in queueing system because at any time the system may get inactive due to some errors inside the system or it may come from outside of system. "Boucherie and Boxma [1996] , Jain and Sigman [1996] and Dudin and Nishimura [1999] investigated queueing systems with catastrophes". Artalejo [2000], discussed the Comprehensive treatment od queueing models with catastrophes". "B. Krishna kumar, S. Pavai Madheswari, K.S. venkatakrishnan [2007] studied the Transient solution of an M/M/2 Queue with heterogeneous servers subject to catastrophes".

2. Model Description and Analysis

Let us examine an M/M/3 queueing system with three heterogeneous servers. We presume that the service time go up exponential distribution with the service rate μ_1, μ_2 and μ_3. Also the arrival of the customer follows Poisson distribution with the rate λ and there is waiting line in the system. The queueing discipline of the model follow FCFS. The customer who is first in queue is first served by the server when the server is free. Other than arrival and service rate, here occurs the catastrophes in the service facilties and it follows Poisson distribution with the rate ρ. On whatever occasion a catastrophes occur in the system, there is a immediate destroy of all the customers in the system, all the three servers get inoperative temporarily and the service starts at the time when new customer arrives for service.

Let $\{X(t), t \in R^+\}$ be the number of customers in the system at time t. Let $P_n(t)$ = P(X(t) = n), n= =3,4,… denote the probability that there are n customers in the system at time t. Let $P_0(t)$= P(X(t) = 0) be the probability that the system is empty at time t, $P_1(t)$= P(X(t) = 1) be the probability that there is one customer in the system, $P_2(t)$= P(X(t) = 2) be the probability that there are two customers in the system and $P_3(t)$= P(X(t) = 3) be the probabilitythat there are three customers in the system.

The state probabilities $P_1(t)$, $P_2(t)$, $P_3(t)$ and $P_n(t)$ n=3,4,5,… satisfy the system of differential difference equation given below,

$$\frac{dP_0(t)}{dt} = -\lambda P_0(t) + \mu_1 P_1(t) + \rho\,(1 - P_0(t)) \quad (1)$$

$$\frac{dP_1(t)}{dt} = -(\lambda + \mu_1 + \rho)\,P_1(t) + \lambda P_0(t) + \mu_1 P_2(t) + \mu_2 P_2(t) \quad (2)$$

$$\frac{dP_2(t)}{dt} = -(\mu_1 + \mu_2 + \lambda)\,P_2(t) + \lambda P_1(t) + \mu_1 P_3(t) + \mu_2 P_3(t) + \mu_3 P_3(t) \quad (3)$$

$$\frac{dP_3(t)}{dt} = -(\mu_1 + \mu_2 + \mu_3 + \lambda)\,P_3(t) + \lambda\,P_2(t) + \mu_1 P_4(t) + \mu_2 P_4(t) + \mu_3 P_4(t) \quad (4)$$

$$\frac{dP_n(t)}{dt} = -(\mu_1 + \mu_2 + \mu_3 + \lambda)\,P_n(t) + \lambda\,P_{n-1}(t) + (\mu_1 + \mu_2 + \mu_3)\,P_{n+1}(t) \quad (5)$$

By assumption that if there is no customer at time t=0 then $P_0(0) = 1$. By solving the system of equations using probability generating function technique, we define the probability generating function as,

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$P(z,t) = Q_0(t) + \sum_{n=0}^{\infty} P_{n+4}(t)z^{n+1} + 1$ (6)

where, $Q_0(t) = P_0(t) + P_1(t) + P_2(t) + P_3(t)$ and also with the initial condition $P(z,0) = 1$.

By adding the system of equations (1) to (5) with the standard generating function argument, we get

$\frac{\partial P(z,t)}{\partial t} = [\lambda z + \frac{\mu}{z} - (\lambda + \mu + \rho)][P(z,t) - Q_0(t)] + \rho[1 - Q_0(t)] + \lambda(z-1)P_3(t)$ (7)

where $\mu = (\mu_1 + \mu_2 + \mu_3)$.

By using the 1st order linear differential equation in P(z, t) and solving it we get,

$P(z,t) = e^{[\lambda z + \frac{\mu}{z} - a]t} + \int_0^t \{\rho[1 - Q_0(t)] + \lambda(z-1)P_3(t) - (\lambda z + \frac{\mu}{z} - a)Q_0(t)\} e^{\left[\lambda z + \frac{\mu}{z} - a\right](t-u)}$ du (8)

where $a = \lambda + \mu + \rho$

With $I_n(.)$ the 1st kind of Modified Bessel function of order n. After substituting in equation (8) and expressing the terms of $P(z,t)$ as a series in z and on both sides comparing the coefficients of z^n we get, for n = 1,2,3,…

$P_{n+3}(t) = n\,\beta^n \int_0^t P_3(u)\, e^{-a(t-u)} [\frac{I_n(\alpha(t-u))}{(t-u)}]$ du (9)

By solving the system of equations from (1) to (3) we find the probabilities P_0 , P_1 , P_2 and P_3. We express the equations (1) to (3) in matrix form as,

$\frac{dP(t)}{dt} = CP(t) + \rho e_1 + \mu P_3(t)$, where $\mu = \mu_1 + \mu_2 + \mu_3$ (10)

where, $P(t) = (P_0(t), P_1(t), P_2(t))^T$, $C = \begin{pmatrix} -(\lambda+\rho) & \mu_1 & 0 \\ 2 & -(\lambda+\mu_1+\rho) & (\mu_1+\mu_2) \\ 0 & \lambda & -(\lambda+\mu_1+\mu_2+\rho) \end{pmatrix}$

$e_1 = (1,0,0)^T$, $e_2 = (0,0,1)^T$

In literary, the Laplace Transform of $P_n(t)$ is denoted by $P_n^*(s)$. Now, in equation (13) we take Laplace Transform and obtain as follows, multiplying e^{-st} on both sides in equation (13) we get,

$P^*(s) = (s - C)^{-1}\{\left(1 + \frac{\rho}{s}\right) e_1 + \mu P_3(t) e_2\}$, with $P(0) = (1,0,0)^T$ (11)

Using Laplace Transform we find the value of $P_3^*(s)$

$P_3^*(s) = \frac{\left(1+\frac{\rho}{s}\right)[1-(s-C)^{-1}e^T(s+\rho)e_1]}{(s+\rho)(s-C)^{-1}\mu e_2 + (s+\lambda+\rho) - \frac{1}{2}(\tau - \sqrt{\tau^2 - \alpha^2} - \alpha\beta)}$ (12)

Let , $(s - C)^{-1} = (c_{ij}^*(s))_{3*3}$. It is simple to note that,

$$(sI - C)^{-1} = \frac{1}{|D(s)|}\begin{pmatrix} a_1(s)a_2(s) - \lambda(\mu_1 + \mu_2) & \mu_1 a_2(s) & \mu_1^2 + \mu_1\mu_2 \\ \lambda a_2(s) & a_2(s)b(s) & b(s)(\mu_1+\mu_2) \\ \lambda^2 & \lambda b(s) & a_1(s)b(s) - \lambda\mu_1 \end{pmatrix} \quad (13)$$

where , $a_1(s) = s + \lambda + \mu_1 + \rho$, $a_2(s) = s + \lambda + \mu_1 + \mu_2 + \rho$, $b(s) = s + \lambda + \rho$

And $|D(s)| = s^3 + (3\lambda + 3\rho + \mu)s^2 + [(\lambda + \mu_1 + \rho)(\lambda + \mu_1 + \mu_2 + \rho) + (\lambda + \rho)(2(\lambda + \rho) + \mu)]s + (\lambda + \rho)(\lambda + \mu_1 + \rho)(\lambda + \mu_1+\mu_2 + \rho)$

By applying (19) we get $(\mathrm{s} + \rho)\mathrm{e}^{\mathrm{T}}(\mathrm{sI} - \mathrm{C})^{-1}\mathrm{e}_1 = (\mathrm{s} + \rho)\sum_{\mathrm{j}=1}^{3} \mathrm{c}_{\mathrm{j}1}^{*}(\mathrm{s})$ (14)

And $(\mathrm{s} + \rho)\mathrm{e}^{\mathrm{T}}(\mathrm{sI} - \mathrm{C})^{-1}\mu\mathrm{e}_1 = (\mathrm{s} + \rho)[\mu\sum_{\mathrm{j}=1}^{3} \mathrm{c}_{\mathrm{j}3}^{*}(\mathrm{s})]$ (15)

By using equations (14) and (15) in (12), we get

$$P_3^*(s) = \frac{\left(1+\frac{\rho}{s}\right)[1-(s+\rho)\sum_{\mathrm{j}=1}^{3} \mathrm{c}_{\mathrm{j}1}^{*}(\mathrm{s})]}{(s+\rho)[\mu\sum_{\mathrm{j}=1}^{3} \mathrm{c}_{\mathrm{j}3}^{*}(\mathrm{s})]+(s+\lambda+\rho)-\frac{1}{2}(\tau-\sqrt{\tau^2-\alpha^2})} \quad (16)$$

Substituting equation (19) in (14) we get

$$\mathrm{P}_0^*(\mathrm{s}) = \frac{1}{\mathrm{s}}(\mathrm{s} + \rho)\mathrm{c}_{11}^{*}(\mathrm{s}) + [\mu\mathrm{c}_{13}^{*}(\mathrm{s})]\mathrm{P}_3^*(\mathrm{s}) \quad (17)$$

$$\mathrm{P}_1^*(\mathrm{s}) = \frac{1}{\mathrm{s}}(\mathrm{s} + \rho)\mathrm{c}_{21}^{*}(\mathrm{s}) + [\mu\mathrm{c}_{23}^{*}(\mathrm{s})]\mathrm{P}_3^*(\mathrm{s}) \quad (18)$$

$$\mathrm{P}_2^*(\mathrm{s}) = \frac{1}{\mathrm{s}}(\mathrm{s} + \rho)\mathrm{c}_{31}^{*}(\mathrm{s}) + [\mu\mathrm{c}_{33}^{*}(\mathrm{s})]\mathrm{P}_3^*(\mathrm{s}) \quad (19)$$

Applying in equation (14) and solving it after some algebraic manipulation, yields from (16)

$$P_3^*(s) = \frac{\frac{2}{\alpha^2}\left[\tau - \sqrt{\tau^2 - \alpha^2}\right][\frac{\rho}{s} - \sum_{j=1}^{3} \mathrm{a}_{\mathrm{j}1}^{*}(\mathrm{s})]}{1 + \frac{2}{\alpha^2}\left[\tau - \sqrt{\tau^2 - \alpha^2}\right][\mu\sum_{j=1}^{3} \mathrm{a}_{\mathrm{j}3}^{*}(\mathrm{s})]}$$

Therefore, $P_3^*(s) = \frac{2}{\alpha^2}\left[\tau - \sqrt{\tau^2 - \alpha^2}\right]\left[\frac{\rho}{s} - r_1^*(s)\right]\{1 + \frac{2}{\alpha^2}\left[\tau - \sqrt{\tau^2 - \alpha^2}\right][\mu\sum_{j=1}^{3} \mathrm{a}_{\mathrm{j}3}^{*}(\mathrm{s})]\}^{-1}$

where $r_i^*(s) = \sum_{j=1}^{3} \mathrm{a}_{\mathrm{j}i}^{*}(\mathrm{s})$, $\mathrm{i} = 1,3$ (20)

Hence the above equation can be put in the form as,

$$P_3^*(s) = \sum_{n=0}^{\infty}(-i)^n \frac{2^{n+1}}{\alpha^{n+1}}[\sum_{k=0}^{n} nc_k\mu^n((r_3^*(s))^k)^{n-k}][\frac{1}{s}\rho\frac{\left(\tau-\sqrt{\tau^2-\alpha^2}\right)^{n+1}}{\alpha^{n+1}} - r_1^*(s)\frac{\left(\tau-\sqrt{\tau^2-\alpha^2}\right)^{n+1}}{\alpha^{n+1}}]$$

By taking inversion, it yields an explicit expression for $P_3(t)$ as,

$$\mathrm{P}_3(\mathrm{t}) = \rho\sum_{\mathrm{n}=0}^{\infty}(-1)^{\mathrm{n}}\left(\frac{2}{\alpha}\right)^{\mathrm{n}+1}(\mathrm{n}+1)\int_0^{\mathrm{t}}\sum_{\mathrm{k}=0}^{\mathrm{n}}\mathrm{nc}_{\mathrm{k}}\mu^{\mathrm{k}}\int_0^{\mathrm{u}}\mathrm{r}_3^{(\mathrm{k})}(\mathrm{u}-\mathrm{v})\mathrm{dy}.\,\mathrm{I}_{\mathrm{n}+1}\frac{\left(\alpha(\mathrm{t}-\mathrm{u})\right)}{(\mathrm{t}-\mathrm{u})}.\,\mathrm{e}^{-\mathrm{a}(\mathrm{t}-\mathrm{u})}\mathrm{du}$$

$$+\sum_{\mathrm{n}=0}^{\infty}(-1)^{\mathrm{n}}\left(\frac{2}{\alpha}\right)^{\mathrm{n}+1}(\mathrm{n}+1)\int_0^{\mathrm{t}}\sum_{\mathrm{k}=0}^{\mathrm{n}}\mathrm{nc}_{\mathrm{k}}\mu^{\mathrm{k}}\int_0^{\mathrm{u}}\int_0^{\mathrm{v}}\mathrm{r}_1^{\mathrm{k}}(\mathrm{y})\,\mathrm{r}_3^{(\mathrm{n}-\mathrm{k})}(\mathrm{v}-\mathrm{y})\mathrm{dy}.\,\mathrm{I}_{\mathrm{n}+1}\frac{(\alpha(\mathrm{u}-\mathrm{v}))}{(\mathrm{u}-\mathrm{v})}.\,\mathrm{e}^{-\mathrm{a}(\mathrm{u}-\mathrm{v})}\mathrm{du}\,\mathrm{dv} \quad (21)$$

where $r_i^{(n)}(t)$ is the n-fold convolution of $r_i(t)$ with itself. We see that, $r_i(0) = \delta(t)$, the Dirac delta function.

Transposing (17) – (19) using some algebraic manipulation, yields

$$P_0(t) = c_{11}(t) + \rho \int_0^t c_{11}(u)du + \int_0^t [\mu c_{13}(t-u)]P_3(u)du \quad (22)$$

$$P_1(t) = c_{21}(t) + \rho \int_0^t c_{21}(u)du + \int_0^t [\mu c_{23}(t-u)]P_3(u)du \quad (23)$$

$$P_2(t) = c_{31}(t) + \rho \int_0^t c_{31}(u)du + \int_0^t [\mu c_{33}(t-u)]P_3(u)du \quad (24)$$

Hence the equations (9) and (21) – (24) expresses all the system size probabilities.

Conclusion:

In this paper, we have discussed a three servers under heterogeneous service rate in queueing system. An error occurs in the system either from inside or from outside the system. Thus with three heterogeneous servers we considered catastrophes and derived the model called 'Transient solution of an M/M/3 queue with heterogeneous servers subject to catastrophes.' With the help of Modified Bessel function and the definitions of Laplace Transform and Inverse Laplace Transform, we find the solution of the model. This model is applicable in medical field, where we can compare three medicine under transient state and steady state and find which medicine is best out of three. So that, it is very useful to doctors to prescribe the best medicine with less side effects.

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M/M/C Multiple Vacation Queueing Systems with Differentiated Vacations

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Abstract

We introduced the concept of differentiated vacation into a multi server queueing system and derived the formulas for the steady state probabilities and expected waiting time in the system. Also we made an analysis about the average waiting time of the system in various durations of vacations. Further we studied about how the number of servers influences the duration of vacations to reduce the waiting time in the system.

Key words: Vacation queueing system, Multi server queueing system, Differentiated vacation, Average waiting time.

1. Introduction

A vacation queueing system is a queueing system in which a server may become unavailable for a random period of time from a primary service center. The attention of many researchers have attracted into the queueing system with server vacation. This idea was first discussed in the paper of Levy and Yenchiali(1975). After that many researchers have made excellent survey on vacation models, in which the survey given by B. T. Doshi(1986,1990) was discussed deeply about vacations in a single-server queueing system and at the end of the work he concluded that many queueing problems and their solutions can be simplified if viewed as vacation type problems. Most of the researchers like Servi and Finn(2002) and Baba(2005) studied working vacation models in that they assumed that those consecutive vacations follow the same distributions. But recently Oliver C Ibe and Olubukola A ISijola (2014) studied M/M/1multiple vacation queueing system with differentiated vacations. Differentiated vacation occurs in environments where "breaks" of different durations can occur. In this paper we introduced the idea of differentiated vacations in to a multi server queueing system. In our proposed queueing model there are more than one server is available to perform the need of a customer. Here we give an advantage for the servers is that, they can take two type of vacations, the first type is taken after a non zero busy period and the second type is taken after a zero busy period. But for the first and second type of vacations there are separate timing and fixed duration for all the servers in the system. That is at the time of type one vacation all of them should leave from the service area together and after completing the vacation all of them should enter in to the service area simultaneously. The case is similar to that of type two vacations also. The main advantage of this model is that, it helps to avoid the idle characters of servers and hence the performance level of them gets increased. As a result more customers will arrive for the service because of the less waiting time in the system. For example these models can be introduced in the transaction section of a bank to avoid the working pressure of the employees and to improve the efficiency of them.

2. Methodology

We consider a multiple vacation queueing system, with customers arrive according to poisson process with rate λ and the time to serve a customer is assumed to be exponentially distributed with mean $1/\mu$, where $\mu > \lambda$. As mentioned earlier we can assumed that there are two type of vacation for each server. Suppose that there are C servers in the system and for each of the server the duration of type1 vacation is independent of busy period and are exponentially distributed

with mean $1/\gamma_1$. Similarly the duration of type two vacations is also exponentially distributed with mean $1/\gamma_2$ for each server. Let the state of the system be denoted by, (n,k) where n is the number of customers in the system. k = 0, if all the servers are active for serving customers, k = 1, if all the servers are on type one vacation and k = 2, if all the servers are on type 2 vacation. Similar discussions can be seen in papers given by Qingqing Ye and Liwei Liu (2015) and Tuan Phung-Duc(2015). Under these assumptions we can draw the transition diagram. Let $P_{n,k}$ denote the probability that the process is in state (n,k) at the time t and let $P_{n,k} = \lim_{t\to\infty} P_{n,k}(t)$. By analysing,

$$(\lambda+\gamma_1)P_{0,1} = \mu P_{1,0} \tag{1}$$

$$\lambda P_{0,2} = \gamma_1 P_{1,0} \tag{2}$$

$$\lambda P_{n,1} = (\lambda+\gamma_1)P_{n+1,1} \quad n = 0,1,2,.. \tag{3}$$

$$\lambda P_{n,2} = (\lambda+\gamma_2)P_{n+1,2} \quad n = 0,1,2.. \tag{4}$$

By solving equations (3) and (4) recursively we obtain,

$P_{n,1}$=$\alpha_1\beta_1^n P_{1,0}$ and $P_{n,2}$=$\alpha_2\beta_2^n P_{1,0}$,

where $\alpha_1 = \frac{\mu}{(\lambda+\gamma_1)}$, $\alpha_2 = \frac{\mu\gamma_1}{\lambda(\lambda+\gamma_1)}$, $\beta_1 = \frac{\lambda}{(\lambda+\gamma_1)} < 1$, and $\beta_2 = \frac{\lambda}{(\lambda+\gamma_2)} < 1$.

Now from the local balance equations we obtain,

$$\lambda P_{n-1,0} + \lambda P_{n-1,1} + \lambda P_{n-1,2} = n\mu P_{n,0}, \quad n < \text{C} \tag{5}$$

$$\lambda P_{n-1,0} + \lambda P_{n-1,1} + \lambda P_{n-1,2} = C\mu P_{n,0}, \quad n > \text{C} \tag{6}$$

By solving the above equations recursively we obtain,

$$P_{n,0} = \left(\frac{\rho^{n-1}}{n!} + \sum_{i=0}^{n-2} \frac{\rho^{n-(i+1)}(i+1)!}{n!}\left[\alpha_1\beta_1^{i+1} + \alpha_2\beta_2^{i+1}\right]\right)P_{1,0}, \quad n \le \text{C} \tag{7}$$

and

$$P_{n,0} = \left(\frac{\rho^{n-1}}{C^{n-C}C!} + \left(\frac{\rho}{C}\right)^{n-C}\sum_{i=0}^{C-2}\frac{\rho^{n-(i+1)}(i+1)!}{n!}\left[\alpha_1\beta_1^{i+1} + \alpha_2\beta_2^{i+1}\right] + \sum_{i=0}^{C-2}\left(\frac{\rho}{c}\right)^i\left[\alpha_1\beta_1^{n-i} + \alpha_2\beta_2^{n-i}\right]\right)P_{1,0}, \quad n > \text{C}, \tag{8}$$

where $\rho = \frac{\lambda}{\mu}$.

Using the law of total probability, we get

$$P_{1,0} = \left(\sum_{n=1}^{C} P_{n.0} + \frac{\rho}{C-\rho}\left\{P_{C,0} + \frac{\alpha_1\beta_1^C}{1-\beta_1} + \frac{\alpha_2\beta_2^C}{1-\beta_2}\right\} + \frac{\alpha_1}{1-\beta_1} + \frac{\alpha_2}{1-\beta_2}\right)^{-1} \tag{9}$$

Therefore the average queue length of the system is given by,

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$$E(m) = \left\{\left(\frac{C\rho}{(C-\rho)^2}\right)P_{C,0} + \frac{\alpha_1{\beta_1}^{C+1}}{(1-\beta_1)^2} + \frac{\alpha_2{\beta_2}^{C+1}}{(1-\beta_2)^2} + \frac{\alpha_1\rho}{(C-\rho)(1-\beta_1)}\left\{\frac{C\beta_1^C-(C-1)\beta_1^{C+1}}{1-\beta_1} + \frac{C\beta_1^C(1-C-\rho)}{C-\rho}\right\} + \frac{\alpha_2\rho}{(C-\rho)(1-\beta_2)}\left\{\frac{C\beta_2^C-(C-1)\beta_2^{C+1}}{1-\beta_2} + \frac{C\beta_2^C(1-C-\rho)}{C-\rho}\right\}\right\}P_{1,0}. \quad (10)$$

Now from Little's formula we have the average waiting time in the system , $E(v) = \frac{E(m)}{\lambda} + \frac{1}{\mu}$.

3. Sensitivity Analysis

To get an over view about the impact of variations made in the durations of differentiated vacation on a multi server queueing system, let us consider an example. Assume that $\mu = 0.25$. In this section actually we are comparing the average waiting time in the system by taking two values for the number of customers (C), i.e. C=4 and C=2. Also we assume that $\gamma_2 \geq \gamma_1$. First we are fixing the value of $\gamma_2$as 1 and we vary the value of γ_1 as 0.07 and 0.05 respectively. For each pair of (γ_2, γ_1) we evaluated $E(v)$ at some particular values of ρ and for each value of C. Next we did the same by fixing $\gamma_2$as 2 and those values are tabulated in Table 1.

γ_2	ρ	$E(v)$			
		C=4		C=2	
		$\gamma_1 = 0.07$	$\gamma_1 = 0.05$	$\gamma_1 = 0.07$	$\gamma_1 = 0.05$
1	0.2	4.22	4.77	5.50	7.48
	0.5	5.73	8.11	9.36	13.64
	0.8	7.28	10.71	12.27	17.30
	0.9	7.71	11.37	13.11	18.27
2	0.2	4.22	4.78	5.51	7.50
	0.5	5.74	8.14	9.40	13.69
	0.8	7.30	10.74	12.31	17.35
	0.9	7.74	11.40	13.16	18.32

Table 1: Mean time in the system for various ρ

We plotted $E(v)$ by varying ρ in each case. From the graph (Fig 1) we can see that $E(v)$ increases when $1/\gamma_1$ increases and an important observation that we can derive from the graph is that in each of the cases $E(v)$ increases very quickly, if there are only two servers in the system. That is the increment of $E(v)$ is little slow in a four server system for each value of γ_1. We got the graph (Fig 2) with the same behaviour as the first case if we fix the value of $\gamma_2$as 2. We can also observe that for each value of C, if we fix $\gamma_1 = 0.07$ and vary γ_2 as 1 and 2 respectively, $E(v)$ increases as γ_2 increases. A Similar observation obtained if we fix $\gamma_1 = 0.05$. From the total analysis it can be concluded that a small increment in the duration of first type of vacation affect the system noticeably than an increment in the duration of second type of vacation in a C server queueing system.

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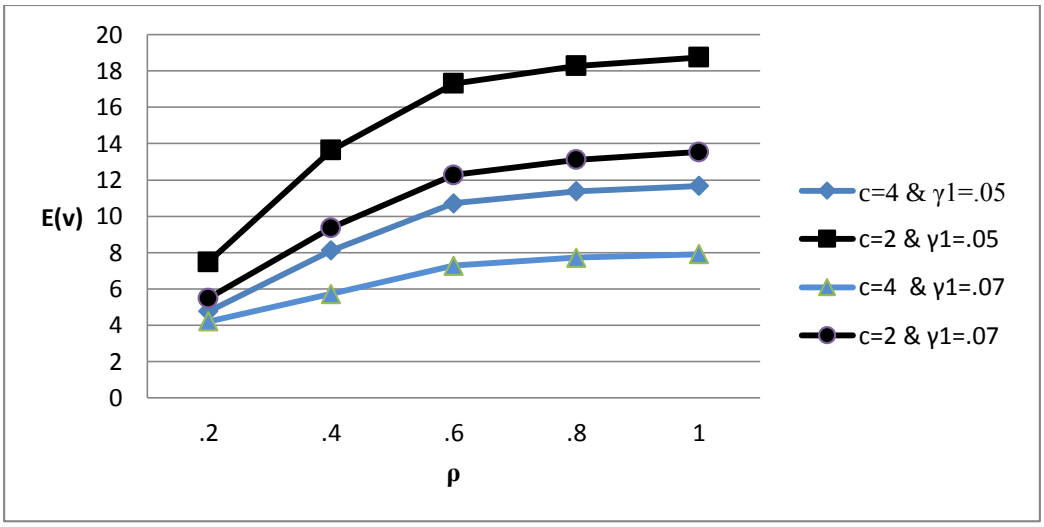

Fig1: Mean time in the system by varying ρ for $\gamma_2 = 1$

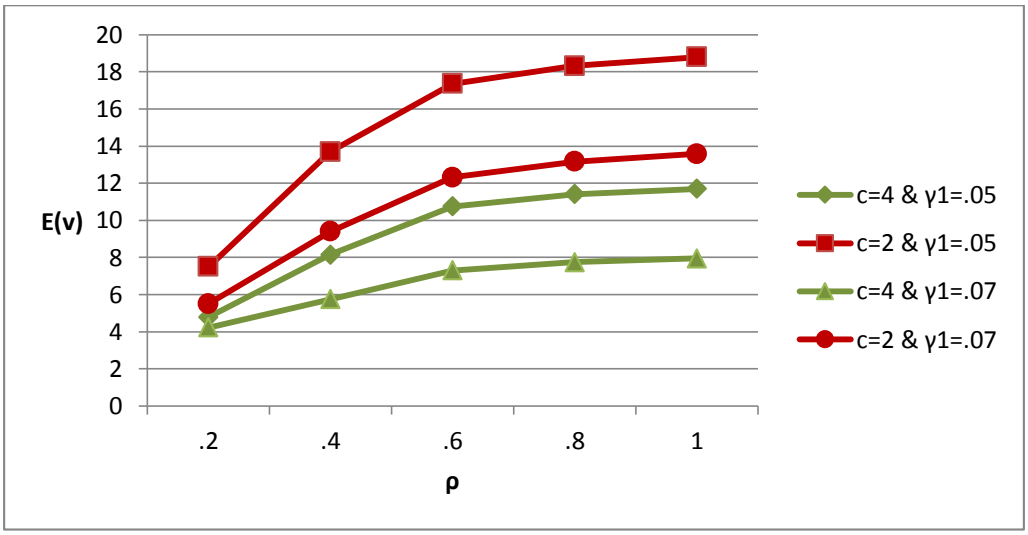

Fig2: Mean time in the system by varying ρ for $\gamma_2 = 2$

4. Conclusion

In this paper we proposed a multi server differentiated vacation queueing system , which is a queueing system with more than one server and each of the server can take two types of vacations of different durations. From the results obtained for us it can be concluded that the expected waiting time in the system is more sensitive to the mean duration of the first type of vacation. Also the expected waiting time increases very quickly when the number of servers in the system is low. If there are many servers in the system the expected waiting time increases very slowly even if the mean duration of type one vacation increases. This queueing system can be introduced in various real life situations in order to improve the efficiency of servers of the system.

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MADM APPROACH FOR INTERVAL VALUED HEXAGONAL NEUTROSOPHIC NUMBERS

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Abstract

In this paper we define Interval valued hexagonal neutrosophic numbers. We develop a new multi attribute group decision making method based on proposed hamming distance and ideal solution. An illustrative example of it is carried out to show the applicability and effectiveness of the proposed method

Keywords

Interval valued hexagonal neutrosophic number, Hamming distance, Ideal solution, MADM

1. Introduction

F.Smrandache established the concept of neutrosophic set and neutrosophic logic to deal uncertainty inconsistency, incompleteness and indeterminacy in 1998. FS,IFS and interval valued intuiniositic fuzzy sets gave a new set known as neutrosophic sets [NS] by adding in determination information. In NS the truth membership indeterminacy membership, false membership functions are completely independent. H.Wang [3] proposed single valued neutrosophic sets and J.Ye [7] gives correlation coefficient and weighted correlation co-efficient in of SVNS. H.Wang [4] proposed interval neutrosophic sets [INS] in which the truth membership indeterminacy membership, false membership functions is extended to interval value. Followed this I.Deli [5] proposed a ranking method for SVNNS using value and ambiguity. I.Deli [6] defined the concept of cut-sets of SVNN and their application to single valued trapezoidal neutrosophic number and triangular neutrosophic number. Ye [8, 9] developed a simplified neutrosophic weighted arithmetic averaging operator and a simplified

neutrosophic weighted geometric averaging operator and applied to multi attribute decision making under simplified neutrosophic environment

2. Preliminaries

Definition : 2.1 [7]

Let X be a space of points (objects),with a generic element in X denoted by x and $x \in X$. A neutrosophic set A in X is characterized by a truth-membership function $T_A(x)$, an indeterminacy-membership function $l_A(x)$ and a falsity-membership function $F_A(x)$ then $T_A(x)$, $l_A(x)$ and $F_A(x)$ are real standard or non-standard subsets of $]0^-,1^+[$. That is $T_A(x):]0^-,1^+[$, $l_A(x): \mathrm{X} \rightarrow]0^-,1^+[$ and $F_A(x): \mathrm{X} \rightarrow]0^-,1^+[$. There is no restriction on the sum of $T_A(x)$, $l_A(x)$ and $F_A(x)$, so $0^- \leq \sup T_A(x) + \sup l_A(x) + \sup F_A(x) \leq 3^+$

Definition: 2.2 [9]

Let X be a universe of discourse. A single valued neutrosphic set A over X is an object having the form $A = \{\langle x, u_A(x), \omega_A(x), v_A(x)\rangle : \mathrm{x} \in X\}$ Where

$\mu_A(x): \mathrm{X} \rightarrow [0,1], \omega_A(x): \mathrm{X} \rightarrow [0,1]$ *and* $v_A(x): \mathrm{X} \rightarrow [0,1]$, *with* $0 \leq \mu_A(x) + \omega_A(x) + v_A(x) \leq 3$ *for* $x \in X$. The intervals $\mu_A(x), \omega_A(x)$ *and* $v_A(x)$ denote the truth-membership degree, the indeterminacy-membership degree and the falsity membership degree of x *to* A, respectively.

Definition: 2.3. Let X be a universe of discourse. A Hexagonal neutrosophic set $\tilde{N}$ in X is defined as follows. $\tilde{N}_{\tilde{H}} = \{\langle x, T_{\tilde{N}}(x), I_{\tilde{N}}(x), F_{\tilde{N}}(x)\rangle / x \in X\}$ Where

$T_{\tilde{N}}(x) \subset [0,1], I_{\tilde{N}}(x) \subset [0,1], F_{\tilde{N}}(x) \subset [0,1]$ are three hexagonal fuzzy numbers such that

$T_{\tilde{N}}(x): X \rightarrow [0,1], I_{\tilde{N}}(x): X \rightarrow [0,1], F_{\tilde{N}}(x): X \rightarrow [0,1]$ with the condition

$0 \leq T_{\tilde{N}}(x) + I_{\tilde{N}}(x) + F_{\tilde{N}}(x) \leq 3, x \in X$

Definition: 2.4. The ideal choice of interval neutrosophic hexagonal number is

$$I^+ = ([1,1,1,1,1,1]:[1,1],[0,0],[0,0])$$

3. INTERVAL VALUED HEXAGONAL NEUTROSOPHIC NUMBERS

3.1. Hamming distance between two IVHNNs

Let $\tilde{A} = [(a_1, b_1, c_1, d_1, e_1, f_1), [T_1, \bar{T}_1], [I_1, \bar{I}_1], [F_1, \bar{F}_1]]$ *and*

$\tilde{B} = [(a_2, b_2, c_2, d_2, e_2, f_2), [T_2, \bar{T}_2], [I_2, \bar{I}_2], [F_2, \bar{F}_2]]$

be two IVHNN then the Hamming distance between $\tilde{A}$ *and* $\tilde{B}$ is defined as follows

$$\left(\frac{1}{36}\left(\begin{array}{l}\left|a_1(2+T_1-I_1-F_1)+a_1(2+\bar{T}_1-\bar{I}_1-\bar{F}_1)-a_2(2+T_2-I_2-F_2)-a_2(2+\bar{T}_2-\bar{I}_2-\bar{F}_2)\right| \\ +\left|b_1(2+T_1-I_1-F_1)+b_1(2+\bar{T}_1-\bar{I}_1-\bar{F}_1)-b_2(2+T_2-I_2-F_2)-b_2(2+\bar{T}_2-\bar{I}_2-\bar{F}_2)\right| \\ +\left|c_1(2+T_1-I_1-F_1)+c_1(2+\bar{T}_1-\bar{I}_1-\bar{F}_1)-c_2(2+T_2-I_2-F_2)-c_2(2+\bar{T}_2-\bar{I}_2-\bar{F}_2)\right| \\ +\left|d_1(2+T_1-I_1-F_1)+d_1(2+\bar{T}_1-\bar{I}_1-\bar{F}_1)-d_2(2+T_2-I_2-F_2)-d_2(2+\bar{T}_2-\bar{I}_2-\bar{F}_2)\right| \\ +\left|e_1(2+T_1-I_1-F_1)+e_1(2+\bar{T}_1-\bar{I}_1-\bar{F}_1)-e_2(2+T_2-I_2-F_2)-e_2(2+\bar{T}_2-\bar{I}_2-\bar{F}_2)\right| \\ +\left|f_1(2+T_1-I_1-F_1)+f_1(2+\bar{T}_1-\bar{I}_1-\bar{F}_1)-f_2(2+T_2-I_2-F_2)-f_2(2+\bar{T}_2-\bar{I}_2-\bar{F}_2)\right|\end{array}\right)\right)$$

3.2. MADM IN INTERVAL VALUED HEXAGONAL NEUTROSOPHIC NUMBERS

In this section we carry over a framework for determining the attribute weights and the ranking orders for all the alternatives with unassigned weight information under interval hexagonal neutrosophic number environment.In a problem of multi-attribute decision making, suppose $A_i = \{A_1, A_2, A_3.....A_n\}$ is set of alternatives which satisfies

$C_i = \{C_1, C_2, C_3, C_4\}$*the* set of attributes, $W = (\tilde{\omega}_1, \tilde{\omega}_2, \cdots \tilde{\omega}_n)$ *where* $\tilde{\omega}_j$ is the weight vector

of the attributes, where, $\omega_i, \in [0,1], \sum_{i=1}^{n} \omega_i = 1$ .Suppose the characteristic information of the alternative is denoted by Interval value hexagonal neutrosophic number

$\tilde{A}_{ij} = [(a_{ij}, b_{ij}, c_{ij}, d_{ij}, e_{ij}, f_{ij}) : T_{ij}, I_{ij}, F_{ij}]$ where,

$0 \le T_6 + I_6 + F_6 \le 3$ *for* $i = 1,2,3.....m,\ j = 1,2,3.....n$ *and* T_{ij} denotes the true value of alternatives A_i to attribute r_j and I_{ij} denotes the indeterminacy value of alternatives A_i to attribute r_j and F_{ij} the false value. We establish a interval valued hexagonal neutrosophic decision matrix as

$\tilde{D} = (\tilde{r}_{ij})_{m \times n} =$

Alternative	**C₁**	**C₂**	**…**	**Cₙ**
A_1	$\tilde{r}_{11}$	$\tilde{r}_{12}$	⋯	$\tilde{r}_{1n}$
A_2	$\tilde{r}_{21}$	$\tilde{r}_{22}$	⋯	$\tilde{r}_{2n}$
.	.	.	.	.
A_n	$\tilde{r}_{m1}$	$\tilde{r}_{m2}$	⋯	$\tilde{r}_{mn}$

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Step 1: Determine the weights of the attributes .We use normalized Hamming distance between two IVHNN et the attribute weight $\tilde{w}_j = [(w_j^1, w_j^2, w_j^3, w_j^4, w_j^5, w_j^6) : [T_j, \overline{T}_j][I_j, \bar{I}_j][F_j, \overline{F}_j]$ for j=1,2,3….n expressed as IVHNN

If $\Delta(\tilde{w}_j, I^+)$ is the distance between weights $\tilde{w}_j$ *and* I^+ then the distance vector is given by

$\Delta(W) = \Delta(\tilde{w}_1, I^+), \Delta(\tilde{w}_2, I^+), \ldots\ldots\ldots \Delta(\tilde{w}_n, I^+)$ Where

$$\Delta(\tilde{w}_j, I^+) = \frac{1}{36}\begin{pmatrix} \left| w_j^1(2 + T_1 - I_1 - F_1) + w_j^1(2 + \overline{T}_1 - \bar{I}_1 - \overline{F}_1) - 6 \right| \\ + w_j^2(2 + T_1 - I_1 - F_1) + w_j^2(2 + \overline{T}_1 - \bar{I}_1 - \overline{F}_1) - 6 \\ + w_j^3(2 + T_1 - I_1 - F_1) + w_j^3(2 + \overline{T}_1 - \bar{I}_1 - \overline{F}_1) - 6 \\ + w_j^4(2 + T_1 - I_1 - F_1) + w_j^4(2 + \overline{T}_1 - \bar{I}_1 - \overline{F}_1) - 6 \\ + w_j^5(2 + T_1 - I_1 - F_1) + w_j^5(2 + \overline{T}_1 - \bar{I}_1 - \overline{F}_1) - 6 \\ + w_j^6(2 + T_1 - I_1 - F_1) + w_j^6(2 + \overline{T}_1 - \bar{I}_1 - \overline{F}_1) - 6 \end{pmatrix} \text{-----(1)}$$

The corresponding normalization vector is given by

$$\Delta = \Delta(\tilde{w}_1, I^+), \Delta(\tilde{w}_2, I^+), \ldots\ldots\ldots \Delta(\tilde{w}_n, I^+) \text{-----(2)}$$

Where $\Delta(\tilde{w}_j, I^+) = \left[\frac{\Delta(\tilde{w}_j, I^+)}{\max_j \Delta(\tilde{w}_j, I^+)} \right]$ **for j=1,2,…..n**

The entropy measure of the jth attribute C_j **of the available alternative can be obtained**

from $e_j = -\frac{1}{\ln(m)} \left[\frac{\Delta(\tilde{w}_j, I^+)}{\sum_{j=1}^{n} \Delta(\tilde{w}_j, I^+)} \ln \left[\frac{\Delta(\tilde{w}_j, I^+)}{\sum_{j=1}^{n} \Delta(\tilde{w}_j, I^+)} \right] \right]$ ------(3)

Using the above equation we obtain the normalized weight of the jth attribute

$$\tilde{w}_j = \frac{1 - e_j}{\sum_{j=1}^{n} 1 - e_j} \text{--------(4)}$$

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Step 2: Determine the aggregated weighted distance between ideal alternatives and alternatives. The normalized Hamming distance between the attribute value

$$\tilde{A}_{ij} = [(a_{ij}, b_{ij}, c_{ij}, d_{ij}, e_{ij}, f_{ij}) : [T_{ij}, \overline{T}_{ij}][I_{ij}, \overline{I}_{ij}][F_{ij}, \overline{F}_{ij}]$$

and the ideal value $I^+ = [(1,1,1,1,1,1) : (1,1), (0,0), (0,0)]$ can be obtained as follows

$$\Delta(A_{ij}, I^+) = \frac{1}{36}\begin{pmatrix} \left|a_{ij}(2+T_1-I_1-F_1)+a_{ij}(2+\overline{T}_1-\overline{I}_1-\overline{F}_1)-6\right| \\ +b_{ij}(2+T_1-I_1-F_1)+b_{ij}(2+\overline{T}_1-\overline{I}_1-\overline{F}_1)-6 \\ +c_{ij}(2+T_1-I_1-F_1)+c_{ij}(2+\overline{T}_1-\overline{I}_1-\overline{F}_1)-6 \\ +d_{ij}(2+T_1-I_1-F_1)+d_{ij}(2+\overline{T}_1-\overline{I}_1-\overline{F}_1)-6 \\ +e_{ij}(2+T_1-I_1-F_1)+e_{ij}(2+\overline{T}_1-\overline{I}_1-\overline{F}_1)-6 \\ +f_{ij}(2+T_1-I_1-F_1)+f_{ij}(2+\overline{T}_1-\overline{I}_1-\overline{F}_1)-6 \end{pmatrix} ------(5)$$

Therefore the distance vector for the alternatives $A_i (i = 1,2.....m)$ with respect to the ideal value I^+ can be set as $\Delta(A_i) = \Delta(\tilde{a}_{1j}, I^+), \Delta(\tilde{a}_{2j}, I^+), ...\Delta(a_{nj}, I^+)$

Using equation (4) and (5) we can calculate the aggregated weighted distance between the ideal point and alternatives $\Delta^w(A_i, I^+) = \sum_{j=1}^{n} \tilde{w}_j \Delta(\tilde{a}_{ij}, I^+),\ for\ i = 1,2...m,\ j = 1,2...n ---(6)$

Step 3. Rank all the alternatives using the values of the distance $\Delta^w(A_i, I^+)\ for i = 1,2...m,$ of $A_i (i = 1,2,.....m).$ .The basic idea of ranking the alternative is the smaller the value of $\Delta^w(A_i, I^+)$ better the closeness of an alternative to ideal solution

4. Numerical example

In this section, we consider an MADM problem which deals with the supplier selection in supply chain management. Assuming that the problem consists of Four foreign export companies A_1, A_2, A_3, A_4 ,and four attributes $C_1, C_2, C_3.C_4$. The four attributes are Commodities (C_1) ,Direction of foreign trade (C_2) value and volume of trade (C_3) and Affordable price (C_4) .It is assumed that the alternatives A_1, A_2, A_3, A_4 are to be assessed in terms of the interval neutrosophic hexagonal numbers with respect to the four attributes $C_1, C_2, C_3.C_4$. The following decision matrix represents the assessment values of alternatives over the attributes.

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Table 4. 1. Rating values of alternatives

Attributes	C_1	C_2	C_3	C_4
A_1	[.2 .3 .4 .5 .6 .7] [.6 .7] [.3 .4] [.1 .3]	[.3 .4 .5 .6 .7 .8] [.2 .3][.4 .5] [.5 .6]	[.1 .2 .3 .4 .5 .6] [.5 .6] [.3 .4] [.1 .2]	[.4 .5 .6 .7 .8 .9] [.7 .8] [.2 .3] [.1. .2]
A_2	[.5 .6 .7 .8 .6 .9 1.0] [.4 .5] [.3 .4] [.1 .2]	[.1 .2 .3 .4 .5 .6.] [.4 .8] [.2 .3] [.1 .2]	[.3 .4 .5 .6 .7 .8] [.5 .7] [.1 .2] [.1 .2]	[.2 .3 .4 .5 .6 .7] [.6 .7] [.3 .4] [.2 .3]
A_3	[.1 .2 .3 .4 .5 .6] [.7 .8] [.3 .4] [.1 .2]	[.2 .3 .4 .5 .6 .7] [.4 .5] [.2 .3] [.1 .2]	[.4 .5 .6 .7 .8 .9] [.6 .7] [.4 .5] [.2 .3]	[..3 .4 .5 .6 .7 .8] [.8. .9] [.2 .4] [.1 .3]
A_4	[.4 .5 .6 .7 .8 .9] [.5 .6] [.2 .3] [.2 .3]	[.5 .6 .7 .8 .9 1.0] [.7 .8] [.1 .2] [.1 .2]	[.3 .4 .5 .6 .7 .8] [.4 .5] [..3 .4] [.2 .3]	[.2 .3 .4 .5 .6 .7] [.5 .8] [.3 .5] [.1 .2]

The importance of attributes $C_j\,(j=1,2,3,4)$ are given by

$$W=\begin{bmatrix}[.2\ \ .3.4\ .5\ .6\ .7][.5\ .6][.3\ .4][.2\ .3]\\ [.1.2\ \ .3.4\ .5\ .6\ ][.4\ .5.][.2\ .3\,][.2\ .3]\\ [\,.3.4\ .5\ .6\ .7\ \ .8][5.\ .6][.3\ .4][.2\ .3]\\ [.4\ .5\ .6\ .7\ \ .8\ .9][\,.3\ .5.][.2\ \ .4][.1\ .3]\end{bmatrix}$$

$$=\ \tilde{w}_1,\tilde{w}_2,\tilde{w}_3,\tilde{w}_4,-------(6)$$

Step-1: Determine the weights of attributes

Using equation (1) and Equation (2), we obtain the distance vector with respect to ideal interval neutrosophic trapezoidal number as: $\Lambda=[0.7075.,0.7725,0.6425,0.5775]$

Utilizing equation (3) and equation (4), we obtain the weight vector of the attributes:

W= {0.2481, 0.2482, 0.2503, 0.2532}.

Step-2: Determine the aggregated weighted distances for each alternative

Using equation (6) and the weight vector, we obtain the aggregated weighted distances of alternatives: $\Delta(A_1,\tilde{I}^+)=0.6678,\Delta(A_2,\tilde{I}^+)=0.6269,\Delta(A_3,\tilde{I}^+)=0.6447,.\Delta(A_4,\tilde{I}^+)=0.5798$

Step -3: Rank the alternatives

Smaller value of distance indicates the better alternative. So the ranking of the alternatives appear as: $A_4\geq A_2\geq A_3\geq A_1$. The ranking order reflects that A_4 is the supplier for the considered problem. Therefore the company A_4 is the best alternative

4.1. Conclusions:

In this paper we have proposed interval valued hexagonal neutrosophic number and we have developed a MADM problem based on hamming distance and ideal solution .This has been presented with an illustrative example and its application is demonstrated.

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MODIFIED METHODOLOGY OF FUZZY TOPSIS

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Abstract:

Fuzzy TOPSIS is a multi-criteria decision making tool to find the best option from all the alternatives. In this paper, the ranking of the alternatives has been evaluated and modified by means of correlation coefficient to determine closest approximation and illustrated with a practical example.

Key words– DecisionMaking, Triangular fuzzy number,correlation coefficient.

1. Introduction:

As there exists several methods in solving decision making problems. TOPSIS was one of the classical methods, It was developed by Hwang and Yoon[8] in solving a MCDM problems and the ratings and weights of the criteria were given as crisp values. In addition to this C.T.Chen [5] has extended the concept of TOPSIS to develop a methodology for solving multi-criteria decision making problems in fuzzy environment. Considering the fuzziness in the decision making process linguistic variables were used to access the weights of all criteria and the ratings of each alternative

with respect to each criterion. On the basis of the fuzzy TOPSIS, the fuzzy positive ideal solution(FPIS) and the fuzzy negative ideal solution (FNIS) were defined and distance of each alternative were calculated and the ranking order of the alternatives has been determined. In recent years, several MCDM[2][3] techniques and approaches have been suggested in order to choose the probable optimal options. An extension to the fuzzy multiple criteria decision making (MCDM) model is suggested in this work, where the ratings of alternatives versus criteria, and the importance weights of all criteria, are assessed in linguistic values represented by fuzzy numbers.

In this paper, using the proposed distance of each alternative between two triangular fuzzy ratings from the FPIS and FNIS are calculated and the ranking order of the alternatives is determined using the correlation coefficient and is illustrated with the numerical example.

2. Preliminaries:

Definition2.1

Let $\widehat{A} = (a_1, a_m, a_2)$ and $\widehat{B} = (b_1, b_m, b_2)$ be two triangular fuzzy numbers. Then the distance between $\widehat{A}$ and $\widehat{B}$ is defined [7] as $d(\widehat{A}, \widehat{B}) = {}^{1}/_{2}\{\max(|a_1 - b_1|, |a_2 - b_2|) + |a_m - b_m|\}$

Definition 2.2

Let $\widehat{A}$ and $\widehat{B}$ be two triangular fuzzy numbers. Then the fuzzy number $\widehat{A}$ is closer to fuzzy number $\widehat{B}$ as $d(\widehat{A}, \widehat{B})$ approaches 0.

3. ALGORITHM FOR THE PROPOSED METHOD:

The procedure of fuzzy TOPSIS is similar to the classic one and can be expressed in a series of steps:

Step-1:Construct the normalized decision matrix.

In the fuzzy environment, in order to avoid the complicated normalization formula used in classical TOPSIS, simple formulas are used to transform the various criteria scales into a comparable scale. The linear scale transformation [5] is:

$$r_{ij} = \left[\frac{a_{ij}}{c_{j*}}, \frac{b_{ij}}{c_{j*}}, \frac{c_{ij}}{c_{j*}}\right],\ j \in B \quad \text{and} \quad c_j * = max\, c_{ij} \quad \text{---------- (3.1)}$$

$$r_{ij} = \left[\frac{\hat{a}}{c_{ij}}, \frac{\hat{a}}{b_{ij}}, \frac{\hat{a}}{a_{ij}}\right],\ j \in C \quad \text{and} \quad \hat{a} = \min a_{ij} \quad \text{---------- (3.2)}$$

Step-2. Construct the weighted normalized decision matrix.

$\widehat{v_{ij}} = r_{ij}(.)w$, i = 1, 2, … m, j = 1, 2, … n ---------- (3.3)

Step-3. Determine the fuzzy ideal and fuzzy negative-ideal solutions.

$A^+ = (\widehat{v_1}*, \widehat{v_2}*, \ldots\ldots\ldots \widehat{v_n}^*)$ ---------- (3.4)

$A- = (\widehat{v_1}, \widehat{v_2}, \ldots\ldots\ldots \widehat{v_n})$ ---------- (3.5)

Where $\widehat{v_j}^* = (1,1,1)$ and $\widehat{v_j} = (0,0,0)$, j = 1,2,…..n ---------- (3.6)

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The distance of each alternative from A^+ and A^- can be calculated as

$$d_i^+ = \sum_{j=1}^{n} d(\widehat{v_{ij}}, \widehat{v_j}^*), \quad i = 1,2,,,,,,,,m \quad \text{---------- (3.7)}$$

$$d_i^- = \sum_{j=1}^{n} d(\widehat{v_{ij}}, \widehat{v_j}), \quad i = 1,2,,,,,,,,m \quad \text{---------- (3.8)}$$

Where d(.,.) is the distance measurement between two fuzzy numbers

Step-4:Once the d_i^+ and d_i^- of each alternative A_i(i=1,2,….m) has been calculated, a closeness coefficient is defined to determine the ranking order of all alternatives.

The Closeness coefficient of each alternative is calculated as

$CC_i = \frac{d_i^-}{d_i^+ + d_i^-}$, i=1,2,…..m ----------(3.9)

As CCi approaches to 1, according to the closeness coefficient, we can determine the ranking order of all alternatives and select the best one from among a set of feasible alternatives.

Step-5: Though we have already determined the closeness coefficient, a positive correlation for the priority vector has been determined using the correlation coefficient (i.e) it determines themeasure of thestrength of the relationship between the separation measures, which gives the best alternative . It has been calculated using the formula

$$r = \sum \frac{d_i^+ d_i^-}{\sqrt{d_i^{+2}} * \sqrt{d_i^{-2}}} \quad \text{---------- (3.10)}$$

where r lies between -1 and 1

4. Numerical Example:

Selecting the 'right' engineering college is a big decision, both for students and their family. The parents and students has to take a decision for good career path.In order to choose the best college ,several criteria can be considered such as (i)Cost (Tuition,/Hostel), (ii)Facilities(Hostel, Cafetria, Extra curricular) (iii)Placements &Internships (iv) Faculty (v)Location /accessibility . If the student had to choose between three engineering colleges for the same engineering branch, the better established college should be the choice. The hierarchical structure of the problem is purely based on the above criteria and the alternatives are the three different engineering colleges. In order to solve this problem the three engineering experts D1,D2 and D3 evaluated three types of colleges namely A, B and C and given their evaluations in linguistic variables with respect to the objectives(ie.)Cost (C1), Facilities (C2), Placements & Internships (C3), Faculty (C4) and location of the college (C5)

The three decision makers use the seven points scale linguistic variables whose values are given as triangular fuzzy numbers to express the importance weight / priority to five criteria given by

4.1 Linguisticvariables:

Fuzzy number	Linguistic variables (level of measures taken in all states)
(0,0,0.1)	Very Low (VL)
(0,0.1,0.3)	Low (L)
(0.1,0.3,0.05)	Medium Low (ML)
(0.3,0.5,0.7)	Medium (M)
(0.5,0.7,0.9)	Medium High (MH)
(0.7,0.9,1.0)	High (H)
(0.9,1.0,1.0)	Very High (VH)

Table -4.1

The assessment of the criteria importance by the decision makers are given by

Criteria/Alternatives	D1	D2	D3
C1	H	VH	VH
C2	H	H	H
C3	MH	H	MH
C4	MH	MH	MH
C5	H	H	H

Table – 4.2

Based on the above assessment and using the given values of the linguistic variables, the fuzzy weight of each criterion j is determined.

The ratings of the best Engineering college has been normalized by (3.3) fuzzy decision matrix based on all criteria are determined as follows

Criteria/Alternatives	C1	C2	C3	C4	C5
A	(0.4731,0.553,0.57)	(0.22,0.69,0.88)	(0.297,0.56,0.83)	(0.38,0.65,0.9)	(0.21,0.45,0.7)
B	(0.83,0.97,1)	(0.63,0.9,1)	(0.39,0.68,0.932)	(0.35,0.63,0.9)	(0.44,0.75,0.97)
C	(0.664,0.776,0.8)	(0.48,0.77,0.97)	(0.38,0.65,0.89)	(0.414,0.68,0.9)	(0.49,0.81,1)

Table-4.3

Taking the fuzzy positive and fuzzy negative ideal solutions, we determine the distance of each alternative from the positive and negative solution from (3.7) & (3.8) and the separation measures for the alternatives are determined as follows

Alternatives	d_i^+	d_i^-
A	2.7585	3.3915
B	1.715	4.366
C	1.948	4.118

Table-4.4 Separation Measures

The Closest coefficient is given by (3.9) (i.e) CC1 $=\frac{3.3915}{3.7585+3.3915} = 0.5514$

CC2 $= \frac{4.366}{1.715+4.366} = 0.7179$

CC3 $=\frac{4.118}{1.9478+4.118} = 0.67886$

According to the closeness coefficient , the ranking order of the three alternatives is B >C>A.In order to strengthen the ranking, we determine the correlation coefficient using the formula (3.10). Hence the correlation coefficient r= $\frac{24.8663}{\sqrt{14.345}*\sqrt{47.522}} = 0.9524$

As the correlation coefficient of r lies between -1 and 1 , the ranking priority gives the more closest relationship between the separation measures which is alternative B , hence the best Option is Engineering college B.

5. Conclusion:

In this paper, the concept of fuzzy TOPSIS, has been discussed and using the proposed distance method , the distance of each alternative from the FPIS and FNIS are calculated and the ranking order of the alternatives is determined using the correlation coefficient to strengthen the closest approximation of the best alternative. A numerical example on selection of the right engineering college is used to illustrate this proposed method.

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Trapezoidal Neutrosophic Numbers in Game Theory

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Abstract:

The objective of this paper is to propose single valued trapezoidal neutrosophicnumbersin game theory. The single valued trapezoidal neutrosophic payoff matrix is reduced to a crisp pay off matrix using score function and then the game is solved. Corresponding numerical example is illustrated.

Keywords:**N**eutrosophic numbers,Single Valued Trapezoidal Neutrosophic Matrix,Game Theory.

1. Introduction:

Zadeh [9] was the first to propose the fuzzy set (FS) todeal with the fuzzy information,because the fuzzy set considered only the membership degree and does not take the non-membership degree into account, Atanassov [1] further proposed the intuitionistic fuzzy set (IFS) which was used to overcome the shortcoming of the FS. In other words, theintuitionistic fuzzy set (IFS) consisted of membership degree and non-membership degree. Similar tothe FS, IFS paid more attention to the membership degree and non-membership degree and did notconsider the indeterminacy-membership degree. On the basis of the intuitionistic fuzzy set,Smarandache [5] further proposed theneutrosophic numbers (NNs).Single valued neutrosophic numbers are a special case of single valued neutrosophic sets and are ofimportance for a neutrosophicmultiattribute decision making problems. Wang et al. [8] proposed asingle valued neutrosophic set and Irfan Deli, Yusuf S¸uba¸ [2]defined the concept of single valued neutrosophic numbers, single valued trapezoidal neutrosophic numbers and single valued triangular neutrosophic numbers with operations. In this paper, we introduce single valued trapezoidal neutrosophic matrix (SVNM) with its arithmetic operations and solved the game theory problems with SVNM.

2. Preliminaries:

Definition2.1.

Let E be a universe. A single valued neutrosophicset(SVNS) A ,which can be used in real scientific and engineering applications, Here E is characterized by a truth-membership function

T_A, a indeterminacy-membership function I_A and a falsity-membership function F_A. $T_A(x)$; $I_A(x)$ and $F_A(x)$ are real standard elements of [0, 1]. It can be written as

$A = \{< x, (T_A(x), I_A(x), F_A(x)) >: x \in E, T_A(x), I_A(x), F_A(x) \in [0, 1]\}$.

There is no restriction on the sum of $T_A(x)$; $I_A(x)$ and $F_A(x)$, So $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$.

Definition2.2.

A single valued trapezoidal neutrosophic number $\bar{a} = \langle (a, b, c, d); w_{\bar{a}}, u_{\bar{a}}, y_{\bar{a}} \rangle$ is a special neutrosophic set on the real number set R, whose truth-membership, indeterminacy-membership, and a falsity-membership are given as follows:

$$\mu_{\bar{a}}(x) = \begin{cases} \frac{w_{\bar{a}}(x-a)}{(b-a)} & a \leq x \leq b \\ w_{\bar{a}} & b \leq x \leq c \\ \frac{w_{\bar{a}}(d-x)}{(d-c)} & c \leq x \leq d \\ 0 & otherwise \end{cases}$$

$$\vartheta_{\bar{a}}(x) = \begin{cases} \frac{b-x+u_{\bar{a}}(x-a)}{(b-a)} & a \leq x \leq b \\ u_{\bar{a}} & b \leq x \leq c \\ \frac{x-c+u_{\bar{a}}(d-x)}{(d-c)} & c \leq x \leq d \\ 1 & otherwise \end{cases}$$

$$\lambda_{\bar{a}}(x) = \begin{cases} \frac{b-x+y_{\bar{a}}(x-a)}{(b-a)} & a \leq x \leq b \\ y_{\bar{a}} & b \leq x \leq c \\ \frac{x-c+y_{\bar{a}}(d-x)}{(d-c)} & c \leq x \leq d \\ 1 & otherwise \end{cases}$$

Definition2.3.

Let $\bar{a} = \langle (a, b, c, d); w_{\bar{a}}, u_{\bar{a}}, y_{\bar{a}} \rangle$ be a single valued trapezoidal neutrosophic number then the score function is defined as

$$S(\bar{a}) = \frac{1}{16}(a + b + c + d)(2 + w_{\bar{a}} - u_{\bar{a}} - y_{\bar{a}})$$

3. Single Valued Trapezoidal Neutrosophic Matrix:

A Single valued Trapezoidal Neutrosophic Matrix (SVTNM) is defined as

$\bar{M} = (\bar{m}_{ij})_{m \times n}$ where $\bar{m}_{ij} = \langle (a_{ij}, b_{ij}, c_{ij}, d_{ij}); w_{\bar{m}_{ij}}, u_{\bar{m}_{ij}}, y_{\bar{m}_{ij}} \rangle$

3.1Single Valued Trapezoidal Neutrosophic MatrixGames :

Consider a game with $m \times n$ payoff matrix whose elements are single valued trapezoidal neutrosophic numbers $\bar{a}_{ij} = \langle (a_{ij}, b_{ij}, c_{ij}, d_{ij}); w_{\bar{a}_{ij}}, u_{\bar{a}_{ij}}, y_{\bar{a}_{ij}} \rangle$

Step 1:

Convert each neutrosophic cost into crisp value by the score function and obtain the classicalpayoff matrix.Calculate the score function of each element in the payoff matrix using the formula

$S(\bar{a}_{ij}) = \frac{1}{16}(a_{ij} + b_{ij} + c_{ij} + d_{ij})\left(2 + w_{\bar{a}_{ij}} - u_{\bar{a}_{ij}} - y_{\bar{a}_{ij}}\right)$ for all i and j

If $S(\bar{a}_{ij}) < S(\bar{a}_{jk})$ then $\bar{a}_{ij} < \bar{a}_{jk}$

Step 2:

Check whether a saddle point exists in the payoff matrix.If it exists,the solution can be obtained by applying maximin and minimax principle.

Step 3:

If the saddle point does not exist, apply the dominance property and reduce the game. Comparison of column strategies and row strategies can be done by using score function.

(i) The Game may reduce to a single cell giving information about the value of the game and optimal strategies of players.

(ii) The game may reduce to a 2× 2 matrix without a saddle point and hence it can be solved using mixed strategy.

Example 3.1.1:

Consider the game with payoff matrix whose elements are SVTN with saddle point

$$\text{BA}\begin{pmatrix} \langle(1,4,5,6);\,0.9,0.5,0.1\rangle & \langle(0,1,3,4);\,0.6,0.3,0.7\rangle \\ \langle(2,5,6,7);\,0.5,0.3,0.8\rangle & \langle(1,3,4,5);\,0.4,0.5,0.7\rangle \end{pmatrix}$$

Solution:

Calculate the scorefunction for each SVTN,thenthe matrix reduces to the2× 2 matrix as

$$\text{BA}\begin{pmatrix} 2.3 & 0.8 \\ 1.75 & 0.975 \end{pmatrix}$$

Here, Row Minimum =(0.8,0.975) and Column Maximum=(2.3, 0.975)

Maximin$\underline{v}$ = 0.975 Minimax$\bar{v}$ =0.975

Maximin=Minimax

Hence value of the game is v = 0.975 and Saddle point is (2,2)

Example 3.1.2:

Consider the game with 2× 2 payoff matrix whose elements are SVTN with no saddle point

$$\text{BA}\begin{pmatrix} \langle(1,4,5,6);0.6,0.5,0.1\rangle & \langle(6,7,9,10);0.9,0.3,0.1\rangle \\ \langle(5,8,9,10);0.6,0.1,0.5\rangle & \langle(1,2,3,4);0.6,0.3,0.7\rangle \end{pmatrix}$$

Calculate the score function for each SVTN,then the matrix reduces to the2×2 matrix as

$$\text{BA}\begin{pmatrix} 2 & 5 \\ 4 & 1 \end{pmatrix}$$

Since the saddle point does not exist, we calculate the optimum mixed strategy.

The optimum mixed strategy is $S_A=\begin{bmatrix} A_1 & A_2 \\ p_1 & p_2 \end{bmatrix}$&$S_B=\begin{bmatrix} B_1 & B_2 \\ q_1 & q_2 \end{bmatrix}$

$p_1 = \frac{a_{22}-a_{21}}{a_{11}+a_{22}-(a_{12}+a_{21})} = \frac{1}{2}$ $\quad p_2 = 1 - p_1 = \frac{1}{2}$

$q_1 = \frac{a_{22}-a_{12}}{a_{11}+a_{22}-(a_{12}+a_{21})} = \frac{1}{3}$ $\quad q_2 = 1 - q_1 = \frac{2}{3}$

Value of the game v = $\frac{a_{11}a_{22}-a_{12}a_{21}}{a_{11}+a_{22}-(a_{12}+a_{21})} = 3$

Example 3.1.3:

Consider the game with payoff matrix whose elements are SVTN

$$\begin{pmatrix} \langle(3,4,6,7);0.4,0.7,0.9\rangle & \langle(8,9,11,12);0.9,0.05,0.05\rangle & \langle(2,3,5,7);0.7,0.2,0.3\rangle \\ \langle(10,11,13,14);0.5,0.3,0.2\rangle & \langle(5,7,9,11);0.1,0.5,0.6\rangle & \langle(9,10,11,12);0.86,0.1,0.1\rangle \\ \langle(4,6,10,12);0.8,0.1,0.1\rangle & \langle(2,5,6,7);0.5,0.3,0.8\rangle & \langle(7,8,10,12);0.9,0.2,0.1\rangle \end{pmatrix}$$

Calculate the score for each SVTN, the matrix reduces to

$$\begin{pmatrix} 1 & 7 & 2.3375 \\ 6 & 2 & 6.9825 \\ 5.2 & 1.75 & 6.0125 \end{pmatrix}$$

Since the saddle point does not exist we apply the dominance property.

Row 3 is dominated by row 2 and column 3 is dominated by column 1. We omit row 3 and column 3.The matrix reduces to

$$\begin{pmatrix} 1 & 7 \\ 6 & 2 \end{pmatrix}$$

Since the saddle point does not exist, we calculate the optimum mixed strategy.

Strategy for A = $\left\{\frac{2}{5},\frac{3}{5},0\right\}$ Strategy for A = $\left\{\frac{1}{2},\frac{1}{2},0\right\}$

Value of the game v = 4

4. Conclusion:

In this paper, the single valued trapezoidal neutrosophic matrix has been introduced.The neutrosophic cost is converted into a crisp payoff matrix using the score functions.Then the games involving these single valued trapezoidal neutrosophic matrix is solved. In future it may be

applied to many operations research problems and decision making problems involving indeterminate evaluation information.

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OPTIMIZATION OF REQUIREMENT OF PERSONNEL IN A HOSPITAL USING NEUTROSOPHIC NUMBERS

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Abstract: This paper describes the optimization of personnel in a hospital by using neutrosophic linear programming problem with trapezoidal numbers by ranking function. An illustrative numerical example is presented in order to verify the proposed approach.

Keywords: Trapezoidal neutrosophic number, Linear Programming problem, optimum solution

1 Introduction

In 2012 Hanafy and Salama[3,4,7] introduced and studied some operations on neutrosophic sets and investigated the correlation of neutrosophic data[8]. Atanassov[1, 2] introduced another type of fuzzy sets that is called intuitionistic fuzzy set (IFS) which is more practical in real life situations. Intuitionistic fuzzy sets handle incomplete information i.e., the grade of membership function and non-members hip function but not the indeterminate information and inconsistent information which exists obviously in belief system. Smarandache and Salama[8] introduced another concept of imprecise data called neutrosophic sets. neutrosophic set is a part of neutrosophy which studied the origin, nature and scope of neutralities, as well as their interactions

with ideational spectra. The neutrosophic set generalized the concept of classical fuzzy set[5,9,10], interval-valued fuzzy set, intuitionistic fuzzy set[1, 2], etc. In this paper we discuss neutrosophic linear programming problem.

2 Preliminaries

2.1 Definition[6]

Let X be a fixed set. A neutrosophic set A of X is an object having the form A = $\{x, \mu_A(x), \nu_A(x), \gamma_A(x), x \in X\}$ where the function: μ_A, ν_A *and* γ_A are real standard or non standard subsets of $]^{-}0,1^{+}[$ define respectively the degree of membership. Degree of non-membership and degree of indeterminacy of the element x ∈ X to the set A, which is a subset of X and for every x ∈ X, $^{-}0 \leq {}^{-}0 \leq \mu_A(x) + \nu_A(x) + \gamma_A \leq {}^{+}3$

2.2 Definition[6]

Let X be a universe of discourse, a trapezoidal neutrosophic set $\tilde{A}$ in X is defined as the following form: $\tilde{N} = \{\langle x, T_{\tilde{N}}(x), I_{\tilde{N}}(x), F_{\tilde{N}}(x)\rangle \mid x \in X\}$, where $T_{\tilde{N}}(x) \subset [0,1]$, $I_{\tilde{N}}(x) \subset [0,1]$ and $F_{\tilde{N}}(x) \subset [0,1]$ are three trapezoidal fuzzy numbers with the condition $0 \leq T_{\tilde{N}}(x) + I_{\tilde{N}}(x) + F_{\tilde{N}}(x) \leq 3$, xϵX. For convenience, the three trapezoidal fuzzy numbers are denoted by $T_{\tilde{N}}(x)$ = (a,b,c,d), $I_{\tilde{N}}(x)$ = (e,f,g,h) and $F_{\tilde{N}}(x)$ = (l,m,n,p).

Thus a trapezoidal number is denoted by $\tilde{n}$ = <(a,b,c,d), (e,f,g,h),(l,m,n,p)> which is a basic element in the trapezoidal neutrosophic set.

2.3 Formulation of neutrosophic linear programming problem (NLPP)

The general form of optimization problem with Neutrosophic objective function and Neutrosophic constraints is given by

$$\min\ z_k(\tilde{A}) = \sum_{j=1}^{n} \tilde{c}_j^{\,k} x_j \quad \text{, Where } k = 1,2,3,.....,K$$

$$\text{subject to } \sum_{i=1}^{n} \tilde{a}_{ij} x_j \geq \tilde{k}_i,\ i = 1,2,3,.....,m\ ; \quad j = 1,2,3,.....,n$$

$$x_j \geq 0,\ j = 1,2,3,....,n.$$

2.4 Ranking of Trapezoidal neutrosophic Number

Let $\tilde{n}$ = <(a,b,c,d),(e,f,g,h),(l,m,n,p)> be a trapezoidal neutrosophic number. The average representation of this Neutrosophic trapezoidal numbers is given by R($\tilde{n}$) where

$$\mathrm{R}(\tilde{n}) = \frac{a+b+c+d}{4} \times \frac{e+f+g+h}{4} \times \frac{l+m+n+p}{4}$$

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3 Neutrosophic linear programming problem

This section extends a trapezoidal neutrosophic linear programming problem, which is a preferred practice.

3.1 Algorithm for solving neutrosophic linear programming problem

Step 1: Formulate the linear programming problem as

$$\min\ z_k(\tilde{A}) = \sum_{j=1}^{n} \tilde{c}_j^{\,k} x_j$$

subject to

$$\sum_{i=1}^{n} \tilde{a}_{ij} x_j \le \tilde{k}_i,\ i = 1,2,3,.....,m;\quad j = 1,2,3,.....,n$$

Step 2: Convert the formulation into neutrosophic linear programming problem.

Step 3: Convert the neutrosophic linear programming problem into crisp linear programming problem by ranking

Step 4: Compute the net Evaluations by using the relation $\tilde{z}_j - \tilde{c}_j = \tilde{c}_B \tilde{a}_j - \tilde{c}_j$ and examine the sign of $\tilde{z}_j - \tilde{c}_j$

(a) If all $\tilde{z}_j - \tilde{c}_j \ge 0$ then the solution is optimal solution.

(b) If atleast one $\tilde{z}_j - \tilde{c}_j < 0$ then the solution is not optimal.

Step 5: Go to step 2 until you get optimal solution.

3.2 Numerical Problem

Consider a hospital that is open on all seven days in a week. Based on the present patients admission, the number of nurses required for a particular day is given as follows.

Decision Variable	x_1	x_2	x_3	x_4	x_5	x_6	x_7
Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat
No. of Nurses	100	200	150	250	90	160	300

Every nurse works five consecutive days, and then takes two days off, repeating this cyclic pattern continuously. Here we calculate the optimum requirement of Nurses as per the patient intake. Let x_1 be number of nurses starting duty on Sunday (Sunday – Thursday), x_2 be number of nurses starting duty on Monday (Monday – Friday) etc.

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Solution:

Step 1: Let x_i be the number of workers who begin their five day shift on day i.

By formulating the given problem

$$\min z = x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7$$

subject to,

$$\begin{aligned}
&x_1 + x_4 + x_5 + x_6 + x_7 \geq 100\\
&x_1 + x_2 + x_5 + x_6 + x_7 \geq 200\\
&x_1 + x_2 + x_3 + x_6 + x_7 \geq 150\\
&x_1 + x_2 + x_3 + x_4 + x_7 \geq 250\\
&x_1 + x_2 + x_3 + x_4 + x_5 \geq 90\\
&x_2 + x_3 + x_4 + x_5 + x_6 \geq 160\\
&x_3 + x_4 + x_5 + x_6 + x_7 \geq 300\\
&x_1, x_2, x_3, x_4, x_5, x_6, x_7 \geq 0
\end{aligned}$$

Step 2: Linear programming is converted to neutrosophic linear programming problem where

c_i =1where i = 1,2,3,4,5,6,7 is taken as ((0.2, 0.3, 0.4, 0.5)(0.4, 0.5, 0.6, 0.7)(0.6, 0.7, 0.7, 0.8))

$$\begin{aligned}
\min z = {} & ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_1 +\\
& ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_2 +\\
& ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_3 +\\
& ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_4 +\\
& ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_5 +\\
& ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_6 +\\
& ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_7
\end{aligned}$$

subject to

$$\begin{aligned}
&((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_1 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_4\\
&+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_5 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_6\\
&+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_7 \geq 100
\end{aligned}$$

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$((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_1 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_2$
$+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_5 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_6$
$+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_7 \geq 200$

$((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_1 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_2$
$+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_3 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_6$
$+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_7 \geq 150$

$((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_1 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_2$
$+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_3 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_4$
$+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_7 \geq 250$

$((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_1 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))_2$
$+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_3 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_4$
$+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_5 \geq 90$

$((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_2 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_3$
$+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_4 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_5$
$+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_6 \geq 160$

$((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_3 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_4$
$+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_5 + ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_6$
$+ ((0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5)(0.2,0.3,0.4,0.5))x_7 \geq 300$

$x_1, x_2, x_3, x_4, x_5, x_6, x_7 \geq 0$

Step 3: Neutrosophic linear programming problem is converted to crisp linear programming problem by using ranking function

$$\min z = 0.13x_1 + 0.13x_2 + 0.13x_3 + 0.13x_4 + 0.13x_5 + 0.13x_6 + 0.13x_7$$

subject to,

$$0.13x_1 + 0.13x_4 + 0.13x_5 + 0.13x_6 + 0.13x_7 \geq 100$$
$$0.13x_1 + 0.13x_2 + 0.13x_5 + 0.13x_6 + 0.13x_7 \geq 200$$
$$0.13x_1 + 0.13x_2 + 0.13x_3 + 0.13x_6 + 0.13x_7 \geq 150$$
$$0.13x_1 + 0.13x_2 + 0.13x_3 + 0.13x_4 + 0.13x_7 \geq 250$$

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$$0.13x_1 + 0.13x_2 + 0.13x_3 + 0.13x_4 + 0.13x_5 \geq 90$$
$$0.13x_2 + 0.13x_3 + 0.13x_4 + 0.13x_5 + 0.13x_6 \geq 160$$
$$0.13x_3 + 0.13x_4 + 0.13x_5 + 0.13x_6 + 0.13x_7 \geq 300$$
$$x_1, x_2, x_3, x_4, x_5, x_6, x_7 \geq 0$$

Step 4: The crisp linear programming is thus solved and the solution is min z = 303, $x_1 = 0$,$x_2 = 25.64$, $x_3 = 794.84$, $x_4 = 0$, $x_5 = 410.26$, $x_6 = 0$ and $x_7 = 1102.56$

Hence the hospital could give the first preference to the shift from Saturday and the last preference to the shift from Tuesday to minimize and optimize the number of nurses in a duty.

4 Conclusion

Nurses shift allotment is an important aspect in running of a Hospital. The resulting schedule includes balanced schedules in terms of the distribution of shift duties, fairness in terms of the number of consecutive night duties and the preferences of the nurses. The finding of this research enables optimum utilization of the available resources, increase in the efficiency of the services provided by the nurses and maximum profit with minimum resources. This research paper can be further extended to all the other fields of work which pursue shift system.

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Vague soft matrix in decision making problems

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Abstract: This paper aims to use vague soft matrices in decision making problems

Key words: vague soft matrix, vague soft matrix product, VSMmDM algorithm

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Notations: VSM, VSMmDM denote respectively vague soft matrix and vague soft max- minimum decision making method

1. Introduction

Russian researcher Molodtsov [1] introduced soft set theory in 1999 to deal with uncertainties and vagueness where two point crisp set always fails. Maji et. al [2] discussed some of its operations and introduced it in decision making problems. In its developmental stages, soft set theory has undergone through many modifications in its operations. Some of these operations are found helpful in uni-int decision making method.

In this modern era, matrix theory found very useful for computational purposes, especially in computers. Matrices are easy to store and manipulate datas in computer memory. Soft matrix theory developed and soft max-min decision making method developed. Hybrid structures like fuzzy soft [1], soft fuzzy [1], vague soft, soft vague, neutrosophic intutionistic are also developed in different directions. Maji et al. presented the idea of fuzzy soft set by embedding the ideas of fuzzy sets. Using fuzzy soft set theory Cagman and Enginoglu [3] introduced fuzzy soft matrix theory in 2012 with its application in decision making problems. Borah et al [4] extended fuzzy soft matrix theory. Later in 2014 R.Nagarajan and K. Balamurugan [5] gave a different decision making approach for solving fuzzy soft matrix. In 2014 R. Rajarajeswari & P.Dhanalakshmi [6] proposed interval valued soft matrix theory on the basis of weights. So soft matrix theory has an important place in the developmental scenario of soft set theory. In this paper, through vague soft matrix theory , one real life application for decision making problems are presented.

2. Preliminaries

Definition 2.1 [1](Vague set)

A vague set A in the universe of discourse U=$\{u_1, u_2, \ldots\ldots, u_n\}$ is characterized by 2 membership functions given by
(1) a truth membership function t_A: U $\longrightarrow$ [0,1]
(2) a false membership function f_A: U$\longrightarrow$ [0,1]

where $t_A(u_i)$ is a lower bound of the grade of membership of $u_i$derived from the " evidence for u_i" and $f_A(u_i)$ is a lower bound on the negation of u derived from the "evidence against u_i" and $t_A(u_i)$+$f_A(u_i)$1. Thus the grade of membership of u_i in the vague set A is bounded by a sub-interval $[t_A(u_i), 1-f_A(u_i)]$ of [0,1]. This indicates that if the actual grade of membership is $\mu(u_i)$ then $t_A(u_i)\mu(u_i)f_A(u_i)$. The vague set A is written as A ={$(u_i,[t_A(u_i),1-f_A(u_i)])/ u_i$∈U}, where interval $[t_A(u_i), 1-f_A(u_i)]$ is called the vague value of u_i in A denoted by $V_A(u_i)$

Definition 2.2 [2]**(Soft set)**

Let U be the initial universe and E be the set of parameters. Let P(U) denote the power set of U and A be a non-empty subset of E. A pair (F,A) is called a soft set over U where F is a mapping given by F: A ⟶P(U)

Definition 2.3 [4](Fuzzy soft set)

Let U be an initial universe and E be the set of parameters. Let A ⊆ E. A pair (F, A) is called fuzzy soft set over U where F is a mapping given by F: A⟶I^U, where I^U denotes the collection of all fuzzy subsets of U

Definition 2.4 [3] (Vague soft set)

Let U be a universe, E be a set of parameters, V(U) be the power set of vague set on U and A⊆B.A pair (F,A) is called a vague soft set over U where F is a mapping given by F:A⟶V(U). In other words, a vague soft set over U is a parameterized family of vague sets of the universe U. For e∈A, $\mu_{F(e)}$:U⟶[0,1] is regarded as the set of e-approximate elements of the vague soft sets.

Definition 2.5 [5] (Fuzzy soft matrix)

Let U ={c_1, c_2, c_3------, c_m} be the universal set and E be the set of parameters given by E={e_1,e_2,e_3,---------e_n}. Let A ⊆ E and (F, A) be a fuzzy soft set in the fuzzy soft class (U, E). Fuzzy soft set (F, A) in matrix form is given as

$A_{m\times n}$= $[a_{ij}]_{m\times n}$ or A = $[a_{ij}]$, i =1,2,-----,m ; j =1,2,-----n; a_{ij} = $\begin{cases} \mu_j(c_i) \text{ if } e_j \in A \\ 0 \quad \text{if } ej \notin A \end{cases}$

μ_j (c_i) represents the membership of c_i in the fuzzy set F(e_j)

Definition 2.6 [6] (Vague Soft Matrix)

Let U ={u_1, u_2, u_3, --------, u_m} be the universal set and E be the set of parameters E={e_1, e_2, e_3, ---------, e_n}. Let A ⊆ E and (F, A) be a vague soft set in the vague soft class (U, E). Then vague soft set (F, A) in a matrix form as

$A_{m\times n}$ = $[a_{ij}]_{m\times n}$ or A =$[a_{ij}]$, i=1, 2, -----, m; j=1, 2, -----n where a_{ij} = $\begin{cases} V_{A_j}(u_i) \text{if } e_j \in A \\ [0,\ 0] \text{ if } e_j \notin A \end{cases}$

Example 2.7

Let U_1= {b_1, b_2, b_3}be food varieties for break-fast Mr. X prefer . Add a parameter set for characteristics of different hotels say, E={e_1 = luxury, e_2= famous, e_3= warm serviced, e_4= early check-in and late check-out, e_5= honest information, e_6= hospitality}. Mr X prefers the parameter set A={e_3,e_6}

Vague soft set according to his interest is given by,

(F, A) = $\left\{\left(e_3, \left(\langle \frac{[0.3,0.5]}{b_1}, \frac{[0.5,0.7]}{b_2}, \frac{[0.7,0.9]}{b_3} \rangle\right)\right), \left(e_6, \left(\langle \frac{[0.4,0.6]}{b_1}, \frac{[0.6,0.8]}{b_2}, \frac{[0.8,0.9]}{b_3} \rangle\right)\right)\right\}$

Vague soft matrix representation of the above is given as follows

$$A = \begin{array}{c} \\ b_1 \\ b_2 \\ b_3 \end{array} \begin{array}{c} \begin{array}{cccccc} e_1 & e_2 & e_3 & e_4 & e_5 & e_6 \end{array} \\ \begin{bmatrix} [0,0] & [0,0] & [0.3,0.5] & [0,0] & [0,0] & [0.4,0.6] \\ [0,0] & [0,0] & [0.5,0.7] & [0,0] & [0,0] & [0.6,0.8] \\ [0,0] & [0,0] & [0.7,0.9] & [0,0] & [0,0] & [0.8,0.9] \end{bmatrix} \end{array}$$

Remark 2.8

Set of all vague soft matrices of order $(m \times n)$ over U is denoted by $VSM_{m\times n}$

3. Product of vague soft matrices

4 special products of vs-matrices are used to construct vs-decision making problems, which is given below

Definition 3.1

Let $[a_{ij}]$, $[b_{ik}] \in VSM_{m\times n}$. Then AND product of $[a_{ij}]$ and $[b_{ik}]$ is defined by
$\wedge_{VSM}: VSM_{m\times n} \times VSM_{m\times n} \rightarrow VSM_{m\times n^2}$

$[a_{ij}] \wedge [b_{ik}] = [c_{ip}]$ where $c_{ip} = \min\{a_{ij}, b_{ik}\}$ such that $p = n(j-1)+k$

Definition 3.2

Let $[a_{ij}]$, $[b_{ik}] \in VSM_{m\times n}$. Then OR product of $[a_{ij}]$ and $[b_{ik}]$ is defined by
$\vee_{VSM}: VSM_{m\times n} \times VSM_{m\times n} \rightarrow VSM_{m\times n^2}$

$[a_{ij}] \vee [b_{ik}] = [c_{ip}]$ where $c_{ip} = \max\{a_{ij}, b_{ik}\}$ such that $p = n(j-1)+k$

Definition 3.3

Let $[a_{ij}]$, $[b_{ik}] \in VSM_{m\times n}$. Then AND-NOT product of $[a_{ij}]$ and $[b_{ik}]$ is defined by
$\overline{\wedge}_{VSM}: VSM_{m\times n} \times VSM_{m\times n} \rightarrow VSM_{m\times n^2}$

$[a_{ij}] \,\overline{\wedge}\, [b_{ik}] = [c_{ip}]$ where $c_{ip} = \min\{a_{ij}, 1-b_{ik}\}$ such that $p = n(j-1)+k$

Definition 3.4

Let $[a_{ij}]$, $[b_{ik}] \in VSM_{m\times n}$. Then OR-NOT product of $[a_{ij}]$ and $[b_{ik}]$ is defined by

$\overline{\vee}_{VSM}: VSM_{m\times n} \times VSM_{m\times n} \rightarrow VSM_{m\times n^2}$

$[a_{ij}] \,\overline{\vee}\, [b_{ik}] = [c_{ip}]$ where $c_{ip} = \max\{a_{ij}, 1-b_{ik}\}$ such that $p = n(j-1)+k$

4. Max-Min Decision making using vague soft matrices

Four types of decision making methods VSMmDM, VSmMDM, VSmmDM, VSMMDM can be used using 'vague soft matrix'. Among them VSMmDM method is used here. For this VSM max-min decision function is defined below.

Definition 4.1
Let $[c_{ip}] \in VSM_{m\times n^2}$, I_k ={p: ∄ I, $c_{ip} \neq [0, 0]$, (k−1)n < p ≤ kn} for all k ∈ I ={1, 2, -------,n}. Then VSM max-min decision function is defined below

Mm: $VSM_{m\times n^2} \rightarrow VSM_{m\times 1}$,

Mm$[c_{ip}]$=[d_{i1}]= [$\underset{k}{max}\{t_{ik}\}$] where $t_{ik} = \begin{cases} \underset{p \in I_k}{min} \{c_{ip}\}; & \text{if } I_k \neq \emptyset \\ [0,0] \quad ; & \text{if } I_k = \emptyset \end{cases}$

One column vs-matrix Mm $[c_{ip}]$ is called max-min decision vs-matrix

Definition 4.2
Let U = {u_1, u_2, ---------,u_m}be an initial universe and Mm$[c_{ip}]$=$[d_{i1}]$. Subset of U can be obtained by using $[d_{i1}]$ as in the following way
$opt_{[d_{i1}]}$(U) = {$\frac{d_{i1}}{u_i}$ / u_i: u_i ∈ U, d_{i1} ≠0}is the optimum vague set on U

Algorithm for VSMmDM method

Step 1: choose feasible subsets of the set of parameters
Step 2: construct the VSM for each set of parameters
Step 3: find a convenient product of the VSM's
Step 4: find a max-min decision VSM
Step 5: find an optimum vague set on U

5. Real life application

Suppose capital city of one country has 5 different choices for hotels for accommodating special guest on the day of a special ceremony say U = {h_1, h_2, h_3, h_4,h_5}. Assume that it is associated with a set of parameters E = {e_1= early check-in and late check-out, e_2= warm service, e_3= hospitality, e_4= honest information}

Step 1:

Suppose two foreign ambassadors say ambassadors for Italy and Germany have selected their parameter set as A = { e_1, e_3, e_4} and B={ e_2, e_3,e_4} respectively

Step 2:

Vague soft matrices constructed according to their choice parameters is given as follows

$$[a_{ij}]_{5\times 4} = \begin{array}{c} \\ h_1 \\ h_2 \\ h_3 \\ h_4 \\ h_5 \end{array} \begin{array}{c} \begin{array}{cccc} e_1 & e_2 & e_3 & e_4 \end{array} \\ \begin{bmatrix} [0.4,0.6] & [0,0] & [0.4,0.6] & [0.5,0.6] \\ [0.5,0.5] & [0,0] & [0.5,0.7] & [0.1,0.9] \\ [0.3,0.4] & [0,0] & [0.6,0.8] & [0.3,0.4] \\ [0.7,0.7] & [0,0] & [0.4,0.6] & [0.6,0.6] \\ [0.2,0.8] & [0,0] & [0.5,0.6] & [0.5,0.7] \end{bmatrix} \end{array}$$

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$$[b_{ik}]_{5\times4} = \begin{array}{c} \\ h_1 \\ h_2 \\ h_3 \\ h_4 \\ h_5 \end{array} \begin{array}{c} \begin{array}{cccc} e_1 & e_2 & e_3 & e_4 \end{array} \\ \begin{bmatrix} [0,0] & [0.6,0.7] & [0.5,0.9] & [0.5,0.6] \\ [0,0] & [0.8,0.8] & [0.6,0.6] & [0.8,0.9] \\ [0,0] & [0.4,0.4] & [0.7,0.8] & [0.7,0.8] \\ [0,0] & [0.5,0.7] & [0.6,0.7] & [0.8,0.9] \\ [0,0] & [0.6,0.8] & [0.8,0.9] & [0.2,0.5] \end{bmatrix} \end{array}$$

Step 3:

AND product for vague soft matrices can be used for finding the product of the above matrices

$[a_{53}]\wedge[b_{53}] = [c_{5,16}]$

$[c_{5,16}] =$

$$\begin{bmatrix} [0,0] & [0.4,0.6] & [0.4,0.6] & [0.4,0.6] & [0,0] & [0,0] & [0,0] & [0,0] & [0,0] & [0.4,0.6] & [0.4,0.6] & [04,0.6] & [0,0] & [0.5,0.6] & [0.5,0.6] & [0.5,0.6] \\ [0,0] & [0.5,0.5] & [0.5,0.5] & [0.5,0.5] & [0,0] & [0,0] & [0,0] & [0,0] & [0,0] & [0.5,0.7] & [0.5,0.6] & [0.5,0.7] & [0,0] & [0.1,0.8] & [0.1,0.6] & [0.1,0.9] \\ [0,0] & [0.3,0.4] & [0.3,0.4] & [0.3,0.4] & [0,0] & [0,0] & [0,0] & [0,0] & [0,0] & [0.4,0.4] & [0.6,0.8] & [0.6,0.8] & [0,0] & [0.3,0.4] & [0.3,0.4] & [0.3,0.4] \\ [0,0] & [0.5,0.7] & [0.6,0.7] & [0.7,0.7] & [0,0] & [0,0] & [0,0] & [0,0] & [0,0] & [0.4,0.6] & [0.4,0.6] & [0.4,0.6] & [0,0] & [0.5,0.6] & [0.6,0.6] & [0.6,0.6] \\ [0,0] & [0.2,0.8] & [0.2,0.8] & [0.2,0.5] & [0,0] & [0,0] & [0,0] & [0,0] & [0,0] & [0.5,0.6] & [0.2,0.5] & [0.2,0.5] & [0,0] & [0.5,0.7] & [0.5,0.7] & [0.2,0.5] \end{bmatrix}$$

Step 4:

$Mm([a_{ij}]\wedge[b_{ik}])=[d_{i1}]$; i=1, 2, 3, 4, 5

d_{11} = max {[0.4, 0.6], [0, 0], [0.4, 0.6], [0.5, 0.6]} = [0.5, 0.6]

d_{21} = max {[0.5, 0.5], [0, 0], [0.5, 0.6], [0.1, 0.6]} = [0.5, 0.6]

d_{31} = max {[0.3, 0.4], [0, 0], [0.4, 0.4], [0.3, 0.4]} = [0.4, 0.4]

d_{41} = max {[0.5, 0.7], [0, 0], [0.4, 0.6], [0.5, 0.6]} = [0.5, 0.7]

d_{51} = max {[0.2, 0.5], [0, 0], [0.2, 0.5], [0.2, 0.5]} = [0.2, 0.5]

$opt_{[d_{i1}]}(U) = \left\{\frac{d_{i1}}{u_i}: u_i \in U, d_{i1} \neq 0\right\}$

$$d_{i1} = \begin{bmatrix} [0.5,0.6] \\ [0.5,0.6] \\ [0.4,0.4] \\ [0.5,0.7] \\ [0.2,0.5] \end{bmatrix}_{5\times1}$$

$opt_{Mm([a_{ij}]\wedge[b_{ik}])}(U) = \{[0.5,0.6] / h_1, [0.5,0.6] / h_2, [0.4,0.4] / h_3, [0.5,0.7] / h_4, [0.2,0.5] / h_5\}$

$= [0.5,0.7] / h_4$

Step 5:

Finally method selects maximum alternative as the final decision. It gives sometimes even a subset of the universal set. In the present case maximum vague membership alternative is

[0.5, 0.7], indicates that subject to the given set of parameters, ambassadors for Italy and Germany book hotel 4.

In the same manner other products $[a_{ij}] \vee [b_{ik}]$, $[a_{ij}] \overline{\wedge} [b_{ik}]$, $[a_{ij}] \overline{\vee} [b_{ik}]$ with suitable decision making functions can be used for other problems.

5. Conclusion

This paper is a continuation of Cagman and Enginoglu's work on fuzzy soft matrix theory done in 2012. With a real-life example, one of the applications of vague soft matrix theory has shown in this paper. It could be further used in different combinations to provide more useful results

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A Study of sgb-frontier in Intuitionistic Fuzzy Topological Spaces

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Abstract: In this paper, we introduce intuitionistic fuzzy sgb-frontier and study some of their properties in intuitionistic fuzzy topological spaces.

Keywords: Intuitionistic fuzzy sgb-frontier, intuitionistic fuzzy sgb Q-neighborhood, intuitionistic fuzzy sgb-adherence, intuitionistic fuzzy sgb-accumulation point and intuitionistic fuzzy sgb-continuous.

1. Introduction

Fuzzy set was introduced by **Zadeh**[17] in 1965 and Intuitionistic fuzzy sets was introduced by **Atanassov**[2] in 1986 .IFS is a sufficiently generalized notion to include both fuzzy sets and vague sets. Fuzzy sets are IFSs but the converse is not necessarily true [2], whereas the notion of vague set defined by **Gau** and **Buehrer** [9] was proven by **Bustince** and **Burillo** [7] to be the same as IFS.

Levine [15] generalized the notion of open sets as semiopen sets. **Azad** [5] carried out this fuzzification in 1981, and thus initiated the study of the concepts of fuzzy semiopen and fuzzy semiclosed sets. The concept of generalized b closed sets due to **Benchalli** and **Jenifer** [6] in intuitionistic fuzzy topology. **Angelin Tidy** and **Francina Shalini** [1] introduced intuitionistic fuzzy sgb-closed sets.

Tang[16] has used fuzzy topology for studying land cover changes in China. Considering the inherent nature of Geographic Information Science (GIS) phenomena, it seems more suitable to study the problem of land cover changes using intuitionistic fuzzy topology. Tang has made a heavy use of the notion of fuzzy boundary. Thus, for recasting the GIS problem in terms of Intuitionistic Fuzzy Topology makes the study of intuitionistic fuzzy frontier imperative.

Athar Kharal [4] studied the notion of frontier in IF topology and establish several of its properties, thus providing sufficient material for researchers to utilize these concepts

fruitfully. The study of weaker forms of different notions of intuitionistic Fuzzy Topology is currently underway [10,11,13]. Using the notion of intutionistic fuzzy semisets, it also define the notion of intuitionistic fuzzy semifrontier and characterize intuitionistic fuzzy semicontinuous functions in terms of intuitionistic fuzzy semifrontier.

In this paper, we use the notion of intutionistic fuzzy sgb- closed sets and we also define the notion of intuitionistic fuzzy sgb-frontier and characterize intuitionistic fuzzy sgb-continuous functions in terms of intuitionistic fuzzy sgb-frontier.

2. Preliminaries

Definition 2.1: [3] Let X be a nonempty fixed set. An intuitionistic fuzzy set (briefly IFS) A is an object of the form $A = \{\langle x, \mu(x), \nu(x)\rangle : x \in X\}$, where μ and ν are degrees of membership

and non-membership of each $x \in X$, respectively, and $0 \leq \mu(x) + \nu(x) \leq 1$ for each $x \in X$. A class

of all the IFS's in X is denoted as IFS(X). When there is no danger of confusion, an

IFS $A = \{\langle x, \mu(x), \nu(x)\rangle : x \in X\}$ may be written as $A = \langle \mu_A, \nu_A\rangle$.

Definition 2.2: [3] Let X be a nonempty set and $A = \langle \mu_A, \nu_A\rangle$, $B = \langle \mu_B, \nu_B\rangle$ IFSs in X. Then

(1) $A \subseteq B$ if $\mu_A(x) \leq \mu_B(x)$ and $\nu_A(x) \geq \nu_B(x)$, for all $x \in X$,

(2) $A = B$ if $A \subseteq B$ and $B \subseteq A$,

(3) $\overline{A} = \{\langle x, \nu_A(x), \mu_A(x)\rangle : x \in X\}$,

(4) $A \cap B = \{\langle x, \mu_A(x) \wedge \mu_B(x), \nu_A(x) \vee \nu_B(x)\rangle : x \in X\}$ [15],

(5) $A \cup B = \{\langle x, \mu_A(x) \vee \mu_B(x), \nu_A(x) \wedge \nu_B(x)\rangle : x \in X\}$[15].

Definition 2.3: [8] IFS's $\tilde{0}$ and $\tilde{1}$ are defined as $\tilde{0} = \{\langle x, 0, 1\rangle : x \in X\}$ and

$\tilde{1} = \{\langle x, 1, 0\rangle : x \in X\}$, respectively.

Definition 2.4: [14] Let $\alpha, \beta \in [0, 1]$ and $\alpha + \beta \leq 1$. An intuitionistic fuzzy point (IFP for short) $x_{(\alpha,\beta)}$ of X is an IFS of X defined by

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$$x_{(\alpha,\beta)}(y) = \begin{cases} (\alpha,\beta) & \text{if} \quad y = x, \\ (0,1) & \text{if} \quad y \neq x. \end{cases} \qquad (1)$$

In this case, x is called the support of $x_{(\alpha,\beta)}$ and α and β are called the value and the nonvalue of $x_{(\alpha,\beta)}$, respectively. An IFP $x_{(\alpha,\beta)}$ is said to belong to an IFS $A = \langle \mu_A, \nu_A \rangle$ in X, denoted by $x_{(\alpha,\beta)} \in A$ if $\alpha \leq \mu_A(x)$ and $\beta \geq \nu_A(x)$. Clearly an intuitionistic fuzzy point can be represented by an ordered pair of fuzzy points as follows:

$$x_{(\alpha,\beta)} = (x_\alpha , 1\text{-}x_{1-\beta}) \qquad (2)$$

A class of all IFP's in X is denoted as IFP(X).

Definition 2.5: [8] An intuitionistic fuzzy topology (IFT for short) on a nonempty set X is a family of IFSs in X satisfying the following axioms:

(1) $\tilde{0}$, $\tilde{1} \in \tau$,

(2) $G_1 \cap G_2 \in \tau$ for any $G_1, G_2 \in \tau$,

(3) $\cup G_i \in \tau$ for any arbitrary family $\{G_i : i \in J\} \subseteq \tau$.

In this case, the pair (X, τ) is called an intuitionistic fuzzy topological space (briefly, IFTS) and members of τ are called intuitionistic fuzzy open (briefly, IFO) sets. The complement $\overline{A}$ of an IFO set A is called an intuitionistic fuzzy closed (IFC) set in X. Collection of all IFO (resp., IFC) sets in IFTS X is denoted as IFO(X) (resp., IFC(X)).

Proposition 2.6: [12] Let X be an IFTS. Then the following hold:

(1) $\tilde{1}, \tilde{0} \in$ IFC(X),

(2) If $A_1, A_2 \in$ IF(X), then $A_1 \in A_2 \in$ IFC(X),

(3) If $\mathcal{A} \subset$ IF(X), then $\cap \mathcal{A} \in$ IFC(X).

Definition 2.7: [8] Let (X, τ) be an IFTS and $A = \langle \mu_A, \nu_A \rangle$ an IFS in X. Then the fuzzy interior and fuzzy closure of A are denoted and defined as

$$\text{Cl } A = \cap \{K : K \text{ is an IFC set in X and } A \subseteq K\} ,$$

$$\text{Int } A = \cup \{G : G \text{ is an IFO set in X and } G \subseteq A\} . \qquad (3)$$

Proposition 2.8: [8] Let (X, τ) be an IFTS and A, B be IFSs in X. Then the following properties hold: (1) Int $\tilde{1} = \tilde{1}$, (Cl $\tilde{0} = \tilde{0}$),

(2) Int A $\subseteq$ A, ($A \subseteq$ Cl A),

(3) $\overline{\text{Int } A} = \text{Cl } \overline{A}$, ($\overline{\text{Cl } A} = \text{Int } \overline{A}$),

(4) Int Int A = Int A, (Cl Cl A = Cl A),

(5) $A \subseteq B \Rightarrow$ Int A $\subseteq$ Int B, ($A \subseteq B \Rightarrow$ Cl A $\subseteq$ Cl B),

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(6) Int (A ∩ B) = Int A ∩ Int B (Cl (A∪B) = Cl A ∪ Cl B),

(7) Int (A ∪ B) ⊇ Int A ∪ Int B, (Cl (A∩B) ⊆ Cl A ∩ Cl B).

Definition 2.9: [1] An IFS A is said to be an intuitionistic fuzzy semi generalized b-closed set (IFSGbCS) if bcl(A) ⊆ U whenever A ⊆ U and U is an IFSOS in (X,τ).

An IFS A is said to be an intuitionistic fuzzy semi generalized b-open set (IFSGbOS) in (X,τ) if the complement A^c is an IFSGbCS in (X,τ).

Definition 2.10: [1] Let (X, τ) be an IFTS and A = ⟨ x, μ_A, ν_A⟩ be an IFS in (X, τ). Then the intuitionistic fuzzy b closure of A (bcl(A)) and intuitionistic fuzzy b interior of A (bint(A)) are defined as bint(A) = ∪ { G / G is an IFbOS in X and G ⊆ A},

bcl (A) = ∩ { K / K is an IFbCS in X and A ⊆ K }.

Definition 2.11: [4] Let X be an IFTS and let A ∈ IFS(X). Then $x_{(\lambda,\mu)}$ ∈ IFP(X) is called an intuitionistic fuzzy frontier point (in short, IFFP) of A if $x_{(\lambda,\mu)}$ ∈ Cl A ∩ Cl $\overline{A}$. The union of all the IFFPs of A is called an IF frontier of A and denoted by Fr A. It is clear that Fr A = Cl A ∩ Cl $\overline{A}$.

Definition 2.12: [4] Let (X, τ) be an IFTS, A ∈ IFS(X) and let $x_{(\lambda,\mu)}$ ∈ IFP(X). Then A is called an intuitionistic Q-neighborhood (in short, IQN) of $x_{(\lambda,\mu)}$ if there is a B ∈ τ such that $x_{(\lambda,\mu)}$qB ⊂ A.The family of all the IQNs of $x_{(\lambda,\mu)}$ is called the system of IQNs of $x_{(\lambda,\mu)}$ and denoted by $\mathcal{N}_{IQ}(x_{(\lambda,\mu)})$.

Definition 2.13: [4] Let X be an IFTS and let A ∈ IFS(X). Then $x_{(\lambda,\mu)}$ ∈ IFP(X) is called an intuitionistic fuzzy adherence point (in short, IFAP) of A if for each U ∈ $\mathcal{N}_{IQ}(x_{(\lambda,\mu)})$, UqA.

Definition 2.14: [4] Let X be an IFTS and A ∈ IFS(X). Then $x_{(\lambda,\mu)}$ ∈ IFP(X) is called an intuitionistic fuzzy accumulation point of A if it satisfies the following conditions:

(1) $x_{(\lambda,\mu)}$ is an IFAP of A,

(2) if $x_{(\lambda,\mu)}$ ∈ A, then for each U ∈ $\mathcal{N}_{IQ}(x_{(\lambda,\mu)})$, U and A are quasi coincident at some point y∈ X such that y ≠ x.

The union of all the intuitionistic fuzzy accumulation points of A is called the derived set of A and is denoted by A^d. It is clear that A^d ⊂ Cl A

Definition 2.15: [4] Let (X, τ) and (Y, ϕ) be two IFTSs and f : X → Y, a function. Then f is said to be intuitionistic fuzzy continuous if the preimage of each IFS in ϕ is in τ..

3.Intuitionistic Fuzzy sgb-frontier

Definition 3.1: Let A be an IFS in IFTS X. Then the intuitionistic fuzzy sgb-frontier of A is defined as *s*gbFr A = bCl A ∩ bCl $\overline{A}$. Obviously, sgbFr A is an intuitionistic fuzzy semi generalized b-closed set.

Theorem 3.2: For IFSs A and B in an IFTS X, one has

(1) $\overline{\text{bInt A}}$ = bCl $\overline{A}$,

(2) $\overline{\text{bCl A}}$ = bInt $\overline{A}$,

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(3) bCl bCl A = bCl A,

(4) bInt bInt A = bInt A,

(5) bInt (A∪B) ⊇ bInt A ∪ bInt B,

(6) bInt (A∩B) = bInt A ∩ bInt B,

(7) bCl (A∪B) = bCl A ∪ bCl B,

(8) bCl (A∩B) ⊆ bCl A ∩ bCl B.

Theorem 3.3: For an IFS *A* in IFTS *X*, the following hold:

(1) sgbFr A = sgbFr $\overline{A}$,

(2) $\overline{\text{sgbFr A}}$ = *s*gbInt A ∪ *s*gbInt $\overline{A}$,

(3) *s*gbFr A ⊆ Fr A,

(4) bCl *s*gbFr A ⊆ Fr A.

Proof:(1) sgbFr A = bCl A ∩ bCl $\overline{A}$ = bCl $\overline{A}$ ∩ bCl A = bCl $\overline{A}$ ∩ $\overline{\text{bCl } \overline{A}}$ = sgbFr $\overline{A}$.

(2) $\overline{\text{sgbFr A}}$ = $\overline{\text{bCl A} \cap \text{bCl } \overline{A}}$ = $\overline{\text{bCl A}} \cup \overline{\text{bCl } \overline{A}}$ = bInt $\overline{A}$ ∪ bInt A.

(3) sgbFr A = bCl A ∩ bCl $\overline{A}$ ⊆ Cl A ∩ Cl $\overline{A}$ [∵ bCl A ⊆ Cl A and bCl $\overline{A}$ ⊆ Cl $\overline{A}$]= Fr A.

(4) bCl sgbFr A = bCl (bCl A ∩ bCl $\overline{A}$) ⊆ bCl bCl A ∩ bCl bCl $\overline{A}$ = bCl A ∩ bCl $\overline{A}$

= sgbFr A ⊆ Fr A

The converse of (3) and (4) of above theorem not true as seen from the following example.

Example 3.4: Let X = {a, b} and let τ = {$0_{\sim}$, G , $1_{\sim}$} be an IFT on (X, τ) where G = ⟨x, (0.2, 0.3), (0.7, 0.6) ⟩. Consider an IFS A = ⟨x, (0.6, 0.5), (0.3, 0.4) ⟩ and $\overline{A}$ = ⟨x, (0.3, 0.4), (0.6, 0.5) ⟩.

Then calculations give, Fr A ⊄ $\overline{A}$ = sgbFr A and Fr A ⊄ $\overline{A}$ = bCl sgbFr A.

Theorem 3.5: Let A be an IFS in IFTS X. Then one has

(1) sgbFr A = bCl A – bInt A,

(2) sgbFr bInt A ⊆ sgbFr A,

(3) sgbFr bCl A ⊆ sgbFr A,

Proof: (1) sgbFr A = bCl A ∩ bCl $\overline{A}$ = bCl A - $\overline{\text{bCl } \overline{A}}$ [∵ $\overline{\text{bCl } \overline{A}}$ = bInt A]= bCl A – bInt A

(2) sgbFr bInt A = bCl bInt A ∩ bCl ($\overline{\text{bInt A}}$) = bCl bInt A ∩ bCl bCl $\overline{A}$ = bCl bInt A ∩ bCl $\overline{A}$ ⊆ bCl A ∩ bCl $\overline{A}$ = sgbFr A.

(3) sgbFr bCl A = bCl bCl A ∩ bCl $\overline{\text{bCl A}}$ = bCl A ∩ bCl bInt $\overline{A}$ ⊆ bCl A ∩ bCl $\overline{A}$

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= sgbFr A

The converse of (2) and (3) of above theorem not true as seen from the following example.

Example 3.6: Let X = {a, b} and let $\tau = \{0_{\sim}, G, 1_{\sim}\}$ be an IFT on (X, τ) where G = ⟨x, (0.2, 0.3), (0.7, 0.6) ⟩. Consider an IFS A = ⟨x, (0.6, 0.5), (0.3, 0.4) ⟩ and $\overline{A}$ = ⟨x, (0.3, 0.4), (0.6, 0.5) ⟩.

Then calculations give

$$\text{sgbFr A} = \overline{A} \not\subseteq \tilde{0} = \text{sgbFr A and sgbFr A} = \overline{A} = \text{bCl sgbFr A}.$$

Theorem 3.7: Let A and B be IFSs in an IFTS X. Then sgbFr (A∪B) ⊆ sgbFr A ∪ sgbFr B.

Proof: Consider sgbFr (A∪B) = bCl (A∪B) ∩ bCl ($\overline{A \cup B}$)

⊆ (bCl A ∪ bCl B) ∩ (bCl $\overline{A}$ ∩ bCl $\overline{B}$)

= [(bCl A ∪ bCl B) ∩ bCl $\overline{A}$] ∩ [(bCl A ∪ bCl B) ∩ bCl $\overline{B}$]

= [(bCl A ∩ bCl $\overline{A}$) ∪ (bCl B ∩ bCl $\overline{A}$)] ∩ [(bCl A ∩ bCl $\overline{B}$) ∪ (bCl B ∩ bCl $\overline{B}$)]

= [sgbFr A ∪ (bCl B ∩ bCl $\overline{A}$)] ∩ [(bCl A ∩ bCl$\overline{B}$) ∪ sgbFr B]

= (sgbFr A ∪ sgbFr B) ∩ ((bCl B ∩ bCl $\overline{A}$) ∪ (bCl A ∩ bCl $\overline{B}$))

⊆ (sgbFr A ∪ sgbFr B).

The converse of above theorem not true as seen from the following example.

Example 3.8: Let X = {a, b} and let $\tau = \{0_{\sim}, G, 1_{\sim}\}$ be an IFT on (X, τ) where G = ⟨x, (0.6, 0.8), (0.4, 0.2) ⟩. Consider an IFS A = ⟨x, (0.6, 0.5), (0.2, 0.5) ⟩ and B = ⟨x, (0.6, 0.5), (0.3, 0.5)⟩.

Then calculations give

$$\text{sgbFr A} \cup \text{sgbFr B} = \overline{A} \cup \overline{B} = \overline{B} \not\subseteq \text{sgbFr A} = \text{sgbFr (A} \cup \text{B)}$$

Theorem 3.9: For IFSs A and B in IFTS X, one has sgbFr (A∩B) ⊆ (sgbFr A ∩ bCl B) ∪ (sgbFr B ∩ bCl A).

Proof: Consider sgbFr (A∩B) = bCl (A∩B) ∩ bCl ($\overline{A \cap B}$)

⊆ (bCl A ∩ bCl B) ∩ (bCl $\overline{A}$ ∪ bCl $\overline{B}$)

= [(bCl A ∩ bCl B) ∩ bCl $\overline{A}$] ∪ [(bCl A ∩ bCl B) ∩ bCl $\overline{B}$]

= (sgbFr A ∩ bCl B) ∪ (sgbFr B ∩ bCl A).

Example 3.10: Let X = {a, b} and let $\tau = \{0_{\sim}, G, 1_{\sim}\}$ be an IFT on (X, τ) where G = ⟨x, (0.6, 0.8), (0.4, 0.2) ⟩. Consider an IFS A = ⟨x, (0.6, 0.5), (0.2, 0.5) ⟩ and B = ⟨x, (0.6, 0.5), (0.3, 0.5)⟩.

Then calculations give

$$(\text{sgbFr A} \cap \text{bCl B}) \cup (\text{sgbFr B} \cap \text{bCl A}) = (\overline{A} \cap B) \cup (\overline{B} \cap A) = \overline{A} \cup \overline{B}$$

$$= \overline{B} \not\subseteq \text{sgbFr (A} \cap \text{B)}$$

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Corollary 3.11: For IFSs A and B in IFTS X, one has sgbFr (A⋂B) ⊆ sgbFr A ⋃ *s*gbFr B.

Definition 3.12: An IFS A in IFTS X is called an intuitionistic fuzzy sgb-Q-neighborhood of an IFP e if there exists an IFSO set B in X, such that eqB ⊆ A.

Definition 3.13: An IFP e is called a sgb-adherence point of an IFS A if every intuitionistic fuzzy sgb-Q-neighborhood of e is quasi-coincident with A.

Definition 3.14: An IFP e is called a sgb-accumulation point of an IFS A if e is a sgb-adherence point of A and every sgb-Q-neighborhood of e and A is quasi-coincident at some point different from supp(e), whenever e ∈ A.The union of all the sgb-accumulation points of A is called the intuitionistic fuzzy sgb-derived set of A, denoted as A^{sgbd}. It is evident that A^{sgbd} ⊆ bCl A.

Proposition 3.15: Let A be an IFS in X, then bCl A = A ⋃ A^{sgbd}.
Proof: Let Ω = {e | e is a sgb-adherence point of A}. Then from Theorem 3.15, bCl A = ⋃Ω. On the other hand, e ∈ Ω is either e ∈ A or e ∉ A; for the latter case, by Definition 3.17, e ∈ A^{sgbd}; hence bCl A = ⋃Ω ⊂ A ⋃ A^{sgbd} .The reverse inclusion is obvious.

Corollary 3.16: For any IFS A in an IFTS X, A is IFSGbC if A^{sgbd} ⊆ A.

Definition 3.17: Let f : X → Y be a function from an IFTS X to another IFTS Y.Then f is said to be an intuitionistic fuzzy sgb-continuous function if f^{-1}(A) is IFSGbO in X for each IFO set A in Y.

Theorem 3.18: Let f : X → Y be a function. Then the following are equivalent:

(1) f : X → Y is intuitionistic fuzzy sgb-continuous,

(2) f(A^{sgbd}) ⊆ bCl f(A), for any IFS A in X.

Proof: (1) ⟹ (2). Suppose that f is intuitionistic fuzzy sgb-continuous. Let A be an IFS in X. Since bCl f(A) is IFC in Y, f^{-1}(bCl f(A)) is IFSGbC in X. A ⊆ f^{-1}(bCl f(A)) gives bCl A ⊆ bCl

f^{-1}(bCl f(A)) = f^{-1}(bCl f(A)). Therefore, f(A^{sgbd}) ⊆ f(bCl A) ⊆ f f^{-1}(bCl f(A)) ⊆ bCl f(A). Consequently, f(A^{sgbd}) ⊆ bCl f(A).

(2) ⇒ (1) Suppose f(A^{sgbd}) ⊆ bCl f(A). Letting B be any IFC set in Y, we show that f^{-1}(B) is IFSGbC in X. By our hypothesis, f($[f^{-1}(B)]^{sgbd}$) ⊆ bCl f(f^{-1}(B)) ⊆ bCl B = B or f($[f^{-1}(B)]^{sgbd}$) ⊆ B gives $[f^{-1}(B)]^{sgbd}$ ⊆ f^{-1}(f $[f^{-1}(B)]^{sgbd}$) ⊆ f^{-1}(B) or $[f^{-1}(B)]^{sgbd}$ ⊆ f^{-1}(B) implies f^{-1}(B) is IFSGbC in X. Thus, f is intuitionistic fuzzy sgb-continuous.

Theorem 3.19: Let f : X → Y be a intuitionistic fuzzy sgb-continuous function. Then one has

sgbFr f^{-1}(B) ⊆ f^{-1}(sgbFr B) for any IFS B in Y.

Proof: Suppose that f is intuitionistic fuzzy sgb-continuous. Let B be an IFS in Y.

Then sgbFr f^{-1}(B) = bCl f^{-1}(B) ⋂ bCl $\overline{f^{-1}(B)}$
⊆ bCl f^{-1}(bCl B) ⋂ bCl f^{-1}(bCl $\overline{B}$)
= f^{-1}(bCl B) ⋂ f^{-1}(bCl B)
= f^{-1}(bCl B ⋂ bCl B)
= f^{-1}(sgbFr B) .
Therefore, sgbFr f^{-1}(B) ⊆ f^{-1}(sgbFr B).

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APPLICATIONS OF NEUTROSOPHIC CHAOTIC CONTINUOUS FUNCTIONS

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ABSTRACT

In this paper, the concepts of chaotic locally indiscrete, chaotic compact, orbit compact, mildly orbit compact, orbit lindelof and chaotic lindelof are introduced under neutrosophic sets and studied. Furthermore, we will study new types of separation axioms.

1.INTRODUCTION

The fuzzy set was introduced by Zadeh[11] in 1965 where each elements had a degree of membership. The intuitionistic fuzzy set on a universe X was introduced by K.Atanassov[1,2,3] in 1983 as a generalization of fuzzy set, where besides the degree of membership a degree of non-membership of each element is also defined. Smarandache[7,8] originally gave the definition of a neutrosophic set and neutrosophic logic. The neutrosophic logic is a formal frame trying to measure the truth, indeterminacy and falsehood. In 1989, R.L. Deveney[4] defined chaotic function in general metric space. T. Thrivikraman and P.B. Vinod Kumar[10] defined Chaos and fractals in general topological spaces. M. Kousalyaparasakthi, E. Roja, M.K. Uma[5] introduced the concept of intuitionistic chaotic continuous functions. In[6] we introduced the concept of neutrosophic chaotic continuous functions. In this paper, we extend the above concept to neutrosophic chaotic locally indiscrete, neutrosophic chaotic compact, neutrosophic orbit compact, neutrosophic mildly orbit compact, neutrosophic orbit lindelof and neutrosophic chaotic lindelof. Also the concept of neutrosophic orbit hausdroff, neutrosophic chaotic hausdroff, neutrosophic orbit regular, neutrosophic chaotic regular, neutrosophic orbit normal, neutrosophic chaotic normal, neutrosophic orbit T_1 and neutrosophic chaotic T_1.

2.PRELIMINARIES

Definition 2.1 ([8]). Let X be a non empty set. A neutrosophic set (NS for short) A is an object having the form $A = \langle x,A^1,A^2,A^3\rangle$ where A^1,A^2,A^3 represent the degree of membership , the degree of indeterminacy and the degree of non-membership respectively of each element $x \in X$ to the set A.

Definition 2.2 ([8]). Let X be a non empty set, $A = \langle x,A^1,A^2,A^3\rangle$ and $B = \langle x,B^1,B^2,B^3\rangle$ be neutrosophic sets on X, and let $\{A_i : i \in J\}$ be an arbitrary family of neutrosophic sets in X, where $A^i = \langle x,A^1, A^2, A^3\rangle$

(i) $A \subseteq B$ if and only if $A^1 \subseteq B^1$, $A^2 \supseteq B^2$ and $A^3 \supseteq B^3$

(ii) $A = B$ if and only if $A \subseteq B$ and $B \subseteq A$.

(iii) $\overline{A} = \langle x,A^3,A^2,A^1\rangle$

(iv) $A \cap B = \langle x,A^1 \cap B^1,A^2 \cup B^2,A^3 \cup A^3\rangle$; $A \cup B = \langle x,A^1 \cup B^1,A^2 \cap B^2,A^3 \cap B^3\rangle$

(v) $\cup A_i = \langle x,\cup A_i^1,\cap A_i^2,\cap A_i^3\rangle$; $\cap A_i = \langle x,\cap A_i^1,\cup A_i^2,\cup A_i^3\rangle$

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(vi)$A - B = A \cap \overline{B}$.

(vii) $\varphi_N = \langle x,\varphi,\varphi,\varphi\rangle$; $X_N = \langle x,X,X,X\rangle$.

Definition 2.3 ([9]). A neutrosophic topology (NT for short) on a nonempty set X is a family τ of neutrosophic set in X satisfying the following axioms:

(i) $\varphi_N, X_N \in \tau$.

(ii) $G_1 \cap G_2 \in \tau$ for any $G_1, G_2 \in \tau$.

(iii) $\cup G_i \in \tau$ for any arbitrary family $\{G_i : i \in J\} \subseteq \tau$.

In this case the pair (X, τ) is called a Neutrosophic topological space (NTS for short) and any Neutrosophic set in τ is called a Neutrosophic open set(NOS for short) in X. The complement A of a Neutrosophic open set A is called a Neutrosophic closed set (NCS for short) in X.

Definition 2.4 ([9]). Let (X, τ) be a neutrosophic topological space and

$A = \langle X,A_1,A_2,A_3\rangle$ be a set in X. Then the closure and interior of A are defined by

$Ncl(A) = \cap\{K : K$ is a neutrosophic closed set in X and $A \subseteq K\}$,

$Nint(A) = \cup\{G : G$ is a neutrosophic open set in X and $G \subseteq A\}$.

It can be also shown that Ncl(A) is a neutrosophic closed set and Nint(A) is a neutrosophic open set in X, and A is a neutrosophic closed set in X iff cl(A) = A; and A is a neutrosophic open set in X iff Nint(A) = A.

Definition 2.5.([6]) Let (X, τ) be a neutrosophic topological space and

$F = \langle x,F^1,F^2,F^3\rangle \in NK(X)$. Let $f : F \to F$ be a neutrosophic continuous function. Then f is said to be neutrosophic chaotic on F if

(i) $Ncl(NO_f(x)) = F$ for some $x \in F$.

(ii) neutrosophic periodic points of f are neutrosophic dense in F. That is, $Ncl(NP_f(x)) = F$.

(iii)$f \in S(F)$.

Definition 2.6. ([6]) A neutrosophic topological space (X, τ) is called a neutrosophic chaos space if $CH(X) \neq \varphi$. The members of CH(X) are called neutrosophic chaotic sets.

Definition 2.7. ([6]) Let (X, τ) be a neutrosophic topological space. A neutrosophic set

$A = \langle x,A^1,A^2,A^3\rangle$ is neutrosophic clopen if it is both neutrosophic open and neutrosophic closed.

Definition 2.8. ([6]) Let (X, τ) be a neutrosophic topological space.

(i) A neutrosophic open orbit set is a neutrosophic set which is both neutrosophic open and neutrosophic orbit.
(ii) A neutrosophic closed orbit set is a neutrosophic set which is both neutrosophic closed and neutrosophic orbit.

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(iii) A neutrosophic clopen orbit set is a neutrosophic set which is both neutrosophic clopen and neutrosophic orbit.

Definition 2.9. ([6]) Let (X, τ) be a neutrosophic topological space.

(i) A neutrosophic open chaotic set is a neutrosophic set which is both neutrosophic open and neutrosophic chaotic.
(ii) A neutrosophic closed chaotic set is a neutrosophic set which is both neutrosophic closed and neutrosophic chaotic.
(iii) A neutrosophic clopen chaotic set is a neutrosophic set which is both neutrosophic clopen and neutrosophic chaotic.

Definition 2.10. ([6]) Let (X, τ) and (X,σ) be any two neutrosophic chaos spaces. A function f : (X, τ) → (X,σ) is said to be neutrosophic chaotic continuous if for each periodic point x ∈ X and each neutrosophic clopen chaotic set F = <x,F^1,F^2,F^3> of f(x) ∃ a neutrosophic open orbit set $NO_f(x)$ of the periodic point x ∍ $f(NO_f(x)) \subseteq F$.

Definition 2.11. ([6]) Let (X, τ) and (X, σ) be any two neutrosophic chaos spaces. A function f : (X, τ) → (X, σ) is said to be a neutrosophic chaotic*** continuous if for each periodic point x ∈ X and each neutrosophic closed chaotic set F of f(x) ∃ a neutrosophic clopen orbit set $NO_f(x)$ of the periodic point x ∍ $f(Nint(NO_f(x))) \subseteq F$.

3. APPLICATIONS OF NEUTROSOPHIC CHAOTIC CONTINUOUS FUNCTIONS

Definition 3.1. A neutrosophic chaos space (X, τ) is said to be neutrosophic chaotic locally indiscrete if every neutrosophic open orbit set of (X, τ) is a neutrosophic open chaotic set in (X, τ).

Definition 3.2. Let (X, τ) be a neutrosophic chaos space. If a family { <x, F_i^1, F_i^2, F_i^3> : i ∈ J} of neutrosophic open chaotic sets in (X, τ) satisfies the condition ∪{ <x, F_i^1, F_i^2, F_i^3> : i ∈ J} = X_N, then it is called a neutrosophic open chaotic cover of (X, τ). A finite subfamily of a neutrosophic open chaotic cover { <x, F_i^1, F_i^2, F_i^3> i:i ∈ J} of X, which is also a neutrosophic open chaotic cover of X. Then the neutrosophic open chaotic cover is called a finite neutrosophic open chaotic subcover of { F = <x, F_i^1, F_i^2, F_i^3> i : i ∈ J}.

Definition 3.3. A neutrosophic chaos space (X, τ) is said to be neutrosophic chaotic compact if every neutrosophic open chaotic cover has a finite neutrosophic open chaotic subcover.

Definition 3.4. Let (X, τ) be a neutrosophic chaos space. If a family $\{NO_f(x_i) : i \in J\}$ of neutrosophic open orbit sets in (X, τ) satisfies the condition $\cup\{NO_f(x_i) : i \in J\} = X_N$, then it is called an neutrosophic open orbit cover of (X, τ). A finite subfamily of a neutrosophic open orbit cover {NO_f(xi) : i ∈ J} of X, which is also a neutrosophic open orbit cover of X. Then the neutrosophic open orbit cover is called a finite neutrosophic open orbit subcover of $\{NO_f(x_i) : i \in J\}$.

Definition 3.5. A neutrosophic chaos space (X, τ) is said to be neutrosophic orbit compact if every neutrosophic open orbit cover has a finite neutrosophic open orbit subcover.

Definition 3.6. Let (X, τ) and (X, σ) be any two neutrosophic chaos spaces. Let f : (X, τ) → (X,σ) be a function. Then f is said to be a neutrosophic open chaotic function if the image of every neutrosophic open chaotic set in (X, τ) is neutrosophic open chaotic in (X, σ).

Theorem 3.7. Let (X, τ) and (X, σ) be any two neutrosophic chaos spaces. Let f : (X, τ) → (X, σ) be a neutrosophic chaotic continuous function, neutrosophic closed and surjection. If (X, τ) is neutrosophic orbit compact and neutrosophic locally indiscrete then (X, σ) is neutrosophic chaotic compact.

Proof Obvious from definition

Definition 3.8. Let (X, τ) be a neutrosophic chaos space. If a family { <x, F_i^1, F_i^2, F_i^3> : i ∈ J} of neutrosophic closed chaotic sets in (X, τ) satisfies the condition ∪{ F = <x,F^1,F^2,F^3> : i ∈ J} = X_N, then it is called a neutrosophic closed chaotic cover of (X, τ). A finite subfamily of a neutrosophic closed chaotic cover {<x, F_i^1, F_i^2, F_i^3> : i ∈ J} of X, which is also a neutrosophic closed chaotic cover of X. Then the neutrosophic closed chaotic cover is called a finite neutrosophic closed chaotic subcover of {<x, F_i^1, F_i^2, F_i^3> : i ∈ J}.

Definition 3.9. Let (X, τ) be a neutrosophic chaos space. A neutrosophic cover is said to be neutrosophic clopen chaotic cover if it is both neutrosophic open chaotic cover and neutrosophic closed chaotic cover.

Definition 3.10. A neutrosophic chaos space (X, τ) is said to be neutrosophic mildly orbit compact if every neutrosophic clopen chaotic cover has a finite neutrosophic open orbit subcover.

Theorem 3.11. Let f : (X, τ) → (X, σ) be a neutrosophic chaotic continuous function, surjective and neutrosophic open orbit function. If (X, τ) is neutrosophic orbit compact, then (X, σ) is neutrosophic mildly chaotic compact.

Proof Since f is neutrosophic chaotic continuous, {F_α = <x, $F_\alpha^1, F_\alpha^2, F_\alpha^3$>: α ∈ I} is a neutrosophic clopen chaotic cover of (X, σ) there exists a neutrosophic open orbit cover {$f^{-1}(F_\alpha)$: α ∈ I} of (X, τ). Since (X, τ) is neutrosophic orbit compact, there exists a finite subset I_0 of I such that X_N = ∪{$f^{-1}(F_\alpha)$: α ∈ I_0} of (X, τ). Now {$f^{-1}(F_\alpha)$: α ∈ I_0} is a finite neutrosophic open orbit subcover of {$f^{-1}(F_\alpha)$: α ∈ I} of (X, τ). Since f is surjective and neutrosophic open orbit, {f($f^{-1}(F_\alpha)$) : α ∈ I_0} = {F_α : α ∈ I} is neutrosophic open orbit subcover of (X, σ). Hence, (X, σ) is neutrosophic mildly chaotic compact.

Definition 3.12. A neutrosophic chaos space (X, τ) is said to be countably neutrosophic orbit compact if every countable neutrosophic open orbit cover has a finite neutrosophic open orbit subcover.

Definition 3.13. A neutrosophic chaos space (X, τ) is said to be countably neutrosophic mildly chaotic compact if every countable neutrosophic clopen chaotic cover has a finite neutrosophic open orbit subcover.

Theorem 3.14. If f : (X, τ) → (X, σ) neutrosophic chaotic continuous, neutrosophic open orbit and surjection. If (X, τ) is countably neutrosophic orbit compact then (X, σ) is countably neutrosophic mildly chaotic compact.

Proof The Proof is similar to that of Theorem 3.11.

Definition 3.15. A neutrosophic chaos space (X, τ) is said to be neutrosophic closed orbit compact if every neutrosophic closed orbit cover has a finite neutrosophic open orbit subcover.

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Theorem 3.16. If f : (X, τ) → (X, σ) neutrosophic chaotic*** continuous, neutrosophic open orbit and surjection. If (X, τ) is neutrosophic closed orbit compact then (X, σ) is neutrosophic closed orbit compact.

Proof Since f is neutrosophic chaotic*** continuous, $\{F_\alpha = \langle x, F_\alpha^1, F_\alpha^2, F_\alpha^3 \rangle : \alpha \in \Delta\}$ is neutrosophic closed chaotic cover of (X, σ) there exists a neutrosophic clopen orbit cover $\{f^{-1}(F_\alpha) : \alpha \in \Delta\}$ of (X, τ). Therefore, $f^{-1}(F_\alpha)$ is a neutrosophic closed orbit cover of (X, τ). Since (X, τ) is neutrosophic closed orbit compact, there exists a finite subset Δ_0 of Δ such that $X_N = \cup\{f^{-1}(F_\alpha) : \alpha \in \Delta_0\}$. Now, $\{f^{-1}(F_\alpha) : \alpha \in I_0\}$ is a finite neutrosophic open orbit subcover of $\{f^{-1}(F_\alpha) : \alpha \in I\}$ of (X, τ). Since f is surjective and neutrosophic open orbit, $\{f(f^{-1}(F_\alpha)) : \alpha \in I_0\} = \{F_\alpha : \alpha \in I_0\}$ is neutrosophic open orbit subcover of (X, σ). Hence, (X, σ) is neutrosophic closed orbit compact.

Definition 3.17. A neutrosophic chaos space (X, τ) is said to be countably neutrosophic closed orbit compact if every countable neutrosophic closed orbit cover has a finite neutrosophic open orbit subcover.

Theorem 3.18. If f : (X, τ) → (X, σ) neutrosophic chaotic continuous, neutrosophic open orbit function and surjection. If (X, τ) is countably neutrosophic closed orbit compact then (X, σ) countably neutrosophic closed orbit compact.

Proof The Proof is follows from Theorem 3.16.

Definition 3.19. A neutrosophic chaos space (X, τ) is said to be neutrosophic orbit Lindelof if every neutrosophic open orbit cover has a countable neutrosophic open orbit subcover.

Definition 3.20. A neutrosophic chaos space (X, τ) is said to be neutrosophic mildly chaotic Lindelof if every neutrosophic clopen chaotic cover has a countable neutrosophic open orbit subcover.

Theorem 3.21. Let f : (X, τ) → (X, σ) be a neutrosophic chaotic continuous function, neutrosophic open orbit and surjection. If (X, τ) is neutrosophic orbit Lindelof then (X, σ) neutrosophic mildly chaotic Lindelof.

Proof Since f is neutrosophic chaotic continuous, $\{F\alpha = \langle x, F_\alpha^1, F_\alpha^2, F_\alpha^3 \rangle : \alpha \in I\}$ is neutrosophic clopen chaotic cover of (X, σ) there exists a neutrosophic open orbit cover $\{f^{-1}(F_\alpha) : \alpha \in I\}$. Since (X, τ) is neutrosophic orbit Lindelof, there exists a countable subset I_0 of I such that $X_N = \cup\{f^{-1}(F_\alpha) : \alpha \in I_0\}$. Now, $\{f^{-1}(F_\alpha) : \alpha \in I_0\}$ is a countable neutrosophic open orbit subcover of $\{f^{-1}(F_\alpha) : \alpha \in I\}$ of (X, τ). Since f is surjective and neutrosophic open orbit, $\{f(f^{-1}(F_\alpha)) : \alpha \in I_0\} = \{F_\alpha : \alpha \in I_0\}$ is a countable neutrosophic open orbit subcover of $\{F_\alpha : \alpha \in I\}$. Hence, (X, σ) is neutrosophic mildly chaotic Lindelof.

Definition 3.22. A neutrosophic chaos space (X, τ) is said to be neutrosophic closed orbit Lindelof if every neutrosophic closed orbit cover has a countable neutrosophic open orbit subcover.

Theorem 3.23. If f : (X, τ) → (X, σ) neutrosophic chaotic continuous, neutrosophic closed and surjection. If (X, τ) is neutrosophic closed orbit Lindelof then (X, σ) is neutrosophic mildly chaotic Lindelof.

Proof The Proof is similar to that of Theorem 3.21.

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Definition 3.24. A neutrosophic chaos space (X, τ) is said to be neutrosophic orbit Hausdorff if for every two distinct periodic points of X, there exist neutrosophic open orbit sets $NO_f(x_1)$ and $NO_f(x_2)$ such that $NO_f(x_1) \cap NO_f(x_2) = \varphi_N$.

Definition 3.25. A neutrosophic chaos space (X, τ) is said to be neutrosophic chaotic Hausdorff if for every two distinct periodic points of X, there exist neutrosophic clopen chaotic sets F_1 and F_2 such that $F_1 \cap F_2 = \varphi_N$.

Theorem 3.26. Let f : (X, τ) → (X, σ) be neutrosophic chaotic continuous. If (X, σ) is neutrosophic chaotic Hausdorff then (X, τ) is neutrosophic orbit Hausdorff .

Proof Obvious from definition

Definition 3.27. A neutrosophic chaos space (X, τ) is said to be neutrosophic orbit regular if for each neutrosophic closed orbit set $NO_f(x_1)$, $x_1 \in X$ in (X, τ) and each periodic points $x \notin NO_f(x_1)$ there exist neutrosophic open orbit sets $NO_f(x_2)$ and $NO_f(x_3)$, $x_2, x_3 \in X$ with $NO_f(x_2), NO_f(x_3) \neq \varphi_N$ such that $NO_f(x_1) \subseteq NO_f(x_2)$ and $x \in NO_f(x_3)$.

Definition 3.28. A neutrosophic chaos space (X, τ) is said to be neutrosophic chaotic regular if for each neutrosophic closed chaotic set $F = \langle x, F^1, F^2, F^3 \rangle$ in (X, τ) and each periodic points $x \notin F$ there exist neutrosophic open chaotic sets $U = \langle x, U^1, U^2, U^3 \rangle$ and $V = \langle x, V^1, V^2, V^3 \rangle$ with $U, V \neq \varphi_N$ such that $F \subseteq U$ and $x \in V$.

Theorem 3.29. Let f : (X, τ) → (X, σ) be a neutrosophic chaotic continuous function. If (X, σ) is neutrosophic chaotic regular and f is neutrosophic open orbit or neutrosophic closed orbit then (X, τ) is neutrosophic orbit regular.

Proof Suppose that f is neutrosophic open orbit. Let the periodic point $x \in X$ and $NO_f(x)$ be an neutrosophic open orbit set containing x. Then $f(NO_f(x))$ is a neutrosophic open orbit set of (X, σ) containing f(x). Since (X, σ) is neutrosophic chaotic regular, there exists an neutrosophic clopen chaotic set F such that $f(x) \in F \subset f(NO_f(x))$. Then $x \in f^{-1}(F) \subset NO_f(x)$ is neutrosophic clopen chaotic set in (X, σ). By Theorem Inverse image of every neutrosophic clopen chaotic set of (X, σ) is a neutrosophic clopen orbit set of (X, τ). $f^{-1}(F)$ is neutrosophic clopen orbit in (X, τ). Therefore, (X, τ) is neutrosophic orbit regular. Suppose that f is neutrosophic closed. Let the periodic point $x \in X$ and $NO_f(x)$ be any neutrosophic closed orbit set of (X, τ) not containing x. Since f is injective and neutrosophic closed orbit, $f(x) \notin f(NO_f(x))$ and f(F) is neutrosophic closed orbit in (X, σ). By the neutrosophic chaotic regularity of (X, σ), there exists an neutrosophic clopen chaotic set F such that $f(x) \in F \subset Y - f(NO_f(x))$. Therefore, $x \in f^{-1}(NO_f(x))$ and $F \subset X - f^{-1}(F)$. By again the Theorem Inverse image of every intuitionistic clopen chaotic set of (X, σ) is a neutrosophic clopen orbit set of (X, τ). $f^{-1}(F)$ is neutrosophic clopen orbit set in (X, τ). Thus, (X, τ) is neutrosophic orbit regular.

Definition 3.30. A neutrosophic chaos space (X, τ) is said to be neutrosophic orbit normal if for any pair of neutrosophic closed orbit sets $NO_f(x_1)$ and $NO_f(x_2)$, $x_1, x_2 \in X$ of (X, τ) there exist neutrosophic open orbit sets $NO_f(x_3)$ and $NO_f(x_4)$, $x_3, x_4 \in X$ such that $NO_f(x_1) \subseteq NO_f(x_3)$ and $NO_f(x_2) \subseteq NO_f(x_4)$.

Definition 3.31. A neutrosophic chaos space (X, τ) is said to be neutrosophic chaotic normal if for any pair of neutrosophic closed chaotic sets $A = \langle x, A^1, A^2, A^3 \rangle$ and $B = \langle x, B^1, B^2, B^3 \rangle$ of (X, τ) there exist neutrosophic open chaotic sets $U = \langle x, U^1, U^2, U^3 \rangle$ and $V = \langle x, V^1, V^2, V^3 \rangle$ such that $A \subseteq U$ and $B \subseteq V$.

Theorem 3.32. Let f : (X, τ) → (X, σ) be an neutrosophic chaotic continuous. If (X, σ) is neutrosophic chaotic normal and f is neutrosophic closed orbit then (X, τ) is neutrosophic orbit normal.

Proof Let $NO_f(x_1)$,$NO_f(x_2)$ be any two neutrosophic closed orbit sets of (X, τ) with $NO_f(x_1)$,$NO_f(x_2) \neq \varphi_N$. Since f is neutrosophic closed orbit and injective, $f(NO_f(x_1))$ and $f(NO_f(x_2))$ are neutrosophic closed orbit sets of (X, σ) with $f(NO_f(x_1))$,$f(NO_f(x_2)) \neq \varphi_N$. Since (X, σ) is neutrosophic chaotic normal, there exist neutrosophic clopen chaotic sets $V_1 = <x, V_1^1, V_1^2, V_1^3>$ and $V_2 = <x, V_2^1, V_2^2, V_2^3>$ such that $F_1 \subset f^{-1}(V_1)$ and $F_2 \subset f^{-1}(V_2)$. Since f is neutrosophic chaotic continuous, $f^{-1}(V_i)$ is neutrosophic open orbit. Moreover, $f^{-1}(V_1) \cap f^{-1}(V_2) = \varphi_N$. Hence, (X, τ) is neutrosophic orbit normal.

Definition 3.33. A neutrosophic chaos space (X, τ) is said to be neutrosophic orbit T_1 if for each pair of distinct periodic points x and y in X, there exist neutrosophic open orbit sets $NO_f(x)$ and $NO_f(y)$ such that $NO_f(x) \cap NO_f(y) = \varphi_N$.

Definition 3.34. A neutrosophic chaos space (X,τ) is said to be neutrosophic chaotic T_1 if for each pair of distinct periodic points x and y in X, there exist neutrosophic clopen chaotic sets $F_1 = <x, F_1^1, F_1^2, F_1^3>$ and $F_2 = <x, F_2^1, F_2^2, F_2^3>$ such that $F_1 \cap F_2 = \varphi_N$.

Theorem 3.35. Let f : (X, τ) → (X, σ) be neutrosophic chaotic continuous. If (X, σ) is neutrosophic chaotic T_1 then (X, τ) is neutrosophic orbit T_1.

Proof Obvious from definition.

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A New form of b-closed sets in Simple Extended Ideal Topology Space

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Abstract

In this paper we introduces a new class of closed sets in simple extension Ideal topology called πgbI^+ - closed set and some of its characterizations are discussed. Also, its relationship with other existing sets are dealt with. As an application of this set we form new spaces and its properties are investigated.

Introduction

The concept of α - closed sets was introduced by O. Nijastad [17] in topological spaces. N Levine [11] and Mashhour [14] proposed the idea of semi closed sets and pre closed sets in topological spaces. Andrijevic [1] divised the concept of semi-pre open sets and b-open sets. Stone M.H. [23] introduced the notion of regular closed sets in topological spaces. In 1968 Zaitsev [24] defined π-closed sets. Generalized open sets play a very important role in general topology and they are now the research topics of many researchers worldwide. Indeed a significant topic in general topology and real analysis concern the variously modified forms of continuity, separation axioms etc., by utilizing generalized opens sets. The idea of πgb-closed [21] sets was introduced by D. Sreeja and C. Janaki.

The Contribution of Hamlelt and Jankovic in ideal Topological space initiated the generalized of some important properties in general topological ideals. The properties like decomposition of continuity separation axioms, connectedness, compactness and resolvability have been generalized using the concept of ideals in topological spaces. By a space (X, τ) we mean a topological space with a topology τ defined on X on which no separation axioms are assumed unless otherwise explicitly stated. For a given point x in a space (X, τ) the system of open neighbourhoods of x is denoted by $N(x) = \{U \in \tau : x \in U\}$. For a given subset A of a space (X, τ). cl^{+*} and interior of A, respectively, with respect to the topology.

In 1963 N. Levine introduced the concept of simple extension of a topology as, $\tau^+(B) = (OU(O' \cap B) / O, O' \in \tau , B \notin \tau \}$ F. Nirmala Irudayam and Sr. I. Arockirani [15] proposed the idea of α-closed, semi closed, pre closed and b closed sets in simple extension topology. F. Nirmala Irudayam and S.Reena proposed simple extension [16] topology in πgb – closed set. In this paper we extend this concept to ideal simple extension topological space and study its properties.

Preliminaries:
Definition 2.1: A subset A of a topological space (X, τ) is said to be

(1) α –closed [17] if $cl(int(A)) \subseteq A$
(2) semi – closed [11] if $int(cl(A)) \subseteq A$.
(3) pre - closed [14] if $cl(int(A)) \subseteq A$.
(4) sp- closed [1] if $int(cl(int(A))) \subseteq A$
(5) regular –open [23] if A = in (cl (A))
(6) b – open [2] or γ – open if $A \subset int(cl(A)) \cup cl(int(A))$
(7) π – open [24] if A is a finite union of regular open sets.
(8).Q – set [12] if int (cl(A)) = cl(int (a))

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Definition 2.2: A subset A of a extended topological space (X , τ^+) is said to be

i. α^+ - closed [15] if $cl^+(int(A))) \subseteq A$
ii. $semi^+$ - closed [15] if $int(cl^+(A)) \subseteq A$
iii. pre^+ - closed [15] if $cl^+(int(A)) \subseteq A$.
iv. semi –pre^+ open set [15] if $A \subset cl^+(int(cl^+(A)))$
v. b^+ - open[15] if$(A) \subset A$ $int(cl^+(A)) \cup (cl^+(A)))$

Definition 2.3: The notation of closed sets in topological spaces has been generalized to generalized closed sets.

i. gp-closed [13] if pcl (A) $\subset U$ whenever A$\subset U$ *and* U is open in X.
ii. gs -closed [3] if scl (A) $\subset U$ whenever A$\subset U$ *and* U is open in X.
iii. gb -closed [10] if bcl (A) $\subset U$ whenever A$\subset U$ *and* U is open in X.
iv. πg -closed [7] if cl (A) $\subset U$ whenever A$\subset U$ *and* U is π - open in X.
v. πgp -closed [18] if pcl(A) $\subset U$ whenever A$\subset U$ *and* U is π- open in X.
vi. πgs -closed [4] if α cl(A) $\subset U$ whenever A$\subset U$ *and* U is π- open in X.
vii. πgsp –closed [19] if spcl(A) $\subset U$ whenever A$\subset U$ *and* U is π- open in X.
viii. πgb -closed [21] if bcl (A) $\subset U$ whenever A$\subset U$ *and* U is π -open in X.

Definition 2.4: A topological space X is said to be

a) extremely disconnected [6] if the closure of every open subset of X is open in X,
b) hyper connected [22] if the closure of every open subset is X,
c) πgb – space [21] if every πgb –closed set is closed,
d) πgb –$T_{1/2}$ space [21] if every πgb closed set is b- closed.
e) πgb –compact[20] if every πgb –open cover of X has a finite subcover.
f) πgp -compact [18] if every πgp –open cover of X has a finite subcover.
g) gb – compact [5] if every gb-open cover of X has a finite subcover.
h) b-compact [9] if every b-open cover of X has a finite subcover.
i) b-normal (or γ - normal)[8] if for every pair of disjoint closed subsets A, B of X, there exist disjoint b-open subsets U, V of X such that $A \subset U$ and $B \subset U$.

Definition 2.5: The intersection of all πgb -closed sets, each containing a set A in a topological space X is called the πgb -closure [20] of A and it is denoted by πgb - cl (A)

Definition 2.6: A nearly compact space [18] is a topological space in which every cover by regular open sets has a finite subcover.

Definition 2.7: A collection $\{G_1 : i \in \wedge\}$ of πgb^+ - open sets in a topological space X is called a πgb^+-open cover [20] of a subset A of X if $A \subset \{G_1 : i \in \wedge\}$ holds.

Definition 2.8: A subset A of a topological space X is said to be πgb –compact relative to X [20] if, for every collection $\{U_1 : i \in 1\}$ of πgb –open subsets of X such that $A \subset U\{U_1 : i \in I_0\}$

Definition 2.9: Let (X, τ) be a topological space $A \subset X$ and x ∈ X is said to b – limit point [21] of A if every –open set containing x contains a point A different from x.

Definition 2.10: Let (X, τ) be a topological space, $A \subset$ X. the set of all b-limit point of A is said to be b-derived set [21] of A and is denoted by D_b [A].

3. πgbI^+ - Closed sets:

Let A be a subset of a space X. Then the closure of A in extended Ideal topology and the interior of A topology are denoted by cl^{+*} (A) and int (A) respectively.

Definition 3.1: A subset A of a topological space X is said to be regular - open in simple extended Ideal topology if A = int (cl^{+*} (A)).

Definition 3.2: A subset A of a space (X,τ^+,I) is called π^+ open if A is a finite union of regular open sets.

Definition 3.3: A subset A of (X,τ^+,I) is called πgbI^+ closed if bI^+cl^{+*} (A) $\subset$ U whenever A $\subset$ U and U is π^+ open in (X,τ^+,I), By πGBI^+ C (X,τ^+,I) we mean the family of all πgbI^+ - closed subsets of the space (X, τ^+,I). **Lemma 3.4:** Let A be a subset of a space X. Then

(a) bI^+cl^+ *(A) = sI^+cl^{+*} (A) $\cap$ pI^+cl^{+*} (A) = A $\cup$ ((int(cl^{+*}A)) $\cap$ cl^{+*} (int(A)))

(b) bI^+ int(A) = sI^+ int(A) $\cup$ pI^+ int(A) = A $\cap$ (int(cl^+ *(A)) $\cup$ cl^+ *(int(A))).

Definition 3.5: A subset A of a topological space X is called:

(a) gI^+ - closed if cl^{+*} (A) $\subset$ U whenever A $\subset$ U and U is open in X.

(b) gpI^+ - closed if pI^+ cl^+* (A) $\subset$ U whenever A $\subset$ U and U is open in X.

(c) gsI^+ - closed if sI^+ cl^+*(A) $\subset$ U whenever A $\subset$ U and U is open in X.

(d) gbI^+ - closed if bI^+cl^+*(A) $\subset$ U whenever A $\subset$ U and U is open in X.

(e) πgI^+ - closed if cl^+*(A) $\subset$ U whenever A $\subset$ U and U is π^+ open in X.

(f) πgpI^+ - closed if pI^+ cl^+*(A) $\subset$ U whenever A $\subset$ U and U is π^+ open in X.

(g) πgsI^+ - closed if sI^+cl^+*(A) $\subset$ U whenever A $\subset$ U and U is π^+ open in X.

(h) $\pi g\alpha I^+$ - closed if αI^+cl^+*(A) $\subset$ U whenever A $\subset$ U and U is π^+ open in X.

(i) $\pi gspI^+$ - closed if spI^+cl^+*(A) $\subset$ U whenever A $\subset$ U and U is π^+ open in X.

The family of all πgb^+I– closed (resp.bI^+ - closed) sets in a topological space (X, τ+,I) is denoted by πGBI^+ C(X)(resp.BI^+ C(X))

Definition 3.6: A function f : X → Y is said to be

(a) π^+- continuous (resp. πgI^+ - continuous, πgpI^+ - continuous, πgsI^+ - continuous) if f^{-1}(V) is π^+ - closed (resp. πgI^+ - closed, πgpI^+ - closed, πgsI^+ closed) in X for every closed set V of Y.

(b) bI^+ - continuous (resp.gI^+ - continuous, gbI^+ - continuous) if f^{-1}(V) is bI^+ - closed (resp.gI^+ - closed,gbI^+ - closed) in X for every closed set V of Y.

(c) Almost - bI^+ - continuous if f^{-1}(V) is bI^+ - closed in X for every regular closed set V of Y.

(d) π^+- irresolute if f^{-1}(V) is π^+ - closed in X for every π^+ closed set V of Y.

(e) bI^+ - irresolute if f^{-1}(V) is bI^+ - closed in X for every bI^+ closed set V of Y.

(f) regular I^+ - open if f(V) is regular I^+ - open in Y for every open set V of X.

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(g) bI^+ - closed if f(V) is bI^+ - closed in Y for every b^+ closed set V of X.

Theorem 3.7: Every closed set is πgbI^+ - closed.

Proof: Let A be any closed set in X such that $A \subset U$, where U is π^+ open. We know that $bI^+ cl^+{}^*(A) \subset cl^+{}^*(A)$ and since A is closed $bI^+ cl^+{}^*(A) \subset cl^+{}^*(A) = A$, i.e., $bI^+ cl^+{}^*(A) \subset A$ and $A \subset U$, where U is π^+ open. Therefore $bI^+ cl^+{}^*(A) \subset U$. Hence A is πgbI^+ - closed set in X.

Theorem 3.8: Every gI^+ closed is πgbI^+ - closed.

Proof: Let A be any gI^+ - closed set in X and U be any $\pi+$ open set containing A. We know that $bI^+ cl^{+*}(A) \subset cl^{+*}(A)$ and since A is gI^+ closed, $bI^+ cl^{+*}(A) \subset cl^{+*}(A) = A$, i.e., $bI^+ cl^+{}^*(A) \subset A$ and $A \subset U$, where U is π^+ open. Therefore $bI^+ cl^{+*}(A) \subset U$. Hence A is πgbI^+ - closed set.

Theorem 3.9: Every αI^+ closed is πgbI^+ - closed.

Proof: Let A be any αI^+ - closed set in X and U be any π^+ open set containing A. We know that $bI^+cl^+ *(A) \subset cl^+ *(A)$ and since A is αI^+ closed, $bI^+cl*(A) \subset \alpha I^+cl^+ (A) \subset cl^+ *(A) = A$, i.e., $bI^+cl^+ *(A) \subset A$ and $A \subset U$, where U is π^+ open. Therefore $bI^+cl^+ *(A) \subset U$. Hence A is πgbI^+- closed set.

Theorem 3.10: Every pre I^+ closed is πgbI^+ - closed.

Proof: Let A be any pre I^+ - closed set in X and U be any π^+ open set containing A. We know that A is pre^+ closed, $bI^+cl^+ *(A) \subset pI^+cl^+ (A) \subset cl^+ *(A) = A$. i.e., $bI^+cl^+ *(A) \subset A$ and $A \subset U$, where U is π^+ open. Therefore $bI^+cl^+ *(A) \subset U$. Hence A is πgbI^+- closed set.

Theorem 3.11: Every gbI^+ closed is πgbI^+ - closed.

Proof: Let A be any gbI^+ - closed set in X and U be any π^+ open set containing A. We know that every π^+ open set is open, $bI^+cl^+*(A) \subset bI^+cl^+*(A) \subset cl^+*(A) = A$. i.e., $bI^+cl^+ *(A) \subset A$ and $A \subset U$, where U is π^+ open. Therefore $bI^+cl^+ *(A) \subset U$. Hence A is πgbI^+ - closed set.

Theorem 3.12: Every πgI^+ closed is πgbI^+ - closed.

Proof: Let A be any πgI^+ - closed set in X and U be any π^+ open set containing A. We know that every π^+ open set is open, $bI^+cl^+*(A) \subset cl^+*(A) = A$. i.e., $bI^+cl^{+*} (A) \subset A$ and $A \subset U$, where U is π^+ open. Therefore $bI^+cl^+* (A) \subset U$. Hence A is πgbI^+ - closed set.

Theorem 3.13: Every πgpI^+ closed is πgbI^+ - closed.

Proof: Let A be any πgpI^+ - closed set in X and U be any π^+ open set containing A. We know that every π^+ open set is open, $bI^+cl^+*(A) \subset pI^+cl^+* (A) \subset cl^+* (A) = A$. i.e., $bI^+cl^+*(A) \subset A$ and $A \subset U$, where U is π^+ open. Therefore $bI^+cl^+*(A) \subset U$. Hence A is πgbI^+ - closed set.

Theorem 3.14: Every $\pi g\alpha I^+$ closed is πgbI^+ - closed.

Proof: Let A be any $\pi g\alpha I^+$ - closed set in X and U be any π^+ open set containing A. We know that every π^+ open set is open, $bI^+ cl^+{}^*(A) \subset \alpha I^+ cl^+ (A) \subset cl^+{}^*(A) = A$. i.e., $bI^+ cl^+{}^*(A) \subset A$ and $A \subset U$, where U is π^+ open. Therefore $bI^+ cl^+{}^*(A) \subset U$. Hence A is πgbI^+ - closed set.

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Theorem 3.15: Every πgsI^+ closed is $\pi gb^+ I$ - closed.

Proof: Let A be any πgsI^+ - closed set in X and U be any π^+ open set containing A. We know that every π^+ open set is open, $bI^+ cl^{+*}(A) \subset sI^+ cl^{+*}(A) \subset cl^{+*}(A) = A$. i.e., $bI^+ cl^{+*}(A) \subset A$ and $A \subset U$, where U is π^+ open. Therefore $bI^+ cl^{+*}(A) \subset U$. Hence A is πgbI^+ - closed set.

Theorem 3.16: Every πgbI^+ closed is $\pi g\beta bI^+$ - closed.

Proof: Let A be any πgbI^+ - closed set in X and U be any π^+ open set containing A. We know that every π^+ open set is open, $bI^+ cl^{+*}(A) \subset spI^+ cl^{+*}(A) \subset cl^{+*}(A) = A$. i.e., $bI^+ cl^{+*}(A) \subset A$ and $A \subset U$, where U is π^+ open. Therefore $bI^+ cl^{+*}(A) \subset U$. Hence A is πgbI^+ - closed set.

Converses of the above need not to be true as seen in the following examples.

Example 3.17: Consider X = {a,b,c}, τ = {∅,{a},{a, c}}. Let B = {c} then τ^+ = {X, ∅,{a},{c},{a,c}}. Let I = {∅,{b}} , A = {b}. Then A is πgbI^+ - closed but not closed.

Example 3.18: Consider X = {a,b,c}, τ = {∅,{a},{a,c}}. Let B = {c} then τ^+ = {X,∅,{a},{c},{a,c}}. Let I = {∅,{b}} , A = {a} Then A is πgbI^+ - closed but not gI^+ closed.

Example 3.19: Consider X = {a,b,c}, τ = {∅,{a},{a,c}}. Let B = {c} then τ^+ = {X,∅,{a},{c},{a,c}}. Let I = {∅,{b}}, A = {a,c} Then A is πgbI^+ - closed but not αI^+ closed.

Example 3.20: Consider X = {a,b,c}, τ = {∅,{a},{a,c}}. Let B = {c} then τ^+ = {X,∅,{a},{c},{a,c}}.

Let I = {∅,{b}}, A = {a} Then A is πgbI^+ - closed but not gbI^+ closed.

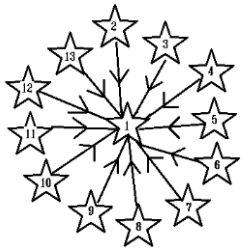
Example 3.21: Consider X = {a,b,c}, τ = {∅,{a},{a,c}}. Let B = {c} then τ+ = {X, ∅,{a},{c},{a,c}}. Let I = {∅,{b}}, A = {a}. Then A is πgbI^+ - closed but not πgI^+ closed.

Example 3.22: Consider X = {a,b,c}, τ = {∅,{a},{a,c}}. Let B = {c} then τ^+ = {X,∅,{a},{c},{a,c}}. Let I = {∅,{b}} , A = {a}. Then A is πgbI^+ - closed but not πgpI^+ closed.

Example 3.23: Consider X = {a,b,c}, τ = {∅,{a},{a,c}}. Let B = {c} then τ^+ = {X,∅,{a},{c},{a,c}}. Let I = {∅,{b}}, A = {a}. Then A is πgbI^+ - closed but not $\pi g\alpha I^+$ closed.

Example 3.24: Consider X = {a,b,c}, τ = {∅,{a},{a,c}}. Let B = {c} then τ^+ = {X,∅,{a},{c},{a,c}}. Let I = {∅,{b}} , A = {a}. Then A is πgbI^+ - closed but not pre I^+ closed.

Remark 3.25:



1. α^+ gI- closed set
2. gI α^+ - closed set
3. semi$^+$ - closed set
4. sgI^+ - closed set
5. gsI^+ - closed set
6. pre$^+$ - closed set
7. gpI^+ - closed set
8. $gspI^+$ - closed set
9. $gspI^+$ - closed set
10. bI^+ - closed set
11. gbI^+ - closed set
12. πgI^+ - closed set
13. $\pi g\alpha I^+$ - closed set

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Theorem 3.26: If A is π^+ open and πgbI^+ - closed, then A is bI^+ - closed.

Proof: Let us assume that A is π^+ open and πgbI^+ closed. We know that $A \subset A$ where A is π^+ open. Since A is πgbI^+ - closed, $bI^+cl^{+*}(A) \subset A$. Then $A = bI^+cl^{+*}(A)$ Hence A is bI^+- closed.

Theorem 3.27: For a subset of A of X, the following statements are equivalent:

(1) A is π^+ open and πgbI^+ - closed. (2) A regular I^+ open.

Proof: (1) $\Rightarrow$ (2) Let A be a π^+ open and πgbI^+ closed subset of X. Then $bI^+cl^{+*}(A) \subset A$ and so $int(cl^{+*}(A)) \subset A$ holds. Since A is open then A is pre I^+ - open and thus $A \subset int(cl^{+*}(A))$. Therefore, we have $int(cl^{+*}(A)) = A$, which shows that A is regular I^+open.

(2) $\Rightarrow$ (1) Since every regular I^+ open set is π^+ - open then $bI^+cl^{+*}(A) = A$ and $bI^+cl^{+*}(A) \subset A$. Hence A is πgbI^+ - closed.

Theorem 3.28: Let A be πgbI^+ - closed in (X,τ^+,I). Then $bI^+cl^{+*}(A) - A$ does not contain any non-empty π^+ closed set.

Proof: Let F be a non empty π^+ - closed set such that $F \subset bI^+cl^{+*}(A) - A$. Since A is πgbI^+ - closed. $A \subset X - F$ where X-F is π^+ open implies $bI^+cl^{+*}(A) \subset X - F$. Hence $F \subset X - bI^+cl^{+*}(A)$. Now, $F \subset bI^+cl^{+*}(A) \cap (X - bI^+cl^{+*}(A))$ implies $F = \emptyset$ which is contradiction. Therefore $bI^+cl^{+*}(A)$ does not contain any non empty π^+ closed set.

Corollary 3.29: Let A be πgbI^+ - closed in (X,τ^+,I). Then A is bI^+ - closed if $bI^+cl^{+*}(A) - A$ is π^+ - closed.

Proof: Let A be bI^+ - closed. Then $bI^+cl^{+*}(A) = A$. This implies $bI^+cl^{+*}(A) - A = \emptyset$. which is π^+ - closed. Assume $bI^+cl^{+*}(A) - A$ is π^+ - closed. Then $bI^+cl^{+*}(A) - A = \emptyset$. Hence $bI^+cl^{+*}(A) = A$. Hence the proof.

Theorem 3.30: Let A be πgbI^+- closed set such that $cl^{+*}(A) = X$. Then A is πgpI^+ - closed.

Proof: Suppose that A is a πgbI^+ closed set such that $cl^{+*}(A) = X$. Let U be an π^+ - open set containing A. Since $bI^+cl^{+*}(A) = A \cup [int(cl^{+*}(A)) \cap cl^{+*}(int(A))]$ and $cl^{+*}(A) = X$, we obtain $bI^+cl^{+*}(A) = A \cup cl^{+*}(int(A)) = pI^+cl^{+*} \subset U$. Therefore, A is πgpI^+ closed.

Theorem 3.31: If A is πgbI^+ - closed set and B is any set such that $A \subset B \subset bI^+cl^{+*}(A)$. Then B is πgbI^+ - closed set.

Proof: Let $B \subset U$ and U be π^+ open. Given $A \subset B$. Then let us assume $A \subset U$. Since A is πgbI^+ - closed. $A \subset U$ implies $bI^+cl^{+*}(A) \subset U$. By assumption it follows that $B \subset bI^+cl^{+*}(A)$ then $bI^+cl^{+*}(B) \subset bI^+cl^{+*}(A) \subset U$. Hence B is a πgbI^+ - closed set.

Remark 3.32: Finite union of πgbI^+ - closed sets need not be πgbI^+ - closed.

Remark 3.33: Finite intersection of πgbI^+ - closed set need not to be πgbI^+ - closed.

Definition 3.34: Let (X,τ^+,I) be a topological space and $A \subset X$. The set of all bI^+ - limit points of A is said to be bI^+ - derived set of A and is denoted by $D_b{}^+[A]$.

Lemma 3.35: If $D(A) \subset D_b{}^+(A)$, then we have $cl^{+*}(A) = bI^+cl^{+*}(A)$.

Lemma 3.36: If $D(A) \subset D_b{}^+(A)$, then we have $cl^{+*}(A) = bI^+cl^{+*}(A)$.

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Lemma 3.37: If $D(A) \subset D_{b+}(A)$ for every subset A of X. Then for any subsets F and B of X. We have $bI^{+}cl^{+*}(F \cup B) = bI^{+}cl^{+*}(F) \cup bI^{+}cl^{+*}(B)$.

Theorem 3.38: Let A and B be πgbI^{+} - closed sets in (X, τ^{+}, I) such that $D[A] \subset D_b^{+}[A]$ and $D[B] \subset D_b^{+}[B]$ then $A \bigcup B$ is πgbI^{+} - closed.

Proof: Let U be π^{+} open set such that $A \cup B \subset U$. Since A and B are πgbI^{+} - closed sets we have $bI^{+}cl^{+*}(A) \subset U$ and $bI^{+}cl^{+*}(B) \subset U$. Since $D[A] \subset D_b^{+}[A]$ and $D[B] \subset D_b^{+}[B]$, by lemma 3.35, $cl^{+*}(A) = bI^{+}cl^{+*}(A)$ and $cl^{+*}(B) = bI^{+}cl^{+*}(B)$. Thus $bI^{+}cl^{+*}(A \cup B) \subset cl^{+}(A \cup B) = cl^{+}(A) \cup cl^{+}(B) = bI^{+}cl^{+*}(A) \bigcup bI^{+}cl^{+*}(B) \subset U$. This implies $A \bigcup B$ is πgbI^{+} - closed.

Proposition 3.38: Let A be a subset of a topological space X. If A is semi I^{+} - open then $pI^{+}cl^{+*}(A) = cl^{+*}(A)$.

Definition 3.39: A topological space X is said to be extremely disconnected in τ^{+} if the closure in the extended topology of every open subset of X is open in X.

Theorem 3.40: A space X is extremely disconnected in τ^{+} if and only if every πgbI^{+} - closed subset of X is πgpI^{+} - closed.

Proof: Suppose that X is extremely disconnected. Let A be πgbI^{+} - closed and let U be a π^{+} open set containing A. Then $bI^{+}cl^{+*}(A) = A \bigcup [int(cl^{+*}(A) \cap cl^{+*}(int(A))] \subset U$, i.e.,$[int(cl^{+*}(A) \cap cl=+*(int(A))] \subset U$. Since $int(cl^{+*}(A))$ is closed, we have $cl^{+*}(int(A)) \subset cl^{+*}[int(cl^{+*}(A)) \cap int(A)] \subset [cl^{+*}(int(cl^{+*}(A))) \cap cl^{+*}(int(A))] \subset U$. If follows that $pI^{+}cl^{+*}(A) = A \bigcup cl^{+*}(int(A)) \subset U$. Hence A is πgpI^{+} - closed. To prove the converse, let every πgbI^{+}- closed subset of X be πgpI^{+}-closed. Let A be a regular I^{+} open subset of X. Then $bI^{+}cl^{+*}(A) = A \bigcup [int(cl^{+*}(A)) \cap cl^{+*}(int(A))] = A \bigcup [A \cap cl^{+*}(int(A))] \subset A$. Then A is πgbI^{+} - closed and so A is πgpI^{+} - closed. Since every regular^{+} open is semi^{+} - open set and by proposition 3.38, we have $cl^{+*}(A) = pI^{+}cl^{+*}(A)$. Hence $cl^{+*}(A) \subset A$. Therefore, A is closed. This shows that X is extremely disconnected.

Definition 3.41: A topological space X is said to be hyper connected in τ^{+} if the closure in the extended topology of every open subset is X.

Theorem 3.42: Let X be a hyper connected space. Then every πgbI^{+} - closed subset of X is πgsI^{+}-closed.

Proof: Assume that X is hyper connected, Let A be πgbI^{+} closed and let U be a π^{+} - open set containing A. Then $bI^{+}cl^{+*}= A \bigcup [int(cl^{+*}(A)) \cap cl^{+*}(int(A)) = A \bigcup int(cl^{+*}(A)) = sI^{+}cl^{+*}(A)$. Since $bI^{+}cl^{+*} = sI^{+}cl^{+*}(A)$, we $sI^{+}cl^{+*}(A) \subset U$. Hence A is πgsI^{+} closed.

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A NEW FORMS OF NEUTROSOPHIC INFRA OPEN SETS IN NEUTROSOPHIC INFRA TOPOLOGICAL SPACES

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ABSTRACT

The purpose of this paper is to construct a new form of open set called the neutrosophic infra open set in neutrosophic infra topological spaces. Further we analyze the properties of neutrosophic infra open sets and study their relationships.

Keywords: Neutrosophic infra set, Neutrosophic infra open sets, Neutrosophic infra topological spaces.

1. INTRODUCTION

In 1965, Zadeh [7] introduced fuzzy set, where each element had a degree of membership. The intuitionistic fuzzy set was introduced by K.Atanassov [4] in 1986 as a generalization of fuzzy set. The neutrosophic set concept was introduced by Smarandache in 1999 [5] by the neutrosophic components T, I, F which represent the membership, inderminacy, and non-membership values respectively, where $]^{-}0,1^{+}[$ is a non-standard unit interval. The concepts of Neutrosophic Set and Neutrosophic topological Spaces was introduced by Salama & Alblowi[1] in 2012. Adel.M.AL.Odhari [2,3] introduced the concept of infra topological space and studied infra continuous and infra* continuous functions. Vaiyomathi.k and Nirmala Irudayam.F [6] introduced the notion of infra open sets and studied various properties in infra topological spaces. In this paper we introduce the definitions of neutrosophic infra open sets. And we obtain the several properties which enables us to bring out the relationship between these sets.

2. PRELIMINARIES

Definition 2.1: Let T, I, F be real standard or nonstandard subsets of $]^{-}0,1^{+}[$, with

Sup-T=t-sup, inf-T=t-inf ; Sup-I=i-sup, inf-I=i-inf ; Sup-F=f-sup, inf-F=f-inf

n-sup= t-sup+ i-sup+ f-sup; n-inf= t- inf + i- inf + f- inf ,Where T, I, F are called the neutrosophic components.

Definition 2.2 [5]: Let X be a non-empty fixed set. A neutrosophic set (NS) A is an object having the form $A=\{\langle x,\mu_A(x),\sigma_A(x),\gamma_A(x),\rangle : x\in X\}$ Where $\mu_A(x),\sigma_A(x)$ and $\gamma_A(x)$ which represent the degree of membership function, the degree of indeterminacy, the degree of non-membership respectively of each element $x\in X$ to the set A. A neutrosophic $A=\{\langle x,\mu_A(x),\sigma_A(x),\gamma_A(x),\rangle : x\in X\}$ can be identified to an ordered triple $\langle\mu_A(x),\sigma_A(x),\gamma_A(x)\rangle$ in $]^{-}0,1^{+}[$ on X.

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Definition 2.3 [5]: Let $\{A_i : i \in J\}$ be an arbitrary family of neutrosophic sets in X. Then

(i) $\bigcap A = \{\langle x, \wedge\mu_{A_i}(x), \wedge\sigma_{A_i}(x), \vee\gamma_{A_i}(x)\rangle : x \in X\}$

(ii) $\bigcup A = \{\langle x, \vee\mu_{A_i}(x), \vee\sigma_{A_i}(x), \wedge\gamma_{A_i}(x)\rangle : x \in X\}$

Definition 2.4 [1,5]: A neutrosophic topology (NT) on a nonempty set X is a family τ of neutrosophic sets in X satisfying the following axioms:

$(i) 0_N, 1_N \in \tau$

$(ii) G_1 \bigcap G_2 \in \tau$ for any $G_1, G_2 \in \tau$

$(iii) \bigcup G_i \in \tau$ for arbitrary family $\{G_i : i \in \Lambda\} \subseteq \tau$

In this case the ordered pair (X, τ) or simply X is called a neutrosophic topological spaces (NTS) and each neutrosophic set in τ is called a neutrosophic open set (NOS). The complement (A^c) of a NOS A in X is called a neutrosophic closed set (NCS) in X.

Definition 2.5: Let A be a neutrosophic set in a neutrosophic topological space X. Then (i) $Nint(A) = \bigcup\{G : G$ is a neutrosophic open set in X and $G \subseteq A\}$

(ii) $Ncl(A) = \bigcap\{G : G$ is a neutrosophic closed set in X and $G \supseteq A\}$

Definition 2.6 [2]: Let X be any arbitrary set. An Infra –topological space on X is a collection τ_{iX} subsets of X such that the following axioms are satisfying:

Ax-1: ϕ , X $\epsilon\tau_{iX}$.

Ax-2:The intersection of the elements of any sub collection of τ_{iX} in X.

i.e) If Oi$\epsilon\tau_{iX}$,$1 \leq i \leq n \rightarrow \cap$ $O_i \epsilon\tau_{iX}$.

Terminology, the order pair (X,τ_{iX}) is called infra-topological space. We simply say X is an infra space.

Definition 2.7 [2]: Let (X,τ_{iX}) be an infra-topological space and A$\subset X$. A is called an infra open set (IOS) if A ϵ τ_{iX} and A is called an infra-closed set (ICS) iff X \A $\epsilon\tau_{iX}$.

Definition 2.8: Let (X, τ_{iX}) be an infra topological space and A . The infra Closure Point (ICP) of A is given by : icp(A) = (i.e) icp(A) is the intersection of all infra closed set containing the set A and the infra Interior Point (IIP) of A is given by: iip(A) = (i.e) iip(A) is the union of all infra open set contained in the set A.

3. NEUTROSOPHIC INFRA TOPOLOGICAL SPACES

In this section, we define a neutrosophic infra set and introduce a new class of open sets called neutrosophic infra semi-open set, neutrosophic infra pre-open set, neutrosophic infra α -open set, neutrosophic infra b-open set, neutrosophic infra β -open set and study some of their properties.

Definition 3.1: Let X be a non-empty fixed set. A neutrosophic infra set (NIS) A_{NI} is an object having the form $A_{NI} = \left\{ \left\langle x, \mu_{A_{NI}}(x), \sigma_{A_{NI}}(x), \gamma_{A_{NI}}(x) \right\rangle : x \in X \right\}$ Where $\mu_{A_{NI}}(x), \sigma_{A_{NI}}(x)$ and $\gamma_{A_{NI}}(x)$ which represent the degree of membership function, the degree of indeterminacy, the degree of non-membership respectively of each element $x \in X$ to the set A_{NI} .

A neutrosophic infra set $A_{NI} = \left\{ \left\langle x, \mu_{A_{NI}}(x), \sigma_{A_{NI}}(x), \gamma_{A_{NI}}(x) \right\rangle : x \in X \right\}$ can be identified to an ordered triple $\left\langle \mu_{A_{NI}}(x), \sigma_{A_{NI}}(x), \gamma_{A_{NI}}(x) \right\rangle$ in $\left]^{-}0,1^{+}\right[$ on X.

Definition 3.2: Let X be a non-empty fixed set. The neutrosophic infra sets A_{NI} and B_{NI}

are in the form as follows:

$A_{NI} = \left\{ \left\langle x, \mu_{A_{NI}}(x), \sigma_{A_{NI}}(x), \gamma_{A_{NI}}(x) \right\rangle : x \in X \right\}$, $B_{NI} = \left\{ \left\langle x, \mu_{B_{NI}}(x), \sigma_{B_{NI}}(x), \gamma_{B_{NI}}(x) \right\rangle : x \in X \right\}$

Then (i) The complement of the neutrosophic infra set A_{NI} (ie:($A^{c}{}_{NI}$)) defined as

$A^{c}{}_{NI} = \left\{ \left\langle x, \gamma_{A_{NI}}(x), \sigma_{A_{NI}}(x), \mu_{A_{NI}}(x) \right\rangle : x \in X \right\}$

(ii) The subset of the neutrosophic infra sets A_{NI} and B_{NI} are defined as

$A_{NI} \subseteq B_{NI} \Leftrightarrow \mu_{A_{NI}}(x) \le \mu_{B_{NI}}(x),\ \sigma_{A_{NI}}(x) \le \sigma_{B_{NI}}(x),\ \gamma_{A_{NI}}(x) \ge \gamma_{B_{NI}}(x)$ forall $x \in X$

(iii) The neutrosophic infra sets $A_{NI} = B_{NI} \Leftrightarrow A_{NI} \subseteq B_{NI}$ and $B_{NI} \subseteq A_{NI}$

(iv) The intersection of the neutrosophic infra sets A_{NI} and B_{NI} are defined as

$A_{NI} \cap B_{NI} = \left\{ \left\langle x, \mu_{A_{NI}}(x) \wedge \mu_{B_{NI}}(x), \sigma_{A_{NI}}(x) \wedge \sigma_{B_{NI}}(x), \gamma_{A_{NI}}(x) \right\rangle \vee \gamma_{B_{NI}}(x) : x \in X \right\}$

(v) The union of the neutrosophic infra sets A_{NI} and B_{NI} are defined as

$A_{NI} \cup B_{NI} = \left\{ \left\langle x, \mu_{A_{NI}}(x) \vee \mu_{B_{NI}}(x), \sigma_{A_{NI}}(x) \vee \sigma_{B_{NI}}(x), \gamma_{A_{NI}}(x) \right\rangle \wedge \gamma_{B_{NI}}(x) : x \in X \right\}$

(vi) $[\ ]A_{NI} = \left\{ \left\langle x, \mu_{A_{NI}}(x), \sigma_{A_{NI}}(x), 1 - \mu_{A_{NI}}(x), \right\rangle : x \in X \right\}$

(vii) $\langle\ \rangle A_{NI} = \left\{ \left\langle x, 1 - \gamma_{A_{NI}}(x), \sigma_{A_{NI}}(x), \gamma_{A_{NI}}(x), \right\rangle : x \in X \right\}$

Since our aim is to construct the tool for developing neutrosophic infra topological spaces, we must introduce the neutrosophic infra sets 0_{NI} and 1_{NI} in X as follows:

Definition 3.3: Let $0_{NI} = \{\langle x,0,0,1\rangle : x \in X\}$ and $1_{NI} = \{\langle x,1,1,0\rangle : x \in X\}$

Definition 3.4: A neutrosophic infra topology (NIT) on a nonempty set X is a family τ_{NI} of neutrosophic sets in X satisfying the following axioms:

$(i) 0_N, 1_N \in \tau_{NI}$

$(ii) G_1 \cap G_2 \in \tau_{NI}$ for any $G_1, G_2 \in \tau_{NI}$

In this case the ordered pair (X, τ_{NI}) or simply X is called a neutrosophic infra topological spaces (NITS) and each neutrosophic set in τ_{NI} is called a neutrosophic open set (NIOS). The complement (A_{NI}^c) of a NIOS A_{NI} in X is called a neutrosophic closed set (NICS) in X.

Definition 3.5: Let A_{NI} be a neutrosophic infra set in a neutrosophic infra topological space X. Then $NIint(A_{NI}) = \cup\{F : F \text{ is a neutrosophic open set in X and } F \subseteq A_{NI}\}$ is called the neutrosophic interior of A_{NI};

$NIcl(A_{NI}) = \cap\{K : K \text{ is a neutrosophic closed set in X and } K \supseteq A_{NI}\}$ is called the neutrosophic closure of A_{NI}.

It can also shown that $NIcl(A_{NI})$ is NICS and $NI\,\text{int}(A_{NI})$ is a NIOS in X.

(i) A_{NI} is in X if and only if NIcl(A_{NI}).

(ii) A_{NI} is NICS in X if and only if NIint(A_{NI})= A_{NI}

Proposition 3.6: Let (X, τ_{NI}) be an neutrosophic infra topological space and the two neutrosophic infra sets A_{NI} and B_{NI} in X. Then the following properties hold:

$(i) NI\,\text{int}(A_{NI}) \subseteq A_{NI}$, $(ii) A_{NI} \subseteq NIcl(A_{NI})$

$(iii) A_{NI} \subseteq B_{NI} \Rightarrow \text{NIint}(A_{NI}) \subseteq \text{NIint}(B_{NI}), (iv) A_{NI} \subseteq B_{NI} \Rightarrow \text{NIcl}(A_{NI}) \subseteq \text{NIcl}(B_{NI})$

$(v) NI\,\text{int}(NI\,\text{int}(A_{NI})) = NI\,\text{int}(A_{NI})$, $(vi) NIcl(NIcl(A_{NI})) = NIcl(A_{NI})$

$(vii) NI\,\text{int}(1_{NI}) = 1_{NI}$, $(viii) NIcl(0_{NI}) = 0_{NI}$

$(ix) NI\,\text{int}(A_{NI} \cup B_{NI})) = NI\,\text{int}(A_{NI}) \cup NI\,\text{int}(B_{NI})$; $(x) NIcl(A_{NI} \cap B_{NI})) = NIcl(A_{NI}) \cap NIcl(B_{NI})$

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Definition 3.7: A neutrosophic infra set $A_{NI} = \left\{ \left\langle x, \mu_{A_{NI}}(x), \sigma_{A_{NI}}(x), \gamma_{A_{NI}}(x) \right\rangle : x \in X \right\}$ in neutrosophic infra topological space(X, τ_{NIX}) is said to be

(i) Neutrosophic infra semi-open set (NISOS in short) if $A_{NI} \subseteq NIcl\left(NIint\ (A_{NI})\right)$.

(ii)Neutrosophic infra pre-open set (NIPOS in short) if $A_{NI} \subseteq NIint\left(NIcl\ (A_{NI})\right)$.

(iii)Neutrosophic infra α-open set (NI α OS in short) if $A_{NI} \subseteq NIint\left(NIci\,(NIint(A_{NI})\right)$.

(iv)Neutrosophic infra b-open set (NIBOS in short) if $A_{NI} \subseteq NIint\left(NIcl\left(A_{NI}\right)\right) \cup NIcl\left(NIint\left(A_{NI}\right)\right)$.

(v)Neutrosophic infra β -open set (NI β OS in short) if $A_{NI} \subseteq NIcl\left(NIint\ (NIcl(A_{NI})\right)$) .

The complement of the above mentioned neutrosophic infra open sets are called their respective neutrosophic infra closed sets.

Proposition 3.8: Let A_{NI} be a neutrosophic infra set of a space(X, τ_{NIX}). Then

(1) $NIscl\ (A_{NI})\big) = A_{NI} \cup (NIint(NIcl\ (A_{NI})\big))$

$NIsint\ (A_{NI})\big) = A_{NI} \cap (NIcl\left(NIint\ (A_{NI})\right))$

(2) $NIpcl\left(A_{NI}\right) = A_{NI} \cup (NIcl\left(NIint\ (A_{NI})\right))$

$NIpint\ (A_{NI}\big) = A_{NI} \cap (NIint\,(NIcl\ (A_{NI})\big))$

(3) $NIspcl\left(A_{NI}\right) = A_{NI} \cup (NIint(NIcl\left(NIint\left(A_{NI}\right)\right))$

$NIspint\ (A_{NI}\big) = A_{NI} \cap (NIcl(NIint\,(NIcl\ (A_{NI})\big))$

(4) $NIscl\left(NIsint\ (A_{NI})\right)$= $NIsint\ (A_{NI}) \cup (NIint(NIcl\left(NIint\left(A_{NI}\right)\right))$

(5) $NIpcl(NIpint\ (A_{NI}\big)) = NIpint\ (A_{NI}\big) \cup (NIcl\left(NIint\ (A_{NI})\right))$

(6) $NIspcl\left(\text{NI}spint\ (A_{NI})\right) = \text{NI}spint\ (NIspcl\left(A_{NI}\right))$

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Theorem 3.9: In a neutrosophic infra topological space (X, τ_{NIX})

(i)Every neutrosophic $infra\ semi$-open set is neutrosophic infra b -open set.

(ii)Every neutrosophic $infra\ pre$- open set is neutrosophic infra b-open set.

Proof: The result is Obvious.

The converse of the above theorem need not be true as shown by the following example.

Example 3.10: Let (X, τ_{NIX}) be a neutrosophic infra topological space and X={a, b}. Define the neutrosophic infra sets A, B, C_1 and C_2 as follows:

$$A=\left\langle x,\frac{a}{(0.3,0.2,0.5)},\frac{b}{(0.4,0.4,0.7)}\right\rangle \quad B=\left\langle x,\frac{a}{(0.4,0.5,0.7)},\frac{b}{(0.5,0.6,0.8)}\right\rangle$$

$C_1=\left\langle x,\frac{a}{(0.5,0.5,0.6)},\frac{b}{(0.6,0.6,0.7)}\right\rangle$ and $C_2=\left\langle x,\frac{a}{(0.3,0.3,0.3)},\frac{b}{(0.4,0.5,0.5)}\right\rangle$ .Then the families $\tau_{NIX}=\{0_{NI},1_{NI},A,B,A\cap B\}$ is a neutrosophic infra topology on X. Here C_1 is neutrosophic infra b-open set but not neutrosophic $infra\ pre$- open set and C_2 is neutrosophic infra b-open set but not neutrosophic infra semi-open set.

Proposition 3.11: Let A_{NI} be a neutrosophic infra set of a space(X, τ_{NIX}). Then the following are equivalent:

a) A_{NI} is neutrosophic infra b- open set. b) $A_{NI}=NIpint(A_{NI})\cup NIsint(A_{NI})\Big)$

c) $A_{NI}\subseteq\Big(NIpcl\ (NIpint(A_{NI})\Big)$

Proof: Let $A_{NI}\subseteq$ (X, τ_{NIX}).

(a)⇒(b) Let A_{NI} be a neutrosophic infra b- open set.(i.e) $A_{NI}\subseteq NIint\Big(NIcl\ \Big(A_{NI}\Big)\Big)\cup$ $NIcl\ \Big(NIint\Big(A_{NI}\Big)\Big)$. Then by proposition (3.8), $NIpint\Big(A_{NI}\Big)\cup NIsint\Big(A_{NI}\Big)$

$=(A_{NI}\cap NIint\Big(NIcl\ (A_{NI})\Big))\cup(A_{NI}\cap(NIcl\ \Big(NIint\ (A_{NI})\Big))$

$=A_{NI}\cap(NIint\ \Big(NIcl\ (A_{NI})\Big)\cup(NIcl\ \Big(NIint\ (A_{NI})\Big))=A_{NI}$

Therefore $A_{NI}=NIpint(A_{NI})\cup NIsint\ (A_{NI})\Big)$

(b) ⇒ (c), By Proposition (3.8) We have,

$A_{NI} = NIpint\left(A_{NI}\right) \cup NIsint\left(A_{NI}\right) = NIpint\left(A_{NI}\right) \cup \left(A_{NI} \cap NIcl\left(NIint\left(A_{NI}\right)\right)\right) \subseteq NIpint\left(A_{NI}\right) \cup \left(NIcl\left(NIint\left(A_{NI}\right)\right)\right) = \left(NIpcl\left(NIpint(A_{NI}\right)\right)$

(c) $\Rightarrow (a)$, By Proposition (3.8) We have , $A_{NI} \subseteq NIpint\left(A_{NI}\right) \cup \left(NIcl\left(NIint\left(A_{NI}\right)\right)\right) \subseteq NIint\left(NIcl\left(A_{NI}\right)\right) \cup \left(NIcl\left(NIint\left(A_{NI}\right)\right)\right)$.

Therefore A is neutrosophic infra b-open set.

Theorem 3.12: Let A_{NI} be a neutrosophic infra set of a space(X, τ_{NIX}). Then

(a) $NIbcl\left(A_{NI}\right) = NIscl\left(A_{NI}\right) \cap$ NIpcl $\left(A_{NI}\right)$

(b) $NIbint\left(A_{NI}\right) = NIsint\left(A_{NI}\right) \cup NIpint\left(A_{NI}\right)$

Proof: Obvious.

Theorem 3.13: Let A_{NI} be a neutrosophic infra set of a space(X, τ_{NIX}), then $NIbint\left(NIbcl\left(A_{NI}\right)\right) = NIbcl(NIbint\left(A_{NI}\right))$.

Proof: Let A_{NI} be a subset of a space (X, τ_{NIX}).

Now $NIbint\left(NIbcl\left(A_{NI}\right)\right) = NIsint\left(NIbcl\left(A_{NI}\right)\right) \cup NIpint\left(NIbcl(A_{NI}\right)\right) = NIbcl\left(NIsint\left(A_{NI}\right)\right) \cup NIpint\left(NIbcl\left(A_{NI}\right)\right)$

$= NIscl\left(NIsint\left(A_{NI}\right)\right) \cup NIpint\left(NIpcl\left(A_{NI}\right)\right)$ ---------- (1)

& $NIbcl\left(NIbint\left(A_{NI}\right)\right) = NIbcl\left(NIsint\left(A_{NI}\right) \cup NIpint\left(A_{NI}\right)\right) = NIbcl\left(NIsint\left(A_{NI}\right)\right) \cup NIbcl\left(NIpint\left(A_{NI}\right)\right)$

$= NIscl\left(NIsint\left(A_{NI}\right)\right) \cup NIpint\left(NIpcl(A_{NI}\right)\right)$---------- (2)

Hence, From (1) & (2),$NIbint\left(NIbcl(A_{NI}\right)\right) = NIbcl\left(NIbint\left(A_{NI}\right)\right)$

Theorem 3.14:

In a neutrosophic Infra topological space X, every neutrosophic infra b-open set (b-closed set) is a neutrosophic infra β- open set (β -closed set).

Proof: Let A_{NI} be a neutrosophic infra b-*open set* in X. Then

$$A_{NI} \subseteq NIcl\left(NIint\left(A_{NI}\right)\right) \cup NIint\left(NIcl\left(A_{NI}\right)\right) \subseteq NIcl(NIint\left(NIcl\left(A_{NI}\right)\right) \cup NIint(NIcl\left(A_{NI}\right)) \subseteq NIcl(NIint\left(NIcl\left(A_{NI}\right)\right).$$

Therefore A_{NI} is neutrosophic infra β - open set.

The converse is not true as seen in the following example:

Example3.17: Let (X, τ_{NIX}) be a neutrosophic infra topological space and X=$\{a, b\}$. Define the neutrosophic infra sets A, B, C_1 and C_2 as follows:

$$A=\left\langle x,\frac{a}{(0.3,0.2,0.5)},\frac{b}{(0.4,0.4,0.7)}\right\rangle \quad B=\left\langle x,\frac{a}{(0.4,0.5,0.7)},\frac{b}{(0.5,0.6,0.8)}\right\rangle$$

and $C=\left\langle x,\frac{a}{(0.3,0.4,0.4)},\frac{b}{(0.4,0.5,0.5)}\right\rangle$ .Then the families $\tau_{NIX}=\{0_{NI},1_{NI},A,B,A\cap B\}$ is a neutrosophic infra topology on X. Here C is neutrosophic infra β -open set but not neutrosophic infra b-open set.

Proposition 3.18: The intersection of a neutrosophic infra-open set and a neutrosophic $infra\ b-open\ set$ is a neutrosophic $infra\ b-open\ set$.

Proof: The result is obvious.

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A Study On Difference Between Pythagorean Vague Sets

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ABSTRACT

In this paper, we introduce and study a new concept of Pythagorean vague sets. Based on these definition Pythagorean vague distances are proposed and studied with suitable illustration.

Key words: In Pythagorean vague Sets, Hamming Pythagorean Vague Measures, Normalized Hamming Pythagorean Vague Measures, Euclidean Pythagorean Vague Measures, Normalized Euclidean Pythagorean Vague Measures.

INTRODUCTION

The concept of fuzzy set was introduced by Zadeh [14] in 1965. The membership of an element to a fuzzy set is a single value between 0 and 1. In 1968 the theory of fuzzy topology was introduced by C.L. Chang [3]. Atanassov [1] initiated the concept of intuitionistic fuzzy set (IFS), which is a generalization of Zadesh's fuzzy set in 1986.

The theory of vague set was proposed by Gaw and Buchere [6] as an extension of fuzzy set theory. The idea of vague set is defined by a truth membership (t_v) and false membership function (f_v). The value of $t_v(x)$ and $f_v(x)$ are both defined on the closed interval [0,1] with each point in a basic set X, where $t_v(x) + f_v(x) \leq 1$.

In 2013 Yagar [13] introduced the model of Pythagorean fuzzy sets (PFS) characterized by a membership and non membership degree, which satisfies the condition that, the square sum of its membership and non membership degree is less than or equal to 1. Peng and Yang [10] studied some results of Pythagorean fuzzy sets in 2015. In 1997 Szmidt and Kacprzyk [4] defined different types of distances between intuitionistic fuzzy sets . Atanassov [2] defined the hamming distance and Euclidean distances between vague sets in 1999. Liu [9] defined the distances formula of Vague sets in 2005. Hung and Yang [8] Grzegorzewski [7] Chen [4] and Yang and Chiclana [12] proposed the Hausdorff distances of Vague Sets respectively.

The purpose of this paper is to introduce the concept of Pythagorean vague sets and obtain measuring distance between Pythagorean vague sets.

2. PRELIMINARIES:

Definition 1[6]:

A vague set V in a universe of discourse X is characterized by a true membership function t_v , and a false membership function f_v, as follows: $t_v : U \rightarrow [0, 1]$, $f_v: U \rightarrow [0, 1]$, and $t_v+f_v \leq 1$, where $t_v(x)$ is a lower bound on the grade of membership of x derived from the evidence for x, and $f_v(x)$ is a lower bound on the grade of membership of the negation of x derived from the evidence against x. The vague set A is written as,

$A=\{ < x, t_A(x), 1-f_A(x) > | x \in X\}$.

Definition 2 [6]:

A vague topology (VT in short) on X is a family A of vague sets(VS in short) in X satisfying the following axioms:

(1) 0,1 ∈ A;

(2) $G_1 \cap G_2 \in A$ for any $G_1, G_2 \in A$.

(3) $\cup G_i \in A$ for any family $\{G_i : i \in N\} \subseteq A$.

In this case the pair (X, A) is called a vague topological space (VTS in short) and any vague set in A is known as a vague open set (VOS) in X. The complement A^c of a VOS A in a VTS (X,A) is called a vague closed set (VCS in short) in X.

Definition 3[6]:

Let (X,τ) be VTS and $A=\{ < x, t_A(x), 1-f_A(x)>\}$ be VS in *X*. Then the vague interior and vague closure are defined by

vint(A) = ∪ {G/G is aVOS in X and G ⊆ A}

vcl(A) = ∩ { K / K is aVCS in X and A⊆ K}

Definition 4[11]:

Let X be a universe of discourse. A Pythagorean Vague Set (PVS) A in X is given by $A = \{< x, t_A(x), 1-f_A(x) >| x \in X\}$, where $t_A(x): X \rightarrow [0,1]$ denotes the truth value and $1-f_A(x) : X \rightarrow [0,1]$ denotes the false value of the element $x \in X$ to the set A, respectively, with the condition that $0 \leq (t_A(x))^2 + (1-f_A(x))^2 \leq 1$.

Definition 5[11]:

Let $P= <t_p,1-f_p>$, $P_1= <t_{p_1}, 1-f_{p_1}>$, $P_2 = <t_{p_2}, 1-f_{p_2}>$ be the Pythagorean vague elements and $\lambda>0$, satisfies the following operations.

1. $P^\lambda = [(t_p)^\lambda, \sqrt{1-(1-(1-f_p)^2)^\lambda}]$,

2. $\lambda P= [\sqrt{1-(1-t_p^{\,2})^\lambda}, (1-f_v)^\lambda]$

3. $P_1 \oplus P_2 = \left[\sqrt{(t_{p_1})^2 + (t_{p_2})^2 - t_{p_1}^{\,2}.t_{p_2}^{\,2}}, (1-f_{p_1})(1-f_{p_2})\right]$

4. $P_1 \otimes P_2 = \left[\sqrt{(1-f_{p_1})^2 + (1-f_{p_2})^2 - (1-f_{p_1})^2.(1-f_{p_2})^2}, (t_{p_1})(t_{p_2})\right]$

Definition 6[11]:

Let $P= \{<x,(a,b)>|x\in X\}$ and $P_1 =\{<x, (a_1,b_1)>| x\in X\}$, $P_2= \{<x, (a_2, b_2)>| x\in X\}$ be the pythagorean vague sets and $\lambda \geq 0$, then

*$P_1 \cup P_2$ = (max (a_1,a_2), max (b_1,b_2))

*$P_1 \cap P_2$ =(min(a_1,a_2), min (b_1,b_2))

*P^c = (b,a).

3. Distance Measures of Pythagorean Vague Sets

Definition 3.1 :

Let A= {<x,(t_A(x), 1-f_A(x))>|x∈ X} and B ={<x, (t_B, 1-f_B(x))>| x∈ X} pythagorean vague sets in X

1. Hamming Distance

$$H_{PV}(A,B)=\frac{1}{2}\sum_{i=1}^{n}\left(|t_A(x_i)-t_B(x_i)|+|[1-f_A(x)]-[1-f_B(x_i)]|+|\pi_A(x_i)-\pi_B(x_i)|\right)$$

2.Normalized Hamming Distance

$$N_{PV}(A,B)=\frac{1}{2n}\sum_{i=1}^{n}\left(|t_A(x_i)-t_B(x_i)|+|[1-f_A(x_i)]-[1-f_B(x_i)]|+|\pi_A(x_i)-\pi_B(x_i)|\right)$$

3.Euclidean Distance

$$E_{PV}(A,B)=\sqrt{\frac{1}{2}\sum_{i=1}^{n}\left((t_A(x_i)-t_B(x_i))^2+([1-f_A(x_i)]-[1-f_B(x_i)])^2+(\pi_A(x_i)-\pi_B(x_i))^2\right)}$$

Where $\pi_A(x_i)$ =1-t_A(x_1)- (1-f_A(x_i)) $\pi_B(x_i)$ =1-t_B(x_1)- (1-f_B(x_i)) be the degree of indeterminacy of x in A and B.

4. Normalized Euclidean Distance

$$NE_{PV}(A,B)=\sqrt{\frac{1}{2n}\sum_{i=1}^{n}\left((t_A(x_i)-t_B(x_i))^2+([1-f_A(x_i)]-[1-f_B(x_i)])^2+(\pi_A(x_i)-\pi_B(x_i))^2\right)}$$

Distance measures satisfies the following conditions:

$0 \le H_{VS}(A,B) \le 2n$

$0 \le N_{VS}(A,B) \le 2$

$0 \le E_{VS}(A,B) \le \sqrt{2n}$

$0 \le NE_{VS}(A,B) \le \sqrt{2}$

Example 3.2:

Let X={1,2} and let A and B are the Pythagorean fuzzy set in X defined by

A={<x, (0.1,0.4), (0.3,0.6)>} B={<x,(0.4,0.6),(0.5,0.7)>}

1.Hamming Distance

$$H_{PV}(A,B)=\frac{1}{2}\left(\sum_{i=1}^{n}\left(|t_A(x_i)-t_B(x_i)|+|[1-f_A(x)]-[1-f_B(x_i)]|+|\pi_A(x_i)-\pi_B(x_i)|\right)\right)$$

$$=\frac{1}{2}(|0.1\text{-}0.4|+|0.4\text{-}0.6|+|0.3\text{-}0.5|+|0.6\text{-}0.7|)$$

$$=\frac{1}{2}(0.3+0.2+0.2+0.1)=0.4$$

2. Normalized Hamming Distance

$$N_{PV}(A,B)=\frac{1}{2n}\sum_{i=1}^{n}\left(|t_A(x_i)-t_B(x_i)|+|[1-f_A(x_i)]-[1-f_B(x_i)]|+|\pi_A(x_i)-\pi_B(x_i)|\right)$$

$$=\frac{1}{2n}(0.4)=0.2$$

3.Euclidean Distance

$$E_{PV}(A,B)=\sqrt{\frac{1}{2}\sum_{i=1}^{n}\left((t_A(x_i)-t_B(x_i))^2+([1-f_A(x_i)]-[1-f_B(x_i)])^2+(\pi_A(x_i)-\pi_B(x_i))^2\right)}$$

$$=0.09$$

4. **Normalized Euclidean Distance**

$$NE_{PV}(A,B)=\sqrt{\frac{1}{2n}\sum_{i=1}^{n}\left((t_A(x_i)-t_B(x_i))^2+([1-f_A(x_i)]-[1-f_B(x_i)])^2+(\pi_A(x_i)-\pi_B(x_i))^2\right)}$$

$$=0.04$$

Distance in Pythagorean vague sets should be calculated by taking truth membership and false membership function and it also satisfies the following conditions.

1. $0\leq H_{PV}(A,B)\leq 2n$

   $0\leq 0.4\leq 4$

2. $0\leq N_{PV}(A,B)\leq 2$

   $0\leq 0.2\leq 2$

3. $0\leq E_{PV}(A,B)\leq \sqrt{2n}$

   $0\leq 0.09\leq 2$

4. $0\leq NE_{PV}(A,B)\leq \sqrt{2}$

   $0\leq 0.04\leq 1.41$.

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Distances between Pythagorean Vague Sets Based on Hausdorff Measure

Definition 3.3:

1. $H_{PV}(A,B) = \sum_{i=1}^{n} \max\{|t_A - t_B|, |(1-f_A)-(1-f_B)|, |\pi_A - \pi_B|\}$

2. $NH_{PV}(A,B) = \frac{1}{n} \sum_{i=1}^{n} \max\{|t_A - t_B|, |(1-f_A)-(1-f_B)|, |\pi_A - \pi_B|\}$

3. $E_{PV}(A,B) = \sqrt{\sum_{i=1}^{n} \max\{|t_A - t_B|^2, |(1-f_A)-(1-f_B)|^2, |\pi_A - \pi_B|^2\}}$

4. $NE_{PV}(A,B) = \sqrt{\frac{1}{n}\sum_{i=1}^{n} \max\{|t_A - t_B|^2, |(1-f_A)-(1-f_B)|^2, |\pi_A - \pi_B|^2\}}$

Example 3.4:

Let X={1,2} and let A and B are the Pythagorean fuzzy set in X defined by

A={<x, (0.2,0.5), (0.1,0.4)>} B={<x,(0.1,0.4),(0.1,0.5)>}

1. $H_{PV}(A,B) = \sum_{i=1}^{n} \max\{|t_A - t_B|, |(1-f_A)-(1-f_B)|, |\pi_A - \pi_B|\}$

= max{|0.2-0.1|,|0.5-0.4|,|0.1-0.1|,|0.4-0.5|}

= max{0.1,0.1,0,0.1}= 0.1

2. $NH_{PV}(A,B) = \frac{1}{n} \sum_{i=1}^{n} \max\{|t_A - t_B|, |(1-f_A)-(1-f_B)|, |\pi_A - \pi_B|\}$

$= \frac{1}{2}(0.1) = 0.05$

3. $E_{PV}(A,B) = \sqrt{\sum_{i=1}^{n} \max\{|t_A - t_B|^2, |(1-f_A)-(1-f_B)|^2, |\pi_A - \pi_B|^2\}}$

=0.1

4. $NE_{PV}(A,B) = \sqrt{\frac{1}{n}\sum_{i=1}^{n} \max\{|t_A - t_B|^2, |(1-f_A)-(1-f_B)|^2, |\pi_A - \pi_B|^2\}}$

= 0.22

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Numerical Example 3.5:

We have taken survey from the hospital in which they are facing many problems in which we have chosen the most common problems. We have consider only four patients, let the patients be P_1, P_2, P_3, P_4 are denoted by the set X = { P_1, P_2, P_3, P_4 } and the set of symptoms S = {Shivering, Wait loss, Dizziness, Itchiness, Hungry}. Let the set of health problems be H = {Fever, Jaundice, Anemia, Chicken Box, Diabetes}.

Table 1: Represents the Patients and their symptoms

	Shivering	Wait loss	Dizziness	Itchiness	Hungry
P_1	(0.9, 0.1)	(0.7, 0.2)	(0.1, 0.9)	(0.7, 0.2)	(0.2, 0.7)
P_2	(0, 0.7)	(0.4, 0.5)	(0.6, 0.2)	(0.2, 0.7)	(0.1, 0.2)
P_3	(0.7, 0.1)	(0.7, 0.1)	(0, 0.5)	(0.1, 0.7)	(0, 0.6)
P_4	(0.5, 0.1)	(0.4, 0.3)	(0.4, 0.5)	(0.8, 0.2)	(0.3, 0.4)

Table 2: Represents related health problems

	Fever	Jaundice	Anemia	Chicken Box	Diabetes
Shivering	(0.3, 0)	(0, 0.6)	(0.2, 0 .2)	(0.2, 0.8)	(0.2, 0.9)
Wait loss	(0.3, 0.5)	(0.2, 0.6)	(0.5, 0.2)	(0.1, 0.5)	(0, 0.7)
Dizziness	(0.2, 0.8)	(0, 0.8)	(0.1, 0.7)	(0.7, 0)	(0.2, 0.8)
Itchiness	(0.7, 0.3)	(0.5, 0)	(0.2, 0.6)	(0.1, 0.7)	(0.1, 0.8)
Hungry	(0.2, 0.6)	(0.1, 0.8)	(0.1, 0.9)	(0.2, 0.7)	(0.8, 0.1)

Using Pythagorean Vague Normalized Euclidean Distance Measures Definition to calculate the distance between each patients and health problem with reference to the symptoms, we get the table below.

Table 3: Patients and Health Problems

	Fever	Jaundice	Anemia	Chicken Box	Diabetes
P_1	**0.2569**	0.3987	0.3271	0.5666	0.5771
P_2	0.4111	0.4147	0.3674	**0.2145**	0.3633
P_3	0.3435	0.4505	**0.2191**	0.4528	0.5263
P_4	**0.1732**	0.3478	0.3256	0.4347	0.4868

Overall, the Pythagorean vague normalized Euclidean distance method gives the final result of four Patients health problems that is from Table 3, we see that

1. The shortest value of P_1 is 0.2569 and therefore P_1 faces Fever.
2 . The shortest value of P_2 is 0.2145 and therefore P_2 faces Chicken Box
3. The shortest value of P_3 is 0.2191 and therefore P_3 faces Anemia.
4. The shortest value of P_4 is 0.1732 and therefore P_4 faces Fever

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Conclusion

We conclude that the health problem of each patients by applying Pythagorean vague normalized Euclidean distance method of Pythagorean vague set is more accuracy for the root of finding the problem.

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Supra b minimal and Supra *b minimal homeomorphism in Supra Topological Spaces

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Abstract - In this paper we use supra b-m_i-closed and supra $^{*}b$-m_i-closed sets and introduced supra b minimal homeomorphism and supra $^{*}b$ minimal homeomorphism in supra topological spaces. Further their characterizations are analyzed.

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Keywords - Supra b-m_i-closed, supra $^*b$-m_i-closed, supra b minimal homeomorphism and supra $^*b$ minimal homeomorphism, supra b-m_i^*-homeomorphism.

1. Introduction: In 1970, Levine[4] introduced the concept of generalized closed sets which formed a strong tool in the characterization of topological spaces. Andrijevic[1] derived a new class of generalized open sets in a topological space, the so called b- open sets. In 1983, Mashhour et al. [6] introduced supra topological spaces. In 2010, O.R. Sayed and Takashi Noiri [10] formulated the concept of supra b-open sets and supra b-continuity on topological spaces. Nakaoka and N. Oda derived some applications of minimal open sets [7]. M. Kalaivani and M. Trinita Pricilla[2],[3] introduced supra b-m_i-closed, supra $^*b$-m_i-closed, supra b-m_i-continuous and supra $^*b$-m_i-continuous mapping in supra topological spaces. In this paper we use the notion of supra b-m_i-closed and supra $^*b$-m_i-closed sets and introduce supra b minimal homeomorphism and supra $^*b$ minimal homeomorphism and their properties are derived.

2. Preliminaries:

Definition 2.1:[6] A subfamily μ of X is said to be a supra topology on X if

i) $X, \phi \in \mu$

ii) If $A_i \in \mu$ for all $i \in J$, then $\cup A_i \in \mu$. (X, μ) is called supra topological space. The elements of μ are called supra open sets in (X, μ) and complement of supra open set is called supra closed set and it is denoted by μ^c.

Definition 2.2:[6] The supra closure and supra interior of a set A are defined as

$$cl^{\mu}(A) = \cap\{B : B \text{ is supraclosed and } A \subseteq B\}$$
$$\text{int}^{\mu}(A) = \cup\{B : B \text{ is supraopen and } A \supseteq B\}$$

Definition 2.3:[10] Let (X, μ) be a supra topological space. A set A is called a supra b-open set if $A \subseteq cl^{\mu}(\text{int}^{\mu}(A)) \cup \text{int}^{\mu}(cl^{\mu}(A))$. The complement of a supra b-open set is called supra b-closed set.

Definition 2.4: A proper nonempty subset A of a topological space (X, τ) is called

i) A minimal open[7] (minimal closed[9]) set is any open (resp.closed) subset of X which is contained in A, is either A or ϕ.

ii) A maximal open[8] (maximal closed[9]) set is any open (resp.closed) set which contains A, is either A or X.

Definition 2.5: A mapping $f : (X, \tau) \to (Y, \sigma)$ is said to be

i) generalized closed (g-closed) map[5] if the image of every closed set in X is g-closed set in Y.

ii) minimal open (resp. minimal closed) map[11] if the image of every minimal open (resp. minimal closed) in X is open (resp. closed) in Y.

iii) maximal open (resp. maximal closed) map[11] if the image of every maximal open (resp. maximal closed) in X is open (resp. closed) in Y.

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Definition 2.6:[11] If $f:(X,\mu_1)\to(Y,\sigma)$ is said to be generalized minimal homeomorphism (briefly g-m_i- homeomorphism) if f and f^{-1} are g-m_i-continuous maps.

Definition 2.7:[2] A subset *A* of a supra topological space (X,μ) is called supra b-m_i-closed if $bcl^{\mu}(A)\subseteq U$ whenever $A\subseteq U$ and *U* is supra m_i-open set in (X,μ).

Definition 2.8:[2] A subset *A* of a supra topological space (X,μ) is called supra $^{*}b$-m_i-closed if $bcl^{\mu}(A)\subseteq U$ whenever $A\subseteq U$ and *U* is supra m_i-b open set in (X,μ).

Definition 2.10:[3] A mapping $f:(X,\mu_1)\to(Y,\mu_2)$ is called supra b minimal continuous (briefly supra b-m_i-continuous) map if the inverse image of every supra minimal closed set in *Y* is supra b-m_i-closed set in *X*.

Definition 2.11:]3] A mapping $f:(X,\mu_1)\to(Y,\mu_2)$ is called supra $^{*}b$ minimal continuous (briefly supra $^{*}b$-m_i-continuous) map if the inverse image of every supra minimal closed set in *Y* is supra $^{*}b$-m_i-closed set in *X*.

3. Supra b-m_i-homeomorphism:

Definition 3.1: A mapping $f:(X,\mu_1)\to(Y,\mu_2)$ is said to be

i) supra minimal open (resp. supra minimal closed) map if the image of every supra minimal open (resp. supra minimal closed) in *X* is supra open (resp. supra closed) in *Y*.
ii) supra maximal open (resp. supra maximal closed) map if the image of every supra maximal open (resp. supra maximal closed) in *X* is supra open (resp. supra closed) in *Y*.
iii) supra b minimal open (briefly supra b-m_i-open) map if the image of every supra minimal open set in *X* is supra b-m_i-open set in *Y*.
iv) supra b minimal closed (briefly supra b-m_i-closed) map if the image of every supra minimal closed set in *X* is supra b-m_i-closed set in *Y*.
v) supra b maximal open (briefly supra b-m_a-open) map if the image of every supra maximal open set in *X* is supra b-m_a-open set in *Y*.
vi) supra b maximal closed (briefly supra b-m_a-closed) map if the image of every supra maximal closed set in *X* is supra b-m_a-closed set in *Y*.
vii) supra $^{*}b$ minimal open (briefly supra $^{*}b$-m_i-open) map if the image of every supra minimal open set in *X* is supra $^{*}b$-m_i-open set in *Y*.
viii) supra $^{*}b$ minimal closed (briefly supra $^{*}b$-m_i-closed) map if the image of every supra minimal closed set in *X* is supra $^{*}b$-m_i-closed set in *Y*.
ix) supra $^{*}b$ maximal open (briefly supra $^{*}b$-m_a-open) map if the image of every supra maximal open set in *X* is supra $^{*}b$-m_a-open set in *Y*.
x) supra $^{*}b$ maximal closed (briefly supra $^{*}b$-m_a-closed) map if the image of every supra maximal closed set in *X* is supra $^{*}b$-m_a-closed set in *Y*.

Definition 3.2: If $f:(X,\mu_1)\to(Y,\mu_2)$ is said to be supra b minimal homeomorphism (briefly supra b-m_i-homeomorphism) if f and f^{-1} are supra b-m_i-continuous maps.

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Definition 3.3: If $f:(X,\mu_1)\to(Y,\mu_2)$ is said to be supra $^*b$minimal homeomorphism (briefly supra $^*b$ -m_i-homeomorphism) if f and f^{-1} are supra $^*b$-m_i-continuous maps.

Theorem 3.4: If $f:(X,\mu_1)\to(Y,\mu_2)$ is a bijective map, then the following statements are equivalent.

i) Its inverse map $f^{-1}:(Y,\mu_2)\to(X,\mu_1)$ is supra b -m_i-continuous (supra $^*b$ -m_i-continuous).
ii) f is a supra b-m_a-open (supra $^*b$-m_a-open) map.
iii) f is a supra b-m_i-closed (supra $^*b$-m_i-closed)map.

Proof: $(i)\Rightarrow(ii)$: Let E be any supra maximal open set in X, so that E^c is supra minimal closed set in X. From (i) $\left(f^{-1}\right)^{-1}(E^c)=f(E^c)=(f(E))^c$ is supra b-m_i-closed set in Y, so that $f(E)$ is supra b-m_a-open set in Y. Therefore f is a supra b-m_a-open map.

$(ii)\Rightarrow(iii)$: Let E be any supra minimal closed set in X, so that E^c is supra maximal open set in X. From (ii) $f(E^c)=(f(E))^c$ is supra b-m_a-open set in Y, so that $f(E)$ is supra b-m_i-closed set in Y. Therefore f is a supra b-m_i-closed map.

$(iii)\Rightarrow(i)$: Let E be any supra minimal closed set in X. From (iii) $f(E)$ is supra b-m_i-closed set in Y, so that $\left(f^{-1}\right)^{-1}(E)$ is supra b -m_i-closed set in Y. Therefore the inverse map $f^{-1}:(Y,\mu_2)\to(X,\mu_1)$ is supra b-m_i-continuous.

Theorem 3.5: If $f:(X,\mu_1)\to(Y,\mu_2)$ is a bijective map and supra b-m_i-continuous map, then the following statements are equivalent.

i) f is a supra b-m_a-open (supra $^*b$-m_a-open) map.
ii) f is a supra b-m_i-homeomorphism (supra $^*b$-m_i-homeomorphism).
iii) f is a supra b-m_i-closed (supra $^*b$-m_i-closed) map.

Proof: $(i)\Rightarrow(ii)$: Let E be any supra minimal closed set in X, so that E^c is supra maximal open set in X. From (i) $f(E^c)=(f(E))^c$ is supra b-m_a-open set in Y, so that $f(E)=\left(f^{-1}\right)^{-1}(E)$ is supra b-m_i-closed set in Y. Therefore $f^{-1}:(Y,\mu_2)\to(X,\mu_1)$ is supra b-m_i-continuous map. Hence f is supra b-m_i-homeomorphism.

$(ii)\Rightarrow(iii)$: Let E be any supra minimal closed set in X. From (ii) $\left(f^{-1}\right)^{-1}(E)$ is supra b-m_i-closed set in Y, $f(E)$ is supra b-m_i-closed set in Y. Therefore f is supra b-m_i-closed map.

$(iii)\Rightarrow(i)$: Let E be any supra maximal open set in X, so that E^c is supra minimal closed set in X. From (iii) $f(E^c)=(f(E))^c$ is supra b-m_i-closed set in Y, so that $f(E)$ is supra b-m_a-open set in Y. Therefore f is a supra b-m_a-open map.

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4. Supra b-m_i^*-homeomorphism:

Definition 4.1: If $f:(X,\mu_1)\to(Y,\mu_2)$ is said to be supra $b$minimal* homeomorphism (briefly supra b-m_i^*-homeomorphism) if f and f^{-1} are supra b-m_i-irresolute maps.

Definition 4.2: If $f:(X,\mu_1)\to(Y,\mu_2)$ is said to be supra $^*b$ minimal* homeomorphism (briefly supra $^*b$- m_i^*-homeomorphism) if f and f^{-1} are supra $^*b$-m_i-irresolute maps.

Theorem 4.3: If $f:(X,\mu_1)\to(Y,\mu_2)$ is a bijective map, then the following statements are equivalent.

i) Its inverse map $f^{-1}:(Y,\mu_2)\to(X,\mu_1)$ is supra b-m_i-irresolute (supra $^*b$-m_i-irresolute).
ii) f is a supra b-m_a^*-open (supra $^*b$-m_a^*-open) map.
iii) f is a supra b-m_i^*-closed (supra $^*b$-m_i^*-closed) map.

Proof: It is similar to theorem 3.4.

Theorem 4.4: If $f:(X,\mu_1)\to(Y,\mu_2)$ is a bijective map and supra b-m_i-irresolute map, then the following statements are equivalent.

i) f is a supra b-m_a^*-open (supra $^*b$-m_a^*-open) map.
ii) f is a supra b-m_i^*-homeomorphism (supra $^*b$-m_i^*-homeomorphism).
iii) f is a supra b-m_i^*-closed (supra $^*b$-m_i^*-closed) map.

Proof: Similar to the theorem 3.5.

Theorem 4.5: If $f:(X,\mu_1)\to(Y,\mu_2)$ and $g:(Y,\mu_2)\to(Z,\mu_3)$ are supra b -m_i^*-homeomorphisms then $g\circ f:(X,\mu_1)\to(Z,\mu_3)$ is supra b-m_i^*-homeomorphism.

Proof: Let *U* be any supra b-m_i-closed set in Z. Since g is supra b-m_i^*-homeomorphism, $g^{-1}(U)$ is supra b -m_i-closed set in *Y*. But $f:(X,\mu_1)\to(Y,\mu_2)$ is supra b -m_i^*-homeomorphism. Therefore $f^{-1}\left(g^{-1}(U)\right)=(g\circ f)^1(U)$ is supra b-m_i-closed set in *X*. Hence $g\circ f:(X,\mu_1)\to(Z,\mu_3)$is supra b-m_i-irresolute map. Again let *V* be any supra b-m_i-closed set in *X*. Since f is supra b-m_i^*-homeomorphism, $f(V)=\left(f^{-1}\right)^{-1}(V)$ is supra b-m_i-closed set in *Y*. But $g:(Y,\mu_2)\to(Z,\mu_3)$ is supra b -m_i^*-homeomorphism. Therefore $\left[\left(g^{-1}\right)^{-1}\left(f^{-1}\right)^{-1}\right](V)=\left[\left(g^{-1}\right)^{-1}\circ\left(f^{-1}\right)^{-1}\right](V)$ is supra b -m_i-closed set in Z . That is $\left[\left(f^{-1}\circ g^{-1}\right)^{-1}\right](V)=\left[(g\circ f)^{-1}\right]^{-1}(V)$ is supra b-m_i-closed set in Z . It follows that $(g\circ f)^{-1}$ is supra b-m_i-irresolute. Hence $g\circ f:(X,\mu_1)\to(Z,\mu_3)$ is supra b-m_i^*-homeomorphism.

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ON ALMOST CONTRA NANO*GENERALIZED b-CONTINUOUS FUNCTIONS

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ABSTRACT: In this paper we introduce a new class of functions called contra nano*generalized b-continuous functions and almost contra nano*generalized b-continuous functions in nano topological spaces and their characterizations are analyzed.

Keywords: contra nano*generalized b-continuous function , almost contra nano*generalized b-continuous function.

1.INTRODUCTION

Levine[1] derived the concept of generalized closed sets in topological space. Al Omari and Mohd.Salmi Md.Noorani [2] studied the class of generalized b-closed sets. The notation of nano topology was introduced by LellisThivagar[10] which was defined in terms of approximations and boundry regions of a subset of an universe using an equivalence relation on it and also defined nano closed sets, nano interior and nano-closure. Nano gb-closed set was initiated by

Dhanis Arul Mary and I.Arockiarani[6]. The purpose of the paper is to introduce and investigate some of the fundamental properties of contra nano*generalized b-continuous and almost contra nano*generalized b-continuous functions and study some of its properties.

2.PRELIMINARIES

Definition 2.1[10]: Let U be a non-empty finite set of objects called the universe and R be an equivalence relation on U named as the indiscernibility relation. Then U is divided into disjoint equivalence classes. Elements belonging to the same equivalence class are said to be indiscernible with one another. The pair (U,R) is said to be the approximation space. Let $X \subseteq U$

1. The lower approximation of X with respect to R is the set of all objects, which can be for certainly classified as X with respect to R and it is denoted by $L_R(X)$. That is $L_R(X) = \underset{x \in U}{U}\{R(x) : R(x) \subseteq X\}$, where R(x) denotes the equivalence class determined b $X \in U$

2. The upper approximation of X with respect to R is the set of all objects, which can be possibly classified as X with respect to R and it is denoted by $U_R(X)$. That is $U_R(X) = \underset{x \in U}{U}\{R(x) : R(X) \cap X \neq \varphi\}$

3. The boundary of X with respect to R is the set of all objects, which can be classified neither as X nor as not-X with respect to R and it is denoted by $B_R(X)$. That is $B_R(X) = U_R(X) - L_R(X)$

Definition 2.2[6]: Let U be non-empty, finite universe of objects and R be an equivalence relation on U. Let $X \subseteq U$. Let $\tau_R(X) = \{U, \varphi, L_R(X), U_R(X), B_R(X)\}$. Then $\tau_R(X)$ is a topology on U, called as the nano topology with respect to X. Elements of the nano topology are known as the nano-open sets in U and $(U, \tau_R(X))$ is called the nano topological space. $[\tau_R(X)]^c$ is called as the dual nano topology of $\tau_R(X)$. Elements of $[\tau_R(X)]^c$ are called as nano closed sets.

Definition 2.3[6]: If $\tau_R(X)$ is the nano topolopy on U with respect to X, then the set $B = \{U, L_R(X), U_R(X), B_R(X)\}$ is the basis for $\tau_R(X)$

Definition 2.4[6]: If $(U, \tau_R(X))$ is a nano topological space with respect to X where $X \subseteq U$ and if $A \subseteq U$, then the nano interior of A is defined as the union of all nano-open subsets of A and it is denoted by $N\text{int}(A)$. That is $N\text{int}(A)$, is the largest nano open subset of A. The nano closure of A is defined as the intersection of all nano closed sets containing A and is denoted by $Ncl(A)$. That is $Ncl(A)$, is the smallest nano closed set containing A.

Definition 2.5[5]: A subset A of a nano topological space $(U, \tau_R(X))$ is called nano generalized b-closed(briefly, nano gb-closed), if Nbcl(A)⊆V whenever A⊆V and V is nano open in U .

Definition 2.6[6]: A subset A of a nano topological space $\left(U,\tau_R(X)\right)$ is called nano*generalized b-closed if $Nbcl(A)\subseteq V$ whenever $A\subseteq V$ and V is nano gb-open in U.

Definition 2.7[6]: Let $\left(U,\tau_R(X)\right)$ be a nano topological space and $A\subseteq U$. Then A is said to be

Nano semi open If $A\subseteq Ncl\left(N\operatorname{int}(A)\right)$

Nano b-open if $A\subseteq Ncl\left(N\operatorname{int}(A)\right)\cup N\operatorname{int}\left(Ncl(A)\right)$

Nano regular-open if $A=N\operatorname{int}\left(Ncl(A)\right)$

Definition 2.8[8] :Let $(U,\boldsymbol{\tau}_R(X))$ and $(V,\boldsymbol{\tau}_{R'}(Y))$ be a nano topological spaces, then a map $f:(U,\boldsymbol{\tau}_R(X))\rightarrow(V,\boldsymbol{\tau}_{R'}(Y))$ is said to be

(i) Contra Nano continuous if $f^{-1}(V)$is nano closed in $(U,\boldsymbol{\tau}_R(X))$ for each nano open set V in $(V,\boldsymbol{\tau}_{R'}(Y))$

(ii) Almost Contra Nano continuous if $f^{-1}(V)$is nano closed in $(U,\boldsymbol{\tau}_R(X))$ for each nano regular open set V in $(V,\boldsymbol{\tau}_{R'}(Y))$

3. CONTRA NANO*GENERALIZED b-CONTINUOUS FUNCTIONS

Definition 3.1 :A map $f:(U,\boldsymbol{\tau}_R(X))\rightarrow(V,\boldsymbol{\tau}_{R'}(Y))$ is called contra nano*generalized b-continuous if the inverse image of every nano open set in $(V,\boldsymbol{\tau}_{R'}(Y)))$ is nano*generalized b-closed in $(U,\boldsymbol{\tau}_R(X))$.

Theorem 3.2: (i)Every contra nano continuous function is contra nano*generalized b-continuous

(ii) Every contra nano r-continuous function is contra nano*generalized b-continuous.

(iii) Every contra nano c-continuous function is contra nano*generalized b-continuous.

Proof: Let $f:(U,\boldsymbol{\tau}_R(X))\rightarrow(V,\boldsymbol{\tau}_{R'}(Y)$be contra nano continuous. Let B be any nano open set in $(V, \boldsymbol{\tau}_{R'}(Y))$ .Then the inverse image $f^{-1}(B)$ is nano closed in $(U,\boldsymbol{\tau}_R(X))$. Since every nano closed set is nano*generalized b-closed in $(U,\boldsymbol{\tau}_R(X))$. Therefore f is contra nano*generalized b-continuous. Proof is obvious for others.

Remark 3.3: Converse of the above theorem need not be true it is shown by the following examples.

Example 3.4: Let U={a,b,c} with U/R={{a},{b,c}}. Let X={a}⊆U. Then $\tau_R(X)=\{U,\phi,\{a\}\}$. Let V={a,b,c} with V/R'={V,ϕ,{c},{a,b}}. Let Y={c}⊆V. Then $\tau_{R'}(Y)=\{U,\phi,\{c\}\}$. Define $f:(U,\tau_R(X))\rightarrow(V,\tau_{R'}(Y))$ be a function defined by f(a)=a, f(b)=c, f(c)=b. Hence f is contra nano*generalized b-continuous but not contra nano continuous. Since B={c} is nano open in U but $f^{-1}(\{c\})=\{b\}$ is nano*generalized b-closed set but not nano closed set in V.

Example 3.5: Let U={a,b,c} with U/R={{a},{b,c}}. Let X={a,c}⊆U. Then $\tau_R(X)=\{U,\phi,\{a\},\{b,c\}\}$. Let V={a,b,c} with V/R'={V,ϕ,{b},{a,c}}. Let Y={b}⊆V. Then$\tau_R(Y)=\{U,\phi,\{b\}\}$. Define $f:(U,\boldsymbol{\tau}_R(X))\rightarrow(V,\boldsymbol{\tau}_{R'}(Y))$ be a function defined by f(a)=c, f(b)=a, f(c)=b. Hence f is contra nano*generalized b-continuous but not nano contra r-continuous. Since B={b} is open in U but $f^{-1}(\{b\})=\{c\}$ is nano*generalized b-closed set but not nano r-closed set in V.

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Example 3.6: Let U={a,b,c} with U/R={{a},{b,c}}. Let X={a,c}⊆U. Then $\tau_R(X)=\{U,\emptyset,\{a\},\{b,c\}\}$. Let V={a,b,c} with V/R'={V,∅,{b},{a,c}}. Let Y={b,c}⊆V. Then $\tau_{R'}(Y)=\{U,\emptyset,\{b\},\{a,c\}\}$. Define f:(U,$\tau_R(X)$)→(V,$\tau_{R'}(Y)$) be a function defined by f(a)=a, f(b)=c, f(c)=b. Hence f is contra nano*generalized b-continuous but not nano contra c-continuous. Since B={b} is open in U but $f^{-1}(\{b\})=\{c\}$ is nano*generalized b-closed set but not nano c-closed set in V.

Theorem 3.7: If a map f:(U,$\tau_R(X)$)→(V,$\tau_{R'}(Y)$) is nano*generalized b-irresolute map g:(V,$\tau_{R'}(Y)$)→(W,$\tau_{R''}(Z)$) is nano*generalized b-continuous map, then gof:(U,$\tau_R(X)$) →(W, $\tau_{R''}(Z)$) is contra nano*generalized b-continuous.

Proof: Let F be an nano open set (W,$\tau_{R''}(Z)$). Then $g^{-1}(F)$ is nano*generalized b-closed in (V, $\tau_{R'}(Y)$), because g is contra nano*generalized b-continuous. Since f is nano*generalized b-irresolute, $f^{-1}(g^{-1}(F))=(gof)^{-1}(F)$is nano*generalized b-closed in (U,$\tau_R(X)$).Therefore gof is contra nano*generalized b-continuous.

4. ALMOST CONTRA NANO*GENERALIZED b- CONTINUOUS FUNCTIONS

Definition 4.1 : A function f:(U,$\tau_R(X)$)→(V,$\tau_{R'}(Y)$) is called almost contra nano*generalized b-continuous if $f^{-1}(B)$ is nano*generalized b-closed in (U,$\tau_R(X)$) for every regular open set B in (V,$\tau_{R'}(Y)$).

Theorem 4.2: (i) Every almost nano contra continuous function is almost contra nano*generalized b-continuous

(ii) Every almost nano contra r-continuous function is almost contra nano*generalized b-continuous

(iii) Every almost nano contra c-continuous function is almost contra nano*generalized b-continuous.

Proof: Let f:(U,$\tau_R(X)$)→(V,$\tau_{R'}(Y)$) be almost nano contra continuous. Let B be any nano regular open set in (V, $\tau_{R'}(Y)$) .Then the inverse image $f^{-1}(B)$ is nano closed in (U,$\tau_R(X)$). Since every nano closed set is nano*generalized b-closed in (U,$\tau_R(X)$). Therefore f is almost contra nano*generalized b-continuous. Proof is obvious for others.

Remark 4.3: Converse of the above theorem need not be true it is shown by the following examples.

Example 4.4: Let U={a,b,c} with U/R={{c},{a,b}}. Let X={a,c}⊆U. Then $\tau_R(X)=\{U,\emptyset,\{c\},\{a,b\}\}$. Let V={a,b,c} with V/R'={V,∅,{a},{b,c}}. Let Y={a,c}⊆V. Then $\tau_{R'}(Y)=\{U,\emptyset,\{a\},\{b,c\}\}$. Define f:(U,$\tau_R(X)$) → (V,$\tau_{R'}(Y)$) be a function defined by f(a)=a, f(b)=b, f(c)=c. Hence f is almost contra nano*generalized b-continuous but not almost nano contra continuous. Since B={a} is regular open in U but $f^{-1}(\{a\})=\{a\}$ is nano*generalized b-closed set but not nano closed set in V.

Example 4.5: Let U={a,b,c} with U/R={{b},{a,c}}. Let X={b,c}⊆U. Then $\tau_R(X)=\{U,\emptyset,\{b\},\{a,c\}\}$. Let V={a,b,c} with V/R'={V,∅,{c},{a,b}}. Let Y={a,c}⊆V. Then $\tau_{R'}(Y)=\{U,\emptyset,\{c\},\{a,b\}\}$. Define f:(U,$\tau_R(X)$) → (V,$\tau_{R'}(Y)$) be a function defined by f(a)=a, f(b)=b, f(c)=c. Hence f is almost contra nano*generalized b-continuous but not almost nano contra r-continuous. Since B={a,b} is regular open in U but $f^{-1}(\{a,b\})=\{a,b\}$ is nano*generalized b-closed set but not nano r-closed set in V.

Example 4.6: Let U={a,b,c} with U/R={{a},{b,c}}. Let X={a,c}⊆U. Then $\tau_R(X)$={U,∅,{a},{b,c}}. Let V={a,b,c} with V/R'={V,∅,{b},{a,c}}. Let Y={b,c}⊆V. Then $\tau_{R'}(Y)$={U,∅,{b},{a,c}}. Define f:(U,$\tau_R(X)$)→(V,$\tau_{R'}(Y)$) be a function defined by f(a)=c, f(b)=b, f(c)=a. Hence f is almost contra nano*generalized b-continuous but not almost nano contra c-continuous. Since B={b} is open in U but f^{-1}({b})={b} is nano*generalized b-closed set but not nano c-closed set in V.

Theorem 4.7: Every contra nano*generalized b-continuous function is almost contra nano*generalized b-continuous but not conversely.

Proof: Let f:(U,$\tau_R(X)$)→(V,$\tau_{R'}(Y)$) be nano contra nano*generalized b-continuous. Let B be any nano open set in (V, $\tau_{R'}(Y)$) .We know that every regular open set is open. Then the inverse image f^{-1}(B) is nano*generalized b-closed in (U,$\tau_R(X)$). Therefore f is almost contra nano*generalized b-continuous.

Example 4.8: Let U={a,b,c.d} with U/R={{a},{b},{c,d}}. Let X={a,c}⊆U. Then $\tau_R(X)$={U,∅,{a},{c,d},{a,c,d}}. Let V={a,b,c} with V/R'={V,∅,{a},{b,c}}. Let Y={b,c}⊆V. Then $\tau_{R'}(Y)$={U,∅,{a},{b,c}}. Define f:(U,$\tau_R(X)$) → (V,$\tau_{R'}(Y)$) be a function defined by f(a)=b, f(b)=c, f(c)=a. Hence f is almost contra nano*generalized b-closed continuous but not contra nano*generalized b-continuous. Since B={a} is regular open in U but f^{-1}({a})={c} is nano*generalized b-closed set but not nano closed set in U. Hence f is almost contra nano*gb-continuous.

Theorem 4.9: If f:(U,$\tau_R(X)$) → (V,$\tau_{R'}(Y)$) is almost contra nano*generalized b-continuous and X is locally nano*generalized b-indiscrete space then f is almost contra nano continuous.

Proof: Let B be nano regular open set in Y. Since f is almost contra nano*generalized b-continuous f^{-1}(V) is nano*generalized b-closed in X and X is locally nano*generalized b- indiscrete space, which implies f^{-1}(V) is an nano open set in X. Therefore f is almost contra nano continuous.

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On distances between Generalized Single Valued Neutrosophic sets

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Abstract :

In this paper, we introduce the new class of sets called Generalized Single Valued Neutrosophic Sets and also we have defined various distances between GSVNS sets with examples.

Keywords: Neutrosophic sets, Image processing, Hamming distance, entropy.

1. Introduction:

Neutrosophy is the modern branch of philosophy introduced by Florentin Smarandache. Neutrosophy has laid the foundation for a whole family of new mathematical theories classical counterparts.Neutrosophy deals with the concepts of origin, nature and scope of neutralities, as well as their interactions with different ideational spectra. Smarandache introduced the fundamental concepts of neutrosophic set, that had led Salama and Smarandache [1,2,3,4] to provide a mathematical treatment for the neutrosophic phenomena. A.A. Salama, Florentin smarandache, Mohamed Eisa [5,6], introduced distances between neutrosophic sets like Hamming distance, normalized Hamming distance, Euclidean distance and normalized Euclidean distance.

In this paper, we introduce the distances between Generalized Single Valued Neutrosophic Sets : the Hamming distance, normalized Hamming distance, Euclidean distance and Normalized Euclidean distance.

2. Preliminaries

2.1 Neutrosophic set:[7,8,10]

Let X be the universe of discourse and A be a subset of X. Then A is called Neutrosophic set if it is of the form $A = < x, \mu_A(x), \sigma_A(x), \nu_A(x) >$, $x \in X$ where the functions $\mu, \sigma, \nu : X \to \left]^{-}0,1^{+}\right[$ represents respectively the degree of membership, the degree of indeterminacy and the degree of non-membership of the element $x \in X$ satisfying the following condition $0 \le \mu_A(x) + \sigma_A(x) + \nu_A(x) \le 3$

2.2 Generalized Neutrosophic sets: [1]

Let X be the universe of discourse. A Generalized Neutrosophic set(GNS) is of the form $A = \{< x, \mu_A(x), \sigma_A(x), \nu_A(x) >\ , x \in X\}$ where $\mu_A(x), \sigma_A(x)$ *and* $\nu_A(x)$ represents respectively the degree of membership, the degree of indeterminacy and the degree of non-membership of the element $x \in X$ to the set A where the functionssatisfying following condition $\mu_A(x) \wedge \sigma_A(x) \wedge \nu_A(x) \le 0.5$

2.3Single Valued Neutrosophic set:[9,10]

The difference between Neutrosophic set and Single valued neutrosophic set is the range values. In NS, the range is the non-standard interval $]^{-}0,1^{+}[$. It is difficult to apply for the real life problems. In SVNS, we have taken [0,1] instead of $]^{-}0,1^{+}[$.

Let X be a universal space with generic element *x*. A Single Valued Neutrosophic set A in X is characterized by a truth-membership function $\mu_A(x)$, an indeterminacy membership function $\sigma_A(x)$ and a falsity function (i.e. non-membership function) $\nu_A(x)$, for each point $x \in X$, $0 \le \mu_A(x), \sigma_A(x), \nu_A(x) \le 1$ and $0 \le \mu_A(x) + \sigma_A(x) + \nu_A(x) \le 3$.

When X is continuous , a SVNS A can be written as $A = \int_x \frac{< \mu_A(x), \sigma_A(x), \nu_A(x) >}{x}$, $x \in X$

When X is discrete, a SVNS can be written as $A = \sum_{i=1}^{n} \frac{< \mu_A(x_i), \sigma_A(x_i), \nu_A(x_i) >}{x_i}$, $x_i \in X$

3. GeneralizedSingle Valued Neutrosophic set:

Now we will extend the neutrosophic set to the next level. That means we will combine the concept of Generalized Neutrosophic set and Single valued Neutrosophic set. This gives new class of sets " Generalized Single Valued Neutrosophic sets" simply called as GSVNS.

3.1 Definition

Let X be a space of points (objects), with a generic element in X denoted by x. A Generalized single valued neutrosophic set (GSVNS) A in X characterized by a truth-membership function $\mu_A(x)$, an indeterminacy membership function $\sigma_A(x)$ and a falsity function (i.e. non-membership function) $\nu_A(x)$, for each point $x \in X$,

A Generalized Single Valued Neutrosophic set A can be written as $A = < x, \mu_A(x), \sigma_A(x), \nu_A(x) >$, $x \in X$

Where $0 \le \mu_A(x), \sigma_A(x), \nu_A(x) \le 1$ and $0 \le \mu_A(x) + \sigma_A(x) + \nu_A(x) \le 3$

and the functions satisfies the conditions $\mu_A(x) \wedge \sigma_A(x) \wedge \nu_A(x) \le 0.5$

3.2 Distances between Generalized Single Valued Neutrosophic sets:
In this section, we define different kind of distances between two Generalized Single valued Neutrosophic sets.

Let $X = \{x_1, x_2 ..... x_n\}$.

Let $A = \{\mu_A(x), \sigma_A(x), \nu_A(x) \ x \in X\}$ and where

$0 \le \mu_A(x), \sigma_A(x), \nu_A(x) \le 1$, $0 \le \mu_A(x) + \sigma_A(x) + \nu_A(x) \le 3$ and the function satisfies the condition $\mu_A(x) \wedge \sigma_A(x) \wedge \nu_A(x) \le 0.5$

Let $B=\{\mu_B(x),\sigma_B(x),\nu_B(x)\ x\in X\}$ where

$0\le\mu_B(x),\sigma_B(x),\nu_B(x)\le 1$, $0\le\mu_B(x)+\sigma_B(x)+\nu_B(x)\le 3$ and the function satisfies the condition $\mu_B(x)\wedge\sigma_B(x)\wedge\nu_B(x)\le 0.5$

i) The Hamming Distance is given by

$$d_{GSVNS}(A,B)=\sum_{i=1}^{n}\left\{\left|\mu_A(x_i)-\mu_B(x_i)\right|+\left|\sigma_A(x_i)-\sigma_B(x_i)\right|+\left|\nu_A(x_i)-\nu_B(x_i)\right|\right\}$$

ii) The Euclidean distance is given by

$$e_{GSVNS}(A,B)=\sqrt{\sum_{i=1}^{n}\left\{\left(\mu_A(x_i)-\mu_B(x_i)\right)^2+\left(\sigma_A(x_i)-\sigma_B(x_i)\right)^2+\left(\nu_A(x_i)-\nu_B(x_i)\right)^2\right\}}$$

iii) The normalized Hamming distance is given by

$$NH_{GSVNS}(A,B)=\frac{1}{2n}\sum_{i=1}^{n}\left\{\left|\mu_A(x_i)-\mu_B(x_i)\right|+\left|\sigma_A(x_i)-\sigma_B(x_i)\right|+\left|\nu_A(x_i)-\nu_B(x_i)\right|\right\}$$

iv) The normalized Euclidean distance is given by

$$NE_{GSVNS}(A,B)=\sqrt{\frac{1}{2n}\sum_{i=1}^{n}\left\{\left(\mu_A(x_i)-\mu_B(x_i)\right)^2+\left(\sigma_A(x_i)-\sigma_B(x_i)\right)^2+\left(\nu_A(x_i)-\nu_B(x_i)\right)^2\right\}}$$

3.2.1 Examples:

Let us consider the Generalized Single Valued Neutrosophic sets A, B in X={a,b,c,d,e}.

Let $A=\{\mu_A(x),\sigma_A(x),\nu_A(x)\ x\in X\}$

X	$\mu_A(x)$	$\sigma_A(x)$	$\nu_A(x)$	$\mu_A(x)\wedge\sigma_A(x)\wedge\nu_A(x)$
a	0.6	0.5	0.3	0.3
b	0.5	0.6	0.3	0.3
c	0.4	0.5	0.4	0.4
d	0.3	0.3	0.5	0.3
e	0.3	0.4	0.6	0.3

Let $B=\{\mu_B(x),\sigma_B(x),\nu_B(x)\ x\in X\}$

X	$\mu_B(x)$	$\sigma_B(x)$	$\nu_B(x)$	$\mu_B(x)\wedge\sigma_B(x)\wedge\nu_B(x)$
a	0.5	0.3	0.2	0.2
b	0.2	0.5	0.2	0.2
c	0.5	0.5	0	0.5
d	0.3	0.3	0.4	0.3
e	0.4	0.4	0.2	0.2

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Here A and B are GSVNS , Since $\mu_A(x) \wedge \sigma_A(x) \wedge \nu_A(x) \leq 0.5$, $0 \leq \mu_A(x), \sigma_A(x), \nu_A(x) \leq 1$ and $\mu_B(x) \wedge \sigma_B(x) \wedge \nu_B(x) \leq 0.5$. Then

The Hamming distance is

$$d_{GSVNS}(A,B) = \sum_{x=a,b,c} \left\{ \left|\mu_A(x) - \mu_B(x)\right| + \left|\sigma_A(x) - \sigma_B(x)\right| + \left|\nu_A(x) - \nu_B(x)\right| \right\}$$

$$= 0.1 + 0.2 + 0.1 + 0.3 + 0.1 + 0.1 + 0.1 + 0.4 + 0.1 + 0.1 + 0.4$$

$$d_{GSVNS}(A,B) = 2.0$$

The Euclidean distance is

$$e_{GSVNS}(A,B) = \sqrt{\sum_{x=a,b,c} \left\{ \left(\mu_A(x) - \mu_B(x)\right)^2 + \left(\sigma_A(x) - \sigma_B(x)\right)^2 + \left(\nu_A(x) - \nu_B(x)\right)^2 \right\}}$$

$$= \sqrt{\{0.01 + 0.04 + 0.01\} + \{0.09 + 0.01 + 0.01\} + \{0.01 + 0.16\} + \{0.01\} + \{0.01 + 0.16\}}$$

$$e_{GSVNS}(A,B) = 0.72$$

The Normalized Hamming distance is

$$NH_{GSVNS}(A,B) = \frac{1}{2n} \sum_{i=1}^{n} \left\{ \left|\mu_A(x_i) - \mu_B(x_i)\right| + \left|\sigma_A(x_i) - \sigma_B(x_i)\right| + \left|\nu_A(x_i) - \nu_B(x_i)\right| \right\}$$

$$= \frac{1}{2(5)} d_{GNS}(A,B) \quad = 0.2$$

The Normalized Euclidean distance is

$$NE_{GSVNS}(A,B) = \sqrt{\frac{1}{2n} \sum_{i=1}^{n} \left\{ \left(\mu_A(x_i) - \mu_B(x_i)\right)^2 + \left(\sigma_A(x_i) - \sigma_B(x_i)\right)^2 + \left(\nu_A(x_i) - \nu_B(x_i)\right)^2 \right\}}$$

$$= \sqrt{\frac{1}{2(5)} e_{GNS}(A,B)} \quad = 0.27$$

From this example, we conclude that the formulas (i), (ii), (iii), (iv) satisfies the following conditions

a) $0 \leq d_{GSVNS}(A,B) \leq \frac{n}{2}$

b) $0 \leq NH_{GSVNS}(A,B) \leq 0.5$

c) $0 \leq e_{GSVNS}(A,B) \leq \frac{\sqrt{n}}{2}$

d) $0 \leq NE_{GSVNS}(A,B) \leq 0.5$

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4. Conclusion:

New class of Neutrosophic set called generalized single valued neutrosophic sets were defined and some of the distances between two GSVNS were discussed in this paper. Image interms of pixels into neutrosophic domain is one of the advanced technique in image processing. In our future work will includes the applications of GSVNS in image processing.

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Weaker and Stronger Forms of NVGP-Irresolute Mappings

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Abstract: In this paper we consider the weaker and stronger forms of neutrosophic vague generalized pre irresolute maps and neutrosophic vague generalized pre closed maps via the concept of NVGPCS which is called as NVGP ap-irresolute maps and NVGP ap-closed maps.

Keywords: Neutrosophic Vague topology, neutrosophic vague generalized pre continuous mapping, neutrosophic vague generalized pre irresolute mapping, NVGP ap-irresolute maps, NVGP ap-closed maps.

1.Introduction:

The concept of fuzzy sets and intuitionistic fuzzy sets was introduced by Zadeh [10] in 1965 and Atanassov [1] in 1986. The theory of fuzzy topology was introduced by C.L.Chang [3] in 1967. The theory of vague sets was first proposed by Gau and Buehrer [4] as an extension of fuzzy set theory. Then, Smarandache[8] introduces the neutrosophic set in 1998. Shawkat Alkhazaleh[7] in 2015 introduced the concept of neutrosophic vague set as a combination of neutrosophic set and vague set. With this neutrosophic vague set in 2017 Mary Margaret. A and Trinita Pricilla. M[5],[6] introduced the concept of neutrosophic vague topology and neutrosophic vague continuous and irresolute mapping. In 2000, M.Caldas[2] defined and studied weak and strong forms of irresolute maps in general topology. In this paper we introduce the concept of irresoluteness called neutrosophic vague generalized pre ap-irresolute maps and neutrosophic vague generalized pre ap-closed maps and some of their basic properties.

2. Preliminaries

Definition 2.1:[7] A neutrosophic vague set A_{NV} (NVS in short) on the universe of discourse X written as $A_{NV} = \left\{ \left\langle x; \hat{T}_{A_{NV}}(x); \hat{I}_{A_{NV}}(x); \hat{F}_{A_{NV}}(x) \right\rangle; x \in X \right\}$, whose truth membership, indeterminacy membership and false membership functions is defined as:

$$\hat{T}_{A_{NV}}(x) = \left[T^-, T^+\right], \hat{I}_{A_{NV}}(x) = \left[I^-, I^+\right], \hat{F}_{A_{NV}}(x) = \left[F^-, F^+\right]$$

where,

1) $T^+ = 1 - F^-$
2) $F^+ = 1 - T^-$ and
3) $^-0 \le T^- + I^- + F^- \le 2^+$.

Definition 2.2:[7] Let A_{NV} and B_{NV} be two NVSs of the universe U . If $\forall u_i \in U$, $\hat{T}_{A_{NV}}(u_i) \le \hat{T}_{B_{NV}}(u_i)$; $\hat{I}_{A_{NV}}(u_i) \ge \hat{I}_{B_{NV}}(u_i)$; $\hat{F}_{A_{NV}}(u_i) \ge \hat{F}_{B_{NV}}(u_i)$, then the NVS A_{NV} is included by B_{NV}, denoted by $A_{NV} \subseteq B_{NV}$, where $1 \le i \le n$.

Definition 2.3:[7] The complement of NVS A_{NV} is denoted by A^c_{NV} and is defined by

$$\hat{T}^c_{A_{NV}}(x) = \left[1 - T^+, 1 - T^-\right], \hat{I}^c_{A_{NV}}(x) = \left[1 - I^+, 1 - I^-\right], \hat{F}^c_{A_{NV}}(x) = \left[1 - F^+, 1 - F^-\right].$$

Definition 2.4:[7] Let A_{NV} be NVS of the universe U where $\forall u_i \in U$, $\hat{T}_{A_{NV}}(x) = [1,1]; \hat{I}_{A_{NV}}(x) = [0,0]; \hat{F}_{A_{NV}}(x) = [0,0]$. Then A_{NV} is called a unit NVS(1_{NV} in short), where $1 \le i \le n$.

Definition 2.5:[7] Let A_{NV} be NVS of the universe U where $\forall u_i \in U$, $\hat{T}_{A_{NV}}(x) = [0,0]; \hat{I}_{A_{NV}}(x) = [1,1]; \hat{F}_{A_{NV}}(x) = [1,1]$. Then A_{NV} is called a zero NVS(0_{NV} in short), where $1 \le i \le n$.

Definition 2.6:[7] The union of two NVSs A_{NV} and B_{NV} is NVS C_{NV}, written as $C_{NV} = A_{NV} \cup B_{NV}$, whose truth-membership, indeterminacy-membership and false-membership functions are related to those of A_{NV} and B_{NV} given by,

$$\hat{T}_{C_{NV}}(x) = \left[\max\left(T^-_{A_{NV_x}}, T^-_{B_{NV_x}}\right), \max\left(T^+_{A_{NV_x}}, T^+_{B_{NV_x}}\right)\right] \quad \hat{I}_{C_{NV}}(x) = \left[\min\left(I^-_{A_{NV_x}}, I^-_{B_{NV_x}}\right), \min\left(I^+_{A_{NV_x}}, I^+_{B_{NV_x}}\right)\right]$$

$$\hat{F}_{C_{NV}}(x) = \left[\min\left(F^-_{A_{NV_x}}, F^-_{B_{NV_x}}\right), \min\left(F^+_{A_{NV_x}}, F^+_{B_{NV_x}}\right)\right].$$

Definition 2.7:[7] The intersection of two NVSs A_{NV} and B_{NV} is NVS C_{NV}, written as $C_{NV} = A_{NV} \cap B_{NV}$, whose truth-membership, indeterminacy-membership and false-membership functions are related to those of A_{NV} and B_{NV} given by,

$$\hat{T}_{C_{NV}}(x) = \left[\min\left(T^-_{A_{NV_x}}, T^-_{B_{NV_x}}\right), \min\left(T^+_{A_{NV_x}}, T^+_{B_{NV_x}}\right)\right] \quad \hat{I}_{C_{NV}}(x) = \left[\max\left(I^-_{A_{NV_x}}, I^-_{B_{NV_x}}\right), \max\left(I^+_{A_{NV_x}}, I^+_{B_{NV_x}}\right)\right]$$

$$\hat{F}_{C_{NV}}(x) = \left[\max\left(F^-_{A_{NV_x}}, F^-_{B_{NV_x}}\right), \max\left(F^+_{A_{NV_x}}, F^+_{B_{NV_x}}\right)\right].$$

Definition 2.8:[7] Let A_{NV} and B_{NV} be two NVSs of the universe U. If $\forall u_i \in U$, $\hat{T}_{A_{NV}}(u_i) = \hat{T}_{B_{NV}}(u_i)$; $\hat{I}_{A_{NV}}(u_i) = \hat{I}_{B_{NV}}(u_i)$; $\hat{F}_{A_{NV}}(u_i) = \hat{F}_{B_{NV}}(u_i)$, then the NVS A_{NV} and B_{NV}, are called equal, where $1 \le i \le n$.

Definition 2.9:[5] A neutrosophic vague topology (NVT in short) on X is a family τ of neutrosophic vague sets (NVS in short) in X satisfying the following axioms:

- $0_{NV}, 1_{NV} \in \tau$
- $G_1 \cap G_2 \in \tau$ for any $G_1, G_2 \in \tau$
- $\cup G_i \in \tau, \forall \{G_i : i \in J\} \subseteq \tau$

In this case the pair (X, τ) is called a neutrosophic vague topological space (NVTS in short) and any NVS in τ is known as a neutrosophic vague open set (NVOS in short) in X. The complement A^c of NVOS in a NVTS (X, τ) is called neutrosophic vague closed set (NVCS in short) in X.

Definition 2.10:[5] A NVS $A = \left\{\left\langle x, \left[\hat{T}_A, \hat{I}_A, \hat{F}_A\right]\right\rangle\right\}$ in NVTS (X, τ) is said to be

i) *Neutrosophic Vague pre- closed set* (NVPCS in short) if $NVcl(NV\,\mathrm{int}(A)) \subseteq A$,
ii) *Neutrosophic Vague pre-open set* (NVPOS in short) if $A \subseteq NV\,\mathrm{int}(NVcl(A))$,

Definition 2.11:[5] Let A be NVS of a NVTS (X, τ). Then the neutrosophic vague pre interior of A ($NV\mathrm{p}\,\mathrm{int}(A)$ in short) and neutrosophic vague pre closure of A ($NV\mathrm{p}cl(A)$ in short) are defined by

- $NV\text{p int}(A) = \cup\{G / G \text{ is a NVPOS in } X \text{ and } G \subseteq A\}$,
- $NV\text{pcl}(A) = \cap\{K / K \text{ is a NVPCS in } X \text{ and } A \subseteq K\}$.

Definition 2.12:[5] A NVS A is said to be neutrosophic vague generalized pre-closed set (NVGPCS in short) in (X, τ) if $NV\text{pcl}(A) \subseteq U$ whenever $A \subseteq U$ and U is NVOS in X.

Definition 2.13:[6] A map $f : (X, \tau) \to (Y, \sigma)$ is said to be neutrosophic vague generalized pre irresolute (NVGP irresolute in short) mapping if $f^{-1}(A)$ is NVGPCS in (X, τ) for every NVGPCS A in (Y, σ).

3. NVGP contra irresolute, NVGP ap-irresolute, NVGP ap-closed maps:

Definition 3.1: A mapping $\phi : (X, \tau) \to (Y, \sigma)$ is said to be

i) NVGP contra irresolute if $\phi^{-1}(B)$ is NVGPCS in *X* for every NVGPOS in *Y*.
ii) neutrosophic vague generalized pre approximately irresolute (NVGP ap-irresolute) if $NV\text{pcl}(A) \subseteq \phi^{-1}(B)$, whenever *B* is a NVOS in *Y*, *A* is NVGPCS in *X* and $A \subseteq \phi^{-1}(B)$.
iii) neutrosophic vague generalized pre approximately closed (NVGP ap-closed) if $\phi(B) \subseteq NV\text{p int}(A)$, whenever *A* is a NVGPOS in *Y*, *B* is NVCS in *X* and $\phi(B) \subseteq A$.

Theorem 3.2: NV irresolute mapping is NVGP ap-irresolute mapping.

Proof: Let ϕ be NV irresolute mapping and *B* is NVOS in *Y*, *A* is NVGPCS in *X* such that $A \subseteq \phi^{-1}(B)$. By our assumption $\phi^{-1}(B)$ is NVOS in *X*. Then by the definition of NVGPCS we have $NV\text{pcl}(A) \subseteq \phi^{-1}(B)$. Hence ϕ is NVGP ap-irresolute mapping.

Theorem 3.3: A mapping $\phi : (X, \tau) \to (Y, \sigma)$ is:

i) NVGP ap-irresolute if $\phi^{-1}(A)$ is NVOS in *X* for every NVOS *A* in *Y*.
ii) NVGP ap-closed if $\phi(B)$ is NVCS in *Y* for every NVCS *B* in *X*.

Proof: i) Let *A* be NVOS in *Y*, $\phi^{-1}(A)$ is NVOS in *X* and *B* be NVGPCS in *X* such that $B \subseteq \phi^{-1}(A)$. By the definition of NVGPCS in *X* we have, $NV\text{pcl}(B) \subseteq \phi^{-1}(A)$ whenever $B \subseteq \phi^{-1}(A)$ and $\phi^{-1}(A)$ is NVOS in *X*. Thus ϕ is NVGP ap-irresolute.

ii)Let *B* be NVCS in *X*, $\phi(B)$ is NVCS in *Y* and *A* be NVGPOS in *Y* such that $\phi(B) \subseteq A$. By the definition of NVGPOS in *Y* we have, $\phi(B) \subseteq NV\text{p int}(A)$ whenever $\phi(B) \subseteq A$ and $\phi(B)$ is NVCS in *Y*. Thus ϕ is NVGP ap-closed.

Definition 3.4: A mapping $\phi : (X, \tau) \to (Y, \sigma)$ is said to be NVGP perfectly irresolute if the inverse image of every NVGPOS in *Y* is NVGP clopen in *X*.

Theorem 3.5: Every NVGP perfectly irresolute mapping is NVGP contra irresolute mapping.

Proof: Let ϕ is NVGP perfectly irresolute mapping and let B be NVGPOS in Y. Then by our assumption $\phi^{-1}(B)$ is NVGP clopen in X. Thus $\phi^{-1}(B)$ is NVGPCS in X. Hence NVGP contra irresolute mapping.

The converse of the above theorem is not true in general as seen from the following example.

Example 3.6: Let $X=\{a,b\}$, $Y=\{u,v\}$ and

$$A=\left\{x,\frac{a}{\langle[0.4,0.5];[0.1,0.3];[0.5,0.6]\rangle},\frac{b}{\langle[0.3,0.6];[0.2,0.4];[0.4,0.7]\rangle}\right\},$$

$$B=\left\{y,\frac{u}{\langle[0.6,0.9];[0.1,0.2];[0.1,0.4]\rangle},\frac{v}{\langle[0.7,0.8];[0.2,0.3];[0.2,0.3]\rangle}\right\}.$$

Then $\tau=\{0_{NV},A,1_{NV}\}$ and $\sigma=\{0_{NV},B,1_{NV}\}$ are NVTs on X and Y respectively. Define a mapping $\phi:(X,\tau)\to(Y,\sigma)$ by $f(a)=u$ and $f(b)=v$. Clearly ϕ is NVGP contra irresolute mapping but not NVGP perfectly irresolute mapping, since B is NVGPOS in Y, but $\phi^{-1}(B)$ is NVGPCS and not NVGPOS in X.

Theorem 3.7: Let $\phi:(X,\tau)\to(Y,\sigma)$ and $\eta:(Y,\sigma)\to(Z,\mu)$ be two mapping. Then,

i) $\eta\circ\phi$ is NVGP ap-irresolute, if ϕ is NVGP ap-irresolute and η is NV irresolute.
ii) $\eta\circ\phi$ is NVGP ap-closed, if ϕ is NV closed and η is NVGP ap-closed.
iii) $\eta\circ\phi$ is NVGP perfectly irresolute, if ϕ and η are NVGP perfectly irresolute.
iv) $\eta\circ\phi$ is NVGP contra irresolute, if ϕ is NVGP perfectly irresolute and η is NVGP contra irresolute.
v) $\eta\circ\phi$ is NVGP irresolute, if ϕ is NVGP perfectly irresolute and η is NVGP contra irresolute.
vi) $\eta\circ\phi$ is NVGP irresolute, if ϕ is NVGP perfectly irresolute and η is NVGP irresolute.
vii) $\eta\circ\phi$ is NVGP contra irresolute, if ϕ is NVGP perfectly irresolute and η is NVGP irresolute.
viii) $\eta\circ\phi$ is NVGP irresolute, if ϕ is NVGP contra irresolute and η is NVGP contra irresolute.
ix) $\eta\circ\phi$ is NVGP contra irresolute, if ϕ is NVGP contra irresolute and η is NVGP irresolute.

Proof: It follows from the definition.

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Theorem 3.8: If $\phi:(X,\tau)\to(Y,\sigma)$ is NVGP contra irresolute from a NVTS (X,τ) into a NVTS (Y,σ), then ϕ is NVGP contra continuous mapping.

Proof: Let A be NVOS in *Y*. Since every NVOS is NVGPOS, A is NVGPOS in *Y*. Since ϕ is NVGP contra irresolute, then $\phi^{-1}(A)$ is NVGPCS in *X*. Hence ϕ is NVGP contra continuous mapping.

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BIPOLAR SINGLE-VALUED NEUTROSOPHIC RELATION

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ABSTRACT

In this paper the concept of Bipolar single-valued Neutrosophic relations were studied. We further studied the composition of BNF relations with t-norms and t-conorms and characterize their properties.

Keyword: Bipolar single-valued Neutrosophic set and bipolar single-valued Neutrosophic relation.

1. Introduction:

A mathematical description of a situation where certain elements of sets are related to one another in some way is a Relation. The use of fuzzy relations originated from the observation that real life objects can be related to each other to certain degree. The fuzzy set was introduced by Zadeh[10] in 1965. The introduction of the neutrosophic set was proposed by Smarandache [4,5]. Bosc and Pivert [2] introduced a study is called bipolar fuzzy relations where each tuple is associated with a pair of satisfaction degrees. Irfan Deli [7] and et.al developed bipolar neutrosophic sets and their application.

I.Arockiarani and J.Martina Jency[1] introduced Fuzzy neutrosophic sets, Topological spaces and

Fuzzy Neutrosophic relations. In this paper the concept of Bipolar single-valued Neutrosophic relations were studied. We further studied the composition of BSVN relations with t-norms and t-conorms and characterize their properties.

2. Preliminaries:

Definition (2.1)[10]: The fuzzy set where each element had a degree of membership (T).

The Intuitionistic fuzzy set on a universe as a generalization of fuzzy set, where the degree of membership $\mu_A(x) \in [0,1]$ of each element $x \in X$ to a set A, there was considered a degree of non-membership $\nu_A(x) \in [0,1]$,such that $\forall\ x \in X,\ \mu_A(x) + \nu_A(x) \leq 1$.

Definition (2.2)[9]: A Bipolar single-valued Neutrosophic set (BSVN) A in X is defined in the form of BSVN (A) = $\langle u,(T_{BNF}^{+},T_{BNF}^{-}),(I_{BNF}^{+},I_{BNF}^{-}),(F_{BNF}^{+},F_{BNF}^{-}):u \in X\rangle$ where $(T_{BNF}^{+},I_{BNF}^{+},F_{BNF}^{+}):X \rightarrow [0,1]$ and $(T_{BNF}^{-},I_{BNF}^{-},F_{BNF}^{-}):X \rightarrow [-1,0]$ .In this definition, there T_{BNF}^{+} and T_{BNF}^{-} are acceptable and unacceptable in past. Similarly I_{BNF}^{+} and I_{BNF}^{-} are acceptable and unacceptable in future. F_{BNF}^{+} and F_{BNF}^{-} are acceptable and unacceptable in present respectively.

Definition (2.3): In order to define the BSVN relation, we will use the well-known triangular norms and co-norms in [0, 1].we will call t-norms in [0, 1] to every mappings [0, 1] x [0, 1] → [0, 1] satisfying the following properties

1. Boundary condition T(x, 1) = x and T(x, 0) = 0, for all x ∈ [0, 1]

2. Monotony, T(x, y) ≤ T (z, t) if x ≤ z and y ≤ t

3. Commutative, T(x, y) = T(y, x), for all x, y ∈ [0, 1]

4. Associative, T (T(x, y), z) = T(x, T(y, z)), for all x, y, z ∈ [0, 1]

Given a t-norm T, we can consider the mapping S: [0,1] x [0, 1] → [0, 1] S(x, y) ≡ 1-T(1-x, 1-y). This mapping S will be called dual t-conorm of T. The most important properties of t-norms and t-conorms can be found in **[3,8]**.Here we present the following theorem with regard to the distributive property of t-norms and t-conorms. In this paper unless it is said in the opposite way, we will designate the t-norms and t-conorms with the greek letters α, β, λ, ρ. Let I be a finite family of indices and $\{a\ \}\in I$, $\{bi\ \}i\in I$ be number collection of [0, 1].For every α t-norm or t-conorm and for every λ t-norm or

t-conorm

1. ${}^{\alpha}_{i}(a_i \vee b_i) \geq {}^{\alpha}_{i}(a_i) \vee {}^{\alpha}_{i}(b_i)$ 2. ${}^{\lambda}_{i}(a_i \wedge b_i) \leq {}^{\lambda}_{i}(a_i) \wedge {}^{\lambda}_{i}(b_i)$ are verified.

With the result given by L.W.Fung and S.K.Ku [6] relative to the fact that α is an idempotent t-conorm (idempotent t-norm) if and only if $\alpha = \vee$ ($\alpha = \wedge$), we get the following;

Let $\{a_i\}_{i\in I}$, $\{bi\ \}_{i\in I}$ be two finite number families of [0,1] and α, λ t-norms or t-conorms not null. Then ${}^{\alpha}_{i}(a_i \vee b_i) = {}^{\alpha}_{i}(a_i) \vee {}^{\alpha}_{i}(b_i)$ if and only if $\alpha = \vee$ and ${}^{\lambda}_{i}(a_i \wedge b_i) = {}^{\lambda}_{i}(a_i) \wedge {}^{\lambda}_{i}(b_i)$ if and only if $\lambda = \wedge$.

3. Bipolar single-valued Neutrosophic Relations:

Definition 3.1:A Bipolar single-valued Neutrosophic set relation is defined as a Bipolar single-valued Neutrosophic subset of $X \times Y$ having the form $R = \{<(x,y), T^{+}_{R}(x,y), T^{-}_{R}(x,y), I^{+}_{R}(x,y), I^{-}_{R}(x,y), F^{+}_{R}(x,y), F^{-}_{R}(x,y)> : x \in X, y \in Y\}$ where $\forall (x,y) \in X \times Y$ and also $T^{+}_{R}, I^{+}_{R}, F^{+}_{R} : X \times Y \to [0,1]$, $T^{-}_{R}, I^{-}_{R}, F^{-}_{R} : X \times Y \to [-1,0]$. We will denote with BSVN $(X \times Y)$ the set of all bipolar single-valued Neutrosophic subsets in $X \times Y$.

Definition 3.2: A binary bipolar single valued neutrosophic relation between X and Y, we can define R^{-1} between Y and X by means of $T^{+}_{R^{-1}}(y,x) = T^{+}_{R}(x,y)$, $T^{-}_{R^{-1}}(y,x) = T^{-}_{R}(x,y)$, $I^{+}_{R^{-1}}(y,x) = I^{+}_{R}(x,y)$, $I^{-}_{R^{-1}}(y,x) = I^{-}_{R}(x,y)$, $F^{+}_{R^{-1}}(y,x) = F^{+}_{R}(x,y)$, $F^{-}_{R^{-1}}(y,x) = F^{-}_{R}(x,y)$ $\forall (x,y) \in X \times Y$ to which we call inverse relation of R.

Definition 3.3: Let R and P be two bipolar single-valued neutrosophic relations between X and Y, for every $(x, y) \in X \times Y$ .We can define,

1. $R \leq P \Leftrightarrow < T^{+}_{R}(x,y) \leq T^{+}_{P}(x,y), T^{-}_{R}(x,y) \leq T^{-}_{P}(x,y), I^{+}_{R}(x,y) \geq I^{+}_{P}(x,y),$

$I^{-}_{R}(x,y) \geq I^{-}_{P}(x,y), F^{+}_{R}(x,y) \geq F^{+}_{P}(x,y), F^{-}_{R}(x,y) \geq F^{-}_{P}(x,y) >$

2. $R^{c} = \{<(x,y), (1- T^{+}_{R}(x,y)), (-1- T^{-}_{R}(x,y)), (1- I^{+}_{R}(x,y)), (-1- I^{-}_{R}(x,y)),$

$(1- F^{+}_{R}(x,y)),(-1- F^{-}_{R}(x,y))>\}$

3. $R \vee P = \{<(x,y), T^{+}_{R}(x,y) \vee T^{+}_{P}(x,y), T^{-}_{R}(x,y) \vee T^{-}_{P}(x,y), I^{+}_{R}(x,y) \wedge I^{+}_{P}(x,y),$

$I^{-}_{R}(x,y) \wedge I^{-}_{P}(x,y), F^{+}_{R}(x,y) \wedge F^{+}_{P}(x,y), F^{-}_{R}(x,y) \wedge F^{-}_{P}(x,y) >\}$

4. $R \wedge P = \{<(x,y), T^{+}_{R}(x,y) \wedge T^{+}_{P}(x,y), T^{-}_{R}(x,y) \wedge T^{-}_{P}(x,y), I^{+}_{R}(x,y) \vee I^{+}_{P}(x,y),$
$I^{-}_{R}(x,y) \vee I^{-}_{P}(x,y), F^{+}_{R}(x,y) \vee F^{+}_{P}(x,y), F^{-}_{R}(x,y) \vee F^{-}_{P}(x,y) >\}$

Theorem 3.4: Let R, P, Q be three elements of bipolar single-valued Neutrosophic relations (X×Y)

(i) $R \leq P \Rightarrow R^{-1} \leq P^{-1}$ (ii) $(R \vee P)^{-1} = R^{-1} \vee P^{-1}$ (iii) $(R \wedge P)^{-1} = R^{-1} \wedge P^{-1}$ (iv) $(R^{-1})^{-1} = R$

(v) $R \wedge (P \vee Q) = (R \wedge P) \vee (R \wedge Q)$ and $R \vee (P \wedge Q) = (R \vee P) \wedge (R \vee Q)$

(vi) $R \vee P \geq R, R \vee P \geq P, R \wedge P \leq R, R \wedge P \leq P$

(vii) If $R \geq P$ and $R \geq Q$; then $R \geq (P \vee Q)$ (viii) If $R \leq P$ and $R \leq Q$; then $R \leq (P \vee Q)$

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Proof: (i) If $R \leq P$,then for every $(x,y) \in X \times Y$

$T^{+}_{R^{-1}}(y,x) = T^{+}_{R}(x,y) \leq T^{+}_{P}(x,y) = T^{+}_{P^{-1}}(y,x)$ $T^{-}_{R^{-1}}(y,x) = T^{-}_{R}(x,y) \leq T^{-}_{P}(x,y) = T^{-}_{P^{-1}}(y,x)$

$I^{+}_{R^{-1}}(y,x) = I^{+}_{R}(x,y) \geq I^{+}_{P}(x,y) = I^{+}_{P^{-1}}(y,x)$ $I^{-}_{R^{-1}}(y,x) = I^{-}_{R}(x,y) \geq I^{-}_{P}(x,y) = I^{-}_{P^{-1}}(y,x)$

$F^{+}_{R^{-1}}(y,x) = F^{+}_{R}(x,y) \geq F^{+}_{P}(x,y) = F^{+}_{P^{-1}}(y,x)$ $F^{-}_{R^{-1}}(y,x) = F^{-}_{R}(x,y) \leq F^{-}_{P}(x,y) = F^{-}_{P^{-1}}(y,x)$

Hence $R^{-1} \leq P^{-1}$.

(ii) $(R \vee P)^{-1} = R^{-1} \vee P^{-1}$

$T^{+}_{(R\vee P)^{-1}}(y,x) = T^{+}_{(R\vee P)}(x,y) = T^{+}_{R}(x,y) \vee T^{+}_{P}(x,y) = T^{+}_{R^{-1}}(y,x) \vee T^{+}_{P^{-1}}(y,x) = T^{+}_{R^{-1}\vee P^{-1}}(y,x)$

$T^{-}_{(R\vee P)^{-1}}(y,x) = T^{-}_{(R\vee P)}(x,y) = T^{-}_{R}(x,y) \vee T^{-}_{P}(x,y) = T^{-}_{R^{-1}}(y,x) \vee T^{-}_{P^{-1}}(y,x) = T^{-}_{R^{-1}\vee P^{-1}}(y,x)$

The proof is similar for $I^{+}_{(R\vee P)^{-1}}(y,x) = I^{+}_{R^{-1}\vee P^{-1}}(y,x)$, $I^{-}_{(R\vee P)^{-1}}(y,x) = I^{-}_{R^{-1}\vee P^{-1}}(y,x)$ and

$F^{+}_{(R\vee P)^{-1}}(y,x) = F^{+}_{R^{-1}\vee P^{-1}}(y,x)$, $F^{-}_{(R\vee P)^{-1}}(y,x) = F^{-}_{R^{-1}\vee P^{-1}}(y,x)$.

(iii) $(R \wedge P)^{-1} = R^{-1} \wedge P^{-1}$: The proof is similar to (ii).

(iv) $(R^{-1})^{-1} = R$: The proof follows from the definition.

(v) $R \wedge (P \vee Q) = (R \wedge P) \vee (R \wedge Q)$ and $R \vee (P \wedge Q) = (R \vee P) \wedge (R \vee Q)$

Proof: $T^{+}_{(R\wedge(P\vee Q))}(x,y) = T^{+}_{R}(x,y) \wedge \{T^{+}_{P}(x,y) \vee T^{+}_{Q}(x,y)\} = T^{+}_{R}(x,y) \wedge T^{+}_{P}(x,y) \vee T^{+}_{R}(x,y) \wedge$

$T^{+}_{Q}(x,y) = T^{+}_{R\wedge P}(x,y) \vee T^{+}_{R\wedge Q}(x,y) = T^{+}_{(R\wedge P)\vee(R\wedge Q)}(x,y)$

Similarly for $T^{-}_{(R\wedge(P\vee Q))}(x,y)$, $I^{+}_{(R\wedge(P\vee Q))}(x,y)$, $I^{-}_{(R\wedge(P\vee Q))}(x,y)$, $F^{+}_{(R\wedge(P\vee Q))}(x,y)$, $F^{-}_{(R\wedge(P\vee Q))}(x,y)$.

Hence $R \wedge (P \vee Q) = (R \wedge P) \vee (R \wedge Q)$ .The proof is analogous to the above one, in the case of $R \vee (P \wedge Q) = (R \vee P) \wedge (R \vee Q)$.

(vi) $R \vee P \geq R$, $R \vee P \geq P$, $R \wedge P \leq R$, $R \wedge P \leq P$: The proof is obvious.

(vii) If $R \geq P$ and $R \geq Q$; then $R \geq (P \vee Q)$

Proof: If $R \geq P$ and $R \geq Q$, $T^{+}_{R}(x,y) \geq T^{+}_{P}(x,y)$, $T^{-}_{R}(x,y) \geq T^{-}_{P}(x,y)$, $I^{+}_{R}(x,y) \leq I^{+}_{P}(x,y)$,

$I^{-}_{R}(x,y) \leq I^{-}_{P}(x,y)$, $F^{+}_{R}(x,y) \leq F^{+}_{P}(x,y)$, $F^{-}_{R}(x,y) \leq F^{-}_{P}(x,y)$, $T^{+}_{R}(x,y) \geq T^{+}_{Q}(x,y)$, $T^{-}_{R}(x,y) \geq T^{-}_{Q}(x,y)$, $I^{+}_{R}(x,y) \leq I^{+}_{Q}(x,y)$, $I^{-}_{R}(x,y) \leq I^{-}_{Q}(x,y)$, $F^{+}_{R}(x,y) \leq F^{+}_{Q}(x,y)$, $F^{-}_{R}(x,y) \leq F^{-}_{Q}(x,y)$ $T^{+}_{R}(x,y) \geq T^{+}_{P}(x,y) \vee T^{+}_{Q}(x,y) \Rightarrow T^{+}_{R}(x,y) \geq T^{+}_{P\vee Q}(x,y) \Rightarrow R \geq (P \vee$

Q) ,similarly for $T^{-}_{R}(x,y) \geq T^{-}_{P\vee Q}(x,y)$, $I^{+}_{R}(x,y) \leq I^{+}_{P\vee Q}(x,y)$, $I^{-}_{R}(x,y) \leq I^{-}_{P\vee Q}(x,y)$, $F^{+}_{R}(x,y) \leq F^{+}_{P\vee Q}(x,y)$, $F^{-}_{R}(x,y) \leq F^{-}_{P\vee Q}(x,y)$.Therefore $R \geq (P \vee Q)$.

(viii) If $R \leq P$ and $R \leq Q$; then $R \leq (P \vee Q)$: The proof is similar as (vii).

4. Composition of BSVN Relations:

The composition of binary BSVN relation in [0, 1] and [-1, 0].we can give the following definition.

Definition (4.1): Let α,β,λ,ρ be t-norm or t-conorm,let R∈ BSVNR(XxY) and P∈ BSVNR(YxZ).The composed relation $P \overset{\alpha,\beta}{\underset{\lambda,\rho}{\circ}} R \in$ BSVNR(XxZ) defined $P \overset{\alpha,\beta}{\underset{\lambda,\rho}{\circ}} R = \{<(x,z), T^{+}_{P\circ R}(x,z), T^{-}_{P\circ R}(x,z),$

$I^{+}_{P\circ R}(x,z), I^{-}_{P\circ R}(x,z), F^{+}_{P\circ R}(x,z), F^{-}_{P\circ R}(x,z)/x\in X,z\in Z>\}$ where $T^{+}_{P\circ R}(x,z)= \overset{\alpha}{\underset{y}{}} \{\beta[T^{+}_{R}(x,y), T^{+}_{P}(y,z)]\}$

$T^{-}_{P\circ R}(x,z)= \overset{\alpha}{\underset{y}{}} \{\beta[T^{-}_{R}(x,y), T^{-}_{P}(y,z)]\}$ as same for $I^{+}_{P\circ R}(x,z)$ and $I^{-}_{P\circ R}(x,z)$, $F^{+}_{P\circ R}(x,z)= \overset{\lambda}{\underset{y}{}} \{\rho[F^{+}_{R}(x,y), F^{+}_{P}(y,z)]\}$, $F^{-}_{P\circ R}(x,z)= \overset{\lambda}{\underset{y}{}} \{\rho[F^{-}_{R}(x,y), F^{-}_{P}(y,z)]\}$.

Theorem (4.2): For each R∈ BSVNR (XxY) and P∈ BSVNR (YxZ) and α,β,λ,ρ any t-norm or t-conorm, $(P\circ R)^{-1}=R^{-1}\circ P^{-1}$.

Proof:

Let $T^{+}_{(P\circ R)^{-1}}(z,x)= T^{+}_{(P\circ R)}(x,z)= \overset{\alpha}{\underset{y}{}} \{\beta[T^{+}_{R}(x,y), T^{+}_{P}(y,z)]\}= \overset{\alpha}{\underset{y}{}} \{\beta[T^{+}_{R^{-1}}(x,y), T^{+}_{P^{-1}}(y,z)]\}=$

$\overset{\alpha}{\underset{y}{}} \{\beta[T^{+}_{P^{-1}}(y,z), T^{+}_{R^{-1}}(x,y)]\}= T^{+}_{R^{-1}\circ P^{-1}}(z,x)$, similarly for $T^{-}_{(P\circ R)^{-1}}(z,x)= T^{-}_{R^{-1}\circ P^{-1}}(z,x)$,

$I^{+}_{(P\circ R)^{-1}}(z,x)=I^{+}_{R^{-1}\circ P^{-1}}(z,x)$, $I^{-}_{(P\circ R)^{-1}}(z,x)= I^{-}_{R^{-1}\circ P^{-1}}(z,x)$ and $F^{+}_{(P\circ R)^{-1}}(z,x)= F^{+}_{(P\circ R)}(x,z)= \overset{\lambda}{\underset{y}{}} \{\rho[F^{+}_{R}(x,y), F^{+}_{P}(y,z)]\}= \overset{\lambda}{\underset{y}{}} \{\rho[F^{+}_{R^{-1}}(x,y), F^{+}_{P^{-1}}(y,z)]\}= \overset{\lambda}{\underset{y}{}} \{\rho[F^{+}_{P^{-1}}(y,z), F^{+}_{R^{-1}}(x,y)]\}= F^{+}_{R^{-1}\circ P^{-1}}(z,x)$, for every (z,x)∈ZxX. Similarly for $F^{-}_{(P\circ R)^{-1}}(z,x)=F^{-}_{R^{-1}\circ P^{-1}}(z,x)$. Hence $(P\circ R)^{-1}=R^{-1}\circ P^{-1}$.

Theorem (4.3): For any α,β,λ,ρ any t-norm or t-conorm; R,P ∈ BSVNR(YxZ) and Q ∈ BSVNR(XxY), then $(R \vee P)\circ Q \geq (R\circ Q) \vee (P\circ Q)$ holds.

Theorem(4.4): In the condition of definition (4.1), (i) If $P_1 \leq P_2$, then $P_1\circ R \leq P_2\circ R$ for every R∈BSVNR (ii) If $P_1 \leq P_2$, then $P\circ R_1 \leq P\circ R_2$ for every P∈BSVNR.

Theorem (4.5): let R,P be two elements of BSVNR(YxZ) and Q∈BSVNR(XxY), α,λ not null t-norm or t-conorm.Then $(R \vee P)\circ Q =(R\circ Q) \vee (P\circ Q)$ if and only if $\alpha=\vee$ and $\lambda=\wedge$.

5. Relation on Bipolar single-valued Neutrosophic sets:

Definition (5.1): The Relation $\Delta \in$BSVNR (XxX) is called the Relation of identity if $\forall(x,y)\in XxX$

$T^{+}_{\Delta}(x,y)=\begin{cases}1 & x=y\\ 0 & x\neq y\end{cases}$, $T^{-}_{\Delta}(x,y)=\begin{cases}-1 & x=y\\ 0 & x\neq y\end{cases}$, $I^{+}_{\Delta}(x,y)=\begin{cases}0 & x=y\\ 1 & x\neq y\end{cases}$, $I^{-}_{\Delta}(x,y)=\begin{cases}0 & x=y\\ -1 & x\neq y\end{cases}$,

$F^{+}_{\Delta}(x,y)=\begin{cases}0 & x=y\\ 1 & x\neq y\end{cases}$, $F^{-}_{\Delta}(x,y)=\begin{cases}0 & x=y\\ -1 & x\neq y\end{cases}$. The complementary relation $\Delta^{c}=\Delta$ is defined by

$T^{+}_{\nabla}(x,y)=\begin{cases}1 & x=y\\ 0 & x\neq y\end{cases}$, $T^{-}_{\nabla}(x,y)=\begin{cases}-1 & x=y\\ 0 & x\neq y\end{cases}$, $I^{+}_{\nabla}(x,y)=\begin{cases}0 & x=y\\ 1 & x\neq y\end{cases}$, $I^{-}_{\nabla}(x,y)=\begin{cases}0 & x=y\\ -1 & x\neq y\end{cases}$,

$F^{+}_{\nabla}(x,y)=\begin{cases}0 & x=y\\ 1 & x\neq y\end{cases}$, $F^{-}_{\nabla}(x,y)=\begin{cases}0 & x=y\\ -1 & x\neq y\end{cases}$ .It is evident that $\Delta=\Delta^{-1}$, $\nabla=\nabla^{-1}$.

Definition (5.2): The Relation R $\in$ BSVNR (XxY) is called Reflexive if for every x $\in$ X,

$T^{+}_{R}(x,x)=1$ $T^{-}_{R}(x,x)=-1$, $I^{+}_{R}(x,x)=0$ $T^{-}_{R}(x,x)=0$, $F^{+}_{R}(x,x)=0$ $F^{-}_{R}(x,x)=0$ and Anti reflexive if for every x $\in$ X, $T^{+}_{R}(x,x)=0$ $T^{-}_{R}(x,x)=0$, $I^{+}_{R}(x,x)=1$ $T^{-}_{R}(x,x)=-1$, $F^{+}_{R}(x,x)=1$ $F^{-}_{R}(x,x)=-1$ (i.e) The Relation R is called Anti-reflexive if its complement R^{c} is Reflexive.

Theorem (5.3): For every R $\in$ BSVNR (XxY), it is verified that (i) if R is reflexive then $\Delta \leq R$, (ii) if R is Anti-reflexive then $\Delta \geq R$.
Proof: It is the consequence of the definition 5.1 and 5.2.

Theorem (5.4): Let R_1 br reflexive bipolar single-valued Neutrosophic relation in XxX.Then (i) $(R_1)^{-1}$ is reflexive. (ii) $R_1 \vee R_2$ is reflexive for every $R_2 \in$ BNFR (XxX). (iii) $R_1 \wedge R_2$ is reflexive $\Leftrightarrow$ $R_2 \in$ BSVNR (XxX) is reflexive.

Proof: proof follows from the definition.

Definition (5.5): A Reflexive closure of a reflexive for every R $\in$ BSVNR (XxX) is defined as $R \vee \Delta$.

Definition (5.6): A relation R $\in$ BNFR (XxX) is called symmetric if $R=R^{-1}$ that is, if for every

(x,y) of XxX, $T^{+}_{R}(x,y)=T^{+}_{R}(y,x)$ $T^{-}_{R}(x,y)=T^{-}_{R}(y,x)$, $I^{+}_{R}(x,y)=I^{+}_{R}(y,x)$ $I^{-}_{R}(x,y)=I^{-}_{R}(y,x)$,
$F^{+}_{R}(x,y)=F^{+}_{R}(y,x)$ $F^{-}_{R}(x,y)=F^{-}_{R}(y,x)$.

Definition (5.7): Let R be an element of BSVNR (XxX).We will say that it is ant symmetrical Bipolar single-valued Neutrosophic relation if for every (x,y) of XxX, $x\neq y \Rightarrow T^{+}_{R}(x,y)\neq T^{+}_{R}(y,x)$

$T^{-}_{R}(x,y)\neq T^{-}_{R}(y,x)$, $I^{+}_{R}(x,y)\neq I^{+}_{R}(y,x)$ $I^{-}_{R}(x,y)\neq I^{-}_{R}(y,x)$, $F^{+}_{R}(x,y)\neq F^{+}_{R}(y,x)$

$F^{-}_{R}(x,y)\neq F^{-}_{R}(y,x)$.

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Theorem (5.8): If α,β,λ,ρ are either t-norm or t-conorm and R,P ∈ BSVNR (XxX) are symmetrical then $R \overset{\alpha,\beta}{\underset{\lambda,\rho}{\circ}} P = (R \overset{\alpha,\beta}{\underset{\lambda,\rho}{\circ}} P)^{-1}$. Proof: Let R and P are symmetrical ⇒ $R=R^{-1}$, $P=P^{-1}$ then

$R \overset{\alpha,\beta}{\underset{\lambda,\rho}{\circ}} P = R^{-1} \overset{\alpha,\beta}{\underset{\lambda,\rho}{\circ}} P^{-1} = (R \overset{\alpha,\beta}{\underset{\lambda,\rho}{\circ}} P)^{-1}$.

Definition (5.9): Let us take α t-conorm, β t-norm, λ t-norm and ρ t-conorm, we will say that R ∈ BSVNR (XxX) is (i) Transtive if $R \geq R \overset{\alpha,\beta}{\underset{\lambda,\rho}{\circ}} R$ (ii) c-transtive if $R \leq R \overset{\alpha,\beta}{\underset{\lambda,\rho}{\circ}} R$.

Result (5.10): For α t-conorm, β t-norm, λ t-norm and ρ t-conorm, it is verified that

(i) If R ∈ BSVNR (XxX) is reflexive and transitive, then $R= R \overset{\alpha,\beta}{\underset{\lambda,\rho}{\circ}} R$,

(ii) If R ∈ BSVNR (XxX) is anti-reflexive and c-transitive, then $R= R \overset{\alpha,\beta}{\underset{\lambda,\rho}{\circ}} R$.

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PYTHAGOREAN FUZZY GENERALIZED SEMI CLOSED SETS IN TERMS OF MINIMAL STRUCTURE SPACES

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Abstract:

The purpose of this paper is to introduce the notions PFGS- minimal closed sets, the PFGS^*-minimal closed sets in terms of Pythagorean fuzzy minimal structure space. Also the various properties of this newly formed sets are studied and the corresponding topological structure is discussed.

Keywords: PF minimal open set, PFGS-minimal closed set, PFGS^*- minimal closed set.

1. Introduction

Fuzzy sets were introduced by Zadeh [12] in 1965.Intuitionistic fuzzy sets were introduced by Attanassov [1]. Intuitionistic fuzzy sets take into account both the degree of membership and of non-membership subject to the condition that their sum does not exceed 1.Yager was presented a new set called Pythagorean fuzzy set. In PFS [10,11], each element is expressed by an ordered pair (u, v) satisfying the condition $u^2 + v^2 \leq 1$. The concept of minimal open set was introduced first by Nakaoka F. and Oda Nobuyuki [9]. Levine N [6] initiated the study of Generalized closed sets in topological spaces. The concept of Generalized * closed set has been introduced by Bhattacharya S.(Halder) [3].The notation of Semi-open sets and Semi continuity was first introduced and investigated by Levine N.[7].In this paper, we introduce the new concepts of Pythagorean fuzzy generalized semi minimal closed sets, Pythagorean fuzzy generalized semi* minimal closed sets in Pythagorean fuzzy minimal structure space. Further we investigate some of their properties.

2. Preliminaries

Definition 2.1[10] Let X be a nonempty set and I the unit interval [0,1].A PF set S is an object having the form $S = \{\langle x, u_S(x), v_S(x)\rangle : x \in X\}$ where the functions $u_S : X \to [0,1]$ and $v_S : X \to [0,1]$ denote respectively the degree of membership and degree of non-membership of each element $x \in X$ to the set S, and $0 \leq \left(u_S(x)\right)^2 + (v_S(x))^2 \leq 1$ for each $x \in X$.

Lemma 2.2 [10]] Let X be a nonempty set and I the unit interval [0,1].A PF sets S and T be in the form $S = \{\langle x, u_S(x), v_S(x)\rangle : x \in X\}$ and $T = \{\langle x, u_T(x), v_T(x)\rangle : x \in X\}$.

Then

1) $S^C = \{\langle x, v_S(x), u_S(x)\rangle : x \in X\}$
2) $S \cup T = \left\{\langle x, \max\left(u_S(x), u_T(x)\right), \min(v_S(x), v_T(x))\rangle : x \in X\right\}$
3) $S \cap T = \left\{\langle x, \min\left(u_S(x), u_T(x)\right), \max(v_S(x), v_T(x))\rangle : x \in X\right\}$
4) $1_\sim = \{\langle x, 1,0\rangle : x \in X\}$, $0_\sim = \{\langle x, 0,1\rangle : x \in X\}$
5) $(S^C)^C = S$, ${0_\sim}^C = 1_\sim$, ${1_\sim}^C = 0_\sim$.

Definition 2.3 [5] A fuzzy subset A of X is a fuzzy generalized closed set if $Cl(A) \subseteq U$ whenever $A \subseteq U$, U is a fuzzy open subset of X.

Definition 2.4 [2] A fuzzy subset A of X is a fuzzy dense set if $Cl(A) = 1_{\sim}$.

Definition 2.5 [8] Let (X, τ) be a topological space. A subset A of a space X is called a ⋀-set if it is equal to its kernel that is intersection of all open supersets of A.

3. On Pythagorean Fuzzy Generalized Semi Minimal Closed Sets

In this section the concept of PF generalized semi minimal closed set is introduced and some of its properties are discussed.

Definition 3.1 A PF topology on a nonempty set is a family τ of PF sets in X containing $0_{\sim}, 1_{\sim}$ and closed under arbitrary infimum and finite supremum. The Pair (X, τ) is called a PF topological space and each PF set in τ is known as a PF open set. The Compliment S^C of a PF open set S in a PF topological space (X, τ) is called closed set in X.

Definition 3.2 Let (X, τ) be a PF topological space and Let A be a PF Set in X. Then closure of A is defined by $Cl(A) = \cap \{F: A \subseteq F, F^C \in \tau\}$. and the fuzzy interior of A is defined by $Int(A) = \cup \{G: A \supseteq G, G \in \tau\}$.

Definition 3.3 A subset A of a family τ of PF sets on X is called a PF minimal open set in X if a PF open set which is contained in A is either $0_{\sim}$ or A.

Definition 3.4 A Pythagorean fuzzy subset A of X is a Pythagorean fuzzy dense set if

$Cl(A) = 1_{\sim}$.

Definition 3.5 A PF subset A of a (X, τ) topological spaces is called PF semi-open if

$A \subseteq Cl(int(A))$.

Definition 3.6 A PF set A is said to be a PF generalized minimal closed set, if there exist at least one PF minimal open set U containing A such that $Cl(A) \subseteq U$.

Definition 3.7 A PF set A is said to be a PF generalized semi minimal closed set, if there exist at least one PF minimal open set U containing A such that $SCl(A) \subseteq U$.

Example 3.8 Let $A = \{\langle x, (0.9,0.4)\rangle: x \in X\}$ and $B = \{\langle x, (0.8,0.3)\rangle: x \in X\}$ be two PF subsets of X. Let $\tau = \{0_{\sim}, 1_{\sim}, A, B, A \cup B, A \cap B\}$.Here $A \cap B$ is a PF minimal open set of τ. Consider a set $C = \{\langle x, (0.2,0.8)\rangle: x \in X\}$, then $C \subseteq A \cap B$ and $SCl(C) = \{\langle x, (0.3,0.8)\rangle: x \in X\} \subseteq A \cap B$. Hence C is a PF generalized semi minimal closed set.

Theorem 3.9

Let $A \subseteq B \subseteq U$, where U is a PF minimal open set. If B is a PF generalized semi minimal closed set, then A is also a PF generalized semi minimal closed set.

Proof:

Let $B \subseteq U$, where U is a PF minimal open set i.e. $A \subseteq B \subseteq U$. From definition as B is a PF generalized semi minimal closed set $SCl(B) \subseteq U$ implies $SCl(A) \subseteq SCl(B) \subseteq U$ .Therefore A is also a PF generalized semi minimal closed set.

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Theorem 3.10

A PF set A is PF generalized semi minimal closed and PF semi minimal open set then A is a PF semi closed set.

Proof:

Let if possible A be a PF generalized semi minimal closed set .Then, there exist a PF minimal open set U containing A such that $SCl(A) \subseteq U$. Since A itself is PF semi minimal open set $SCl(A) \subseteq A$. This implies that $int(Cl(A)) \subseteq A$. Hence A is a PF semi closed set.

Theorem 3.11 Every PF generalized semi minimal closed set is a PF generalized semi closed set.

Proof: Let A be a PF generalized semi minimal closed set then there exist a PF minimal open set U such that $A \subseteq U$ implies $SCl(A) \subseteq U$. Since U is a PF minimal open set $U \subseteq O$, where O is a PF open set. Hence $SCl(A) \subseteq U \subseteq O$ i.e. A is a PF generalized semi closed set.

Remark 3.12: Converse of the above theorem need not be true which follows from the following example:

Let $A = \{\langle x, (0.4,0.7)\rangle : x \in X\}$ and $B = \{\langle x, (0.3,0.6)\rangle : x \in X\}$ be two PF subsets of X. Let $\tau = \{1_\sim, 0_\sim, A, B, A \cup B, A \cap B\}$.Here $A \cap B$ is a PF minimal open Set of τ. Consider a set $C = \{\langle x, (0.2,0.9)\rangle : x \in X\}$, then $C \subseteq A \cap B$ and $SCl(C) = \{\langle x, 0.6,0.4\rangle\}$. Hence C is not a PF generalized semi minimal closed set but PF generalized closed set.

Theorem 3.13 Let A be any PF generalized semi minimal closed set then $SCl(A) \subseteq \bigwedge(A)$ if the set X is finite.

Proof: Since A is a PF generalized semi minimal closed set, $A \subseteq U$ where U is a PF minimal open set then $SCl(A) \subseteq U$. Therefore $SCl(A) \subseteq U = \bigwedge(A)$, since $\bigwedge(A)$ is the infimum of all PF open set containing A and the set X being finite $\bigwedge(A)$ is a PF open set.

Theorem 3.14

1) $0_\sim$ is a PF generalized semi minimal closed set but $1_\sim$ is not a PF generalized semi minimal closed set.
2) Arbitrary union of PF generalized semi minimal closed set is a PF generalized semi minimal closed set.
3) Arbitrary intersection of PF generalized semi minimal closed set is a PF generalized semi minimal closed set.

Proof:

(1) is obvious.

(2) Let $\{A_i : i \in I\}$ be an arbitrary collection of PF generalized semi minimal closed set. Since in a PF topological space there exist a unique PF minimal open set. Let U be the corresponding PF minimal open set. i.e. $A_i \subseteq U$, where U is a PF minimal open set, implies $SCl(A_i) \subseteq U$.

Therefore, $\cup \{A_i : i \in I\} \subseteq U$, implies $\cup \{SCl(A_i) : i \in I\} \subseteq U$. But we know that $SCl \cup \{A_i : i \in I\} \subseteq \cup \{SCl(A_i) : i \in I\} \subseteq U$.

Thus arbitrary union of PF generalized semi minimal closed set is a PF generalized semi minimal closed set.

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(3) Let $\{A_i: i \in I\}$ be an arbitrary collection of PF generalized semi minimal closed set. Since in a PF topological space there exist a unique PF minimal open set. Let U be the corresponding PF minimal open set. i.e.$A_i \subseteq U$, where U is a PF minimal open set, implies $SCl(A_i) \subseteq U$.

Obviously $\cap \{A_i: i \in I\} \subseteq U$, and thus $SCl \cap \{A_i: i \in I\} \subseteq U$. But we know that $SCl \cap \{A_i: i \in I\} \subseteq \cap \{SCl(A_i): i \in I\} \subseteq U$.Therefore arbitrary intersection of PF

generalized semi closed set is a PF generalized semi minimal closed set.

4. Some Results on PF Generalized Semi * Minimal Closed Sets

Definition 4.1 A PF set B is said to be a PF generalized semi * minimal closed set, if there exist at least one PF minimal open set A containing B such that $SCl(B) \supseteq A$.

Example 4.2 Let $A = \{\langle x, (0.3,0.7)\rangle: x \in X\}$ and $B = \{\langle x, (0.4,0.8)\rangle: x \in X\}$ be two PF subsets of X. Let $\tau = \{0_\sim, 1_\sim, A, B, A \cup B, A \cap B\}$.Here $A \cap B$ is a PF minimal open set of τ. Consider a set $C = \{\langle x, (0.2,0.9)\rangle: x \in X\}$, then $C \subseteq A \cap B$ and $SCl(C) = \{\langle x, 0.7,0.4\rangle\} \supseteq A \cap B$. Hence C is a PF generalized semi * minimal closed set.

Theorem 4.3

Let $A \subseteq B \subseteq U$, where U is a PF minimal open set. If A is a PF generalized semi * minimal closed set , then B is also a PF generalized semi * minimal closed set .

Proof:

Let $B \subseteq U$, where U is a PF minimal open set i.e. $A \subseteq B \subseteq U$. From definition as A is a PF generalized semi * minimal closed set $SCl(A) \supseteq U$ implies $SCl(B) \supseteq U$ $\left(as\ SCl(B) \supseteq SCl(A)\right)$. Thus B is also a PF generalized semi * minimal closed set.

Theorem 4.4 Every PF minimal open set is a PF generalized semi * minimal closed set in itself.

Proof: Let A be a PF minimal open set, we know that $SCl(A) \supseteq A$. Since A is a minimal open set, then by definition A is a PF generalized semi * minimal closed set.

Remark 4.5 : The converse of the above theorem need not be true, as PF set C in Example 4.2 is PF generalized semi * minimal closed set but it is not a PF minimal open set.

Theorem 4.6 If $B(\neq 0_\sim)$ is a PF open set then B will be PF generalized semi * minimal closed set iff B is a PF minimal open set.

Proof: Let B be a PF open set which is PF generalized semi * minimal closed set From definition there exist a PF minimal open set A containing B such that $SCl(B) \supseteq A$.But a PF minimal open set does not contain any other PF open set except itself i.e. $B = A$ implies B is a PF minimal open set.

Conversely, let B is a PF minimal open set, then as proved in theorem 4.4, B is a PF generalized semi * minimal closed set.

Theorem 4.7 A PF generalized semi * minimal closed set A is PF generalized semi minimal closed set iff $SCl(A) = B$ where B is a PF minimal open set.

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Proof:

Since A is a PF generalized semi * minimal closed set, $A \subseteq B$ where B is a PF minimal open set and $SCl(A) \supseteq B$…… (1)
But A is a PF generalized semi minimal closed set which implies $SCl(A) \subseteq B$…….. (2)
So from (1) and (2) $SCl(A) = B$.
Conversely, let $SCl(A) = B$ and A is a PF generalized semi * minimal closed set.
From definition $A \subseteq B$ implies $SCl(A) \supseteq B$, but $SCl(A) = B$ i.e. $SCl(A) \subseteq B$ implies A is PF generalized semi minimal closed set.

Theorem 4.8 Let A be a closed set and a PF generalized semi * minimal closed set then A is the minimal open set.

Proof: Let U be a PF minimal open set containing A. Since A is a PF generalized semi * minimal closed set, $SCl(A) \supseteq U$ .Then $A \supseteq U$ implies $A = U$. Hence A is an PF minimal open set.

Remark 4.9 $0_{\sim}$ and $1_{\sim}$ are not a PF generalized semi * minimal closed set .

Theorem 4.10 Arbitrary union of PF generalized semi * minimal closed set is a PF generalized semi * minimal closed set if it is contained in a PF minimal open set.

Proof:

Let $\cup\{B_i : i \in I\} \subseteq A$ (where A is a PF minimal open set and i ∈ I) $\Rightarrow$ $\{B_i : i \in I\} \subseteq A$, $SCl\{B_i : i \in I\} \supseteq A$ (B_i is a PF generalized semi * minimal closed set) which implies

$\cup SCl\{B_i : i \in I\} \supseteq A \Rightarrow SCl(\cup\{B_i : i \in I\}) \supseteq A$ $(as\ SCl(\cup\{B_i : i \in I\}) \supseteq \cup SCl\{B_i : i \in I\}) \Rightarrow$ $\cup\{B_i : i \in I\}$ is also a PF generalized semi * minimal closed set.

Theorem 4.11 A PF set A contained in a PF minimal open set is a PF semi generalized* minimal closed set if it is a PF semi generalized* closed set.

Proof: Let $A \subseteq U$, a PF minimal open set. Since a PF minimal open set is a subset of any PF open set, $A \subseteq U \subseteq O$, a PF open set. Here A is a PF generalized* closed set, implies $SCl(A) \supseteq O \supseteq U$ i.e. A is a PF Semi generalized* minimal closed set .

Theorem 4.12 The union of a PF generalized semi minimal closed set and a PF generalized semi * minimal closed set is a PF generalised semi * minimal closed set.

Proof: Let A be a PF generalized semi minimal closed set and B be a PF generalised semi * minimal closed set in the same PF topological space.Let $P = A \cup B$. Here $SCl(A) \subseteq U \subseteq SCl(B)$. Therefore $P = A \cup B \subseteq U$ and $SCl(A \cup B) = SCl(A) \cup SCl(B) = SCl(B) \supseteq U$.

Hence P is a PF generalized semi * minimal closed set.

Remark 4.13 The intersection of a PF generalized semi minimal closed set and a PF generalised semi * minimal closed set is a PF generalized semi minimal closed set.

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Simplified Neutrosophic Bipolar Sets

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Abstract: The main purpose of the paper is to introduce the concept of Simplified Neutrosophic Bipolar Sets (SNBSs) and to present three vector similarity measures between SNBSs as a generalisation of the Jaccard, Dice and cosine similarity measures in vector space.

Keywords: Neutrosophic Bipolar sets, Simplified Neutrosophic Bipolar sets, Vector Similarity measure,

1.Introduction: Ye [2] introduced the concept of a simplified neutrosophic set (SNS), which is a subclass of a neutrosophic set and includes the concepts of INS and SVNS, and defined some operational laws of SNSs, and then he proposed simplified neutrosophic weighted averaging (SNWA) operator and simplified neutrosophic weighted geometric (SNWG) operator and applied them to multicriteria decision-making problems under the simplified neutrosophic environment.. Bipolar-valued fuzzy sets, which was introduced by Lee[6]is an extension of fuzzy sets whose membership degree range is enlarged from the interval [0, 1] to [-1, 1]. Therefore, the main purposes of this paper are to present three vector similarity measures for SNBSs based on the extension of the Jaccard, Dice, and cosine similarity measures between vectors [3-5].

2. Some Concepts of Neutrosophic Bipolar Sets:

Definition 2.1[1]: A bipolar neutrosophic set (NBS) A in X is defined as an object of the form

A=$\{< x, T^{+}(x), I^{+}(x), F^{+}(x), T^{-}(x), I^{-}(x), F^{-}(x) >: x \in X\}$.

Where $T^+(x), I^+(x), F^+(x): X \to [0,1]$and $T^-(x), I^-(x), F^-(x): X \to [-1,0]$.

The positive membership degree $T^+(x), I^+(x), F^+(x)$ denotes the truth membership, indeterminate membership and false membership of an element x$\in X$ corresponding to a bipolar neutrosophic set A and the negative membership degree$T^-(x), I^-(x), F^-(x)$ denotes the truth membership, indeterminate membership and false membership of an element x$\in X$to some implicit counter-property corresponding to a bipolar neutrosophic set A.

Definition 2.2: Let A=$\{< x, {T_A}^+(x), {I_A}^+(x), {F_A}^+(x), {T_A}^-(x), {I_A}^-(x), {F_A}^-(x) >\}$and

B= $\{< x, {T_B}^+(x), {I_B}^+(x), {F_B}^+(x), {T_B}^-(x), {I_B}^-(x), {F_B}^-(x) >\}$ be two NBSs in a universe of discourse X. Then the following operations are defined as follows:

1. A=B if and only if ${T_A}^+(x) = {T_B}^+(x)$, ${I_A}^+(x) = {I_B}^+(x)$, ${F_A}^+(x) = {F_B}^+(x), {T_A}^-(x) = {T_B}^-(x), {I_A}^-(x) = {I_B}^-(x), {F_A}^-(x) = {F_B}^-(x)$.
2. $A^c = \{< x, 1 - {T_A}^+(x), 1 - {I_A}^+(x), 1 - {F_A}^+(x), 1 - {T_A}^-(x), 1 - {I_A}^-(x), 1 - {F_A}^-(x) > \}$.
3. $A \subseteq B$ if and only if ${T_A}^+(x) \leq {T_B}^+(x), {I_A}^+(x) \leq {I_B}^+(x), {F_A}^+(x) \geq {F_B}^+(x)$ and ${T_A}^-(x) \geq {T_B}^-(x), {I_A}^-(x) \geq {I_B}^-(x), {F_A}^-(x) \leq {F_B}^-(x)$.

Simplified Neutrosophic Bipolar Sets:

Definition 3.1: Let X be a space of points (objects), with a generic element in X denoted by x. A neutrosophicset A in X is characterized by positive truth-membership function ${T_A}^+(x)$, an indeterminacy-membership function ${I_A}^+(x)$ and a falsity-membership function ${F_A}^+(x)$ and the negative truth-membership function${T_A}^-(x)$, an indeterminacy-membership function${I_A}^-(x)$and a falsity-membership function ${F_A}^-(x)$. If the functions ${T_A}^+(x), {I_A}^+(x), {F_A}^+(x), {T_A}^-(x), {I_A}^-(x), {F_A}^-(x)$ are singleton subintervals/subsets in the standard [0, 1] and [-1,0], that is $T^+(x): X \to [0,1]$, $I^+(x): X \to [0,1]$, $F^+(x): X \to [0,1]$, $T^-(x): X \to [-1,0]$, $I^-(x): X \to [-1,0]$ and $F^-(x): X \to [-1,0]$. Then, a simplification of the neutrosophic bipolar set A is denoted by,A=$\{< x, {T_A}^+(x), {I_A}^+(x), {F_A}^+(x), {T_A}^-(x), {I_A}^-(x), {F_A}^-(x) > \mid x \in X\}$ which is called a SNBS. It is a subclass of the neutrosophic bipolar set and includes the concepts of INBS and SVNBS.On the one hand, if we only use the SNBS A whose${T_A}^+(x), {I_A}^+(x), {F_A}^+(x), {T_A}^-(x), {I_A}^-(x), {F_A}^-(x)$ are single points in the real standard [0, 1] and [-1, 0] instead of subintervals/subsets in the real standard [0, 1] and [-1, 0], the SNBS A can be described by three positive real numbers in the real unit interval [0, 1] and three negative real numbers in the real unit interval [-1, 0].Therefore, the sum of ${T_A}^+(x) \in [0,1], {I_A}^+(x) \in [0,1], {F_A}^+(x) \in [0,1]$ satisfies the condition $0 \leq {T_A}^+(x) + {I_A}^+(x) + {F_A}^+(x) \leq 3$ and the sum of ${T_A}^-(x) \in [-1,0], {I_A}^-(x) \in [-1,0], {F_A}^-(x) \in [-1,0]$ satisfies the condition $0 \leq {T_A}^-(x) + {I_A}^-(x) + {F_A}^-(x) \leq -3$. In this case, the SNBS A is reduced to the SVNBS A.

Definition 3.1: A SNBS A is contained in the other SNBS B, written as A⊆B, if and only if

${T_A}^+(x) \leq {T_B}^+(x), {I_A}^+(x) \leq {I_B}^+(x), {F_A}^+(x) \geq {F_B}^+(x)$ and ${T_A}^-(x) \geq {T_B}^-(x), {I_A}^-(x) \geq {I_B}^-(x), {F_A}^-(x) \leq {F_B}^-(x)$ for every x in X.

Definition 3.2: The complement of a SNBS A is denoted by A^c and is defined as $1 - {T_A}^+(x), 1 - {I_A}^+(x), 1 - {F_A}^+(x), 1 - {T_A}^-(x), 1 - {I_A}^-(x), 1 - {F_A}^-(x)$ for any x in X.

Definition 3.3: Two SNSs A and B are equal, written as A = B, if and only if A⊆B and B⊆A.

On the other hand, if we only consider three positive membership degrees and the three negative membership degree in a SNBS A as the subunit interval of the real unit interval [0, 1] and [-1,0], the SNBS can be described by three positive interval numbers in the real unit interval [0, 1] and three negative interval numbers in the real unit interval [-1,0]. . For each point x in X, we have that$T_A^+(x)$= $[inf\ T_A^+(x), \sup T_A^+(x)]$, $I_A^+(x) = [inf\ I_A^+(x), supI_A^+(x)]$, $F_A^+(x) = [inf\ F_A^+(x), \sup F_A^+(x)] \subseteq [0,1]$ $andT_A^-(x)$= $[inf\ T_A^-(x), \sup T_A^-(x)]$, $I_A^-(x) = [inf\ I_A^-(x), supI_A^-(x)]$, $F_A^-(x) = [inf\ F_A^-(x), \sup F_A^-(x)] \subseteq$ [-1,0] for any x ∈X. In this case, the SNBS A is reduced to the INBS A. From this concept, we can give the following definitions:

Definition 3.4: The complement of a SNBS A is denoted by A^c and is defined as

$[inf1 - T_A^+(x), sup1 - T_A^+(x)]$, $[inf1 - I_A^+(x), \sup 1 - I_A^+(x)]$, $[inf1 - F_A^+(x), sup1 - F_A^+(x)]$, $[inf1 - T_A^-(x), sup1 - T_A^-(x)]$, $[inf1 - I_A^-(x), sup1 - I_A^-(x)]$

$[inf1 - F_A^-(x), sup1 - F_A^-(x)]$for any x in X.

Definition 3.5: A SNBS A is contained in the other SNBS B, written as A⊆B, if and only if,

$inf\ T_A^+(x) \le inf\ T_B^+(x)$,$sup\ T_A^+(x) \le sup\ T_B^+(x)$,$inf\ I_A^+(x) \le inf\ I_B^+(x)$, $sup\ I_A^+(x) \le sup\ I_B^+(x)$, $inf\ F_A^+(x) \ge inf\ F_B^+(x)$, $sup\ F_A^+(x) \ge sup\ F_B^+(x)$,

$inf\ T_A^-(x) \ge infT_B^-(x)$,$sup\ T_A^-(x) \ge supT_B^-(x)$,$inf\ I_A^-(x) \ge infI_B^-(x)$, $sup\ I_A^-(x) \ge supI_B^-(x)$, $inf\ F_A^-(x) \le infF_B^-(x)$, $sup\ F_A^-(x) \le supF_B^-(x)$.

4.Vector Similarity Measures between SNBSs: The vector similarity measure is one of important tools for the degree of similarity between objects. However, the Jaccard, Dice, and cosine similarity measures are often used for this purpose. In the following, the Jaccard, Dice, and cosine similarity measures between two vectors are introduced from [3-5].

Let X=$\{x_1, x_2, x_3, \dots, x_n\}$ and Y= $\{ y_1, y_2, y_3, \dots, y_n\}$ be the two vectors of length n. The Jaccard index of these two vectors (measuring the "similarity" of these vectors) [19] is defined as,

$$J(X,Y) = \frac{X.Y}{\|X\|_2^2+\|Y\|_2^2-X.Y} = \frac{\sum_{i=1}^n x_i y_i}{\sum_{i=1}^n {x_i}^2+\sum_{i=1}^n {y_i}^2-\sum_{i=1}^n x_i y_i} \quad \text{---------- (1)}$$

Where $X.Y = \sum_{i=1}^n x_i y_i$ is the inner product of the vectors X and Y, $\|X\|_2 = \sqrt{\sum_{i=1}^n {x_i}^2}$ and $\|Y\|_2 = \sqrt{\sum_{i=1}^n {y_i}^2}$ are the Euclidean norms of X and Y (also called the L_2 norms).

Then the Dice similarity measure [4] is defined as follows:

$$D(X,Y) = \frac{2\ X.Y}{\|X\|_2^2+\|Y\|_2^2} = \frac{2\sum_{i=1}^n x_i y_i}{\sum_{i=1}^n {x_i}^2+\sum_{i=1}^n {y_i}^2} \text{----------(2)}$$

Cosine formula is then defined as the inner product of these two vectors divided by the product of their lengths. This is nothing but the cosine of the angle between the vectors. The cosine similarity measure [3] is defined as,

$$C(X,Y) = \frac{X.Y}{\|X\|_2\|Y\|_2} = \frac{\sum_{i=1}^n x_i y_i}{\sqrt{\sum_{i=1}^n {x_i}^2}\sqrt{\sum_{i=1}^n {y_i}^2}} \text{----------(3)}$$

These three formulae are similar in the sense. Then, the cosine measure is undefined if x_i and/or y_i (i=1,2,….n) are equal to zero, while the Jaccard and Dice measures are undefined if x_i and/or y_i (i=1,2,….n) are all equal to zero. For these cases, only let the similarity measures be equal to zero if undefined. It is obvious that the Jaccard, Dice, and cosine similarity measures satisfy the following properties [3-5]:

(P1) $0 \leq J(X,Y), D(X,Y), C(X,Y) \leq 1$;

(P2) $J(X,Y) = J(Y,X)$, $D(X,Y) = D(Y,X)$, , $C(X,Y) = C(Y,X)$;

(P3)$J(X,Y) = 1$, $D(X,Y) = 1$, , $C(X,Y) = 1$ IF X=Y, i.e., $x_i = y_i$(i=1,2,…,n) for every $x_i \in X$ and $y_i \in Y$.Assume that there are two SNBSs,

A=$\{< {T_A}^+(x_i), {I_A}^+(x_i), {F_A}^+(x_i), {T_A}^-(x_i), {I_A}^-(x_i), {F_A}^-(x_i) > | x_i \in X\}$ and

B=$\{< {T_B}^+(x_i), {I_B}^+(x_i), {F_B}^+(x_i), {T_B}^-(x_i), {I_B}^-(x_i), {F_B}^-(x_i) > | x_i \in X\}$. If we only use INBSs in the SNBSs A and B, then the elements in functions${T_A}^+(x_i) = [inf{T_A}^+(x_i), sup{T_A}^+(x_i)]$

${I_A}^+(x_i) = [inf{I_A}^+(x_i), sup{I_A}^+(x_i)]$,${F_A}^+(x_i) = [inf{F_A}^+(x_i), sup{F_A}^+(x_i)]$,${T_A}^-(x_i) = [inf{T_A}^-(x_i), sup{T_A}^-(x_i)]$, ${I_A}^-(x_i) = [inf{I_A}^-(x_i), sup{I_A}^-(x_i)]$,${F_A}^-(x_i) = [inf{F_A}^-(x_i), sup{F_A}^-(x_i)] \subseteq [0,1]$ for any $x_i \in X$ in A or ${T_B}^+(x_i) = inf{T_B}^+(x_i), sup{T_B}^+(x_i)]$,${I_B}^+(x_i) = [inf{I_B}^+(x_i), sup{I_B}^+(x_i)]$,${F_B}^+(x_i) = [inf{F_B}^+(x_i), sup{F_B}^+(x_i)]$,${T_B}^-(x_i) = [inf{T_B}^-(x_i), sup{T_B}^-(x_i)]$, ${I_B}^-(x_i) = [inf{I_B}^-(x_i), sup{I_B}^-(x_i)]$, ${F_B}^-(x_i) = [inf{F_B}^-(x_i), sup{F_B}^-(x_i)] \subseteq [0,1]$ for any $x_i \in X$ in B can be considered as a vector representation. Based on the extension of the above three vector similarity measures, the three similarity measures between SNBSs A and B are proposed in the vector space as follows:

$$S_J(A,B) = \frac{1}{n}\sum_{i=1}^{n} \frac{\begin{pmatrix} inf{T_A}^+(x_i).inf{T_B}^+(x_i)+sup{T_A}^+(x_i).sup{T_B}^+(x_i)+ \\ inf{I_A}^+(x_i).inf{I_B}^+(x_i)+sup{I_A}^+(x_i).sup{I_B}^+(x_i)+ \\ inf{F_A}^+(x_i).inf{F_B}^+(x_i)+sup{F_A}^+(x_i).sup{F_B}^+(x_i)- \\ [inf{T_A}^-(x_i).inf{T_B}^-(x_i)+sup{T_A}^-(x_i).sup{T_B}^-(x_i)+ \\ inf{I_A}^-(x_i).inf{I_B}^-(x_i)+sup{I_A}^-(x_i).sup{I_B}^-(x_i)+ \\ inf{F_A}^-(x_i).inf{F_B}^-(x_i)+sup{F_A}^-(x_i).sup{F_B}^-(x_i)] \end{pmatrix}}{\begin{pmatrix} [inf{T_A}^+(x_i)]^2+[inf{I_A}^+(x_i)]^2+[inf{F_A}^+(x_i)]^2+ \\ [sup{T_A}^+(x_i)]^2+[sup{I_A}^+(x_i)]^2+[sup{F_A}^+(x_i)]^2- \\ ([inf{T_A}^-(x_i)]^2+[inf{I_A}^-(x_i)]^2+[inf{F_A}^-(x_i)]^2)- \\ ([sup{T_A}^-(x_i)]^2+[sup{I_A}^-(x_i)]^2+[sup{F_A}^-(x_i)]^2)+ \\ [inf{T_B}^+(x_i)]^2+[inf{I_B}^+(x_i)]^2+[inf{F_B}^+(x_i)]^2+ \\ [sup{T_B}^+(x_i)]^2+[sup{I_B}^+(x_i)]^2+[sup{F_B}^+(x_i)]^2- \\ ([inf{T_B}^-(x_i)]^2+[inf{I_B}^-(x_i)]^2+[inf{F_B}^-(x_i)]^2)- \\ ([sup{T_B}^-(x_i)]^2+[sup{I_B}^-(x_i)]^2+[sup{F_B}^-(x_i)]^2)- \\ (inf{T_A}^+(x_i).inf{T_B}^+(x_i)+sup{T_A}^+(x_i).sup{T_B}^+(x_i)+ \\ inf{I_A}^+(x_i).inf{I_B}^+(x_i)+sup{I_A}^+(x_i).sup{I_B}^+(x_i)+ \\ inf{F_A}^+(x_i).inf{F_B}^+(x_i)+sup{F_A}^+(x_i).sup{F_B}^+(x_i)- \\ [inf{T_A}^-(x_i).inf{T_B}^-(x_i)+sup{T_A}^-(x_i).sup{T_B}^-(x_i)+ \\ inf{I_A}^-(x_i).inf{I_B}^-(x_i)+sup{I_A}^-(x_i).sup{I_B}^-(x_i)+ \\ inf{F_A}^-(x_i).inf{F_B}^-(x_i)+sup{F_A}^-(x_i).sup{F_B}^-(x_i)]) \end{pmatrix}} \text{----------(4)}$$

$$S_D(A,B) = \frac{1}{n}\sum_{i=1}^{n} \frac{2\begin{pmatrix} infT_A^+(x_i).infT_B^+(x_i)+supT_A^+(x_i).supT_B^+(x_i)+ \\ infI_A^+(x_i).infI_B^+(x_i)+supI_A^+(x_i).supI_B^+(x_i)+ \\ infF_A^+(x_i).infF_B^+(x_i)+supF_A^+(x_i).supF_B^+(x_i)- \\ [infT_A^-(x_i).infT_B^-(x_i)+supT_A^-(x_i).supT_B^-(x_i)+ \\ infI_A^-(x_i).infI_B^-(x_i)+supI_A^-(x_i).supI_B^-(x_i)+ \\ infF_A^-(x_i).infF_B^-(x_i)+supF_A^-(x_i).supF_B^-(x_i)] \end{pmatrix}}{\begin{pmatrix} [infT_A^+(x_i)]^2+[infI_A^+(x_i)]^2+[infF_A^+(x_i)]^2+ \\ [supT_A^+(x_i)]^2+[supI_A^+(x_i)]^2+[supF_A^+(x_i)]^2- \\ ([infT_A^-(x_i)]^2+[infI_A^-(x_i)]^2+[infF_A^-(x_i)]^2)- \\ ([supT_A^-(x_i)]^2+[supI_A^-(x_i)]^2+[supF_A^-(x_i)]^2)+ \\ [infT_B^+(x_i)]^2+[infI_B^+(x_i)]^2+[infF_B^+(x_i)]^2+ \\ [supT_B^+(x_i)]^2+[supI_B^+(x_i)]^2+[supF_B^+(x_i)]^2- \\ ([infT_B^-(x_i)]^2+[infI_B^-(x_i)]^2+[infF_B^-(x_i)]^2)- \\ ([supT_B^-(x_i)]^2+[supI_B^-(x_i)]^2+[supF_B^-(x_i)]^2) \end{pmatrix}} \quad \text{----------(5)}$$

$$S_C(A,B) = \frac{1}{n}\sum_{i=1}^{n} \frac{\begin{pmatrix} infT_A^+(x_i).infT_B^+(x_i)+supT_A^+(x_i).supT_B^+(x_i)+ \\ infI_A^+(x_i).infI_B^+(x_i)+supI_A^+(x_i).supI_B^+(x_i)+ \\ infF_A^+(x_i).infF_B^+(x_i)+supF_A^+(x_i).supF_B^+(x_i)- \\ [infT_A^-(x_i).infT_B^-(x_i)+supT_A^-(x_i).supT_B^-(x_i)+ \\ infI_A^-(x_i).infI_B^-(x_i)+supI_A^-(x_i).supI_B^-(x_i)+ \\ infF_A^-(x_i).infF_B^-(x_i)+supF_A^-(x_i).supF_B^-(x_i)] \end{pmatrix}}{\begin{pmatrix} \sqrt{[infT_A^+(x_i)]^2+[infI_A^+(x_i)]^2+[infF_A^+(x_i)]^2+ \\ [supT_A^+(x_i)]^2+[supI_A^+(x_i)]^2+[supF_A^+(x_i)]^2} \cdot \\ \sqrt{[infT_B^+(x_i)]^2+[infI_B^+(x_i)]^2+[infF_B^+(x_i)]^2+ \\ [supT_B^+(x_i)]^2+[supI_B^+(x_i)]^2+[supF_B^+(x_i)]^2} - \\ (\sqrt{[infT_A^-(x_i)]^2+[infI_A^-(x_i)]^2+[infF_A^-(x_i)]^2+ \\ [supT_A^-(x_i)]^2+[supI_A^-(x_i)]^2+[supF_A^-(x_i)]^2} \cdot \\ \sqrt{[infT_B^-(x_i)]^2+[infI_B^-(x_i)]^2+[infF_B^-(x_i)]^2+ \\ [supT_B^-(x_i)]^2+[supI_B^-(x_i)]^2+[supF_B^-(x_i)]^2} \end{pmatrix}} \text{----------(6)}$$

According to the properties of the Jaccard, Dice, and cosine similarity measures[3-5], each similarity measure S_k (A, B) (k = J, D, C) also satisfies the following properties:

(P1) $0 \le S_k(A,B) \le 1$;

(P2) $S_k(A,B) = S_k(B,A)$;

(P3)$S_k(A,B) = 1\ if\ A = B, i.e., T_A^+(x_i) = T_B^+(x_i), I_A^+(x_i) = I_B^+(x_i), F_A^+(x_i) = F_B^+(x_i), T_A^-(x_i) = T_B^+(x_i), I_A^-(x_i) = I_A^-(x_i), F_A^-(x_i) = F_A^-(x_i)$. For every $x_i \in X$.

Proof:

(P1) It is obvious that the property is true according to the inequality $a^2 + b^2 \ge 2ab$ for Eqs. (4) and (5), and the cosine value for Eq. (6).

(P2) It is obvious that the property is true.

(P3) When A = B, there are$T_A^+(x_i) = T_B^+(x_i), I_A^+(x_i) = I_B^+(x_i), F_A^+(x_i) = F_B^+(x_i), T_A^-(x_i) = T_B^+(x_i), I_A^-(x_i) = I_A^-(x_i), F_A^-(x_i) = F_A^-(x_i)$, i.e.,

$inf\ T_A^+(x_i) = inf\ T_B^+(x_i)$, $sup\ T_A^+(x_i) = sup\ T_B^+(x_i)$, $inf\ I_A^+(x_i) = inf\ I_B^+(x_i), sup\ I_A^+(x_i) = sup\ I_B^+(x_i), inf\ F_A^+(x_i) = inf\ F_B^+(x_i), sup\ F_A^+(x_i) = sup\ F_B^+(x_i)$,

$inf\ T_A^-(x_i) = inf T_B^-(x_i)$, $sup\ T_A^-(x_i) = sup T_B^-(x_i)$, $inf\ I_A^-(x_i) = inf I_B^-(x_i)$, $sup\ I_A^-(x_i) = sup I_B^-(x_i)$, $inf\ F_A^-(x_i) = inf F_B^-(x_i)$, $sup\ F_A^-(x_i) = sup F_B^-(x_i)$ for i=1,2….,n. So there are $S_J(A,B) = 1, S_D(A,B) = 1\ and\ S_C(A,B) = 1$.

However $S_k(A,B)$ is undefined if $T_A^+(x_i) = I_A^+(x_i) = F_A^+(x_i) = T_A^-(x_i) = I_A^-(x_i) = F_A^-(x_i) = 0$ and/or $T_B^+(x_i) = I_B^+(x_i) = F_B^+(x_i) = T_B^-(x_i) = I_B^-(x_i) = F_B^-(x_i) = 0$ for every $x_i \in X$. In this case, let the measure values $S_k(A,B) = 0$ for k= J,D,C.

Furthermore, the differences of importance are considered in the elements in the universe. Thus, we need to take the weight of each element x_i (i = 1, 2,…, n) into account. In the following, we develop weighted similarity measures between SNBSs.

Let w_i be the weight for each elementx_i (i = 1, 2,…, n), $w_i \in [0,1]$, and $\sum_{i=1}^n w_i = 1$, then we have the following three weighted similarity measures:

$$WS_J(A,B) = \sum_{i=1}^n w_i \frac{\begin{pmatrix} infT_A^+(x_i).infT_B^+(x_i)+supT_A^+(x_i).supT_B^+(x_i)+ \\ infI_A^+(x_i).infI_B^+(x_i)+supI_A^+(x_i).supI_B^+(x_i)+ \\ infF_A^+(x_i).infF_B^+(x_i)+supF_A^+(x_i).supF_B^+(x_i)- \\ [infT_A^-(x_i).infT_B^-(x_i)+supT_A^-(x_i).supT_B^-(x_i)+ \\ infI_A^-(x_i).infI_B^-(x_i)+supI_A^-(x_i).supI_B^-(x_i)+ \\ infF_A^-(x_i).infF_B^-(x_i)+supF_A^-(x_i).supF_B^-(x_i)] \end{pmatrix}}{\begin{pmatrix} [infT_A^+(x_i)]^2+[infI_A^+(x_i)]^2+[infF_A^+(x_i)]^2+ \\ [supT_A^+(x_i)]^2+[supI_A^+(x_i)]^2+[supF_A^+(x_i)]^2- \\ ([infT_A^-(x_i)]^2+[infI_A^-(x_i)]^2+[infF_A^-(x_i)]^2)- \\ ([supT_A^-(x_i)]^2+[supI_A^-(x_i)]^2+[supF_A^-(x_i)]^2)+ \\ [infT_B^+(x_i)]^2+[infI_B^+(x_i)]^2+[infF_B^+(x_i)]^2+ \\ [supT_B^+(x_i)]^2+[supI_B^+(x_i)]^2+[supF_B^+(x_i)]^2- \\ ([infT_B^-(x_i)]^2+[infI_B^-(x_i)]^2+[infF_B^-(x_i)]^2)- \\ ([supT_B^-(x_i)]^2+[supI_B^-(x_i)]^2+[supF_B^-(x_i)]^2)- \\ (infT_A^+(x_i).infT_B^+(x_i)+supT_A^+(x_i).supT_B^+(x_i)+ \\ infI_A^+(x_i).infI_B^+(x_i)+supI_A^+(x_i).supI_B^+(x_i)+ \\ infF_A^+(x_i).infF_B^+(x_i)+supF_A^+(x_i).supF_B^+(x_i)- \\ [infT_A^-(x_i).infT_B^-(x_i)+supT_A^-(x_i).supT_B^-(x_i)+ \\ infI_A^-(x_i).infI_B^-(x_i)+supI_A^-(x_i).supI_B^-(x_i)+ \\ infF_A^-(x_i).infF_B^-(x_i)+supF_A^-(x_i).supF_B^-(x_i)]) \end{pmatrix}} \text{----------(7)}$$

$$WS_D(A,B) = \sum_{i=1}^n w_i \frac{2\begin{pmatrix} infT_A^+(x_i).infT_B^+(x_i)+supT_A^+(x_i).supT_B^+(x_i)+ \\ infI_A^+(x_i).infI_B^+(x_i)+supI_A^+(x_i).supI_B^+(x_i)+ \\ infF_A^+(x_i).infF_B^+(x_i)+supF_A^+(x_i).supF_B^+(x_i)- \\ [infT_A^-(x_i).infT_B^-(x_i)+supT_A^-(x_i).supT_B^-(x_i)+ \\ infI_A^-(x_i).infI_B^-(x_i)+supI_A^-(x_i).supI_B^-(x_i)+ \\ infF_A^-(x_i).infF_B^-(x_i)+supF_A^-(x_i).supF_B^-(x_i)] \end{pmatrix}}{\begin{pmatrix} [infT_A^+(x_i)]^2+[infI_A^+(x_i)]^2+[infF_A^+(x_i)]^2+ \\ [supT_A^+(x_i)]^2+[supI_A^+(x_i)]^2+[supF_A^+(x_i)]^2- \\ ([infT_A^-(x_i)]^2+[infI_A^-(x_i)]^2+[infF_A^-(x_i)]^2)- \\ ([supT_A^-(x_i)]^2+[supI_A^-(x_i)]^2+[supF_A^-(x_i)]^2)+ \\ [infT_B^+(x_i)]^2+[infI_B^+(x_i)]^2+[infF_B^+(x_i)]^2+ \\ [supT_B^+(x_i)]^2+[supI_B^+(x_i)]^2+[supF_B^+(x_i)]^2- \\ ([infT_B^-(x_i)]^2+[infI_B^-(x_i)]^2+[infF_B^-(x_i)]^2)- \\ ([supT_B^-(x_i)]^2+[supI_B^-(x_i)]^2+[supF_B^-(x_i)]^2) \end{pmatrix}} \text{----------(8)}$$

$$WS_C(A,B)=\sum_{i=1}^{n} w_i \frac{\begin{pmatrix} infT_A^{+}(x_i).infT_B^{+}(x_i)+supT_A^{+}(x_i).supT_B^{+}(x_i)+ \\ infI_A^{+}(x_i).infI_B^{+}(x_i)+supI_A^{+}(x_i).supI_B^{+}(x_i)+ \\ infF_A^{+}(x_i).infF_B^{+}(x_i)+supF_A^{+}(x_i).supF_B^{+}(x_i)- \\ [infT_A^{-}(x_i).infT_B^{-}(x_i)+supT_A^{-}(x_i).supT_B^{-}(x_i)+ \\ infI_A^{-}(x_i).infI_B^{-}(x_i)+supI_A^{-}(x_i).supI_B^{-}(x_i)+ \\ infF_A^{-}(x_i).infF_B^{-}(x_i)+supF_A^{-}(x_i).supF_B^{-}(x_i)] \end{pmatrix}}{\begin{pmatrix} \sqrt{[infT_A^{+}(x_i)]^2+[infI_A^{+}(x_i)]^2+[infF_A^{+}(x_i)]^2+} \\ \sqrt{[supT_A^{+}(x_i)]^2+[supI_A^{+}(x_i)]^2+[supF_A^{+}(x_i)]^2}\cdot \\ \sqrt{[infT_B^{+}(x_i)]^2+[infI_B^{+}(x_i)]^2+[infF_B^{+}(x_i)]^2+} \\ \sqrt{[supT_B^{+}(x_i)]^2+[supI_B^{+}(x_i)]^2+[supF_B^{+}(x_i)]^2}- \\ \left(\sqrt{[infT_A^{-}(x_i)]^2+[infI_A^{-}(x_i)]^2+[infF_A^{-}(x_i)]^2+} \right. \\ \sqrt{[supT_A^{-}(x_i)]^2+[supI_A^{-}(x_i)]^2+[supF_A^{-}(x_i)]^2}\cdot \\ \left.\sqrt{[infT_B^{-}(x_i)]^2+[infI_B^{-}(x_i)]^2+[infF_B^{-}(x_i)]^2+} \right. \\ \left. \sqrt{[supT_B^{-}(x_i)]^2+[supI_B^{-}(x_i)]^2+[supF_B^{-}(x_i)]^2} \right) \end{pmatrix}} \text{----------(9)}$$

If $w=(1/n, 1/n, \dots, 1/n)^T$, then Eqs. (7)-(9) are reduced to Eqs. (4)-(6). It is obvious that each weighted similarity measure $WS_k(A,B)$ for k= J, D, C also satisfies the following properties:

(P1) $0 \le WS_k(A,B) \le 1$;

(P2) $WS_k(A,B)=WS_k(B,A)$;

(P3) $WS_k(A,B)=1$ *if* $A=B, i.e., T_A^{+}(x_i)=T_B^{+}(x_i), I_A^{+}(x_i)=I_B^{+}(x_i), F_A^{+}(x_i)=F_B^{+}(x_i), T_A^{-}(x_i)=T_B^{+}(x_i), I_A^{-}(x_i)=I_A^{-}(x_i), F_A^{-}(x_i)=F_A^{-}(x_i)$. For every $x_i \in X$.

Similar to the previous proof method, we can prove that the properties (P1)-(P3).

Assume that there are two SNBSs,

A=$\{< T_A^{+}(x_i), I_A^{+}(x_i), F_A^{+}(x_i), T_A^{-}(x_i), I_A^{-}(x_i), F_A^{-}(x_i) > | x_i \in X\}$ and

B=$\{< T_B^{+}(x_i), I_B^{+}(x_i), F_B^{+}(x_i), T_B^{-}(x_i), I_B^{-}(x_i), F_B^{-}(x_i) > | x_i \in X\}$. If we only use SVNBSs in the SNBSs A and B, then the elements in functions $T_A^{+}(x_i)=[infT_A^{+}(x_i), supT_A^{+}(x_i)]$, $I_A^{+}(x_i)=[infI_A^{+}(x_i), supI_A^{+}(x_i)]$, $F_A^{+}(x_i)=infF_A^{+}(x_i), supF_A^{+}(x_i)]$, $T_A^{-}(x_i)=[infT_A^{-}(x_i), supT_A^{-}(x_i)], I_A^{-}(x_i)=[infI_A^{-}(x_i), supI_A^{-}(x_i)]$, $F_A^{-}(x_i)=[infF_A^{-}(x_i), supF_A^{-}(x_i)] \in [0,1]$ for any $x_i \in X$ in A or $T_B^{+}(x_i)=infT_B^{+}(x_i), supT_B^{+}(x_i)]$, $I_B^{+}(x_i)=[infI_B^{+}(x_i), supI_B^{+}(x_i)]$, $F_B^{+}(x_i)=[infF_B^{+}(x_i), supF_B^{+}(x_i)]$, $T_B^{-}(x_i)=[infT_B^{-}(x_i), supT_B^{-}(x_i)], I_B^{-}(x_i)=[infI_B^{-}(x_i), supI_B^{-}(x_i)]$, $F_B^{-}(x_i)=[infF_B^{-}(x_i), supF_B^{-}(x_i)] \in [0,1]$ for any $x_i \in X$ in B can be considered as a vector representation. Then, the three vector similarity measures Eqs. (4)-(6) are reduced, respectively, to the following three similarity measures of SVNBSs:

$$S_J(A,B)=\frac{1}{n}\sum_{i=1}^{n} \frac{(T_A^{+}(x_i).T_B^{+}(x_i)+I_A^{+}(x_i).I_B^{+}+F_A^{+}(x_i).F_B^{+}-[T_A^{-}(x_i).T_B^{-}(x_i)+I_A^{-}(x_i).I_B^{-}+F_A^{-}(x_i).F_B^{-}(x_i)])}{\begin{pmatrix} [T_A^{+}(x_i)]^2+[I_A^{+}(x_i)]^2+[F_A^{+}(x_i)]^2+[T_B^{+}(x_i)]^2+[I_B^{+}(x_i)]^2+[F_B^{+}(x_i)]^2- \\ ([T_A^{-}(x_i)]^2+[I_A^{-}(x_i)]^2+[F_A^{-}(x_i)]^2+[T_B^{-}(x_i)]^2+[I_B^{-}(x_i)]^2+[F_B^{-}(x_i)]^2)- \\ (T_A^{+}(x_i).T_B^{+}(x_i)+I_A^{+}(x_i).I_B^{+}+F_A^{+}(x_i).F_B^{+})-(T_A^{-}(x_i).T_B^{-}(x_i)+I_A^{-}(x_i).I_B^{-}+F_A^{-}(x_i).F_B^{-}(x_i)) \end{pmatrix}} \quad (10)$$

$$S_D(A,B)=\frac{1}{n}$$

$$\sum_{i=1}^{n} \frac{2\left(T_A^{+}(x_i).T_B^{+}(x_i)+I_A^{+}(x_i).I_B^{+}+F_A^{+}(x_i).F_B^{+}-[T_A^{-}(x_i).T_B^{-}(x_i)+I_A^{-}(x_i).I_B^{-}+F_A^{-}(x_i).F_B^{-}(x_i)]\right)}{\left(\begin{matrix}\left[T_A^{+}(x_i)\right]^2+\left[I_A^{+}(x_i)\right]^2+\left[F_A^{+}(x_i)\right]^2+\left[T_B^{+}(x_i)\right]^2+\left[I_B^{+}(x_i)\right]^2+\left[F_B^{+}(x_i)\right]^2- \\ ([T_A^{-}(x_i)]^2+[I_A^{-}(x_i)]^2+[F_A^{-}(x_i)]^2+[T_B^{-}(x_i)]^2+[I_B^{-}(x_i)]^2+[F_B^{-}(x_i)]^2)\end{matrix}\right)} \quad (11)$$

$$S_C(A,B)=\frac{1}{n}$$

$$\sum_{i=1}^{n} \frac{\left(T_A^{+}(x_i).T_B^{+}(x_i)+I_A^{+}(x_i).I_B^{+}+F_A^{+}(x_i).F_B^{+}-[T_A^{-}(x_i).T_B^{-}(x_i)+I_A^{-}(x_i).I_B^{-}+F_A^{-}(x_i).F_B^{-}(x_i)]\right)}{\left(\begin{matrix}\sqrt{\left[T_A^{+}(x_i)\right]^2+\left[I_A^{+}(x_i)\right]^2+\left[F_A^{+}(x_i)\right]^2}.\sqrt{\left[T_B^{+}(x_i)\right]^2+\left[I_B^{+}(x_i)\right]^2+\left[F_B^{+}(x_i)\right]^2}- \\ (\sqrt{[T_A^{-}(x_i)]^2+[I_A^{-}(x_i)]^2+[F_A^{-}(x_i)]^2}.\sqrt{[T_B^{-}(x_i)]^2+[I_B^{-}(x_i)]^2+[F_B^{-}(x_i)]^2})\end{matrix}\right)} \quad (12)$$

Similarly, the three weighted similarity measures Eqs. (7)-(9) are also reduced, respectively.

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Application of Intuitionistic Fuzzy Set in Eye Dignosis Using Composition Function

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Abstract -We propose a new approach for eye diagnosis by employing intuitionistic fuzzy

sets. The composition function , a new score and value functions are all defined to discuss in decision making problem. A topological structure on intuitionistic fuzzy set is considered as a tool to derive some of their characterizations.

Key words - Intuitionistic fuzzy set, max-min composition, eye diagnosis.

I. Introduction

The fuzzy concept was introduced by Zadeh [8] in 1965. The traditional fuzzy set is characterized by the membership value or the grade of membership value. In some real life problems in expert system, belief system, information fusion and so on, we must consider the truth-membership as well as the falsity-membership for proper description of an object in uncertain, ambiguous environment. Intuitionistic fuzzy set is appropriate for such a situation. The intuitionistic fuzzy sets can handle the incomplete information considering both the membership and non-membership values which was introduced by Atanassov [2].In 1995 Burillo and Bustince[3] first proposed intuitionistic fuzzy relation.Further researches of this type of relation can be found in [4,5,7]. De *et al* [6]gave an intuitionistic fuzzy sets approach in medical diagnosis using three steps such as; determination of symptoms, formulation of medical knowledge based on intuitionistic fuzzy relations, anddetermination of diagnosis on the basis of composition of intuitionistic fuzzy relations.

In this article we will present intuitionistic fuzzy sets as a tool for reasoning in the presence of imperfect facts and imprecise knowledge. An example of eye diagnosis will be presented assuming there is a database, i.e. description of a set of symptoms S, and a set of diseases D. We will describe a state of a patient knowing results of his/her eye tests. We have proposed two-criteria approach, based on it the result will be delivered.

II. Preliminaries

Definition 2.1.[2] Let X be a non empty fixed set. An intuitionistic fuzzy set (IFS in short) A in X is an object having the form $A = \{< x, \mu_A(x), \nu_A(x) > / x \in X\}$ where the functions $\mu_A(x) : X \to [0,1]$ and $\nu_A(x) : X \to [0,1]$ denote the degree of membership (namely $\mu_A(x)$) and the degree of non-membership (namely $\nu_A(x)$) of each element $x \in X$ to the set A, respectively, and $0 \leq \mu_A(x) + \nu_A(x) \leq 1$ for each $x \in X$. Denote by IFS(X), the set of all intuitionistic fuzzy set in X.

Definition 2.2. [2] $A = \{< x, \mu_A(x), \nu_A(x) > / x \in X\}$ and $B = \{< x, \mu_B(x), \nu_B(x) > / x \in X\}$. Then

- $A \subseteq B$ if and only if $\mu_A(x) \leq \mu_B(x)$ and $\nu_A(x) \geq \nu_B(x)$ for all $x \in X$
- $A = B$ if and only if $A \subseteq B$ and $B \subseteq A$
- $A^c = \{< x, \nu_A(x) , \mu_A(x) > / x \in X\}$
- $A \cap B = \{< x, \mu_A(x) \square \mu_B(x), \nu_A(x) \square \nu_B(x) > / x \in X\}$
- $A \cup B = \{< x, \mu_A(x) \square \mu_B(x), \nu_A(x) \square \nu B(x) > / x \in X\}$

Definition 2.3.[3] Let X,Ybe ordinary finite non-empty sets, an intuitionistic fuzzy relation(IFR) R between X and Y is defined as an intuitionistic fuzzy set on $X \times Y$, that is, R is

given by: $R = \{\langle (x,y), \mu_R(x,y), \nu_R(x,y)\rangle | (x,y) \in X \times Y\}$, where $\mu_R, \nu_R : X \times Y \to [0,1]$

satisfy the condition $\mu_R(x,y) + \nu_R(x,y) \leq 1$, $\forall (x,y) \in X \times Y$. The set of all IFR between X and Y is denoted by IFR($X \times Y$).

Definition 2.4.[1] The composition $\circ$ of two IFRs, R_1 and R_2 is defined by

$\mu_{R_1 \circ R_2}(x,y) = \max\{\min(\mu_{R_1}(x,z), \mu_{R_2}(z,y))\}$and

$\nu_{R_1 \circ R_2}(x,y) = \min\{\max(\nu_{R_1}(x,z), \nu_{R_2}(z,y))\}$

where R_1 is a relation from A to B R_2 is a relation from B to C.

III Two criteria method for comparing Intuitionistic Fuzzy sets

Definition 3.1 Let A be a Intuitionistic fuzzy set. Then the value function of A is defined as V(A) = T_A + F_A where T_A , F_A denotes Truth value and False value of A respectively.

Definition 3.2 Let A and B be two Intuitionistic fuzzy set. Then the score function of A and B defined as $S_1 = |V(A) - V(B)|$.

Definition 3.3 Let A be Intuitionistic fuzzy set. Then the score function of A is defined as $S_2 = T_i - F_i$.

IV APPLICATION OF INTUITIONISTIC FUZZY SETS IN EYE DIAGNOSIS USING COMPOSITION FUNCTION

We define mathematically; a patient is a intuitionistic fuzzy set, say P_i, on the set of symptoms S and the intuitionistic fuzzy relation from the set of symptoms S to the set of diseases D, which reveals the membership , and the non-membership between thepatients and symptoms and between symptoms and diseases.

Algorithm:

Step 1: The symptoms of the patients are given in Table 1. i.e. the relation Q (P→S) between the patients and symptoms are noted.

Step 2: The medical knowledge relating the symptoms with the set of disease under consideration are noted in Table 2 i.e. R(S→D) the relation of symptoms and disease are given.

Step 3: The composition T(P→D) the relation of patients and disease are found using the definition 2.4 and noted in Table 3

Step 4: Obtain the complement of Table 1 and is given in Table 4.

Step 5: Obtain the complement of Table 2 and is noted in Table 5

Step 6: Applying definition 2.4 for the values of Table 4 and Table 5 is denoted in Table 6

Step 7: Calculate the value function for Table 3 and Table 6 and is given in Table 7 and Table 8 respectively.

Step 8: Find the score function using definition 3.2 for the values in Table 7 and 8 and is noted in Table 9.

Step 9: We apply another score function for the table 3 using the definition 3.3 and it is given Table 10.

Step 10: The higher the score, higher is the possibility of the patient affected with the respective disease.

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Table 1

Q	Fluctuating Vision(S_1)	Photophobia(S_2)	Red Eye(S_3)
Patient 1(P_1)	(0.6,0.3)	(0.7,0.3)	(0.1,0.4)
Patient 2(P_2)	(0.5,0.1)	(0.4,0.5)	(0.5,0.2)
Patient 3(P_3)	(0.6,0.0)	(0.5,0.3)	(0.3,0.4)
Patient 4(P_4)	(0.7,0.3)	(0.6,0.2)	(0.6,0.3)

Table 2

R	Trachoma(D_1)	Retinopathy(D_2)	Blepharitis(D_3)	Keratitis(D_4)
Fluctuating Vision(S_1)	(0.7,0.1)	(0.6,0.2)	(0.5,0.3)	(0.7,0.0)
Photophobia(S_2)	(0.5,0.3)	(0.4,0.2)	(0.7,0.2,)	(0.6,0.3)
Red Eye(S_3)	(0.4,0.5)	(1.0,0.0)	(0.4,0.3)	(0.5,0.5)

Table 3

T	Trachoma(D_1)	Retinopathy(D_2)	Blepharitis(D_3)	Keratitis(D_4)
Patient 1(P_1)	(0.7,0.3)	(0.6,0.3)	(0.7,0.3)	(0.6,0.3)
Patient 2(P_2)	(0.5,0.1)	(0.5,0.2)	(0.5,0.3)	(0.5,0.1)
Patient 3(P_3)	(0.6,0.1)	(0.6,0.2)	(0.5,0.3)	(0.5,0.0)
Patient 4(P_4)	(0.7,0.3)	(0.6,0.2)	(0.6,0.2)	(0.6,0.3)

Table 4

Q'	Fluctuating Vision(S_1)	Photophobia(S_2)	Red Eye(S_3)
Patient 1(P_1)	(0.3,0.6)	(0.3,0.7)	(0.4,0.1)
Patient 2(P_2)	(0.1,0.5)	(0.5,0.4)	(0.2,0.5)
Patient 3(P_3)	(0.0,0.6)	(0.3,0.5)	(0.4,0.3)
Patient 4(P_4)	(0.3,0.7)	(0.2,0.6)	(0.3,0.6)

Table 5

R'	Trachoma(D_1)	Retinopathy(D_2)	Blepharitis(D_3)	Keratitis(D_4)
Fluctuating Vision(S_1)	(0.1,0.7)	(0.2,0.6)	(0.3,0.5)	(0.0,0.4)
Photophobia(S_2)	(0.3,0.5)	(0.2,0.4)	(0.2,0.7,)	(0.3,0.6)
Red Eye(S_3)	(0.5,0.4)	(0.0,1.0)	(0.3,0.4)	(0.5,0.5)

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Table 6

T'	Trachoma(D_1)	Retinopathy(D_2)	Blepharitis(D_3)	Keratitis(D_4)
Patient 1(P_1)	(0.4,0.4)	(0.2,0.6)	(0.3,0.4)	(0.4,0.5)
Patient 2(P_2)	(0.3,0.5)	(0.2,0.4)	(0.2,0.5)	(0.3,0.5)
Patient 3(P_3)	(0.4,0.4)	(0.2,0.5)	(0.3,0.4)	(0.4,0.5)
Patient 4(P_4)	(0.3,0.6)	(0.2,0.6)	(0.3,0.6)	(0.3,0.6)

Table 7

Value Function	Trachoma(D_1)	Retinopathy(D_2)	Blepharitis(D_3)	Keratitis(D_4)
Patient 1(P_1)	(0.8)	(0.9)	(0.8)	(0.9)
Patient 2(P_2)	(0.6)	(0.7)	(0.8)	(0.6)
Patient 3(P_3)	(0.7)	(0.8)	(0.8)	(0.5)
Patient 4(P_4)	(1.0)	(0.8)	(0.8)	(0.9)

Table 8

Value Function	Trachoma(D_1)	Retinopathy(D_2)	Blepharitis(D_3)	Keratitis(D_4)
Patient 1(P_1)	(0.8)	(0.8)	(0.7)	(0.9)
Patient 2(P_2)	(0.8)	(0.6)	(0.7)	(0.8)
Patient 3(P_3)	(0.8)	(0.7)	(0.7)	(0.9)
Patient 4(P_4)	(0.9)	(0.8)	(0.9)	(0.9)

Table 9

Score Function	(D_1)	(D_2)	(D_3)	(D_4)
(P_1)	(0.0)	(0.1)	**(0.1)**	(0.1)
(P_2)	**(0.2)**	(0.1)	(0.1)	(0.1)
(P_3)	(0.1)	(0.1)	(0.1)	**(0.3)**
(P_4)	(0.1)	(0.0)	(0.1)	**(0.4)**

Table 10

Score Function	(D_1)	(D_2)	(D_3)	(D_4)
(P_1)	(0.4)	(0.3)	**(0.4)**	(0.3)
(P_2)	**(0.4)**	(0.3)	(0.2)	(0.4)
(P_3)	(0.5)	(0.4)	(0.2)	**(0.6)**
(P_4)	(0.4)	(0.4)	(0.4)	**(0.4)**

Therefore from the maximum values in boththe Tables 9 and 10 we conclude that P_1 is suffering from Blepharitis, $P_2$is suffering from Trachoma and P_3 and P_4 are suffering from Keratitis.

IV. Conclusion

This paper introduces the notion of intuitionistic fuzzy relations and the novel score function , value function with aview to evolve an expert system for the diagnosis of patients.This gives a flexible and simple solution for eye diagnosis problem in intuitionistic environment.

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Quadripartitioned Single Valued Neutrosophic Rough Sets.

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Abstract In this paper Quadripartitioned single valued neutrosophic relations (QSVNR) and quadripartitioned single valued neutrosophic rough sets have been introduced. We have defined the complement, inverse, reflexive, symmetric, transitive of a QSVNR and also defined the lower and upper approximations of quadripartitioned single valued neutrosophic approximation space and its operators. And also we have studied the properties of a quadripartitioned single valued neutrosophic rough sets .

Keywords Quadripartitioned single valued neutrosophic relations, quadripartitioned single valued neutrosophic rough sets.

Introduction Fuzzy set introduced by Zadeh[9] proposed the concept of imprecision, uncertainity and degrees of truthfulness of values. In fuzzy set degree of the truthfulness is represented by membership functions which lies in a unit interval [0,1]. In 1983, KrassimirT.Atanassov[1] defined the concept of initutionstic fuzzy set which is known as the generalization of the fuzzy set and it consists of membership and non membership functions. In 1998, Smarandache[3] proposed a tri-component logic Neutrosophic set and it has three components truth membership function, indeterminacy membership function and falsity membership function respectively and lies in the non-standard unit interval $]0^-, 1^+[$.

In 1982, Pawlak[5] defined the concept of rough sets and it provide the notions of lower and upper approximations of set. And also it is based on the equivalence relations of the given set.In specific

rough neutrosophic set originated by Broumi and Smarandache (2014) [3] . Later Wang (2010) [8] proposed the concept of single valued neutrosophic set (SVNS) which is a very new hot research topic.Hai Long Yang(2017)[4] proposed the new hybrid model of single valued neutrosopic rough sets. Based on Belnap's four valued logic[2] and Smarandache's "Four Numerical-valued neutrosophic logic"[7]RajashiChatterjee.,et al[6] proposed the concept of Quadripartitionedsingle valued neutrosophic sets(QSVNS) . In this indeterminacy is split into two functions named as 'contradicition' (both true and false) and 'unknown' (neither true and false) so that QSVNS has four functions T,C,U,F which lies in the non-standard unit interval $]0^-, 1^+[$.

This paper is organized in the following ways. Section 1 provides a brief introduction. Section 2 delivered the basic definitions which we need to prove the results in further. Section 3 introduces the concept of Quadripartitioned single valued neutrosophic relations (QSVNR) and Quadripartitioned single valued neutrosophic rough sets and its lower , upper approximation operators are defined . And also we have studied some properties of Quadripartitioned single valued neutrosophic rough sets. Section 4 concludes the paper.

2 Preliminaries In this section we recall the basic definitions of rough sets, Neutrosophic sets, SVNS, QSVNS which will be used in proving the rest of the paper.

Definition 2.1[5] Let U be any non-empty set. Suppose R is an equivalence relation over U. For any non – null subset X of U, the sets

$A_1(x) = \{X : [x]_R \subseteq X\}$ and $A_2(x) = \{X : [x]_R \cap X \neq \phi\}$ are called the lower approximation and upper approximation respectively of X where the pair S=(U,R) is called an approximation space. This equivalence relation R is called indiscernibility relation. The pair $A(X) = (A_1(X), A_2(X))$ is called the rough set of X in S. Here $[x]_R$ denotes the equivalence class of R containing X.

Definition 2.2[7] Let X be an universe of discourse, with a generic element in X denoted by x , the neutrosophic (NS) set is an object having the form, $A = \{< x : \mu_A(x), \nu_A(x), \omega_A(x) >, x \in X\}$ where the functions $\mu, \nu, \omega : X \rightarrow \left]^-0,1^+\right[$ define respectively the degree of membership (or truth) , the degree of indeterminacy, and the degree of non-membership (or falsehood) of the element $x \in X$ to the set A with the condition, $^-0 \leq \mu_A(x) + \nu_A(x) + \omega_A(x) \leq 3^+$

Definition 2.3[11] Let U be a space of points (objects), with a generic element in U denoted by x . A single valued neutrosophic set (SVNS) A in U is characterized by a truth-membership function T_A , an indeterminacy- membership function I_A and a falsity membership function F_A , where $\forall x \in U$, $T_A(x), I_A(x), F_A(x) \in [0,1]$ and $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$. A SVNS A can be expressed as $A = \{< x : T_A(x), I_A(x), F_A(x) >, x \in U\}$

Definition 2.4[4] A SVNS R in $U \times U$ is referred to as a single valued neutrosophic relation (SVNR) in U, denoted by $R = \{< (x, y) : T_R(x, y), I_R(x, y), F_R(x, y) > / (x, y) \in U \times U\}$

where $T_R : U \times U \rightarrow [0,1]$, $I_R : U \times U \rightarrow [0,1]$ *and* $F_R : U \times U \rightarrow [0,1]$ represent the truth – membership function, indeterminacy-membership function and falsity-membership function of R

respectively. Based on a SVNR, Yang et al.[4] gave the notion of single valued neutrosophic rough set as follows.

Let $\tilde{R}$ be a SVNR in U, the tuple $(U,\tilde{R})$ is called a single valued neutrosophic approximation space $\forall \tilde{A} \in SVNS(U)$, the lower and upper approximations of $\tilde{A}$ with respect to $(U,\tilde{R})$ denoted by $\underline{\tilde{R}}(\tilde{A})$ *and* $\overline{\tilde{R}}(\tilde{A})$ are two SVNS's whose membership functions are defined as $\forall x \in U$,

$$T_{\underline{\tilde{R}}(\tilde{A})}(x) = \underset{y\in U}{\wedge}(F_{\tilde{R}}(x,y) \vee T_{\tilde{A}}(y)), T_{\overline{\tilde{R}}(\tilde{A})}(x) = \underset{y\in U}{\vee}(T_{\tilde{R}}(x,y) \wedge T_{\tilde{A}}(y)),$$

$$I_{\underline{\tilde{R}}(\tilde{A})}(x) = \underset{y\in U}{\vee}((1-I_{\tilde{R}}(x,y) \wedge I_{\tilde{A}}(y)), I_{\overline{\tilde{R}}(\tilde{A})}(x) = \underset{y\in U}{\wedge}(I_{\tilde{R}}(x,y) \vee I_{\tilde{A}}(y)),$$

$$F_{\underline{\tilde{R}}(\tilde{A})}(x) = \underset{y\in U}{\vee}(T_{\tilde{R}}(x,y) \wedge F_{\tilde{A}}(y)), F_{\overline{\tilde{R}}(\tilde{A})}(x) = \underset{y\in U}{\wedge}(F_{\tilde{R}}(x,y) \vee F_{\tilde{A}}(y)).$$

The pair $(\underline{\tilde{R}}(\tilde{A}), \overline{\tilde{R}}(\tilde{A}))$ is called a single valued neutrosophic rough set of $\tilde{A}$ with respect to $(U,\tilde{R})$. $\underline{\tilde{R}}$ *and* $\overline{\tilde{R}}$ are referred to as single valued neutrosophic lower and upper approximation operators respectively.

Definition 2.4[6]Let X be a non-empty set. A quadripartitionedneutrosophic set (QSVNS) A over X characterizes each element x in X by a truth-membership function T_A, a contradiction membership function C_A, an ignorance – membership function U_A and a falsity membership function F_A such that for each ,

$x \in X, T_A, C_A, U_A, F_A \in [0,1]$ *and* $0 \le T_A(x) + C_A(x) + U_A(x) + F_A(x) \le 4$ when X is discrete, A is represented as, $A = \sum_{i=1}^{n} \langle T_A(x_i), C_A(x_i), U_A(x_i), F_A(x_i) \rangle / x_i, x_i \in X$. However, when the universe of discourse is continuous, A is represented as,

$A = \int_X \langle T_A(x), C_A(x), U_A(x), F_A(x) \rangle / x, x \in X$

Definition 2.5[6] Consider two QSVNS A and B ,over X. A is said to be contained in B, denoted by $A \subseteq B$ *iff* $T_A(x) \le T_B(x), C_A(x) \le C_B(x), U_A(x) \ge U_B(x)$ *and* $F_A(x) \ge F_B(x)$.

Definition 2.6[6]The complement of a QSVNS A is denoted by A^C and is defined as,

$$A^C = \sum_{i=1}^{n} \langle F_A(x_i), U_A(x_i), C_A(x_i), T_A(x_i) \rangle / x_i, x_i \in X$$

i.e, $T_{A^C}(x_i) = F_A(x_i), C_{A^C}(x_i) = U_A(x_i), U_{A^C}(x_i) = C_A(x_i)$ *and* $F_{A^C}(x_i) = T_A(x_i), x_i \in X$

Definition 2.7[6]The union of two QSVNS A and B is denoted by $A \cup B$ and is defined as,

$$A \cup B = \sum_{i=1}^{n} \langle T_A(x_i) \vee T_B(x_i), C_A(x_i) \vee C_B(x_i), U_A(x_i) \wedge U_B(x_i), F_A(x_i) \wedge F_B(x_i) \rangle / x_i, x_i \in X$$

Definition 2.8[6]The intersection of two QSVNS A and B is denoted by $A \cap B$ and is defined as,

$$A \cap B = \sum_{i=1}^{n} \langle T_A(x_i) \wedge T_B(x_i), C_A(x_i) \wedge C_B(x_i), U_A(x_i) \vee U_B(x_i), F_A(x_i) \vee F_B(x_i) \rangle / x_i, x_i \in X$$

3. The constructive approach of quadripartitioned single valued neutrosophic rough sets:

In this section we will introduce the concept of quadripartitioned single valued neutrosophic relations and quadripartitioned single valued neutrosophic rough sets.

Definition 3.1 A QSVNS R in $U \times U$ is called a quadripartitioned single valued neutrosophic relation (QSVNR) in U , denoted by,

$$R = \{\langle (x,y), T_R(x,y), C_R(x,y), U_R(x,y), F_R(x,y) \rangle / (x.y) \in U \times U\}$$

where $T_R : U \times U \to [0,1], C_R : U \times U \to [0,1], U_R : U \times U \to [0,1], F_R : U \times U \to [0,1]$ denote the truth membership function, a contradiction membership function, an ignorance membership function and a falsity membership function of R respectively.

Definition 3.2 Let R be a QSVNR in U, the complement and inverse of R are defined as follows respectively. $R^C = \{\langle (x,y), T_{R^C}(x,y), C_{R^C}(x,y), U_{R^C}(x,y), F_{R^C}(x,y) \rangle / (x.y) \in U \times U\}$ where,

$\forall (x,y) \in U \times U$, $T_{R^C}(x,y) = F_R(x,y), C_{R^C}(x,y) = U_R(x,y), U_{R^C}(x,y) = C_R(x,y), F_{R^C}(x,y) = T_R(x,y)$

$R^{-1} = \{\langle (x,y), T_{R^{-1}}(x,y), C_{R^{-1}}(x,y), U_{R^{-1}}(x,y), F_{R^{-1}}(x,y) \rangle / (x.y) \in U \times U\}$ where,

$\forall (x,y) \in U \times U$, $T_{R^{-1}}(x,y) = T_R(y,x), C_{R^{-1}}(x,y) = C_R(y,x), U_{R^{-1}}(x,y) = U_R(y,x), F_{R^{-1}}(x,y) = F_R(y,x)$

Example 3.1 Let $U = \{x_1, x_2, x_3\}$. A QSVNR R in U is given in Table 1 . By definition 3.2 we can compute R^C *and* R^{-1} which is given in Table 2 and 3 respectively.Table 1: QSVNR R

R	x_1	x_2	x_3
x_1	(0.4,0.6,0.3,0.2)	(0.5,0.7,0.3,0.1)	(0.9,0.4,0.3,0.2)
x_2	(0.5,0.4,0.3,0.2)	(0.1,0.5,0.7,0.4)	(0.2,0.7,0.3,0.5)
x_3	(0.3,0.9,0.4,0.7)	(0.6,0.4,0.7,0.2)	(0.7,0.8,0.5,0.4)

Table 2 : R^C of R

R^C	x_1	x_2	x_3
x_1	(0.2,0.3,0.6,0.4)	(0.1,0.3,0.7,0.5)	(0.2,0.3,0.4,0.9)
x_2	(0.2,0.3,0.4,0.5)	(0.4,0.7,0.5,0.1)	(0.5,0.3,0.7,0.2)
x_3	(0.7,0.4,0.9,0.3)	(0.2,0.7,0.4,0.6)	(0.4,0.5,0.8,0.7)

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Table 3 : R^{-1} of R

R^{-1}	x_1	x_2	x_3
x_1	(0.4,0.6,0.3,0.2)	(0.5,0.4,0.3,0.2)	(0.3,0.9,0.4,0.7)
x_2	(0.5,0.7,0.3,0.1)	(0.1,0.5,0.7,0.4)	(0.6,0.4,0.7,0.2)
x_3	(0.9,0.4,0.3,0.2)	(0.2,0.7,0.3,0.5)	(0.7,0.8,0.5,0.4)

Definition 3.3 Let R be a QSVNR in U.

(1) If $\forall\, x \in U$, $T_R(x,x)=1$, $C_R(x,x)=1$ and $U_R(x,x)=0, F_R(x,x)=0$ then R is called a reflexive QSVNR.

(2) If $\forall\, x,y \in U$, $T_R(x,y)=T_R(y,x), C_R(x,y)=C_R(y,x), U_R(x,y)=U_R(y,x)$, $F_R(x,y)=F_R(y,x)$ then R is called a symmetric QSVNR.

(3) If $\forall\, x,y,z \in U$,
$\vee_{y\in U}\,(T_R(x,y)\wedge T_R(y,z)) \le T_R(x,z)$, $\vee_{y\in U}\,(C_R(x,y)\wedge C_R(y,z)) \le C_R(x,z)$
$\wedge_{y\in U}\,(U_R(x,y)\vee U_R(y,z)) \ge T_R(x,z)$, $\wedge_{y\in U}\,(F_R(x,y)\vee F_R(y,z)) \ge F_R(x,z)$

then R is called a transitive QSVNR, where "$\vee$"*and* "$\wedge$" denote maximum and minimum respectively.

Definition 3.4 Let R be a QSVNR in U, the tuple (U,R) is called a quadripartitioned single valued neutrosophic approximation space$\forall\, A \in QSVNS(U)$, the lower and upper approximations of A with respect to (U,R) denoted by $\underline{R}(A)$ *and* $\overline{R}(A)$ are two QSVNS's whose membership functions are defined as : $\forall\, x \in U$,

$T_{\underline{R}(A)}(x)=\underset{y\in U}{\wedge}(F_R(x,y)\vee T_A(y))$, $T_{\overline{R}(A)}(x)=\underset{y\in U}{\vee}(T_R(x,y)\wedge T_A(y))$

$C_{\underline{R}(A)}(x)=\underset{y\in U}{\wedge}(U_R(x,y)\vee C_A(y))$, $C_{\overline{R}(A)}(x)=\underset{y\in U}{\vee}(C_R(x,y)\wedge C_A(y))$

$U_{\underline{R}(A)}(x)=\underset{y\in U}{\vee}(C_R(x,y)\wedge U_A(y))$, $U_{\overline{R}(A)}(x)=\underset{y\in U}{\wedge}(U_R(x,y)\vee U_A(y))$

$F_{\underline{R}(A)}(x)=\underset{y\in U}{\vee}(T_R(x,y)\wedge F_A(y))$, $F_{\overline{R}(A)}(x)=\underset{y\in U}{\wedge}(F_R(x,y)\vee F_A(y))$.

The pair $(\underline{R}(A),\overline{R}(A))$ is called the quadripartitioned single valued neutrosophic rough set of A with respect to (U,R) . $\underline{R}$ *and* $\overline{R}$ are referred to as the quadripartitioned single valued neutrosophic lower and upper approximation operators respectively.

Example 3.5 Let $X=\{x_1,x_2,x_3\}$ be the universe. A QSVNR R in X is given in Table 3.

Table 4:QSVNR R

R	x_1	x_2	x_3
x_1	(0,0.3,0.5,0.4)	(1,0.7,0.5,0.4)	(0.3,0.1,0.6,0.2)
x_2	(0,0.9,0.8,0.5)	(0.5,0,0.3,0.4)	(0.3,0.2,0.6,0.8)
x_3	(1,0.2,0.5,0.6)	(0.6,0.2,0.3,0.5)	(0,0.3,0.7,1)

Let $A=\{<x_1,(0.3,0.6,0.7,0.5)>,<x_2,(0,0.2,0.5,0.3)>,<x_3,(0.4,0.9,0.7,0.6)>\}$

According to Definition 3.4,

$T_{\underline{R}(A)}(x_1)=\underset{y\in U}{\wedge}(F_R(x_1,y)\vee T_A(y))=0.4$, $T_{\overline{R}(A)}(x_1)=\underset{y\in U}{\vee}(T_R(x_1,y)\wedge T_A(y))=0.3$

$C_{\underline{R}(A)}(x_1)=\underset{y\in U}{\wedge}(U_R(x_1,y)\vee C_A(y))=0.5$, $C_{\overline{R}(A)}(x_1)=\underset{y\in U}{\vee}(C_R(x_1,y)\wedge C_A(y))=0.3$

$U_{\underline{R}(A)}(x_1)=\underset{y\in U}{\vee}(C_R(x_1,y)\wedge U_A(y))=0.5$, $U_{\overline{R}(A)}(x_1)=\underset{y\in U}{\wedge}(U_R(x_1,y)\vee U_A(y))=0.5$

$F_{\underline{R}(A)}(x_1)=\underset{y\in U}{\vee}(T_R(x_1,y)\wedge F_A(y))=0.3$, $F_{\overline{R}(A)}(x_1)=\underset{y\in U}{\wedge}(F_R(x_1,y)\vee F_A(y))=0.4$

Hence, $\underline{R}(A)(x_1)=(0.4,0.5,0.5,0.3)$ *and* $\overline{R}(A)(x_1)=(0.3,0.3,0.5,0.4)$ .Similarly we can obtain,

$\underline{R}(A)(x_2)=(0.4,0.3,0.7,0.3)$ *and* $\overline{R}(A)(x_2)=(0.3,0.6,0.5,0.4)$

$\underline{R}(A)(x_3)=(0.5,0.3,0.3,0.5)$ *and* $\overline{R}(A)(x_3)=(0.3,0.3,0.5,0.5)$

The properties of Quadripartitioned single valued neutrosophic rough sets:

Theorem 3.1 Let (X,R) be a quadripartitioned single valued neutrosophic approximation space. The quadripartitioned single valued neutrosophic lower and upper approximation operators defined in 3.4 have the following properties. $\forall A,B\in QSVNS(X)$,

(1) $\underline{R}(X)=X$, $\overline{R}(\phi)=\phi$;

(2) If $A\subseteq B$, *then* $\underline{R}(A)\subseteq\underline{R}(B)$ *and* $\overline{R}(A)\subseteq\overline{R}(B)$;

(3) $\underline{R}(A\cap B)=\underline{R}(A)\cap\underline{R}(B)$, $\overline{R}(A\cup B)=\overline{R}(A)\cup\overline{R}(B)$;

(4) $\underline{R}(A\cup B)\supseteq\underline{R}(A)\cup\underline{R}(B)$, $\overline{R}(A\cap B)\subseteq\overline{R}(A)\cap\overline{R}(B)$;

(5) $\underline{R}(A^C)=(\overline{R}(A))^C$, $\overline{R}(A^C)=(\underline{R}(A))^C$

Proof (2) and (4) are following immediately from Definition 3.4. We have to prove only (1) , (3) and (5).By Definition 3.4 , $\forall x\in X$,

$T_{\underline{R}(X)}(x)=\underset{y\in X}{\wedge}(F_R(x,y)\vee T_X(y))=\underset{y\in X}{\wedge}(F_R(x,y)\vee 1)=1$

$C_{\underline{R}(X)}(x)=\underset{y\in X}{\wedge}(U_R(x,y)\vee C_X(y))=\underset{y\in X}{\wedge}(U_R(x,y)\vee 1)=1$

$U_{\underline{R}(X)}(x)=\underset{y\in X}{\vee}(C_R(x,y)\wedge U_X(y))=\underset{y\in X}{\vee}(C_R(x,y)\wedge 0)=0$

$F_{\underline{R}(X)}(x)=\bigvee_{y\in X}(T_R(x,y)\wedge F_X(y))=\bigvee_{y\in X}(T_R(x,y)\wedge 0)=0$

Therefore, $\underline{R}(X)=X$.

$T_{\overline{R}(\phi)}(x)=\bigvee_{y\in X}(T_R(x,y)\wedge T_\phi(y))=\bigvee_{y\in X}(T_R(x,y)\wedge 0)=0,$

$C_{\overline{R}(\phi)}(x)=\bigvee_{y\in X}(C_R(x,y)\wedge C_\phi(y))=\bigvee_{y\in X}(C_R(x,y)\wedge 0)=0,$

$U_{\overline{R}(\phi)}(x)=\bigwedge_{y\in X}(U_R(x,y)\vee U_\phi(y))=\bigwedge_{y\in X}(U_R(x,y)\vee 1)=1,$

$F_{\overline{R}(\phi)}(x)=\bigwedge_{y\in X}(F_R(x,y)\vee F_\phi(y))=\bigwedge_{y\in X}(F_R(x,y)\vee 1)=1,$

Thus , $\overline{R}(\phi)=\phi$ .By Definitions 2.8 and 3.4, $\forall x\in X$,

$T_{\underline{R}(A\cap B)}(x)=\bigwedge_{y\in X}(F_R(x,y)\vee T_{A\cap B}(y))=\bigwedge_{y\in X}(F_R(x,y)\vee(T_A(y)\wedge T_B(y))$

$=\bigwedge_{y\in X}(F_R(x,y)\vee T_A(y))\wedge\bigwedge_{y\in X}(F_R(x,y)\vee T_B(y))=T_{\underline{R}(A)}(x)\wedge T_{\underline{R}(B)}(x)$

$C_{\underline{R}(A\cap B)}(x)=\bigwedge_{y\in X}(U_R(x,y)\vee C_{A\cap B}(y))=\bigwedge_{y\in X}(U_R(x,y)\vee(C_A(y)\wedge C_B(y))$

$=\bigwedge_{y\in X}(U_R(x,y)\vee C_A(y))\wedge\bigwedge_{y\in X}(U_R(x,y)\vee C_B(y))=C_{\underline{R}(A)}(x)\wedge C_{\underline{R}(B)}(x)$

$U_{\underline{R}(A\cap B)}(x)=\bigvee_{y\in X}(C_R(x,y)\wedge U_{A\cap B}(y))=\bigvee_{y\in X}(C_R(x,y)\wedge(U_A(y)\wedge U_B(y))$

$=\bigvee_{y\in X}(C_R(x,y)\wedge U_A(y))\vee\bigvee_{y\in X}(C_R(x,y)\vee U_B(y))=U_{\underline{R}(A)}(x)\vee U_{\underline{R}(B)}(x)$

$F_{\underline{R}(A\cap B)}(x)=\bigvee_{y\in X}(T_R(x,y)\wedge F_{A\cap B}(y))=\bigvee_{y\in X}(T_R(x,y)\wedge(F_A(y)\wedge F_B(y))$

$=\bigvee_{y\in X}(T_R(x,y)\wedge F_A(y))\vee\bigvee_{y\in X}(T_R(x,y)\vee F_B(y))=F_{\underline{R}(A)}(x)\vee F_{\underline{R}(B)}(x)$

Thus, $\underline{R}(A\cap B)=\underline{R}(A)\cap\underline{R}(B)$.Similarly we can prove $\overline{R}(A\cup B)=\overline{R}(A)\cup\overline{R}(B)$

(6) We only need to show that the former part $\forall x\in X$,

$T_{\underline{R}(A^C)}(x)=\bigwedge_{y\in X}(F_R(x,y)\vee T_{A^C}(y))=\bigwedge_{y\in X}(F_R(x,y)\vee F_A(y))=F_{\overline{R}(A)}(x)=T_{(\overline{R}(A))^C}(x)$

$C_{\underline{R}(A^C)}(x)=\bigwedge_{y\in X}(U_R(x,y)\vee C_{A^C}(y))=\bigwedge_{y\in X}(U_R(x,y)\vee U_A(y))=U_{\overline{R}(A)}(x)=C_{(\overline{R}(A))^C}(x)$

$U_{\underline{R}(A^C)}(x)=\bigvee_{y\in X}(C_R(x,y)\wedge U_{A^C}(y))=\bigvee_{y\in X}(C_R(x,y)\vee C_A(y))=C_{\overline{R}(A)}(x)=U_{(\overline{R}(A))^C}(x)$

$F_{\underline{R}(A^C)}(x)=\bigvee_{y\in X}(T_R(x,y)\wedge F_{A^C}(y))=\bigvee_{y\in X}(T_R(x,y)\vee T_A(y))=T_{\overline{R}(A)}(x)=F_{(\overline{R}(A))^C}(x)$

So, $\underline{R}(A^C)=(\overline{R}(A))^C$. Similarly we can prove that, $\overline{R}(A^C)=(\underline{R}(A))^C$.

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Theorem 3.2 Let R_1, R_2 be two QSVNRs in X, $\forall A \in QSVNS(X)$, we have

(1) $\underline{R_1 \cup R_2}(A) = \underline{R_1}(A) \cap \underline{R_2}(A)$;

(2) $\overline{R_1 \cup R_2}(A) = \overline{R_1}(A) \cup \overline{R_2}(A)$.

Proof (1) $\forall x \in X$, by Definition 3.4, we have

$$T_{\underline{R_1 \cup R_2}(A)}(x) = \bigwedge_{y \in X} (F_{R_1 \cup R_2}(x,y) \vee T_A(y)) = \bigwedge_{y \in X} ([F_{R_1}(x,y) \wedge F_{R_2}(x,y)] \vee T_A(y)))$$
$$= \bigwedge_{y \in X} ([F_{R_1}(x,y) \vee T_A(y)] \wedge [F_{R_2}(x,y) \vee T_A(y)])$$
$$= \bigwedge_{y \in X} (F_{R_1}(x,y) \vee T_A(y)) \wedge \bigwedge_{y \in X} (F_{R_2}(x,y) \vee T_A(y)) = T_{\underline{R_1}(A)}(x) \wedge T_{\underline{R_2}(A)}(x)$$

$$C_{\underline{R_1 \cup R_2}(A)}(x) = \bigwedge_{y \in X} (U_{R_1 \cup R_2}(x,y) \vee C_A(y)) = \bigwedge_{y \in X} ([U_{R_1}(x,y) \wedge U_{R_2}(x,y)] \vee C_A(y)))$$
$$= \bigwedge_{y \in X} ([U_{R_1}(x,y) \vee C_A(y)] \wedge [U_{R_2}(x,y) \vee C_A(y)])$$
$$= \bigwedge_{y \in X} (U_{R_1}(x,y) \vee C_A(y)) \wedge \bigwedge_{y \in X} (U_{R_2}(x,y) \vee C_A(y)) = C_{\underline{R_1}(A)}(x) \wedge C_{\underline{R_2}(A)}(x)$$

$$U_{\underline{R_1 \cup R_2}(A)}(x) = \bigvee_{y \in X} (C_{R_1 \cup R_2}(x,y) \wedge U_A(y)) = \bigvee_{y \in X} ([C_{R_1}(x,y) \wedge C_{R_2}(x,y)] \wedge U_A(y)))$$
$$= \bigwedge_{y \in X} ([C_{R_1}(x,y) \wedge U_A(y)] \vee [C_{R_2}(x,y) \wedge U_A(y)])$$
$$= \bigwedge_{y \in X} (C_{R_1}(x,y) \wedge U_A(y)) \vee \bigvee_{y \in X} (C_{R_2}(x,y) \wedge U_A(y)) = U_{\underline{R_1}(A)}(x) \vee U_{\underline{R_2}(A)}(x)$$

$$F_{\underline{R_1 \cup R_2}(A)}(x) = \bigvee_{y \in X} (T_{R_1 \cup R_2}(x,y) \wedge F_A(y)) = \bigvee_{y \in X} ([T_{R_1}(x,y) \wedge T_{R_2}(x,y)] \wedge F_A(y)))$$
$$= \bigwedge_{y \in X} ([T_{R_1}(x,y) \wedge F_A(y)] \vee [T_{R_2}(x,y) \wedge F_A(y)])$$
$$= \bigwedge_{y \in X} (T_{R_1}(x,y) \wedge F_A(y)) \vee \bigvee_{y \in X} (T_{R_2}(x,y) \wedge F_A(y)) = F_{\underline{R_1}(A)}(x) \vee F_{\underline{R_2}(A)}(x).$$

Hence, $\underline{R_1 \cup R_2}(A) = \underline{R_1}(A) \cap \underline{R_2}(A)$. (2) By (1) and Theorem 3.1 (5),

$$\overline{R_1 \cup R_2}(A) = (\underline{R_1 \cup R_2}(A^C))^C = (\underline{R_1}(A^C) \cap \underline{R_2}(A^C))^C = (\underline{R_1}(A^C))^C \cup (\underline{R_2}(A^C))^C = \overline{R_1}(A) \cup \overline{R_2}(A)$$

Conclusion QSVNS is aimprovization of Wang's single valued neutrosophic set and in this case indeterminacy is split into two functions named as Contradiction and Unknown. In this paper a new hybrid model of quadripartitioned single valued neutrosophic rough set has been defined and also studied its lower and upper approximations operators and its properties.

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POTENTIAL OF *MUSA ACUMINATA* BRACT EXTRACT AS CORROSION INHIBITOR FOR MILD STEEL IN PHOSPHORIC ACID ENVIRONMENT

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Inhibition of corrosion of mild steel in phosphoric acid environment in presence and absence of *Musa acuminata* bract (MAB) extract have been evaluated by weight loss method and surface examination. Inhibition efficiency of bract extracts increases with increase in concentration. Surface characterization techniques used ascertain the nature of the protective film. Based on all these results a plausible mechanism of corrosion inhibition has been proposed.
Keywords: *Musa acuminata* bract, Mild steel, Weight loss, Surface Analysis, SEM.I

INTRODUCTION

Mild steel finds a wide range of applications in industries such as pulp and paper, power generation, chemical and oil industries, because of its availability, low cost, ease of fabrication and high tensile strength. But mild steel has a high tendency to corrode easily, especially in acid, alkali and other aggressive environment (Vinod Kumar et al 2010). Corrosion is a prevailing destructive phenomenon in science and technology. Corrosion is a major problem that must be confronted for safety, environmental and economic reasons.

The use of inhibitors is one of the most practical methods for protection against corrosion. The role of inhibitor is to form a barrier of one or several molecular layers against acid attack. Protective action is often associated with chemical or physical adsorption involving variation in charge of, adsorbed substance and transfer of charge from one phase to another phase (Anwar Sathiq 2011). Most of the efficient corrosion inhibitors used in industry is organic compounds having multiple bonds and heteroatoms like nitrogen, oxygen, sulphur through which they are adsorbed on the metal surface (Saliyan 2008). They function by interfering with either the anodic or cathodic reactions or both (Nalini 2011).

The corrosive inhibitive effect of bract extract of *Musa acuminata* in 1N H_3PO_4 on mild steel was carried out using conventional weight loss method and surface examination analysis has been presented

MATERIAL AND METHODS

The plant part taken for the present study in phosphoric acid medium is bract of Musa acuminata.

Figure 1 Photograph of inflorescence with floret and bract

Phytochemical Screening

Extract of *Musa acuminata* bract was subjected to preliminary phytochemical screening to identify the chemical constituents of the plant. The methods of analysis were carried out using standard qualitative methods as described by various researchers Kotate (1999) and Harborne (1984). The samples were screened for the presence of bioactive compounds.

PREPARATION OF THE INHIBITOR

25 gm of dried powder of bract was boiled in 500 ml of 1N phosphoric acid with reflux condenser for three hours and was kept overnight to extract its phytonutrients. The extract was filtered and the filtrate volume was made up to 500 ml using the respective acids. The extract so prepared was taken as 5% stock solution and from this other concentrations were prepared. The extract was used for corrosion study and surface examination.

CORROSION STUDY

Weight loss studies were conducted at room temperature. Mild steel specimens were weighed accurately in electronic balance (SHIMADZU model AUW 220D). After initial weighing, the specimens were fully immersed using glass hooks in beakers containing 100 ml of 1N H_3PO_4 without and with inhibitor of different concentrations at various intervals of time. After the specified period of immersion, the specimens were removed, washed with distilled water, dried and reweighed. The loss in weight was determined. A triplicate was run to ensure the weight loss and the results were averaged. The details of inhibitor concentration and time intervals used in the present study are given below,

Inhibitor concentrations in % v/v	0.05	0.10	0.50	1.00	1.50	2.00
Time interval in hours	1	3	5	7	12	24

RESULTS AND DISCUSSION

The results of the performance of bract extract of Musa acuminata in 1N phosphoric acid are summarised below,

Table 1 Phytochemical constituents present in the extract of *Musa acuminata*

Phyto Compound	**PE**	**CCl_4**	**EtOAc**	**CH_3OH**	**H_2O**
Alkaloids	+	-	-	+	-
Saponins	-	-	-	+	-
Tannins	-	-	-	++	++
Flavonoids	-	-	+	+	-
Terpenoids	-	-	-	+	-
Phlobotannins	-	-	-	-	-
Coumarins	-	-	-	+	+
Cycloglycosides	+	-	-	+	-
Total phenols	-	-	-	+	+
Quinones	-	-	-	-	-
Anthraquinones	-	-	-	-	-
Steroids	-	-	-	+	-

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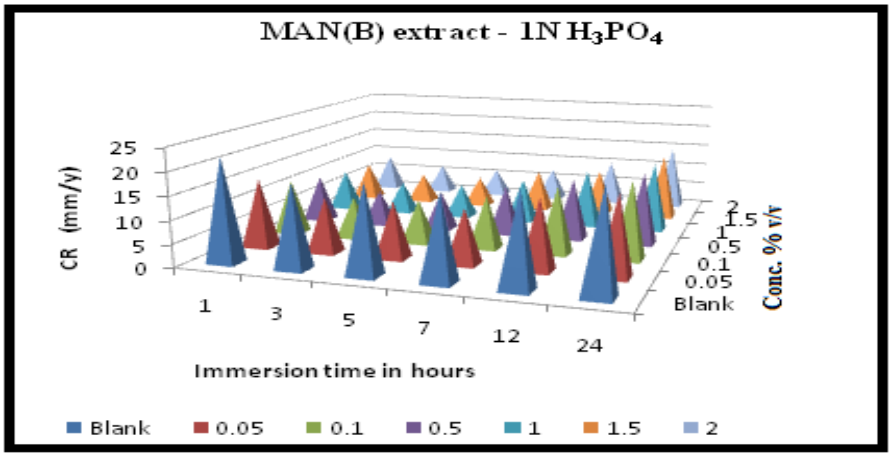
Table 2 CR of mild steel of MAN(B) extract in 1N H_3PO_4 acid in various concentration

Conc. of extract (% v/v)	1 hr	3 hrs	5 hrs	7 hrs	12 hrs	24 hrs
Blank	22.51	17.94	19.19	18.12	19.94	21.83
0.05	15.05	12.07	12.30	12.02	15.39	17.32
0.10	11.93	9.29	9.58	11.59	14.81	16.97
0.50	10.25	7.88	8.49	10.86	13.56	15.89
1.00	9.03	7.21	7.53	9.82	12.90	15.40
1.50	8.47	6.72	6.80	9.25	10.34	14.87
2.00	8.25	6.50	6.40	7.31	9.96	14.39

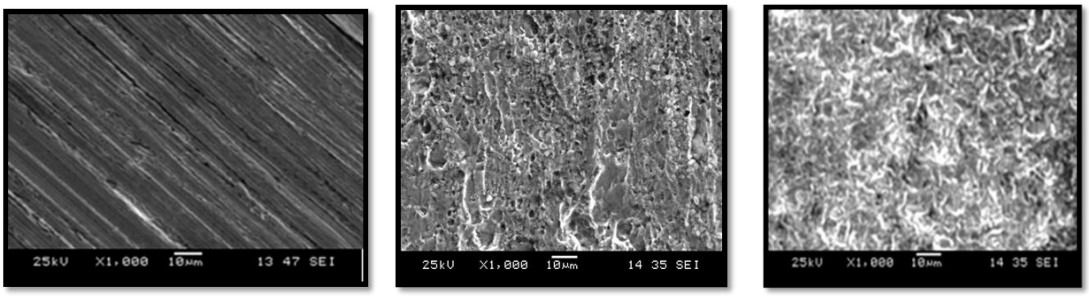


Effect of immersion time on CR of mild steel in 1N H_3PO_4 without and with MAN(B) extract

SURFACE EXAMINATION STUDIES

The results pertaining corrosion inhibition efficiency of bract extract of *Musa acuminata* 'Nendran' in 1N H_3PO_4 on mild steel are supported by the Scanning electron microscopy (SEM) micrographs.

SEM photographs of mild steel samples



Polished mild steel surface MS exposed to 1N H_3PO_4 Exposed to acid with extract

CONCLUSION

The corrosion rate of mild steel was monitored in 1N H_3PO_4 medium without and with various concentrations of *Musa acuminata* bract extracts. Weight loss and SEM were employed in the present investigation.

The following conclusions are drawn from the present study,

The qualitative analysis of *Musa acuminata* plant parts showed the presence of alkaloids, saponins, tannins, flavonoids, terpenoids, coumarins, phenols, and steroids.

The corrosion of mild steel in acid medium is significantly reduced upon the addition of *Musa acuminata* plant extract. The inhibition efficiency increased with the increasing concentration of inhibitor. The maximum inhibitor efficiency was observed at an optimum concentration of 2% v/v.

Prolonged immersion of sample in the acid medium with plant extract leads to greater adsorption of plant constituents. Inhibition efficiency increased up to 3h.

The bract extract of *Musa acuminata* showed maximum efficiency of 94.93% in 1N HCl, 93.09% in 1N H_2SO_4 and 66.67% in 1N H_3PO_4 at 5 hours of immersion.

Surface studies involving SEM confirmed the efficiency of the plant extract as corrosion inhibitor for mild steel. Surface smoothness is in relation to the concentration of the extract. The comparison of the images from scanning electron microscopy revealed that the molecules of the plant extracts are adsorbed on the metal surface, thereby decreasing the corrosion attack on the metal surface.

All the results of the present study indicate that the extract bract of *Musa acuminata* can be used as corrosion inhibitors for mild steel. Further, as these extracts are environmental friendly, they can be considered as green corrosion inhibitors.

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QUALITATIVE AND QUANTITATIVE ANALYSIS OF DIFFERENT BRANDS OF MILK

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ABSTRACT

Qualitative and quantitative analysis of different brands of milk like Milma, Wayanad, Sakthi, Amul and Good life were analyzed for the various parameters like Temperature, odour, appearance, Platform test, Solid Not Fat, Acidity, Protein, Phosphates, Methylene Blue Reduction, Specific Gravity, Adulteration, and Neutralization, to ensure the quality of the different milk brands. Results showed that the values of the various parameters were well within the prescribed AGMARK standard values and proved that the milk brands analyzed can be consumed safely by man as its quality was assured.

Keywords: Milk, qualitative and quantitative analysis, comsumablilty

INTRODUCTION

Milk is a pale liquid produced by the mammary glands of mammals. It is the primary source of nutrition for infant mammals (including humans who breastfeed) before they are able to digest other types of food. Early lactation milk contains colostrum, which carries the mother's antibodies to its young and can reduce the risk of many diseases. It contains many other nutrient (Pehrsson et al, 2000), including protein and lactose.

As an agricultural product milk is extracted from non-human mammals during or soon after pregnancy. Dairy farms produced about 730 million tonnes of milk in 2011 (Anandkumar, 2016), from 260 million dairy cows. India is the world's largest producer of milk, and is the leading exporter of skimmed milk powder, yet it exports few other milk products. The ever increasing rise in domestic demand for dairy products and a large demand-supply gap could lead India being a net importer of dairy products in the future. The United States, India, China and Brazil are the world's largest exporters of milk and milk products. China and Russia were the world's largest importers of milk and milk products until 2016 when both countries became self-sufficient, contributing to a worldwide glut of milk (Gagnon, 2016).In the present study the various parameters like Temperature, Sampling, platform, Acidity, Fat Solid not Fat, Protein, Phosphates, Methylene blue reduction, Adulteration, Neutralization, in the different brands of milk were analyzed and compared to predict the safe consumability of the different brands of milk.

MATERIALS AND METHODS

Different brands of milk like Milma, Wayanad, Sakthi, Amul, and Good life was collected from market, and these milk was analyzed for quality, to make sure that all the brands of milk are free from microbes and that all the milk are good for human consumption. Procedures followed were as per, given by the Research Laboratory in Milma, KoliKozde, Kerela.

RESULTS AND DISCUSSION

Milk testing and quality control is an essential process of any milk processing industry whether small, medium or large scale. Milk being made up of 87 % of water was prone to adulteration by unscrupulous middlemen and unfaithful farm workers. Moreover, its high nutritive value makes it an ideal medium for the rapid multiplication of bacteria, particularly

under unhygienic production and storage at ambient temperatures. In order for any processor to make good dairy products, good quality raw milk materials are essential (Sjaunja, 1984). A milk processor would only be assured of the quality of raw milk from the products to processor and finally to the consumer. Therefore in the present study various parameters were determined to find the milk quality. The results of the qualitative and quantitative analysis of various parameters of milk obtained from various sources from the local market are summarized in the Table 1.

Table 1: The various parameters for different brands of milk

S.No.	**Milk Brand →** / **Parameters ↓**	**Milma**	**Wayanad**	**Sakthi**	**Amul**	**Good life**
1.	Temperature in □ C	6	6	6	7	6
2.	Odour	Pleasant	Pleasant	Pleasant	Pleasant	Pleasant
3.	Appearance	Normal	Normal	Normal	Normal	Normal
4.	**Platform test**					
	Organoleptic test					
	Result	Negative	Negative	Negative	Negative	Negative
	Quality	Good	Good	Good	Good	Good
	Clot on Boiling (COB)					
	Result	Positive	Positive	Positive	Positive	Positive
	Quality	Good	Good	Good	Good	Good
	Corrected Lactometer Reading CLR					
		29.5	30	30	31	31
5.	Fat Percent	3.1	3.0	3.0	3.6	3.7
6.	Solid Not Fat (SNF) %					
		8.50	8.62	8.60	8.90	9.00
7.	Acidity	0.135	0.153	0.153	0.153	0.135
8.	Protein Content (g)	3.2	3.2	2.8	3.5	3.7
9.	Phosphate Test					
	Result	Positive	Positive	Positive	Positive	Positive
10.	Methylene Blue Reduction Test					
	MBRT in Hours	7	6	6	8.30	8
	Milk Quality	Good	Good	Good	Good	Good
11.	Specific gravity	1.0295	1.0283	1.0287	1.0319	1.0311
12.	Adulteration					
	Cane Sugar	Absent	Absent	Absent	Absent	Absent
	Starch	Absent	Absent	Absent	Absent	Absent
	Formalin	Absent	Absent	Absent	Absent	Absent
	Urea	Absent	Absent	Absent	Absent	Absent
	Sodium Chloride	Absent	Absent	Absent	Absent	Absent
	Glucose	Absent	Absent	Absent	Absent	Absent
	Sugar	Absent	Absent	Absent	Absent	Absent
	Hydrogen Peroxide	Absent	Absent	Absent	Absent	Absent
13.	Neutralizer					
	Carbonate	Absent	Absent	Absent	Absent	Absent
	Bicarbonate	Absent	Absent	Absent	Absent	Absent

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CONCLUSIONS

The opaque white fluid secreted by matured female which is rich in protein and fat, is also known for the purity. Milk is almost complete food for infants and a supplement to diets of children and adults. Milk is the one food for which there seems to be no adequate subsititute. Thus dairy product industry is one of the flouring industries worldwide. The nutritive value was to be ensured through various chemical analysis.

In the present study various brands of milk were analyzed for the various parameters and the results are summarized as follows;

The platform test done for all the brand of milk showed that all were qualitatively good.

By analysing different qualities of milk, it was found the temperature ranged between 6 – 7 ° C and the value was within the range of Agmark specification.

Sensory evaluation for all the samples were found to be same for all i.e., sweet flavour, pleasant aroma, and granular texture.

COB value gave a negative result for all the brands.

CLR was in range of 29.5 and 31, It had a value within the range of Agmark value.

% FAT was in range between 3 and 7 and value was within the range of Agmark specification.

% SNF was in the range 8 and 9, it was found in the Agmark specification range.

Acidity also gave a negative result for all the brands

Protein test had a positive result with 2.8 to 3.7 which ranged between Agmark value.

Phosphatase test also showed the colour change within the quality range, which was within the Agmark value.

MBRT test for different brands of milk showed a colour change within 7 to 8 hours.

Results showed that the values of the various parameters were well within the prescribed AGMARK standard values and proved that the milk brands analyzed can be consumed safely by man as its quality was assured.

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INSILICO ANALYSIS ON PHYTONUTRIENTS OF *PHASEOLUS LUNATUS* AGAINST *E COLI* INFECTIONS

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ABSTRACT

Escherichia coli (Ecoli) are most commonly present bacterium in human intestine, which helps in prevention of entry of pathogenic microorganisms. *E coli* are non-pathogenic in normal conditions, but if present in excess, will become causative agent of various diseases like urinary tract infection, diarrhoea, vomiting etc. Many researchers have assessed bioactivity of plant potentials and their valuable phytonutrients against serious infectious organisms. Antibacterial activity of *Phaseolus lunatus* seed phytonutrients were investigated against *Ecoli* using docking analysis. In present study, phytonutrients of *Phaseolus lunatus* namely Chlorogenic acid, Caffeic acid, Ellagic acid, Quercetin and Kaempferol were selected for *insilico* against *Ecoli* protein. The *insilico* studies were performed using Autodock 4.2 and interactions between protein and compounds were analyzed. The efficiency of compounds was screened based on binding energy existing between the protein and inhibitor. The docking studies shows phytonutrients of *Phaseolus lunatus* against *Ecoli* protein was efficient. The potential compounds can be subjected to further experimental trials and can be an alternative in the future management of *Ecoli* infections.

Keywords: *Phaseolus lunatus*, *Ecoli*, Autodock, Molecular docking, Chlorogenic acid, *insilico* analysis

I. INTRODUCTION

Naturally occurring plants have played an important role in the discovery of new therapeutic agents [Mohanty *et al*, 2008]. Virulent strains of *E.coli* can cause gastroenteritis, urinary tract infections, neonatal meningitis etc [Mead *et al*, 1999]. With increasing use of drugs, microorganisms are attaining resistance to commonly used antibiotics, which leads to downfall of effectiveness of conventional medicines and therefore, search for new antimicrobial agents has become necessary. Traditional medicines have been used for many centuries by a substantial proportion of the population of India [Amrita *et al*, 2009]. The major target of phytochemicals in *E. coli* is DNA gyrase (type II A topoisomerase), which plays essential role in bacterial DNA replication [Champoux, 2001; Drlica *et al*, 2003]. Aim of this work was to virtually evaluate antibacterial activity of phytonutrients of seeds of *Phaseolus lunatus* against *Ecoli* using molecular docking analysis.

II. METHODS AND MATERIALS

A LIGAND PREPARATION

The structures of phytochemicals namely Chlorogenic acid, Caffeic acid, Ellagic acid, Quercetin and Kaempferol used in this study were retrieved from Pubchem compound database (figure 1). These phytochemicals satisfied Lipinski's rule of five and ADME properties. The structures were taken as input for docking program in Autodock 4.2 (Morris *et al.*, 2009)

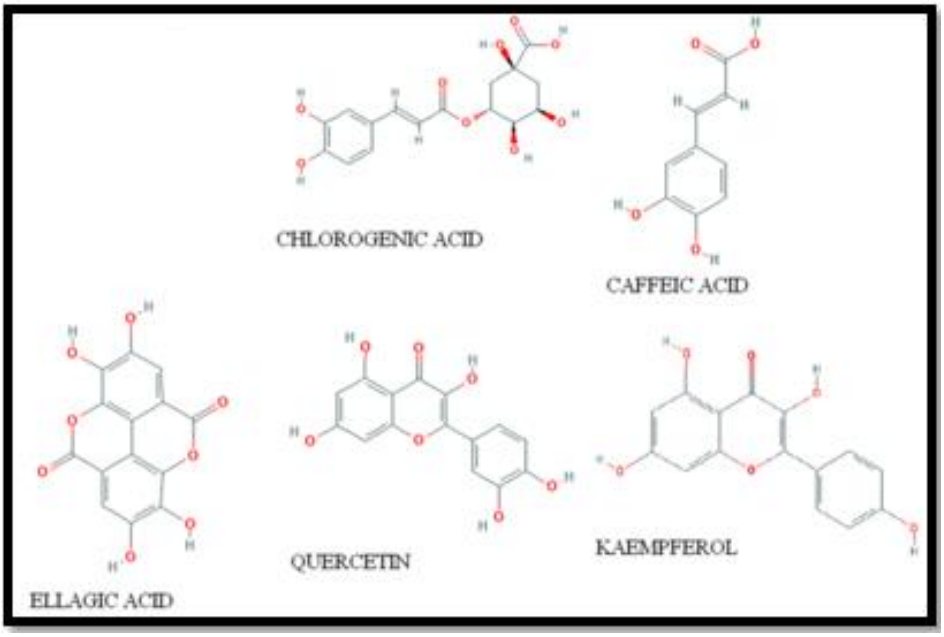

Figure 1. Structure of phytochemicals present in *Phaseolus lunatus* seeds

B. PREPARATION OF PROTEIN

The 3D X-ray crystal structure of target protein was retrieved from Brook Heaven Protein Data Bank (figure 2) (PDBID: 1AB4). The binding site in protein was determined using Computer Atlas of Surface Topology of Proteins (CASTp) [Dundas *et al.*, 2006]. CASTp helps in identifying geometric properties of protein pockets, which are assumable positions on protein surface. The amino acid residues within binding site were identified. The analysis revealed there are several pockets, which fit in role of active site.

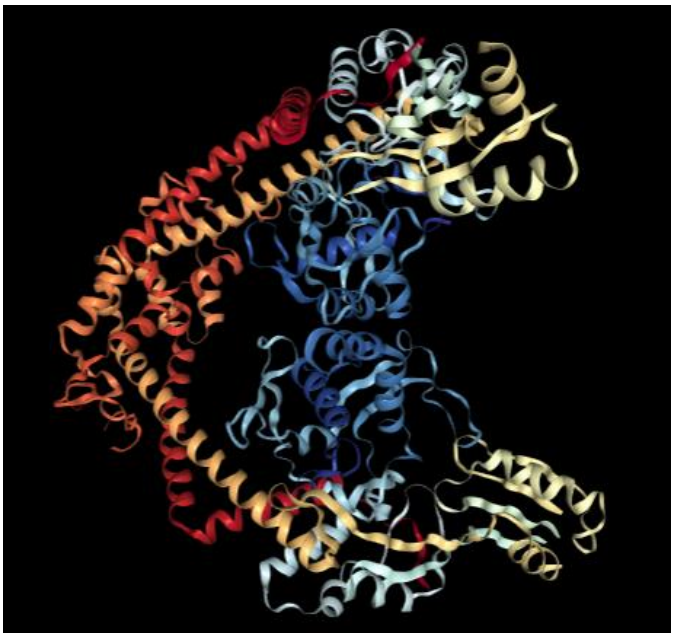

Figure 2. 3- Dimensional structure of DNA Gyrase protein of *Ecoli*

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C. MOLECULAR DOCKING

Molecular docking combined with a scoring function can be used to screen potential drugs *insilico* to identify molecules that are likely to bind to protein target of interest. To perform docking model, AutoDock 4.2 suite molecular-docking tool was used and methodology was followed (Morris *et al*., 2009). The default parameters of automatic settings were used. Each docking experiment consisted of 10 docking runs with 150 individuals and 500,000 energy evaluations. The size of grid box is key parameter in AutoDock. The volume of the box was fixed to 27000Å to have large search space. AutoDock results indicated binding position and bound conformation of protein, as well as hydrogen bond interactions between protein and ligand molecule.

III. RESULTS AND DISCUSSIONS

MOLECULAR DOCKING

Molecular docking studies were performed in order to virtually confirm and to provide understandable evidence for observed antibacterial activity of phytochemicals of *Phaseolus lunatus* seeds. The five phytochemicals were docked using AutoDock 4.2 successfully. The interactions and binding energy of phytochemicals are listed in Table 1. Phytochemicals showed binding energy between -4.82 to -5.84 kcal/ mol. The number of H-bonds was calculated between atoms of protein-ligand docked complex. *Insilico* studies show good affinity of ligand towards protein. The higher the negative value of the energy of binding, the better is the affinity of the molecule to the receptor (Kiran et al., 2018).

TABLE 1. DOCKING RESULTS OF PHYTOCHEMICALS WITH DNA GYRASE

S.No	Molecular Name	Binding Energy (kcal/mol)	Hydrogen Bond Interaction	No. of Hydrogen bonds
1	Chlorogenic acid	-4.82	LIG1:H – A: GLU139: N LIG1: H – A: GLU133: OE2 LIG1: H – A: GLU133: OE2 LIG1:H – A: GLU139: N LIG1: O – A: LYS129: NZ LIG1: H – A: GLU133: OE1	6
2	Caffeic acid	-4.86	LIG1:H – A: GLU325:OE2 LIG1:H – A: GLU325:OE2	2
3	Ellagic acid	-5.68	LIG1:H – A: GLU133:OE1 LIG1:H – A: ASP58:OD2 LIG1:H – A: GLU133:OE2 LIG1:H – A: ASP58:OD2	4

4	Kaempferol	-5.44	LIG1:H – A:ASN53:OD1 LIG1:H – A:ASP58:OD1, OD2 LIG1:H – A: GLU133:OE2 LIG1:O – A: ASP137:N	4
5	Quercetin	-5.84	LIG1:H – A: ASP58:OD2 LIG1:H – A: GLU133:OE2 LIG1:H – A: ASN53:OD1 LIG1: H – A: MET135: O LIG1:H – A: GLU133:OE2	5

The intermolecular interactions between the ligand and the DNA gyrase were investigated. Quercetin and Ellagic acid illustrate high affinity for protein molecules with score of -5.84 and -5.68 (Figure 3). Both phytochemical showed five and four hydrogen bond interactions with DNA gyrase protein. Quercetin shows interactions with GLU133, ASP58, ASN53, MET135 residues of protein. Ellagic acid showed hydrogen interactions with GLU133 and ASN58 residues of protein and was buried in active sites of protein**.**

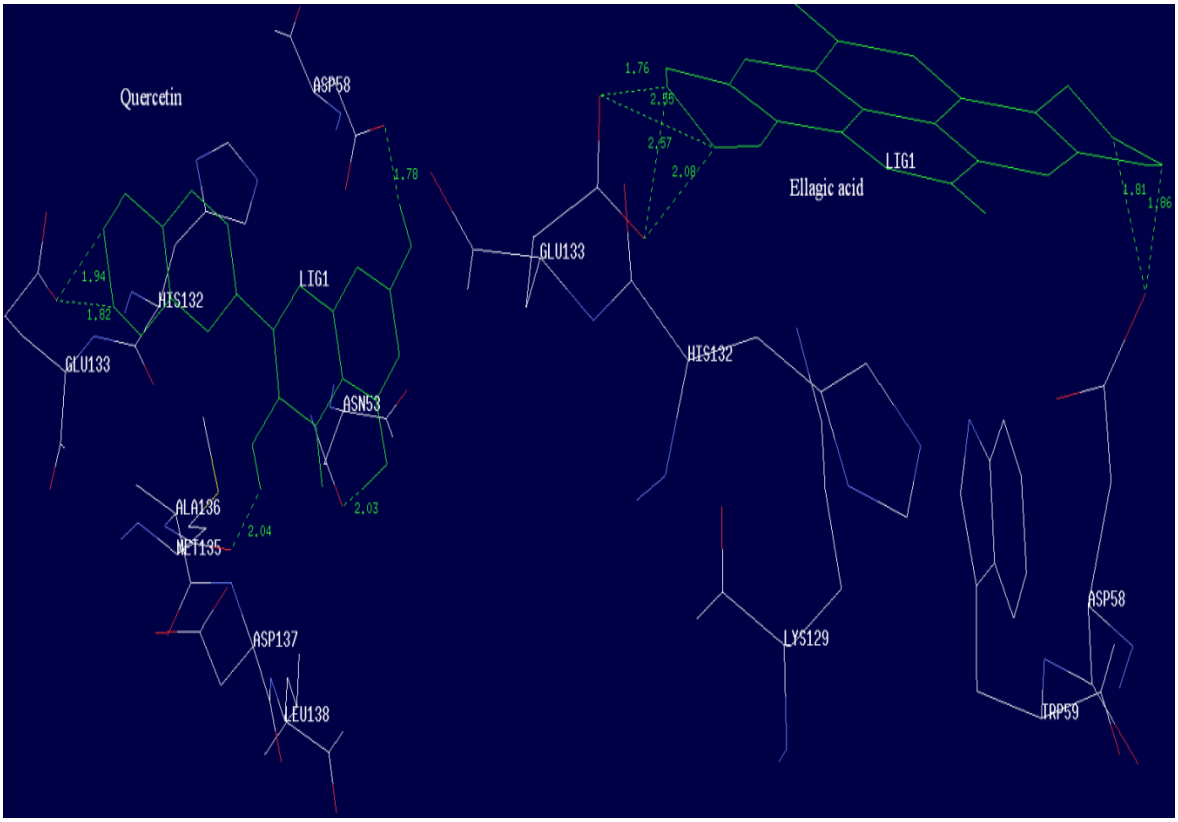

Figure 3: Quercetin and Ellagic acid interacting with residues of protein molecule

The five compounds demonstrated binding affinity towards receptor protein. Among analyzed compounds, Quercetin and Ellagic acid were identified with least binding energy of -5.84 and -5.68. The molecular docking of two compounds showed good binding mode and interaction energy. H-bond pattern was analyzed and confirmed interaction of molecules and showed that these phytochemicals possessed possible antibacterial activity.

IV. CONCLUSION

The data presented herein highlighted some conclusions regarding the affinity of compounds to protein target related to antibacterial action. These phytocompounds are naturally available in *Phaseolus lunatus* and have fewer side effects. *Insilico* analysis would be useful in value outcome of phytochemicals of *Phaseolus lunatus* seeds as well as prove useful in future drug discovery process against *Ecoli* infections. From current study, it can be concluded that Quercetin and Ellagic acid can be used as a DNA gyrase protein inhibitor in future. Further experimental studies on these compounds can be performed to validate inhibition activity and used in treatment of *Ecoli* disease.

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$InCl_3$-ASSISTED ECO-FRIENDLY APPROACH FOR N-FUSED 1,4-DIHYDROPYRIDINE SCAFFOLDS *VIA* RING OPENING MICHAEL ADDITION OF CYCLIC NITROKETENE AND IMINOCOUMARIN: SYNTHESIS AND DFT STUDIES

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ABSTRACT

A novel strategy was developed for the synthesis of twodifferent N-fused 1,4-dihydropyridine (1,4 DHP) scaffolds namely imidazo pyridine derivatives by coupling nitroketene S,S-acetal, various nitrogen containing dinucleophiles, malanonitrile and substituted salicylaldehydes/aldehydes in the presence of $InCl_3$ as catalyst in water-EtOH solvent mixture under reflux condition. Furthermore, mechanism for the formation of 1,4-DHPs was explored through experimental and DFT calculations. DFT studies reveal that the reaction went through lower energy triheterocyclic intermediate than the higher energy chromeno imidazopyridine intermediate. The attractive features of this protocol include short reaction time,easy separation of the product without chromatographic purification, simple execution with excellent yield and possibility to synthesize structurally diverse 1,4-dihydropyridine derivatives through greener approach.

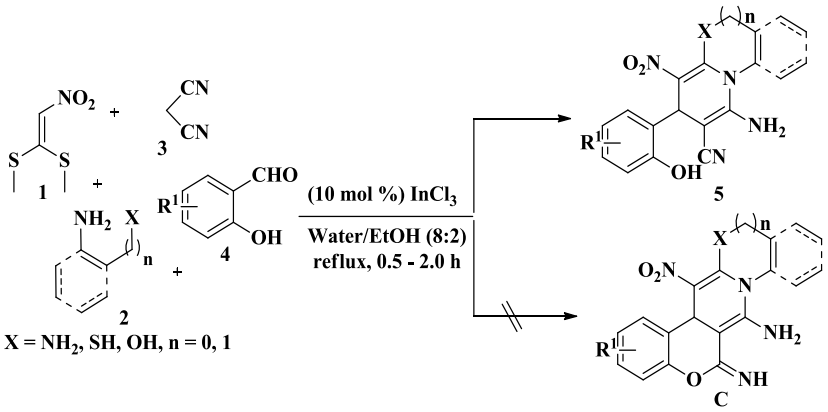
Keywords: Cyclic nitroketene · 1,4-Dihydropyridines · NMR and single crystal XRDstudies · $InCl_3$ · Michael addition

Introduction

A real challenge of synthetic organic chemist lies in the discovery and development of novel strategies for the synthesis of biologically significant heterocyclic scaffolds and reactive intermediates. The strategies must have minimum steps, produce high yield and follow eco-friendly approach which is very much essential for the modern drug discovery.[1] Due to ecological concern, effective methodologies are much needed to replace conventional stepwise methods which use harmful chemicals and solvents that produce vast amounts of waste. Multi component reactions (MCRs),[2] are important synthetic tool for replacing conventional methods to synthesize various biologically significant heterocyclic compounds. MCR consists of several advantages such as operational simplicity, reduced reaction time, high yield, reduced use of toxic and hazardous chemicals, and easy isolation of pure products that avoid tedious purification and reduced production of pollutants. Costs can also be reduced by diminishing of waste generated by organic solvents and chromatographic stationary phases.[3]Water can be considered to be nature's reaction medium and isa non-hazardous, non-flammable, non-toxic, uniquely redox stable, inexpensive solvent that has the additional advantage of being a non-exhaustible resource that is almost freely available even in the least developed countries.

1,4-Dihydropyridines (1,4-DHPs), as the significant "privileged structural motif" present in several natural products and pharmacologically related structures with wide range of pharmaceutical activities, are very attractive targets for combinatoriallibrary synthesis in modern drug discovery.[5,6] These derivatives showbiological activity by scavenging free radicals.[15] Similarly, indole and pyrrole N-fused bicyclic scaffolds, such as oxazinoindolesand dihydropyrrolooxazines exhibit potent antidepressantactivity,[16] and pollenopyrroside B possesses a wide rangeof biological activities, such as antioxidant and antitumor.Based on the pharmacological applications of these scaffolds multi-functionalized N-Fused 1,4-DHPs namely imidazopyridine derivatives was synthesized by using nitroketene S,S-acetal in the presence of

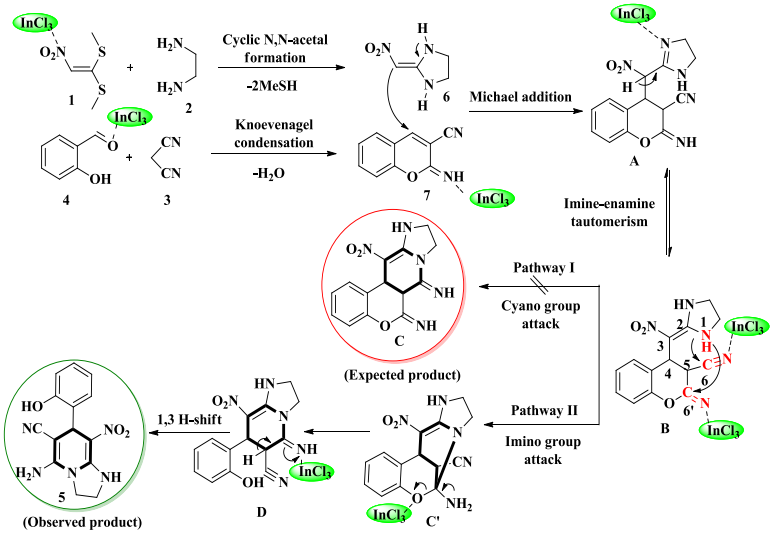
$InCl_3$under reflux conditions with a high atom economy in aqueousmedium via one-pot multi-component reaction is outlined in Scheme 1.



Scheme 1. Synthesis of 2-hydroxyphenyl-N-fused-1,4-DHP derivative 5

Materials and Methods

A plausible mechanistic pathway for the formation of compound 5 is outlined in Scheme 2.The first step is believed to be the formation of cyclic N,N-acetal 6 with elimination of MeSH by the reaction of nitroketene S,S-acetal 1 with ethylenediamine2, which was isolated and fully characterized. Simultaneously, reaction of malanonitrile 3 and salicylaldehyde4 give a Knoevenagel product 7 with elimination of H2O, whichis highly stable iminocoumarin intermediate that could beisolated. Subsequently, the cyclic N,N-acetal 6 undergoes aMicheal addition with iminocoumarin intermediate 7 to generateMichael adduct A. The adduct A undergoes imine–enaminetautomerism to give intermediate B, which rapidlyundergoes intramolecular 6-exo-dig-cyclisation with cyanogroup attack via pathway I (formation of six member ring via1,2,3,4,5,6) to give C as expected product. Similarly, intermediateB undergo another possible intermolecular imino groupattack via pathway II (formation of six member ring via1,2,3,4.5,6') to give the triheterocyclic intermediate C'. This C'undergoes O-bond cleavage in



Scheme 2. Plausible mechanism for formation of compound 5.

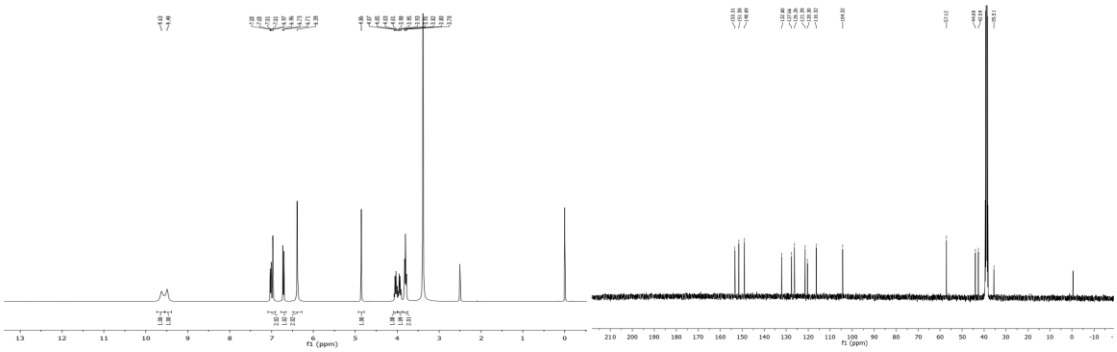
the presence of the catalyst to give D and followed by 1, 3 H-shift to give final product 5. Inorder to find the mechanistic pathway, we tried to separate allthe intermediates. But, the intermediates could not be separated except intermediates 6 and 7. It shows that the intermediates 6 and 7 might be formed concomitantly and reacted rapidly to give the product 5.

Results and Discussion

The synthesis of biologically significant heterocyclic compounds and use of Indium salts as catalyst report the facile and efficient synthesis of multi-functionalized N-fused 1,4-DHPnamelyimidazopyridinederivative by one-pot four-component coupling of nitroketene S,S-acetal, various nitrogen based dinucleophiles, malanonitrile and substituted salicylaldehydes/aldehydes in the presence of $InCl_3$ as catalyst using water-EtOH mixture as a solvent medium at reflux condition (Scheme 1). The reactions were accomplished within 0.5-3 h and the pure solid products were sequestered in good yield by simple filtration of the reaction mixture at the end of the reaction.The product was obtained 0.5-3 h and reaction proceeded smoothly affording a series of 2-hydroxyphenyl-N-fused-1,4-DHP derivatives **5** in excellent yields as 79-92 %.

5-amino-7-(5-chloro-2-hydroxyphenyl)-8-nitro-1,2,3,7-tetrahydroimidazo[1,2a] pyridine-6-carbonitrile (5a)

White solid, Yield: 89 %, m.p.: 242-244 ˚C; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.63 (s, 1H), 9.49 (s, 1H), 7.08 – 6.92 (m, 2H), 6.72 (d, J = 8.5 Hz, 1H), 6.39 (s, 2H), 4.86 (s, 1H), 4.04 (dd, J = 18.5, 9.1 Hz, 1H), 3.94 (dd, J = 17.5, 9.0 Hz, 1H), 3.80 (t, J = 8.7 Hz, 2H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 153.31, 151.58, 149.09, 132.00, 127.66, 126.26, 121.39, 120.30, 116.32, 104.32, 57.12, 44.00, 42.59, 35.51. ESI-HRMS: Anal. Calcd for $C_{14}H_{12}ClN_5NaO_3$ [M^+ + Na]: 356.0526, found: 356.0532.



^{1}Hand ^{13}C NMR of 5a

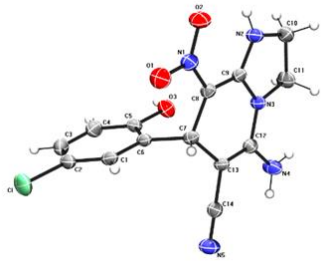


Figure 1. ORTEP diagram of **5a**

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CONCLUSION

A simple and straightforward one-potfour-component domino protocol for the synthesis ofN-fused-1,4-dihydropyridine scaffolds namelyimidazopyridine derivative using $InCl_3$ as catalystin water–EtOH (8 : 2; v/v) at reflux condition was reported. The mechanistic pathway of final products through both experimental and DFT calculations was investigated. This facile and versatile method exemplifies multiple bond-forming efficiency, step economies, excellent yield, good functionality tolerance, inexpensive starting material, broad substrate scope, operational simplicity, time and cost effective through environmentally friendly approach. Significantly, the presence of -NH2,-CN and -NO2 groups on 1,4-DHP scaffolds make these compounds excellent entities as precursors.

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GREEN SYNTHESIS AND CHARACTERIZATION OF COPPER OXIDE (CuO) NANOPARTICLE USING *PRUNUS PERSICA* LEAF EXTRACT AND ITS ANTIMICROBIAL ACTIVITY

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ABSTRACT

The development of nanotechnology is making the interest of researchers towards Green synthesis of nanoparticles. In the present project copper oxide nanoparticles were synthesized using *Prunus persica* leaf extract. The leaf extract act as a reducing agent. The synthesized copper oxide nanoparticles were confirmed by the change of colour after addition of leaf extract into the copper acetate solution.The phytochemical screening of *Prunus persica* leaf extract was done.The biosynthesized CuO Nanoparticles were characterized by using UV-Vis analysis, Fourier Transform Infrared analysis (FTIR), X-ray diffraction analysis (XRD), Scanning Electron Microscopy (SEM). The antimicrobial study of the CuO Nanoparticles was established using both gram positive and gram negative pathogens.
KEY WORDS: Green synthesis, *Prunus persica*, Copper oxide, Nano particle.

INTRODUCTION

Nanotechnology plays an important role in modern research, it can be applied in almost all fields such as pharmaceutical, electronics, health care, food and feed, biomedical science, drug delivery, chemical industry, energy science, cosmetics, environmental health, mechanics and space industries. Advancement of nanotechnology is increasing the interest of researchers towards synthesis of nanoparticles because nanoparticles have a rising application towards medical field [1]. In recent years, synthesis of metal nanoparticles using plant extracts attracted attention of many researchers because of availability of materials, inexpensive and easy processes to carry out in any laboratory and use of non-toxic reagent. There are many ways to synthesize nanoparticles such as sol gel method, chemical reaction, solid state reaction and co-precipitation. Compared to those methods green synthesis method is one of the best method for synthesis of nanoparticles [2]. Metal oxide nanoparticles are of interest because of their unique optical, electronic and magnetic properties. Oxides of transition metals are an important class of semiconductors, which have applications in magnetic storage media, solar energy transformation, electronics, gas sensors and catalysis[3].Due to their high conductivity, copper oxide nanoparticles are applied in conductive inks, adhesives and pastes for a range of electronic devices [4]. Copper oxide is less expensive when compared to silver and gold which possess antimicrobial potential. CuO nanoparticles are potentially high valuable antimicrobial agents due to the fact that when synthesized, they possess extremely unusual crystal morphologies and high surface areas [5]. Various plants were used for the synthesis of nanoparticles using green synthesis method. In this present investigation, *Prunus persica* belonging to the family of Rosaceae commonly known as Peach has be used for the synthesis of copper oxide nanoparticles by green synthesis method.

EXPERIMENTAL METHODS

COLLECTION OF *PRUNUS PERSICA* LEAVES

Prunus persica leaves were collected from agricultural lands of Munnar in Kerala. Leaves were washed with tap water several times and then washed with distilled water 2-3 times to remove dust particles**.** Washed leaves were dried.

PREPARATION OF *PRUNUS PERSICA* LEAF EXTRACT

All glass wares were washed with deionized water and then dried. About 5g of *Prunus persica* leaves were taken in 250 ml beaker and 100ml of deionized water was added and boiled for 30 minutes. After cooling, the extract was filtered using filter paper and stored for further usage. The extract was yellow in colour.

PHYTOCHEMICAL SCREENING

Extract of *Prunus persica* leaves was subjected to preliminary phytochemical screening to identify chemical constitution of plant. Methods of analysis were carried out using standard qualitative method as described by various researchers Kotate, (1999) and Harbrone, (1984). The samples were screened for presence of bioactive compounds.

PREPARATION OF COPPER (II) ACETATE SOLUTION

0.1N copper (II) acetate solution was prepared by dissolving 1.816 g of copper acetate in 100 ml distilled water and stored in clean dry flask.

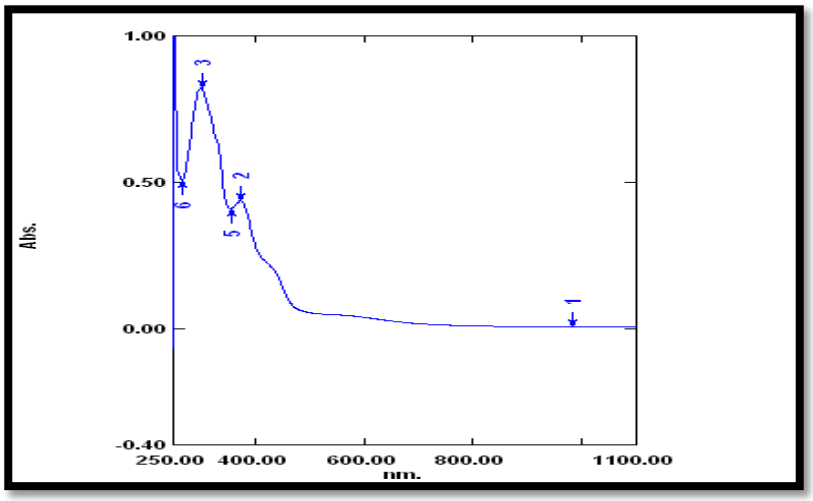
GREEN SYNTHESIS OF COPPER OXIDE NANOPARTICLE

10ml of *Prunus persica* leaf extract was added to 5 ml of 0.1N copper (II) acetate solution and mixed well, colour of solution changed from yellow to brown. Colour change may be due to formation of copper oxide nanoparticles. Solution was allowed to settle and then filtered, dried and stored for further characterization**.**

RESULTS AND DISCUSSION

UV-VISIBLE SPECTROSCOPY

In the present study the synthesized copper oxide nanoparticle had λ_{max}at 266 nm indicating the presence of oxide of copper metal. Similar observation was also made by Ahmed *et al* (2003) and Jayalakshmi *et al* (2014).



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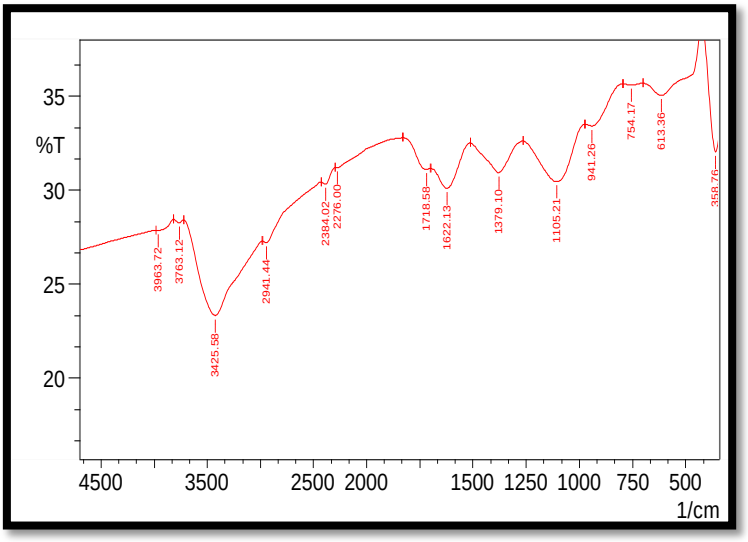
FTIR ANALYSIS



FTIR value	Possible functional group
3763 cm^{-1}	O-H stretching frequency
3425 cm^{-1}	N-H stretching frequency
2941 cm^{-1}	C-H stretching frequency
1622 cm^{-1}	C=C bending frequency
1379 cm^{-1}	C-H bending frequency
1105 cm^{-1}	C- O stretching frequency
754 cm^{-1}	C-Cl stretching frequency
613 cm^{-1}	C-Br stretching frequency

FTIR analysis of copper oxide nanoparticles suggested that they might be surrounded by any of these molecules such as phenols and terpenoids, Kalainila *et al* already reported the same type of results.Important compounds in the plant extract are hydroxyl and carbonyl groups. Both functional groups allowed plant extract to act as reducing agent as well as stabilizing agent. Chemical constituents present in plant leaves extract such as flavonoids, alkaloids and phenols are responsible for reduction of copper ions into copper oxide nanoparticle due to their capping and reducing capacity.

XRD PATTERN

The sizes of the synthesized CuO nanoparticles were calculated from powder XRD pattern using Debye - Scherrer's formula,

$$D=k\lambda/\beta \cos\theta$$

Where,
D - the particle size can be calculated using the equation
θ is the Bragg's angle for the peak
β is the Full Width for Half Maximum for the diffracted peak (FHWM)
λ is the wavelength having value 1.5406
k is Scherrer's constant≈ 0.94

Particle	2 θ (deg)	FWHM(deg)	Peak Number	Crystalline size
Particle (I)	23.0349	0.7587	11	1.8701 nm
Particle (II)	28.5722	0.7444	17	2.6130 nm

In the present study the size of the synthesized copper oxide nanoparticle from copper acetate using *Prunus persica* leaf extract was found to be 1.8701nmand 2.6130nm.Similar observation was also made by Rozina Shaikh*et al* (2016).

SCANNING ELECTRON MICROSCOPE (SEM)

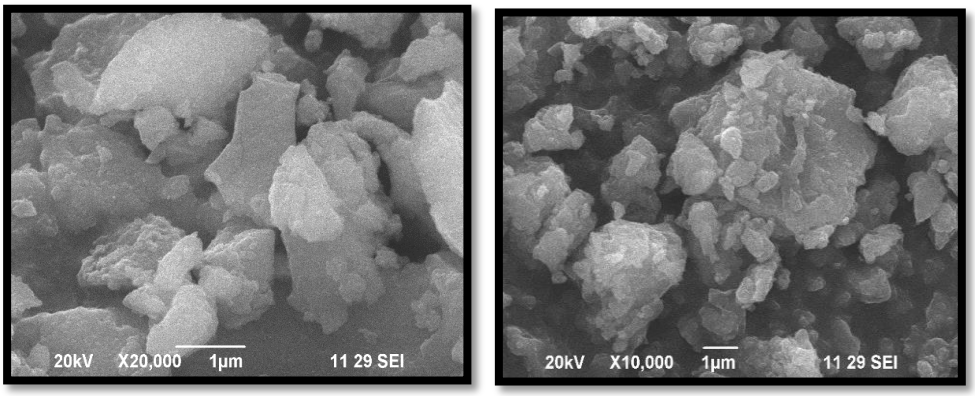


Image obtained by SEM for synthesized CuO nanoparticle showed spherical shaped nanoparticles.

ANTIMICROBIAL ACTIVITY

In the present study synthesized CuO nanoparticles were analysed for inhibition against the bacteria and fungi using Agar diffusion method. The zone of inhibition values for the bacteria and fungi are given in the table. As compared with the standard the synthesized copper oxide nanoparticle having better zone of inhibition values

Zone of inhibition (mm)				
	Bacteria			Fungi
Sample code	***Salmonella typhi***	***Pseudomonas***	***Streptococci***	***Candida albicans***
CuO(*Prunus persica*)	10	8	13	10
Standard (Amikacin)	18	17	17	15
Control	Resistant	Resistant	Resistant	Resistant

CONCLUSIONS

- Phytochemical screening of *Prunus persica* leaf extract showed presence of anthocyanin, saponin, triterpenes, flavonoids, tannin, alkaloids, phenol, lactones and the absence of steroids, coumarins, quinones, carbohydrates and proteins. During the biosynthesis, formation of CuO nanoparticles was indicated by change in colour of mixture (copper acetate and *Prunus persica* leaf extract) from blue to brown after the addition of copper actate into *Prunus persica* leaf extract.
- UV-Vis spectroscopy showed λ_{max} value for the synthesized copper oxide nanoparticle from copper acetate using *Prunus persica* leaf extract at 266 nm.
- FTIR study showed the peak values at 3763 cm^{-1} (O-H stretching frequency), 3425 cm^{-1} (N-H stretching frequency), 2941 cm^{-1} (C-H stretching frequency), 1622 cm^{-1} (Aromatic group (C=C)), 1379 cm^{-1} (C-H bending frequency), 1105 cm^{-1}C-O stretching frequency, 754 cm^{-1} (C-Cl stretching frequency), 613 cm^{-1} (C-Br stretching frequency).
- XRD data showed that size of synthesized copper oxide nanoparticle from copper acetate using *Prunus persica* leaf extract was found to be 1.8701nm and 2.6130 nm.
- SEM image showed that shape of synthesized copper oxide nanoparticle was spherical in shape.
- Synthesized copper oxide nanoparticle from copper acetate using *Prunus persica* leaf extract had greater antimicrobial activity against selected bacteria and fungi.

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SYNTHESIS, SPECTRAL CHARACTERIZATION AND BINDING STUDIES OF NEW COPPER(II) COMPLEXES OF 4-METHOXYSALICYLALDEHYDE-4(*N*)-SUBSTITUTED THIOSEMICARBAZONE

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Abstract

Four Cu(II) complexes were synthesized by the reaction of dichlorobis (dimethyl sulfoxide) copper(II) [$Cu(DMSO)_2Cl_2$] with 4-methoxysalicylaldehyde-4(*N*)-substituted thiosemicarbazone [4-MSal-Rtsc], where R= H, CH_3, C_2H_5 and C_6H_5. The new Cu(II) complexes were characterized by various spectral techniques (IR, UV-Vis and ^{1}H-NMR). Their binding interaction with calf-thymus DNA (CT-DNA) and protein (Bovine serum albumin) was analyzed by using emission spectral titration studies and cyclic voltammetry. The observations indicated significant binding ability of the complexes **1–4** with CT-DNA and BSA.

Introduction

Copper is the one of the earliest metal. It's malleable, ductile, good conductor and produce rich colors.[1] Copper(II) complexes with semicarbazide and thiosemicarbazide have received much attention due to their application as antiviral drugs, exhibiting superior activity compared to that of uncomplexed ligand.[2] *Copper is the one of the most abundant elements in the earth crust. It exist in two oxidation state +1 and +2. Among these +2 is most common and its complexes have been extensively studied. These complexes have octahedral, tetrahedral, square planar and trigonal bipyramidal geometries.[3] Due to the presence of unpaired electrons copper(II) complexes are paramagnetic. DMSO can ligate metal atoms by bonding in one of two possible ways; through the oxygen atom or through the sulfur atom.[4] Among the platinum group metals, ruthenium, nickel, copper, palladium and platinum complexes have been studied extensively.[5]* The present work deals with the synthesis, spectral characterization and DNA/BSA binding studies of new Cu(II)complex containing 4-methoxy salicylaldehyde-4(*N*)-substituted thiosemicarbazone.

Experimental Section

All the reagents used were analar grade and were purified and dried according to standard procedures.[6] The ligands (HL^{1-4}) were synthesized according to the standard literature procedures. [7] The cyclic voltammetric studies were performed on CH-1660E electrochemical workstation.

General procedure for Synthesis of complexes

To a solution of [$Cu(DMSO)_2Cl_2$] (0.3439 mmol) in acetonitrile (5 ml), 4-methoxysalicylaldehyde substituted thiosemicarbazone (0.3439 mmol), in acetonitrile (5 ml) were added. The reaction mixture was then refluxed for 5 h. The dark green suspension gradually turned to brown. The solvent was removed under reduced pressure. The brown solid that formed was washed with petroleum ether (60–80°C) 2–3 times.

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Complex	Yield	Colour	Melting point
Cu(Msal-tsc)Cl	71%	Brown	300°C
Cu(Msal-mtsc)Cl	78%	Brown	300°C
Cu(Msal-etsc)Cl	67%	Dark Brown	178°C
Cu(Msal-ptsc)Cl	68%	Dark Brown	110°C

DNA Binding study

Measurements of emission intensity were carried out by using a buffer solution of 5% DMSO/5 mM Tris–HCl/50 mM NaCl as a blank to make preliminary adjustments. DNA was pretreated with EB in the ratio of [DNA/EB] = 10 for 30 min at 27°C. The metal complexes were then added to this mixture, and their effect on the emission intensity was measured.

BSA binding experiments

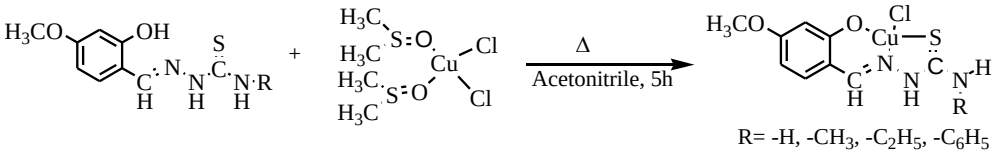
A protein binding study was performed via fluorescence quenching experiments on tryptophan using bovine serum albumin (BSA, 10 mM) as the substrate in phosphate buffer (pH 7.2). Quenching of the emission intensity of tryptophan residues of BSA at 347–349 nm (excitation wavelength of 280 nm) was monitored using ligands (HL^{1-4}) and their complexes (**1-4**) as quenchers with increasing concentrations of the complexes.

Electrochemistry

Electron transfer properties of new complexes (10 ml, 1 mol) and its binding ability with CT-DNA were performed by Cyclic voltammetry using methanol solvent. The working electrode was glassy carbon electrode, Ag/AgCl electrode as the reference electrode, platinum wire as the counter electrode and tetrabutylammoniumperchlorate as supporting electrolyte at a scan rate of $100mvs^{-1}$. Cyclic voltammogram of complexes **1-4** were recorded then five successive additions of 10µl DNA to the new complexes were studied, the change in the potential and current values were noted.

Results and Discussion

The reactions of $[Cu(DMSO)_2Cl_2]$ with an equimolar amount of 4-methoxysalicylaldehyde-4(*N*)-substituted thiosemicarbazones (HL^{1-4}) were refluxed in CH_3CN medium resulted in the formation of new complexes (Scheme 1). The complexes are soluble in common organic solvents such as CH_2Cl_2, acetonitrile, ethanol, methanol, DMF and DMSO.



Scheme 1: Preparation of new Cu(II) complexes

Spectral studies

The IR spectra of the ligands HL^{1-4} showed the absorption bands at of 3458, 3360, 3361, 3339 cm^{-1} respectively corresponding to $\nu_{(O-H)}$ group, which was completely disappear after complexation with the copper(II) ions showing deprotonation prior to coordination through oxygen atom. An azomethine nitrogen $\nu_{(C=N)}$ bands at 1593, 1629, 1692, 1589cm^{-1} and in the new

complexes (**1-4**) has been shifted to the range of 1609,1605, 1659, 1602 cm^{-1} respectively, indicating the coordination of azomethine nitrogen atom.[8] A sharp bands at 771, 780, 795, 736 cm^{-1} assigned to $\nu_{(C=S)}$ in the ligands has retained in the spectra of the complexes at 721, 776, 775 and 736 cm^{-1} respectively due to $\nu_{(C=S)}$ indicated the coordination of thione sulphur atom.[9] From the IR spectra of the new complex it is inferred that the ligand coordinated as ONS ligand to the Cu through its phenolic oxygen, thione sulphur and hydrazinic nitrogen and it act as a tridentate monobasic manner.[10] In UV-vis (DMSO), λ_{max} : 310-315 nm ($n \rightarrow \pi^*$) and 375-385 nm assigned Ligand to Metal Charge Transition for complexes **1-4**. The ^1H NMR spectra of the new copper(II) complexes were recorded in $CDCl_3$. In those spectra no peaks were found. The NMR inactiveness of the complexes confirms the paramagnetic nature and its +2 oxidation state.

DNA Binding Studies:

The ability of the complexes to bind to CT-DNA was confirmed by ethidium bromide (EB) displacement studies (Fig 1). The addition of the complexes **1–4** (0–50 mM) to CT-DNA which is pretreated with EB in a Tris HCl-buffer, decreases of emission intensity indicates the binding capability of metal complexes to EB-DNA. Upon addition of complexes **1-4** to CT-DNA caused significant reduction in the emission intensity at 602 nm (Fig.1) which indicates that the replacement of the EB fluorophore by respective complexes. The quenching extents of complexes **1-4** were evaluated qualitatively by employing Stern–Volmer equation (1). Using the classical Stern-Volmer equation, the quenching constant was determined (Fig 2 and table 1).

$$I_0/I = K_{sv}[Q] + 1 \qquad (1)$$

Table.1. Ksv value for the interaction of the complexes **1-4** with CT-DNA+EB

Complexes	**K_{sv} x 10^4**
1	0.313
2	0.468
3	0.481
4	0.322

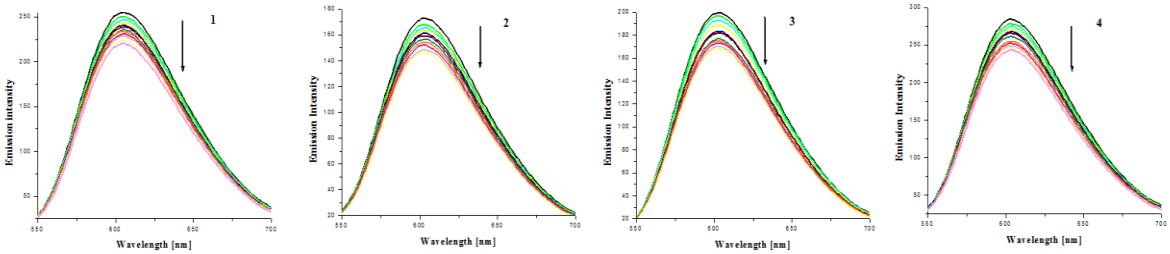


Fig. 1: Emission spectra of the DNA-EB system (λ_{emi}=602 nm) of complex **1-4**.

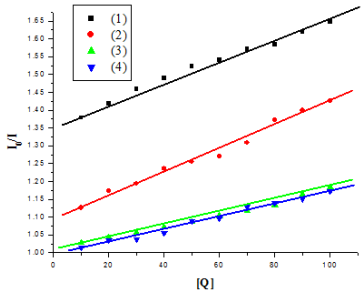


Fig. 2: Stern Volmer plot of complexes **1-4**

BSA binding Studies:

The interactions between the synthesized cupper(II) complexes **1-4** and bovine serum albumins (BSA) was studied by using fluorescence spectroscopy. When excited at 280 the emission spectra of BSA was shown to display an intense fluorescence observed at 338 nm.[11] This is mainly due to the tryptophan residues of the serum albumin. **Fig. 3** showed the effect of increasing concentrations of the complexes on the emission intensity of BSA. Addition of increasing amounts of the complexes to BSA solution resulted in the quenching of emission intensity of the band at 338 nm.

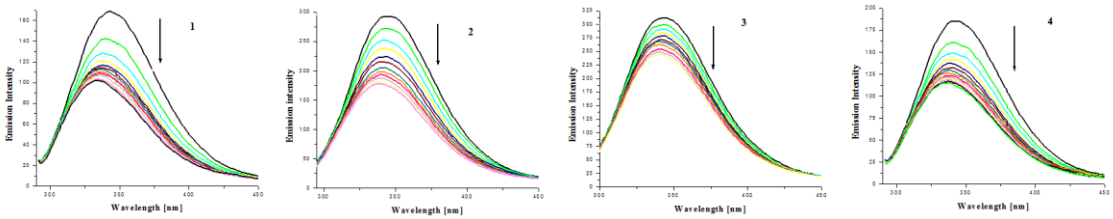


Fig. 3: Emission spectra of BSA (10 μM; λ_{em}: 338 nm) in the presence of increasing concentration of the complexes (0-50 μM)

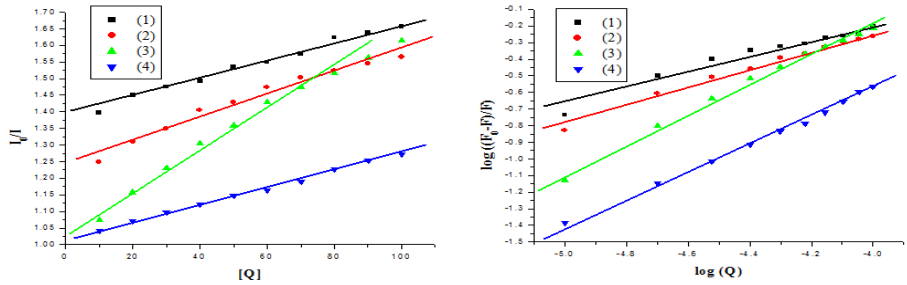


Fig. 4: Stern Volmer plots and Scatchard plots of the complexes **1-4**

Table. 2. Quenching constant (K_{SV}), binding constant (K_b) and number of binding sites (n) for the interactions of complexes with BSA

Complexes	K_{sv} x 10^4	K_b x 10^3	n
1	0.282	0.047	0.76
2	0.256	0.262	0.815
3	0.589	0.489	0.901
4	0.317	0.072	0.73

Electrochemistry

Electron transfer properties of new complexes (10 ml, 1 mol) and its binding ability with CT-DNA were studied (**Fig. 5**). From the electrochemical studies it is inferred that the current and potential corresponding to complexes (around -0.6×10^{-5} A, 0.5V) significantly varied with the successive addition of CT-DNA to the values of (around -0.85×10^{-5} A, 0.5V) current and potential respectively. This indicates the considerable binding interaction of DNA with complexes.

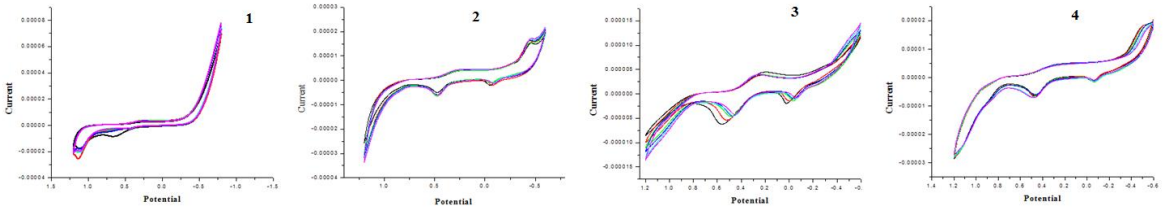


Fig. 5: Cyclicvoltammogram for complex **1-4**

Conclusion

Four new mononuclear copper(II) complexes were synthesized and characterized by various spectroscopic techniques. The NMR inactiveness of the complexes confirms the paramagnetic nature and its +2 oxidation state. From the spectral studies, it is inferred that the ligands acted as a tridentate monobasic fashion and resulted square planar complexes by utilizing their azomethine nitrogen, phenolic oxygen and thione sulphur atoms, forming a five member and six member chelate rings. CT-DNA/protein binding studies were carried out for all the complexes. The complex **3** exhibited higher binding ability than other complexes.

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SYNTHESIS, CHARACTERIZATION AND PHOTOCATALYTIC ACTIVITTY OF ZIRCONIA ON MUREOXIDE

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Abstract

The photocatalytic degradation of mureoxide by undoped zirconium dioxide has been studied and the progress of the reaction was observed spectrophotometrically at 616nm. The effect of various operating variables like temperature, concentration of dye, amount of semiconductor and light intensity on the rate of degradation was observed. A tentative mechanism has been proposed for the photocatalytic degradation of the dye, involving hydroxyl radical as an active oxidizing species.
Key Words: Photocatalyst, Dye, Degradation, Mureoxide

INTRODUCTION:-

Metal are very strong and durable and therefore used to make many things. These are used for making automobiles, satellites. Most metal are hard but some are not. All metal are good conductors are electricity. Photocatalysis is the acceleration of a photo reaction in the presence of catalysis. In catalyzed photolysis light absorbed by an absorbed substrate. In photo generated catalysis, Photocatalysis activity depends on the ability of the catalysis to create electron hole pair which generates free radicals. It's able to undergo secondary reaction.(1) When metal absorbs UV light a chain of events possibly leading to the production of radicals is initiated. These radical can attack the surroundings of the pigment and that can cause breakdown of the organic medium resulting in embrittlement loss of gloss or chalking. When colorants, pigments or dyestuffs are involved, the color can also be affected. If one of the step leading to radical formation is prevented, the catalytic degradation cycle is stopped.

The pollution of water owing the color effluents originating from various industrial capacities is current problem worldwide. Textile dyes and other industrial dyestuffs form one of the largest groups of organic compounds that represent an increasing environmental danger. Textile industry waste water is known to contain considerable amounts of non fixed dyes, azo dye and a quantity of inorganic salts.(2) The most of the dyes used in dying processes are released into the environment. For instance, azo dyes, the most important and frequently used foe colorization in textile industries endanger human health due to either toxic or mutagenic and carcinogenic effect. They are very stable because of their complex aromatic structures, hence are difficult to degrade. Congo red is typical and the first synthetic dye of anionic azo dyes, which is synthesized by coupling tetrazotised benzidine with two molecules of napthionic acid. The quick recombination of change carriers is the main factor influencing the photocatalytic activity.(3)

MATERIALS AND METHODOLOGY

Experimental work carried out for the degradation of Mureoxide dye using zirconium dioxide has been explained. The experimental section includes, (i) Synthesis of ZrO_2 by sol-gel method, (ii) Characterization of ZrO_2 (iii) Degradation of Mureoxide dye

SYNTHESIS OF ZIRCONIUM DIOXIDE

Zirconium was synthesized by sol-gel method. Zirconium acetate was added with Con.HCl in drop wise manner with constant stirring. Then quantitatively weighed polyvinyl propylene was added in the above mixture followed by 25ml distilled water with constant stirring.

Then to this mixture, 200ml of distilled water was added with constant stirring for 18hrs by using magnetic stirrer. After stirring, ammonium buffer solution was added. Then the mixture was kept in furnace for calcination. The calcinations process was carried out in 450˚C. The mixture was kept in furnace for 3hrs and then it is ground well in a mortar. The sample was collected.

CHARACTERIZATION OF ZrO_2

The newly synthesized zirconia was characterized by IR and UV spectroscopy, SEM analysis and XRD studies.

DEGRADATION REACTION

Dye solution was prepared for photo degradation studies. Mureoxide dye is used. 100ppm dye solution was prepared taking 0.1g Mureoxide in water and made up to 100ml. This made up solution is tested for (i) Effect of dye concentration with time, (ii) Effect of catalyst concentration, (iii) Effect of temperature. These factors are also examined for UV data.

RESULTS AND DISCUSSION

CHARACTERIZATION OF METAL OXIDE

FT-IR spectrum of the metal oxide ZrO_2 shows bands observed at 3293.82 and 1629.55cm^{-1} are assigned to the bending and stretching vibration of the O-H bands due to absorbed water molecules. The bands at 449.7 to 621.933cm^{-1} corresponds to various vibrations of the Zr-O bonds. The observation of absorbed peak at 1071cm^{-1} implied that the hydrated molecules could be in several different energetically bonding states.

XRD ANALYSIS OF THE CATALYST

XRD patterns of synthesised ZrO_2 are shows Peaks appearing at 2Θ: 29.6531, 49.8066, 59.3791 corresponding to the diffraction patterns of (101), (112) and (211) respectively of the pure tetragonal phase of ZrO_2. The percentage crystallinity of the catalyst is also determined and is found to have 56.93% crystalline in its structure. The results are tabulated in Table 1 and 2. The percentage crystallininty is calculated using the following formula:

$$\% \lambda_C = \frac{I_c}{I_c + I_a} \times 100$$

SEM ANALYSIS OF THE CATALYST

The surface morphology of ZrO_2 was investigated using SEM. Fig 1 shows the SEM of ZrO_2 which shows a compact arrangement of uniform particles and are almost irregular in shape. The particles are more or less spherical in shape and each particle is found to be aggregate of very small crystallites.

DEGRADATION OF MUREOXIDE

The photocatalytic degradation of mureoxide is observed at λ_{max} = 201-495nm. The plot of log OD Vs time was found to be a straight line. The rate of the reaction was determined using the expression K= 2.303 x slope

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EFFECT OF TEMPERATURE

Reaction was followed at four different temperature is the range of 40 K using 0.02mg of the catalyst. Results are given Table 3. The results indicate that the photodegradation increases with temperature. This may be due to fact that adsorption of reactants on the surface of catalysts is spontaneous exothermic phenomenon enhanced by reaction of temperature.

EFFECT OF DYE CONCENTRATION WITH TIME

Effect of variation of Catalyst concentration was studied by taking different concentration of dye. The results are tabulated in Table 4. From the results, it is evident that the rate of photocatalytic degradation increases concentration of the dyes. This may be due to the fact that as the concentration of the catalyst increased, more dye molecules were available for excitation followed by inter system crossing and hence, there was far increase in the rate.(4) The rate of photocatalytic degradation was found to decrease with increase in the concentration of dyes further. Here, the dyes acting as a filter for the incident light and it does not permit the light to reach the metal oxide and these, decreasing the rate of photocatalytic activity.

EFFECT OF AMOUNT OF ZIRCONIUM DIOXIDE

The amount of metal oxide is also likely to affect the process of dye degradation and the results are summarized in Table 5. It has been observed that, as the amount of catalyst was increased, the rate of photodegradation of dyes increases but the reaction rate becomes constant after a certain amount of catalyst. This may be due to the fact that, as the amount of catalyst increased, the exposed area also increases but after a certain limits, the amount of catalyst has no effect on the rate of photocatalytic degradation.(5) This may be considered as saturation point above which any increases in amount of catalyst only increase the thickening of the layer.

MECHANISM

On the basis of experimental observations, a tentative mechanism may be proposed

$$^1Dye_0 \xrightarrow{h\gamma} {}^1Dye_1$$

$$^1Dye_1 \xrightarrow{h\gamma} {}^3Dye_1$$

$$Catalyst \xrightarrow{h\gamma} e^- (CB) + h^+ VB) / cat^+$$

$$H^+ + OH^- \longrightarrow {}^{\bullet}OH$$

$$^3Dye_1 + {}^{\bullet}OH \longrightarrow Products + l\ dye$$

Dye may absorb radiation of suitable wavelength; it is exited to its first singlet state followed by intersystem crossing (ISC) to triplet state. Catalyst also utilized incident light to exist its electron to conduction bond leaving behind a hole. This hole may abstract an electron from OH^- to from $^{\bullet}OH$ radicals. The exited dye may be oxidized to products by $^{\bullet}OH$ radicals.

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TABLES`

Table 1. X-RAY DIFFRACTION DATA

S.No	Stronges t Peak	2ϴ	D	Relative Intensity
1	5	29.6531	101	2181
2	13	49.8066	112	1717
3	16	59.3791	211	1226

Table 2. Percentage crystallinity of the catalyst

S.No	Total Intensity of the strongest peaks (I_c)	Total Intensity of broad peaks (I_a)	% Crystallinity $=I_c/I_c+I_aX100$
1.	5724	3876	56.93

Table 3. Effect of Temperature

S.NO	WEIGHT(g)	TIME(min)	Observed OD
1.	0.02	40	1.7625
2.	0.02	50	2.0370
3.	0.02	60	2.9076
4.	0.02	70	2.9580

Table 4. Effect of dye concentration with time

S.NO	WEIGHT(g)	TIME(min)	Observed OD
1.	0.02	15	1.3336
2.	0.02	30	1.5688
3.	0.02	45	1.6171
4.	0.02	60	1.7458
5.	0.02	75	1.8428

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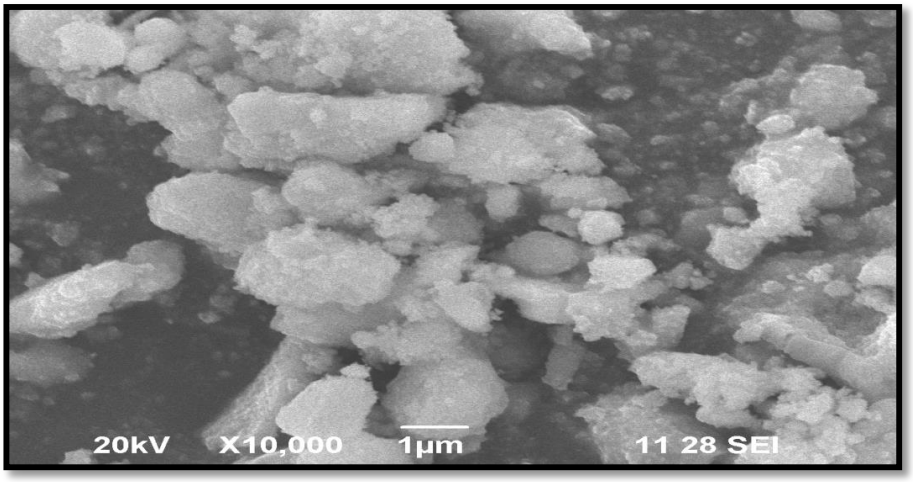
Table 5. Effect of Catalyst Concentration

S.NO	WEIGHT(g)	Observed Optical Density
1.	0.02	0.8331
2.	0.04	1.3258
3.	0.06	1.5245
4.	0.08	1.7332

Scanning Electron Microscope Image



The SEM images of the Catalyst

CONCLUSION

The existence of catalyst and lights is essential for photocatalytic degradation of colored dyes. Visible light/ ZrO_2 system could be efficiently used for the photodegradation of organic dyes. The results indicate that the degree of photodegradation of organic dye was affected by different parameters. The procedure used in this present work can be improved and used as an efficient technology for photocatalytic degradation of organic dyes.

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SCREENING STUDY OF STEM EXTRACT FROM *ECHINOPSIS CALOCHLORA* SCHUM OF CACTACEAE

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Abstract

Plants and plant-based medicaments are the basis of many of the modern pharmaceuticals we use today for our various ailments. The aim of the study was to find out the bioactive chemical constituents and to evaluate the antimicrobial activity of the alcoholic extract of-*Echinopsis calochlora* schum(ECS-S). A qualitative phytochemical analysis was performed for the detection of alkaloids, glycosides, terpenoids, steroids, flavonoids, tannins and reducing sugar. Knowledge of the chemical constituents of plants is desirable, not only for the discovery of therapeutic agents, but also because such information may be of value in disclosing new sources of such economic materials as tannins, oils, gums, precursors for the synthesis of complex chemical substances.
Keywords : flavonoids, phytochemical, antimicrobial activity, alkaloids, glycosides.

1. Introduction:

Phytochemicals are chemical compounds formed during the plants' normal metabolical processes [1].These chemicals are often referred to as secondary metabolites of which there are several classes including alkaloids, flavonoids, coumarins, glycosides, gums, polysaccharides, phenols, tannins and terpenoids [2]. In contrast to synthetic pharmaceuticals based upon single chemicals, many medicinal plants exert their beneficial effects through the additive or synergistic action of several chemical compounds acting at single or multiple target sites associated with physiological process. The primary metabolites are of major importance to plants [3]. The secondary metabolites are of medicinal value to man and these can equally be obtained from various anatomical structures of plants [4].Different parts of the plant have different active constituents and these active constituents may vary in their extent of activity and concentration. Most of active principles are existing in leaves, flower, fruit, bark, root and seeds of the plant. Plant products are often used traditionally to treat many diseases like fever, cold, malaria, rheumatism, aches, toothaches, headaches, indigestion, ulcers, diarrhea, constipation, dysmenorrheal and irregular menstruation. The knowledge of the chemical constituents of plants would further be valuable in discovering the actual value of folkloric remedies. Chemically constituents may be therapeutically active or inactive. The ones which are active are called active constituents and the inactive ones are called inert chemical constituents [5-7]. The phytochemical screening and pharmacological activity of various plant extracts are reported by several researchers [8-12].The present study aims to investigate the phytochemical screening and pharmacological activity of stem of *Echinopsis calochlora schum*(ECS-S)

2. Experimental:

2.1. Materials:

Fresh and crushed stem of *Echinopsis calochlora schum* was soaked in 500 ml of ethyl alcohol for 3 days. After the immersion period the solution was filtered and stored. The filtrate was used as a stock solution for further studies.

2.2. Methods:

2.2.1. Phytochemical Screening

The extracts were examined for the presence of the following phytochemicals: alkaloids, tannins, saponin, steroid, terpenes, flavonoids, and cardiac glycosides etc, using standard procedures[13] as follows:

Test for Alkaloids

The extract was dissolved in 5mL of 1% HCl and 5 drops of Drangendoff's reagent were added. The formation of orange precipitate indicates the presence of alkaloids.

Test for Saponins

The extract, with 5mL of water was vigorously shaken and heated to boil. Frothing that persisted for 30 minutes shows the presence of saponin.

Test for Tannins

The extract was dissolved in 5mL of distilled water, then boiled gently and cooled. 1mL of this solution was put in a test tube and 3 drops of Ferric Chloride solution was added. A deep greenish-black colouration indicates a positive test for tannins.

Test for Terpenes/Terpenoids

The Salkowski test was used. 5mL of the extract was mixed in 2mL of Chloroform, and 3mL concentrated sulphuric acid was carefully added to form a layer. A reddish brown colouration of the inter-face was formed to show positive result for the presence of terpenes or terpenoids.

Test for Steroids

2mL of acetic anhydride was added to 1 ml of extract with 2mL of H_2SO_4. The colour changed from violet to blue, indicating the presence of steroids.

Test for Cardiac glycosides

The Keller-Killani test was used. 5mL of each extracts was treated with 2mL of glacial acetic acid, containing one drop of ferric chloride solution. This was underlayed with 1mL of concentrated sulphuric acid. A browning of the interface indicates a deoxysugar characteristic of 'cardiac glycosides' (cardenolides).

Test for Flavonoids

5mL of diluted ammonia solution was added to a portion of the plant extract, followed by addition of concentrated sulphuric acid. A yellow colouration was observed in each extract, indicating the presence of flavonoids.

2.2.2. Antibacterial activity:

The test microorganisms used for antimicrobial sensitivity testing included *Staphylococcus aureus, Escherichia coli.* Antibacterial assay was carried out on Muller Hinton agar. The active extract fractions were serially diluted in the respective solvent used for its

extraction. The active extract fractions were diluted and used at concentrations of 20, 60 and 80µL concentration. The assay is established by the measurable zones of inhibition after 24 h of incubation at 370C. Ciproflaxacin is used as standard control.

2.2.3. FTIR analysis:

The crude plant extract was employed for FTIR analysis using a Shimadzu spectrometer in the spectral region between 4000 and 500 $cm^{-1.}$

3. Results and Discussion:

3.1. Phytochemical screening:

The phytochemical constituent of the plant extract is shown in Table 1 and Fig 1. The presences of medicinally important metabolites are reported by screening study. The screening shows the presence of alkaloids, coumarins, tannin, anthocyanin, phenol and glycosides in the plant extract.

Table1: Phytochemical analysis of ECS-S

S.NO	Phyto constituents	ECS-S
1.	Alkaloids	+
2.	Terpenoids	-
3.	Coumarins	+
4.	Steroids	-
5.	Tannins	+
6.	Saponins	-
7.	Flavonoids	-
9.	Anthocyanin	+
11.	Phenols	+
12.	Proteins	-
13.	Carbohydrates	-
14.	Glycosides	+

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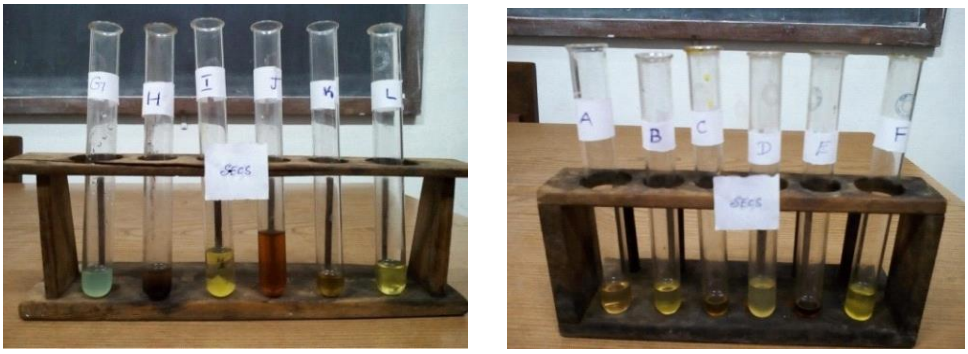

Fig 1: Phytochemical screening of ECS-S

3.2. Microbial activity

The microbial activity of 20µL, 60µL and 80µL concentrations of the crude extract was measured by zone of inhibition as in Table 2. The result showed that no zone of inhibition by the plant extract due to the thickness of the cell wall of the microorganisms and may be the higher concentration of the plant extract inhibits the growth of the pathogens. The standard drug exhibits 25 mm zone of inhibition.

Table 2 : Antimicrobial testing of ECS-S using Agar diffusion method

Sample	**Pathogens**	**Diameter of zone of inhibition(mm)**			
ECS-S		**Standard Ciprofloxacin 100 µg**	**Sample 20 µL**	**Sample 60 µL**	**Sample 80 µL**
	S.aureus	25	0	0	0
	E.coli	25	0	0	0

3.3. FTIR Analysis

FTIR peak values and the spectrum for ECS-S were shown in Table 3 and Fig 4 respectively. The peak at 3328 cm^{-1} and 2989.66cm^{-1} indicate the presence of C-H in alkane and O-H in alcohol. The peak at 1751.36cm^{-1} shows presence of C-O in esters. The peak at 1523.76cm-1 shows the presence of C=C in aromatics. 1381.03cm^{-1} peak indicates the presence of methyl group. The peak at 1238.30cm^{-1} indicates the presence of C-N in aliphatic amines. The peak at 875.68cm^{-1} & 867.97cm^{-1} shows the presence of aromatic meta distributed benzene.

TABLE 3: FTIR peak values for ECS-S

Peak values (cm^{-1})	**Possible groups**
3328	-OH in alcohol
2989.66	C-H in alkane
1751.36	-C=O in ester
1523.76	C=C in aromatic
1381.03	$-CH_3$
1238.30	C-N in aliphatic amines
1041.56	Trifluoromethyl
867.97	Meta disubstituted benzene

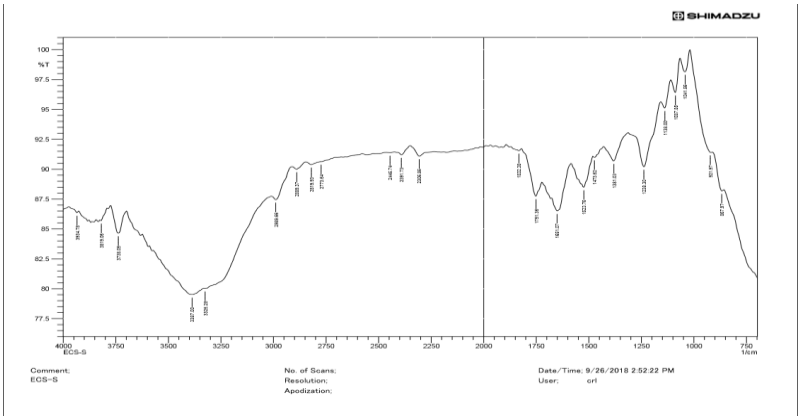

Fig4: FITR Spectrum of ECS-S

Conclusion:

The ethanolic extract of the studied plant contained many bioactive chemical constituents including alkaloids, glycosides, terpenoids, steroids, flavonoids, and tannins. The FTIR analysis revealed the presence different functional groups in the plant extract. The extract of *Echinopsis calochlora* inactive against the tested pathogens. The higher concentration of the plant extract may be inhibiting the bacterial growth.

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PHYTOCHEMICAL INVESTIGATION ON STEM OF *SANSEVIERIA CYLINDRICA*

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Abstract:

Plants historically have served as models in drug development. The production of medicines and the pharmacological treatment of diseases began with the use of natural plant products. The plant extracts are used as therapeutic agents, have varieties of biological activities including heart failure, cancer, anti-neoplastic, anti-inflammatory, sedation, anti-bacterial, antifungal, analgesic, antipyretic and anthelminthic effects. The present study investigates the preliminary phytochemical screening of *Sansevieria cylindrica* belongs to the family Asparagaceae and its FTIR analysis. The screening study revealed the presence of possible phyto constituents in the plant extract.
Keywords: plant products, Agar diffusion method, phytochemical, pharmacological activity

1. Introduction

Bioactive compounds derived from plant extracts have been reported scientifically for biological activities. Plants produce phytochemicals to protect themselves; but recent studies indicate that many phytochemicals can also protect humans against infectious diseases [1-5]. These biologically active ingredients are alkaloids, flavonoids, steroids, glycosides, terpenes and tannins
[6-8]. There are innumerable potentially useful medicinal plants and herbs waiting to be evaluated and exploited for their effective therapeutic application. There is great interest in plant antimicrobials, and several methods are available to detect their inhibitory activity. Various publications have documented the antimicrobial activity of plant extracts. Several methods have been used, and they are based on different principles. So the results obtained are influenced by the method selected, by the microorganism or specific strain used, and by the plant extract test compound (with different phenolic compounds) and degree of solubility [9-10]. The objective of this work was to examine the phytochemical screening and in vitro antimicrobial activity of stem of *Sansevieria cylindrica* extract. Antimicrobial activity was tested by disc diffusion method for determining the susceptibility of A.niger and C.albicans to extract SCEA-S and the standard amphotericin.

2.Exprimental:

2.1. Materials:

Dried and powered stem of *Sansevieria cylindrica* was soaked in 500 ml of ethyl acetate for 3 days. After the immersion period the solution was filtered and stored. The filtrate was used as a stock solution for further studies.

2.2. Methods

2.2.1. Qualitative phytochemical analysis

The ethyl acetate extract of *Sansevieria cylindrica* was subjected to different chemical tests for the detection of phyto constituents such as carbohydrates, glycosides, alkaloids, proteins,

amino acids, tannins, phenolics, saponins, flavonoids, terpenoids, steroids etc using standard procedures[11]. The qualitative test was justified by their color changes with various reagents.

2.2.2. Antibacterial activity

The antimicrobial activity of the ethyl acetate extract of SCEA-S was determined by disc diffusion method. The anti fungal assay was seen against to the micro organisms A.niger and C.albicans. The fungal species were first cultured in a nutrient broth for 24 h before use.

2.2.3. FTIR analysis:

The crude *Sansevieria cylindrica* extract was employed for FTIR analysis using a Shimadzu make spectrometer in the spectral region between 4000 and 500 $cm^{-1.}$

3. Results and Discussion:

3.1. Phytochemical screening:

Preliminary phytochemical screening was performed and reported in Table 1.The presence of phytoconstituents such as alkaloids, Saponins, quinones and carbohydrates were confirmed by the standard procedure[12].Negative results obtained for terpenoids, coumarins, steroids, tannins, flavonoids, anthroquinones and phenols.

Table. 1: Phytochemical analysis of stem of *Sanseveris cylindrica*

PHYTOCHEMICALS	OBSERVATION
Alkaloids	+
Terpenoids	-
Coumarins	-
Steroids	-
Tannins	-
Saponins	+
Flavonoids	-
Quinones	+
Anthroquinones	-
Phenols	-
Carbohydrates	+

+Present - Absent

3.2. Antifungal activity:

Antifungal assay was carried out using different strains of fungal species like A.niger and C.albicans.The results obtained were compared against standard drug amphotericin. The crude ethyl acetate extract of *Sansevieria cylindrica* showed activity against tested fungal species. The extract exhibit moderate antifungal activity against the micro organism A.niger at 80µL concentration of the extract and the extract exhibits no inhibition zone against C.albicans. The antifungal activity is shown in Table 2 and Figure 1 & Figure 2.Both standard drug and the sample showed same zone of inhibition (3mm) against A.niger pathogen.

Table 2: Antifungal activity of SCEA-S by disc diffusion method

Sample	Pathogens	Diameter of zone of inhibition(mm)			
SCEA-S		Amphotericin 250µg	Sample 20 µL	Sample 60 µL	Sample 80 µL
	A.niger	3	0	0	3
	C.albicans	9	0	0	0

Fig 1: Antifungal activity of the standard drug Amphotericin

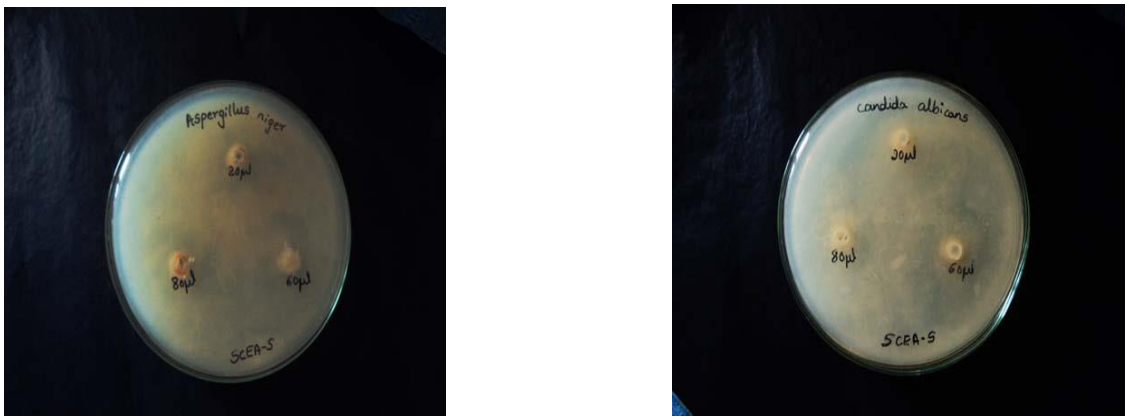

Fig 2: Antifungal assay of SCEA-S

3.3. FTIR analysis

FTIR spectrum of SCEA-S is shown in Fig 3 respectively. The peak at 3383.14cm^{-1} indicate the presence of OH group in alcohols or phenols.1643.35 cm^{-1} peak indicates the presence of C=O in amide. The peak at 1141.86 cm^{-1} shows the presence of esters. 1396.46cm^{-1} indicates the presence of N-O in nitro compound. FTIR study shows the presence of various functional groups in the plant extract.

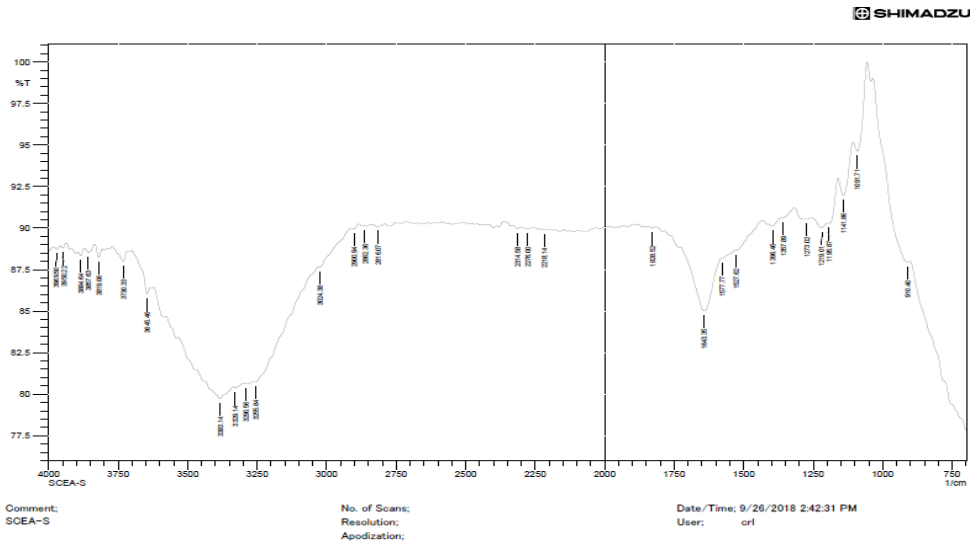

Fig 3: FTIR spectrum of SCEA-S

Conclusion:

The findings of our study indicates that

- The different phytochemical tests performed on the extract of *Sansevieria cylindrica* shows the presence of alkaloids, carbohydrates, saponin and quinines.
- It can be concluded that ethyl acetate stem extract contains bioactive constituents.
- FTIR study revealed the presence of different functional groups in the plant extract.
- Antifungal susceptibility assay indicated that the ethyl acetate extract showed the moderate activity against pathogenic fungal species A.niger.

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IN VITRO ANTIMICROBIAL ASSAY ON ETHYL ACETATE EXTRACT OF *SOLANUM BETACEUM*.

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ABSTRACT

Phytochemical assay and biological activity is essential for the isolation of new compound which directs to the discovery of drug. The adaptability of biological actions can be attributed to the huge amount and wide variety of secondary metabolites in plant organisms. The current work demonstrated the chemical constituents, antibacterial activity of *Solanum betaceum*. Preliminary phytochemical screening was performed by the Harborne method. Different phyto-constituents such alkaloids, carbohydrates, proteins, glycosides, lactones, Flavanoids, were identified in the leaf extract and it shows better antibacterial activity against the tested micro organisms.

Key words: phytoconstituents, alkaloids, antimicrobial action, glycosides, secondary metabolites.

1. INTRODUCTION

Plants generally produce many secondary metabolites which are biosynthetically derived from primary metabolites. Secondary metabolites have been directly playing an important role in human society to combat diseases. Secondary metabolic compounds are present in all plants and many of these are known to provide protection against insect attacks and plant diseases [1-3]. The pharmacological studies was already done by several researchers with various plants such as *Hibiscus rosasinensis* [4], *Linum usitatissimum* [5], *Amaranthus* plant species [6], *Aconitum heterophylum*,[7], *Clerodendron glandulosum* [8], *Eucalyptus camaldulensis* [9], *Tinospora*

cordifolia [10], *Momordica dioica* [11], *Yucca gloriosa* [12].The The aim of this study was to assess the invitro potential of ethyl acetate extract of *Solanum betaceum.*

2. EXPERIMENTAL

2.1 Materials

2.1.1 Preparation of plant extract

The leaves were initially separated from plants body and rinsed with distilled water. Afterwards the samples were dried under shade of sunlight and then homogenized into fine powder using a mortar and were stored in air bottles and the powdered seeds was soaked in solvent ethyl acetate for 3 days. The collected portion was subjected to screening studies.

2.2 METHODS

2.2.1 Preliminary phytochemicals screening

The extract obtained from successive solvent extraction of *Solanum betaceum* were then subjected to various qualitative chemical tests[13] to determine the presence of various phytoconstituents like alkaloids, carbohydrates, proteins/amino acids, glycosides, phenol, tannins, phytosterols, flavonoids, Saponins, lactones, coumarins, terpenes.

2.2.2 FTIR Analysis

FTIR spectrum of the crude plant extract (SBL EA) was investigated for its characteristic functional groups in the spectral region between 4000-500 cm-1 using Shimadzu make spectrometer.

2.2.3 Anti-bacterial analysis

The Antibacterial activity of the extract (SBL EA) was performed with Staphylococcus aurerus, Escherichia coli organisms by Agar diffusion method. The stock cultures of bacteria were revived by inoculating in broth media and grown at 37 degree celcius for 18 hrs. The agar plates of the media were prepared and wells were made in the plate. Each plate was inoculated with 18 hold cultures (100µl, 10^{-4}cfu) and spread evenly on the plate. After 20 min, the wells were filled with of compound at different concentrations. All the plates were incubated at 37 degree celcius for 24 hours and the diameter of inhibition zone were noted and compared with standard ciproflaxin.

3. RESULTS AND DISCUSSION

3.1 Phytochemical Analysis

Preliminary phytochemical screening of (SBL EA) mainly revealed the presence of alkaloids, carbohydrates, proteins, glycosides, lactones, saponin, steroids, flavanoids and negative results were obtained for tannins, terpenes, anthocyanin, phenol and coumarin in ethyl acetate extract. The results pertaining to this study were presented in Table 1.

Table: 1 Qualitative analysis of SBL EA for the presence of phytochemicals

S.No	Phyto constituents	SBL-EA
1	Lactones	+
2	Alkaloids	+
3	Carbohydrates	+
4	Flavanoids	+
5	Proteins	+
6	Saponin	+
7	Steriods	+
8	Glycosides	+
9	Coumarins	-
11	Terpenes	-
12	Anthocyanin	-
13	Quinones	-
14	Phenol	-

+ Presence - Absence

3.2 FTIR Analysis

The FTIR instrument was used to determine the type of functional groups in the plant extract. The observed stretching frequency and the corresponding bond assignment are given in the table 2. The FTIR spectrum of extracts SBL EA is shown in the figure 1. The spectral values indicate that the peak 3622.32 cm^{-1} shows the presence of OH in alcohols or phenols. The peak at 3745.45 cm^{-1} shows the presence of amide N-H stretching. The peak at 3591.46 cm^{-1} shows the presence of amine N-H stretching. The peak at 2958.81 cm^{-1} shows the presence of alkyl C-H stretching. The peak at 1739.79 cm^{-1} shows the presence of aldehyde C=0. The peak at 1516.05 cm^{-1} shows the presence of aromatic C=C band. The peak at 1427.32 cm^{-1} shows the presence of aromatic C-C. The peak at 1242.16 cm^{-1} shows the presence of aliphatic amines.

Table 2: FTIR peak values of *Solanum betaceum*

Peak values	Band Assignments cm^{-1}
3745.76	N-H in Amide
3622.32	O-H in Alchol
3591.46	N-H in Amine
2958.81	C-H in Alkyl
2380.16	O-H in acid
1739.79	C=O in Aldehyde
1647.21	C=C in Alkenyl
1516.05	C=C in Aromatic
1427.32	C-C in Aromatic
1373.32	N-O in Nitro
1242.16	Aliphatic amines

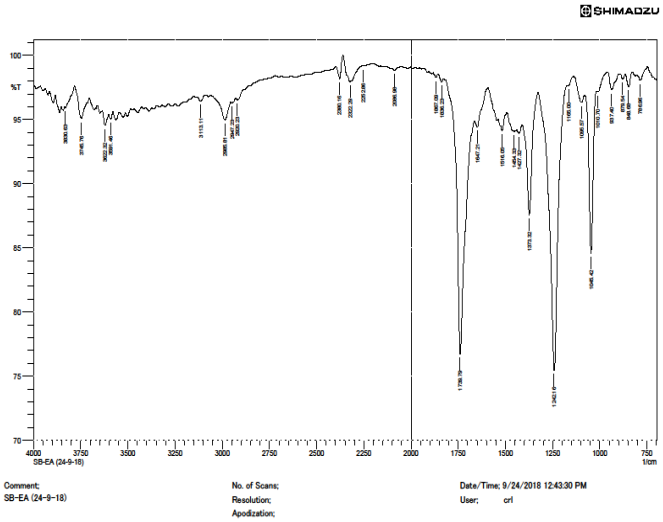

Fig 1: FTIR Spectrum of SBL- EA

3.3 Antibacterial sensitivity

The leaves of *Solanum betaceum* in ethyl acetate extract (SBL EA) was tested for their anti-bacterial using disc diffusion method. At higher concentration the diameter of inhibition zones (DIZ) against *S.aureus* was 19 mm ad *E.coli* was 29 mm. whereas the stand drug Ciprofloxacin at 500µg showed 38 mm DIZ against E.coli and 36 mm against S.aureus for SBL EA. The leaf extract shows better activity against the two tested microorganisms is shown in the table 3. The anti microbial activity of the standard drug is shown in Table 4.

Table: 3 Antibacterial analysis of leaves of *Solanum betaceum*

Sample	Bacteria	20µI	60µI	80µI	MIV µI
SBL EA	E.coli	15	27	29	20
	S. aureus	8	15	19	20

Table 4: Anti-bacterial Activity of std. Ciprofloxacin

Organisms	25 µg	50µg	100µg	250µg	500µg	1000µg	MICµg
E.coli	26	29	32	34	38	*	25
S.aureus	25	28	31	34	36	*	25

4. CONCLUSIONS

The phytochemical screenings of the plant extract states that the plant extract possess medicinally important secondary metabolites. Pharmacological study shows that the leaves of the

plant *Solanum betaceum* has moderate antimicrobial activity due to the presence of various phytochemicals in the plant extracts and FTIR analysis shows that the plant extract exhibits various functional groups like O-H, C-H, C=O, N-O, N-H, C=C. The findings of this study reveal that the ethyl acetate extract of the plant possess potential phyto components that may be of great use for developing plant-based drugs.

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GC-MS INVESTIGATION ON LEAVES OF *MIMOSA DIPLOTRICHA*

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Abstract

The present study investigates phytochemical analysis in the leaf extract of *Mimosa diplotricha* with ethyl alcohol by GC-MS method and preliminary phytochemical screening. The phytochemical assay revealed the presence of flavonoids, glycosides, proteins, phenolic compounds, tannin, terpenoid, saponins, steroids, and carbohydrate and the absence of alkaloids in the extract.GC-MS analysis showed that the plant extract contains variety of phytochemicals and totally 9 different phyto constituents observed in the tested plant material.

Keywords: *Mimosa diplotricha,* phytochemicals, GC-MS analysis, flavonoids

1. Introduction

Plants have been an important source of medicine with qualities for thousands of years. Mainly on traditional remedies such as herbs for their history it has been used as a popular folk medicine. Natural plants materials are expensive gift from human to nature. Herbal medicines are safer than synthetic medicines because the phytochemicals in the plant extract target the biochemical pathway. Medicinal plants have been used all over the world for the treatment and prevention of various ailments, particularly in developing countries where infectious disease are endemic and modern health facilities and services are inadequate. plant based natural constituents can be derived from any part of the plant like bark, leaves, roots, flowers, seeds, fruits, etc. Plants are the traditional sources for many chemicals used as a pharmaceutical biochemicals, fragrances, food colours and flavours [1-3]. Chromatography is the term used to describe a separation technique in which a mobile phase carrying a mixture is caused to move in contact with a selectively absorbent stationary phase. It also plays a fundamental role as an analytical technique for quality control and standardization of phyto therapeuticals[4]. The GCMS analysis of different plant products are reported by several researchers [5-8]. The present investigation was carried out to determine the phytochemical compounds using GC-MS analysis and preliminary screening.

2. Experimental

2.1. Materials

2.1.1. Preparation of plant extract

Fresh leaves of *Mimosa Diplotricha* are collected from Walayar region, Kerala, and are shade-dried and then crushed using a mechanical grinder. These materials were soaked in ethanol for 3 days. The extract was filtered and the solvent was removed from it using rotary evaporator. The collected portion was subjected to screening for further studies.

2.2. Methods

2.2.1. Preliminary phytochemical screening

The crude plant extract tested for the presence of various phyto chemicals like alkaloids, flavonoids, tannins, saponin, carotenoids, terpenoids and steroids etc. using standard procedures[9].

2.2.2. GC-MS Analysis

GC-MS technique was used in this study to identify the components present in the extract. GC-MS technique was carried out at The South India Textile Research Centre (SITRA), Coimbatore. The GC-MS analysis of MDL extracts in ethyl alcohol, was performed using a thermo GC- Trae Ultra ver : 5.0, Thermo MS DSQII equipped with a DB-5 capillary column (5% phenyl95%dimethylpolysiloxane) (30nm X 0.25mm ID X 0.25µmdf) and mass detector turbo mass gold of the company which was operated in EI mode. Helium was the carriers gas at a flow rate of 1ml/min. and the injection volume was 1µl and operated at oven temperature 70ºC was raised to 260ºC at 6ºC/min.

Identification of components:

Interpretation on mass spectrum of GC-MS was done using the database of National Institute Standard and Technology (NIST), WILEY8, FAME having more than 62,000 patterns. The mass spectrum of the unknown component was compared with the spectrum of the known components stored in the (NIST), WILEY8, FAME library. The name, molecular weight, and the structure of the components of the test materials were ascertained [10].

3. Results and Discussions

3.1. Phytochemical Screening

The phytochemical screening showed the presence of flavonoids, glycosides, proteins phenolic compounds, tannin,t erpenoid, saponins, steroids, and carbohydrate and the absence of alkaloids in MDL.

3.2. GC-MS Analysis

The compounds present in the ethanolic extract of leaves of *Mimosa diplotricha* were identified by GC-MS analysis presented in figure 1. The active principle Molecular Weight (MW), Probability, Concentration (%), Molecular Formula (MF), and Retention Time (RT) is presented in Table 1. The structure of the phytoconstituents listed in table 2.

Totally nine compounds were identified in the MDL extract. The prevailing compounds were 1,4-diphenyl but-3-ene -2-ol, methylene triphenyl phosphorane -boran, Trifluoro silyl- octa methyl cyclo tetra silazane, 2-(2-Pyridyl)-3-(tri methyl silyl)-5,6,7,8-tetra hydro quinoline, Neo phytadiene, 1,2-Benzene dicarboxylic acid, dibutyl ester, Citroflex A, Hexanedioic acid, bis(2-ethyl hexyl) ester and 2,6,10,14,18,22-Tetra cosahexaene.

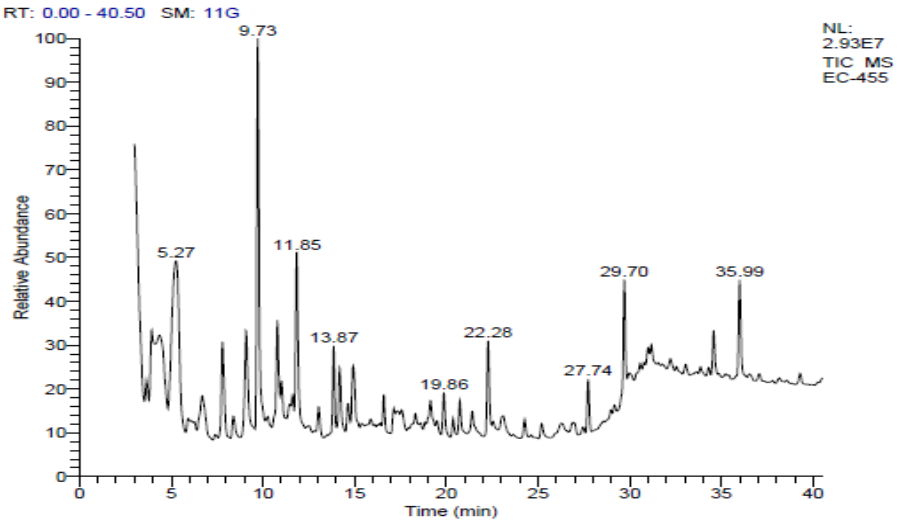

Fig 1: GC-MS Spectrum of MDL

Table 1: Components identified in MDL

RT	Name of the phytoconstituents	Probability	MF	MW	Peak Area %
5.27	1,4-diphenylbut-3-ene-2-ol	49.80	C16H16O	224	13.27
9.73	methylenetriphenylphosphorane-boran	23.29	C19H20BP	290	12.47
11.85	Trifluorosilyl-octamethylcyclotetrasilazane	68.22	C8H27F3N4Si5	376	7.08
13.87	2-(2-Pyridyl)-3-(trimethylsilyl)-5,6,7,8-tetrahydroquinoline	74.36	C17H22N2Si	282	2.56
19.86	Neophytadiene	33.68	C20H38	278	1.46
22.28	1,2-Benzenedicarboxylic acid, dibutyl ester	12.71	C16H22O4	278	3.43
27.74	Citroflex A	79.82	C20H34O8	402	1.58
29.70	Hexanedioic acid, bis(2-ethylhexyl) ester	39.06	C22H42O4	370	4.84
35.99	2,6,10,14,18,22-Tetracosahexaene,	30.40	C30H50	410	3.33

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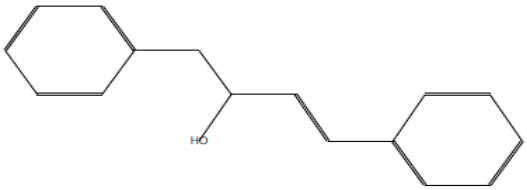
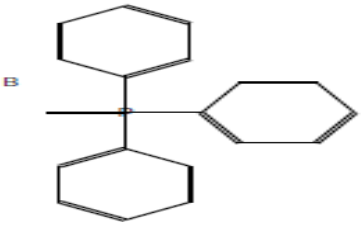
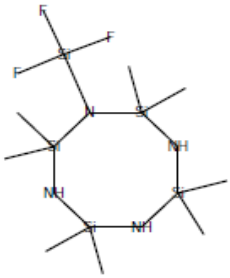
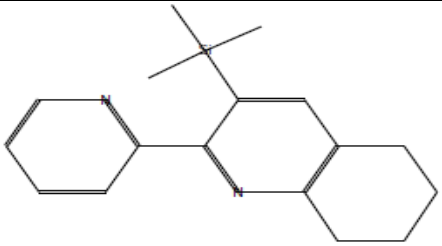
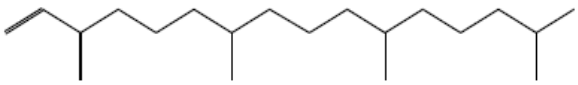
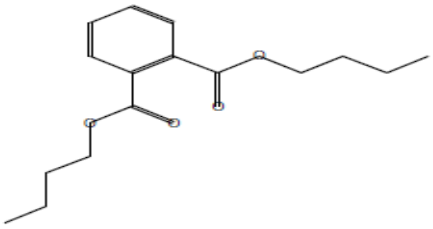
Table 2: Structure of the phyto constituent in MDL

S.No	Name of the phytoconstituents	Structure
1	1,4-diphenylbut-3-ene-2-ol	
2	methylenetriphenylphosphorane-boran	
3	Trifluorosilyl-octamethylcyclotetrasilazane	
4	2-(2-Pyridyl)-3-(trimethylsilyl)-5,6,7,8-tetrahydroquinoline	
5	Neophytadiene	
6	1,2-Benzenedicarboxylic acid, dibutyl ester (CAS)	

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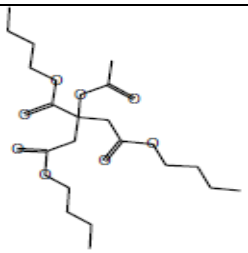
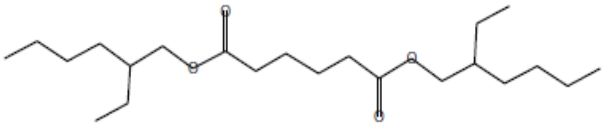
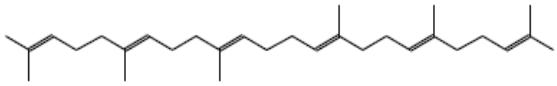
7	Citroflex A	
8	Hexanedioic acid, bis(2-ethylhexyl) ester (CAS)	
9	2,6,10,14,18,22-Tetracosahexaene	

4. CONCLUSIONS

The present research work proved that our tested plant is rich source of various phytochemical constituents like flavonoids, steroids, saponins, tannins, proteins, terpenoids and glycosides. These are performing various pharmacological actions. The production of free radicals in the living body is responsible for a large number of disorders. GC-MS study revealed that the plant extract contains variety of phytochemicals and also explained the structure of the possible phytoconstituents. Totally 9 different phyto constituents present in the leaves of the *Mimosa diplotricha* extract. In MDL the phyto constituent1,4-diphenylbut-3-ene-2-ol has the maximum peak area of 13.27 %. The findings of this study reveal that the leaves of *Mimosa diplotricha*(MDL) have medicinally important phytoconstituents. The prescence of various chemical compounds confirms the application of MDL possesses medicinal value and further plan of study includes isolation and purification of chemical compounds.

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PHYTOCHEMICAL PROFILE AND ANTIBACTERIAL EFFICACY OF *CHLORIS BARBATA*

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ABSTRACT

Plants have been a rich source of compounds for the development of clinically useful therapeutic agents. The plant Chloris barbata contains enamours phytoconstituents which are used in medication and other curative system. The *in vitro* screening of antimicrobial properties of *Chloris barbata* is evaluated by the disc diffusion method. The presence of alkaloids, flavonoids, tannins, phenols, carbohydrates, proteins lactones quinines, triterpenoids and amino acids are detected in the preliminary phytochemical tests. Moderate antibacterial activity is observed in the extract against some pathogenic microorganisms when compared with the standard Ciprofloxacin. The results of present study support traditional usage of *Chloris barbata* in new drug for the therapy of infectious diseases caused by pathogens.
KEY WORDS: *Chloris barbata*, phytochemicals, flavonoids, tannins, phenols

1. Introduction

Nature has given many medicinal plants for our health and survival. A great part of herbal composites is used as main particle in drug discovery to produce synthetic molecular analog. It plays considerable role in herbal and traditional medicine for treatment of various diseases like diabetes, hypertension, asthma, constipation, cancer, and depression, skin diseases like dermatitis, eczema and acne [1-6]. Chloris barbata is a tufted, erect, annual or short-lived perennial grass. It belongs to the family Poaceae. In the present investigation, preliminary phytochemical and antibacterial activity of ethyl alcohol extract of Chloris barbata(CB-AL) was examined.

2. Experimental

2.1. Materials

2.2.1. Preparation of CB-AL extract

The freshly collected whole plant of *Chloris barbata* was shade dried and then crushed using mechanical grinder. A weighed quantity of powder is subjected to ethyl alcohol extraction for 3 days. Then the extract is filtered and the filtrate is used for further studies.

2.2. Methods
2.2.1. Phytochemical studies

The crude plant extract was subjected to preliminary phytochemical screening to identify the active bio constituents present in them using standard procedure [7].

2.2.1. Anti bacterial activity

The stock culture of bacteria were revived by inoculating in broth media and grown at 37º c for 18 hrs. Each plate was inoculated with 18 hrs old culture (100 µl, 10^{-4}cfu) and spread evenly on the plate. After 20-minute wells were filled with the compound at different volumes All the plates were incubated at 37ºc for 24 hrs and the diameter of inhibition zone were noted. The various concentration of the plant extract is tested for antimicrobial assay. Ciprofloxacin at the concentration of 1 mg/ml (10µl/well) was used as standard.

3. Results and Discussion

3.1. Phytochemical screening

Phytochemical and biological screening is necessary for the isolation of new compound, which lead to the discovery of drug. The presence of different phytochemicals in the plant extracts are summarised in the Table 1. Phytochemical test indicated the presence of various class of bioactive secondary metabolite such as terpenoids, alkaloids, carbohydrates, proteins and quinones.

Table: 1 Qualitative phytochemical analysis of CB AL

Phyto constituents	**CB-AL**
Tannins	+
Alkaloids	+
Carbohydrates	+
Terpenoids	+
Proteins	+
Quinones	+
Steriods	+
Glycosides	-
Coumarins	-

+ Presence - Absence

3.2. Antibacterial assay:

The antibacterial activity was done using modified agar well diffusion method according to standard protocol. The pharmacological properties of a plant is directly attributed the presence of various chemical constituents. The crude extract exhibit antibacterial activity with zone of inhibition ranging from 4mm for B.Subtilis and 5 mm for S.typhi at 80 µL concentration. The plant extract possess moderate anti bacterial activity compared with the standard drug. The antibacterial assay of the plant extract and the standard are shown in table 2 and 3 and Fig 1 to 4.

TABLE: 2 Antibacterial activity of CB in AL

ORGANISMS	**20µL**	**60µL**	**80µL**
B.SUBTILIS	0	0	4
S. TYPHI	0	0	5

TABLE: 3 Antibacterial activity of std Ciproflaxin

ORGANISMS	25 µg	50 µg	100 µg	250 µg	500 µg	MIC µg
B.SUBTILIS	20	24	27	30	36	25
S.TYPHI	27	31	35	38	40	25

Fig:1 CB-AL B.subtilis

Fig:2 CB- AL S.typhi

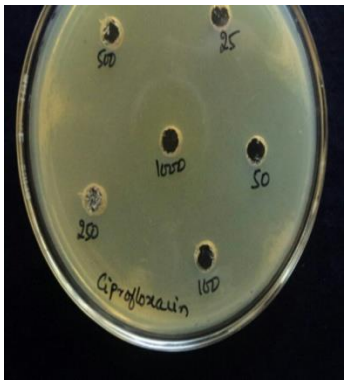

Fig:3 B.Subtilis with Std.Ciprofloxacin

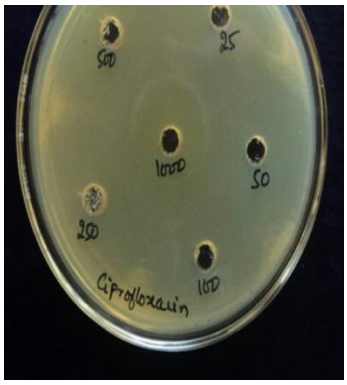

Fig:4 S.Typhi with Std.Ciprofloxacin

4. CONCLUSIONS

The alcoholic extract of *Chloris barbata* exhibited moderate antibacterial activity with all the tested strains of microorganisms at 80µL concentration on comparison with the standard ciprofloxacin. The obtained activity may be due to the presence of flavonoids, alkaloids, tannins etc. Further studies are under progress to characterize the many active principles. This study supports further research will be needed for identification of the many new bioactive compounds, which are responsible for the pharmacological action against the disease causing human pathogens.

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INHIBITION OF METAL CORROSION IN ACID MEDIUM BY *AERVA LANATA* LEAF EXTRACT

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Abstract

Corrosion of metals is a serious environmental problem that has been given adequate attention in the oil and gas industries because, during industrial processes such as acid cleaning and etching, metal surfaces are often made to come in contact with acidic medium, indicating that the use of inhibitors is necessary. The inhibitory action of Aerva *lanata* leaf on the corrosion of mild steel in 1N HCl solution was investigated using weight loss and FTIR techniques. The weight loss results showed that when the concentration of plant extract increased the rate of mild steel corrosion is decreased, which indicates that the inhibition of the corrosion process is produced. FTIR analysis indicates the presence of different functional groups in the tested inhibitor which are responsible for inhibition process.
Keywords: Corrosion, Inhibition efficiency, FTIR, Mild steel

1. Introduction

Corrosion is an irreversible interfacial reaction of a material (metal, ceramic, polymer) with its environment which results in its consumption or dissolution into the material of a component of the environment. Inhibitors are commonly used to reduce the corrosive attack on metallic materials [1]. The selection of inhibitor is controlled by its economic availability, its efficiency to inhibit the substrate material and its environmental side effects. The heavy loss of metal as a result of its contact with acids can be minimized to a great extent by the use of corrosion inhibitors. Pure synthetic chemicals are costly and some of them are not easily biodegradable and their disposal creates pollution problems. Natural products of plant origin contain different organic compounds (alkaloids, tannins, amino acids etc.) and most of them are known to have inhibitive action[2-7]. The aim of the present manuscript is to study the inhibiting

effect of *Aerva lanata* leaf extract on the corrosion of mild steel in 1N HCl medium by weight loss method and FTIR analysis.

2. Experimental

2.1. Materials

2.1.1. Metal specimen preparation:

In preparing the specimens for the experiment, the specimens of mild steel were cut into 5×1 cm and 2 mm thickness. The samples were degreased, dried, polished with emery sheets to have uniform smooth surface weighed and stored in a desiccator. The initial weight of each sample was taken and recorded.

2.1.2. Preparation of medium and plant extract

The blank corrodent 1N HCl was prepared by dilution of analar grade HCl with distilled water. The extract was prepared by refluxing 25g of powered dry leaf of *Aerva lanata* in 1N HCl for 3h and kept overnight for cooling. Then it was filtered and stored. The filterate was diluted with appropriate quantity of acid to obtain various inhibitor test solutions.

2.2. Methods

2.2.1. Weight loss method

In the Weight loss measurements, mild steel coupons in triplicate were completely immersed in 100ml of the test solution of acidic environment (1N HCl) in the presence and absence of the inhibitor for different immersion periods at room temperature. Triplicate samples were used to check reproducibility of results. From the weight loss measurements, Inhibition efficiency (IE) will be calculated using the following relationship [8]

$$IE\ \% = [W_o - W_i / W_o] \times 100$$

2.2.2. FTIR technique.

The IR spectrum was performed by using a Shimadzu spectrometer in the spectral region between 4000 and 500 $cm^{-1.}$ The crude leaf extract was employed for FTIR analysis.

3. Results and Discussion

3.1. Weight loss method

Effect of period of immersion on inhibition efficiency of the plant extract in IN HCl medium

The inhibition efficiency of the plant extract for various immersion times is shown in table1.At various time intervals the inhibition efficiency was estimated without and with the inhibitor by weight loss method. At 0.05% v/v of the inhibitor for 1 hour the inhibition efficiency was found to be 41%. Inhibition efficiency was found to increase with increase in concentration of the inhibitor. Figure 1 shows the relation between the inhibition efficiency and immersion time at various inhibitor concentration. Figure 2 shows the relation between the inhibition efficiency and concentration of the plant extract for different periods of immersion. For 1 hour the IE was found to be 71% and for 24 hours of immersion time IE was found to be 93 at 3% v/v of the inhibitor concentration. The inhibitor is found to have good efficiency at all immersion periods.

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Table: 1 IE of *Aerva lanata* leaf extract in IN HCl at different immersion periods.

Conc. of extract %v/v	Immersion period(h)				
	1h	3h	5h	7h	24h
0.05%	44	73	76	88	83
0.50%	60	73	77	89	87
1%	64	78	78	90	88
1.50%	66	79	82	90	89
2%	69	80	83	91	89
2.50%	70	80	86	93	91
3%	71	81	90	96	93

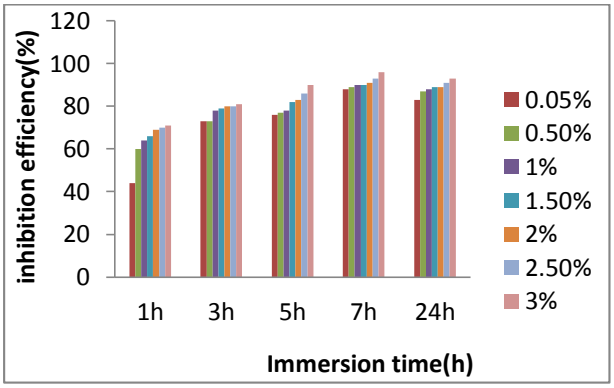

Fig 1: Inhibition efficiency of *Aerva lanata* with different immersion time.

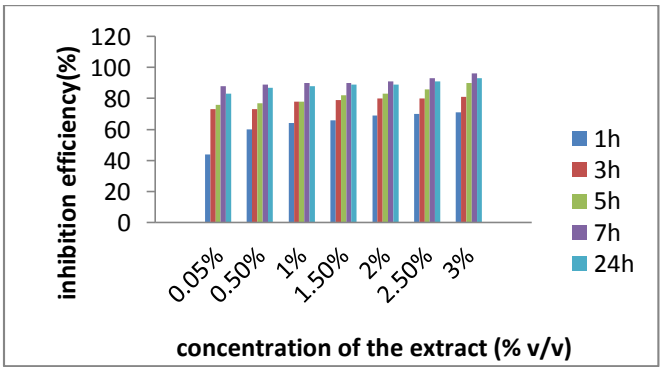

Fig 2: Effect of concentration of *Aerva lanata* with at different immersion time.

3.2. FTIR Analysis

The FTIR instrument is used to determine the type of bonding for organic inhibitors adsorbed on the metal surface. The observed stretching frequency and the corresponding band assignment are given in Table 2. FTIR spectrum of crude extract is shown in Fig 3.The peak values indicates the existence of various functional groups such as –O-H,C=O,N-H, C-X and C≡C groups in the plant extract. The inhibition process obtained through the adsorption these functional groups on mild steel surface and retards further corrosion of metal specimen.

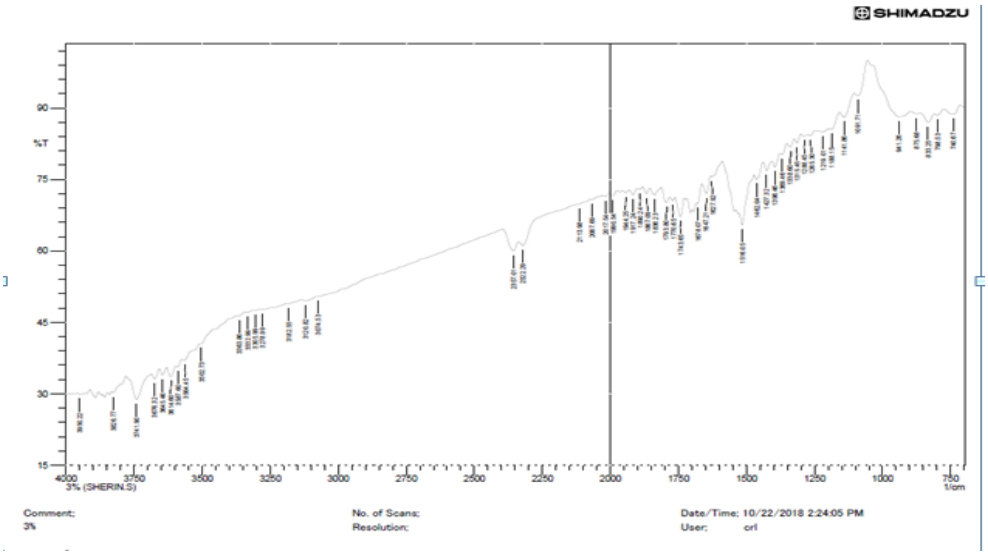

Fig 3: FTIR spectrum of crude Aerva lanata

Table 2: FTIR analysis of crude *Aerva lanata*

Peak values cm^{-1}	**Possible groups**
3741.90	-O-H in alcohol
2357.01	C≡C in alkynes
1793.80	C=O in carbonyl
1516.05	N-H in amines
833.25	C-X in alkyl halides

4. Conclusion

The following conclusions can be made on the basis of the results obtained:

1. The leaf of *Aerva lanata* inhibits the corrosion of mild steel in 1N HCl solution.
2. It was found that the corrosion rate of mild steel decreases with the increase in concentration of the inhibitor.
3. The results of weight loss measurements for different immersion periods at room temperature show the maximum inhibition efficiency of 93% at 3% v/v of inhibitor concentration.
4. The effect of immersion time on inhibition efficiency shows that the inhibitor is effective even for longer immersion periods at low concentration.
5. FTIR analysis indicates the presence of various functional groups in the plant extract, which are may be responsible for corrosion inhibition of the metal.

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ALSTONIA SCHOLARIS AS GREEN INHIBITOR FOR MILD STEEL CORROSION

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Abstract

Green or safe corrosion inhibitors are biodegradable and do not contain heavy metals or other toxic compounds. Most green corrosion inhibitors are obtained from ethanol, aqueous, acid or methanol extract of plant materials. The successful use of naturally occurring substances to inhibit the corrosion of metals in acidic and alkaline environments has been reported by some research groups. The objective of the present study is aimed at investigating inhibitive properties of acid extract of *Alstonia scholaris* leaves for the corrosion of mild steel in 1N HCl by weight loss method and SEM analysis.

Keywords: mild steel, corrosion, inhibitor, plant materials

1. Introduction

The addition of corrosion inhibitors effectively secures the metal against an acid attack. Many studies in this regard using organic inhibitors have been reported. Most of the inhibitors are organic compounds with N, S, and O hetero-atoms having higher electron density, making them the reaction centres. These compounds are adsorbed on the metal surface and wedge the active corrosion sites, and most of them are highly toxic to both human beings and the surroundings. Thus, use of natural plant products as eco-friendly and nontoxic corrosion inhibitors has become popular [1-8]. The aim of this work was to investigate the potential of *Alstonia scholaris* extract to act as an inhibitor of mild steel corrosion in hydrochloric acid.

2. Experimental

2.1. Materials

About 5 grams of dried and powdered leaves of *Alstonia scholaris* were refluxed with 1N HCl for about 3hours and kept overnight to extract the basic components. The solution was filtered off and the filtrate was diluted with blank. This extract was used to study the corrosion inhibition properties. Mild steel specimens with tiny holes on their upper parts were polished with

different grades of emery papers, dried at room temperature, and then stored in a desiccator before use.

2.2. Method

2.2.1. Weight Loss Method

The polished and pre-weighed MS specimens were suspended in 100 ml test solutions using glass hooks, with and without the plant extracts of different concentrations, for different hours of immersion (1h, 3h, 5h, 7h and 24h) at room temperature. After the corrosion test, the specimens were carefully washed in distilled water, dried, and then weighed. The rinse removed loose fragments of the film of the corroded samples. The loss in weight was determined using a four digit Shimadzu make analytical balance. From the weight loss data, the corrosion rate (CR) of the metal specimen was calculated using the following formula[9].

$$CR\ (mpy) = 534\ W/\ D\ A\ t$$

2.2.2. SEM analysis

The mild steel specimens immersed in blank and in the inhibitor solutions for 3h were removed, rinsed with distilled water, dried and observed in a scanning electron microscope to examine the surface morphology.

3. RESULTS AND DISCUSSION

3.1. Weight loss measurement

Tables 1 shows the effect of the inhibitor (plant extract) on corrosion rate of mild steel at different concentrations of the leaves of *Alstonia scholaris*. The Effect of different concentration of *Alstonia scholaris* on CR of mild steel is shown in Fig 1.The Influence of immersion time on corrosion rate of mild steel is shown in Fig 2.

Table 1: Corrosion rate of mild steel with different concentration of *Alstonia scholaris* leaves extract

	CORROSION RATE				
CON. OF EXTRACT	1 hour	3 hour	5hour	7 hour	24 hour
BLANK	632	372	350	869	262
0.05%	227	99	64	230	59
0.50%	183	45	47	149	42
1%	142	41	39	95	37
1.50%	100	38	28	83	30
2%	92	33	25	76	28
2.50%	65	29	23	72	25
3%	57	28	23	64	24

The results revealed that the decreasing corrosion rate is associated with increase in the inhibitor concentration which indicates that more inhibitor molecules are adsorbed on the metal surface, thereby providing wider surface coverage. The corrosion rate of metal decreased from

632 mpy to 57 mpy at 1h of immersion time indicates that the adsorption of plant constituents on the metal surface.

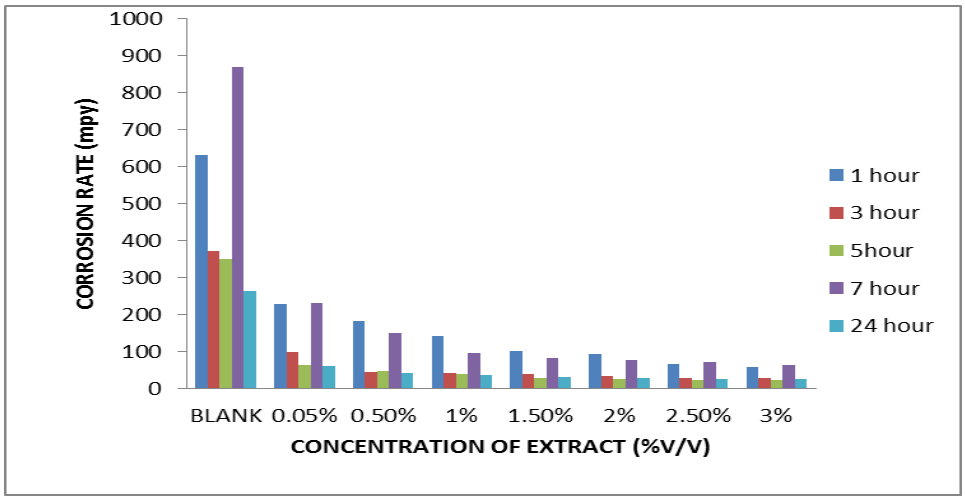

Fig1: Effect of different concentration of *Alstonia scholaris* on CR of mild steel

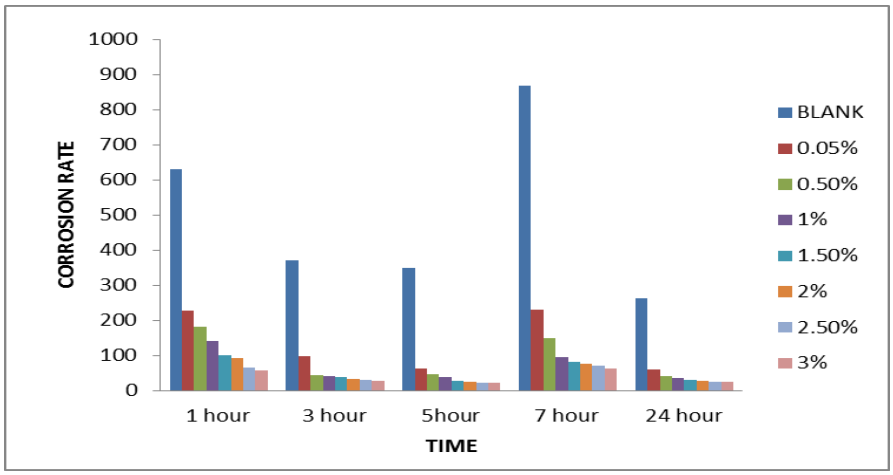

Fig 2: Influence of immersion time on corrosion rate of mild steel

3.2. SEM analysis

The SEM photograph in Figure 3a shows that the surface of MS was extremely damaged in the absence of the extract, while Figure 3b clearly shows the formation of a film by the active *Alstonia scholaris* leaves constituents on the MS surface which was responsible for the corrosion inhibition.

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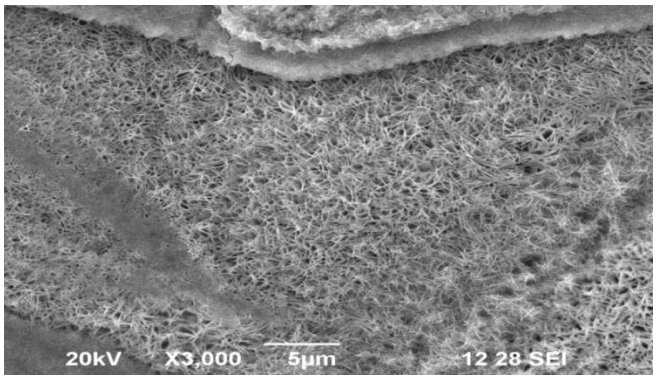
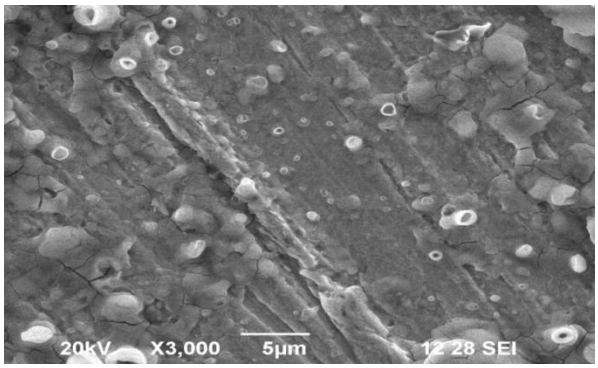


3a



3b

Figure 3: SEM images of MS a) in 1N HCl and b) with *Alstonia scholaris* leaves extract (3%v/v)

4. Conclusions

The active molecules present in the extract of *Alstonia scholaris* leaves have effectively inhibited corrosion of mild steel in 1N HCl at various immersion periods by forming a protective barrier layer. The extract was found to retard corrosion rate of mild steel. SEM results confirm that the introduction of plant extract effectively protects mild steel from corrosion.It is readily available, less toxic and biodegradable and can be considered as corrosion inhibitor for metal in aggressive environment.

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CORROSION INHIBITION BEHAVIOUR OF *DIOSCORIA ALATA* TUBER EXTRACT IN AGGRESIVE MEDIUM

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The inhibiting effect of acid extract of *Dioscoria alata* plant on the corrosion of mild steel in 1N H_2SO_4 solution has been investigated by weight loss method for seven different concentrations of plant extract ranging from 0.05%v/v to 3%v/v and FTIR analysis. The results indicated that the corrosion inhibition efficiency increased on increasing plant extract concentration. The obtained results showed that the *Dioscoria alata* extract acts as a good inhibitor for the corrosion of mild steel in 1N H_2SO_4 solution.
Key words: Inhibition efficiency, Mild steel, FTIR analysis, Weight loss method

1. Introduction

Acid solutions are widely used in industry, such as acid pick-ling, industrial acid cleaning, acid descaling and oil well acidizing. Because of the general aggressively of acid solutions, inhibitors are commonly used to reduce the corrosive attack on metallic materials. There are various organic inhibitors which tend to decrease the corrosion rate of steel and iron in acidic solutions. Recently the use of synthetic inhibitors has created environmental problems due to its toxicity properties. Therefore researchers are now focusing on development of cheap, non - toxic and environmental friendly corrosion inhibitors from natural products [1-7]. In this paper the corrosion behaviour of tuber of *Dioscoria alata* extract was studied by weight loss method and FTIR techniques.

2. Experimental

2.1. Materials

Rectangular specimens of mild steel were mechanically press cut into 5×1 cm and 2 mm thickness and polished with emery papers of different grades. The acidic extract of *Dioscorea alata* tuber was prepared from fresh tuber which was washed, cut into pieces and then grounded well. Then 15g of the tuber was put into RB flask containing 300 ml of 1N sulphuric acid solution. The resulting solutions were refluxed for 3 hr and left overnight before it was carefully filtered. The stock solution was prepared from the filtrate and prepared into the desired concentrations for further study.

2.2. Methods

2.2.1. Weight loss method:

The metal specimens were completely immersed in 100 mL of the test solution of 1N sulphuric acid in the presence and absence of the inhibitor. The specimens were withdrawn from the test solutions for weight measurement after 1h, 3h, 5h, 7h, and 24h, washed thoroughly with distilled water, and dried completely. The weight loss was taken as the difference in weight of the specimens before and after immersion determined using digital balance. From the weight loss measurements, the inhibition efficiency (IE) % of the plant extract was calculated using the following equation[8].

$$IE\ \% = [CR_b - CR_i / CR_b] \times 100$$

Where CR_b and CR_i are the corrosion rate values in absence and in presence of inhibitor.

2.2.2. FTIR technique.

The crude *Dioscorea alata* tuber extract was employed for FTIR analysis using a Shimadzu spectrometer in the spectral region between 4000 and 500 $cm^{-1.}$

3. Results and Discussion

3.1. Weight loss method

Table 1 shows the inhibition efficiency of *Dioscorea alata* tuber extract on mild steel corrosion in 1N H_2SO_4 at different time of immersion. The results show that the inhibition efficiency increases with increase in the concentration of the extract probably due to an increase in the metal surface area covered by the extract. The plant extract shows 64% of IE at 1 h of immersion time and the optimum inhibition efficiency was found to be 95% at the maximum concentration (3%v/v) of the inhibitor at 24h of immersion time.

Table 1: Inhibition efficiency of *Dioscorea alata* tuber extract on mild steel corrosion in 1N H_2SO_4

Conc. of extract(%v/v)	Inhibition Efficiency (%)				
	1h	3h	5h	7h	24h
0.05	7	72	61	38	54
0.5	21	85	82	66	83
1	30	87	88	77	86
1.5	44	91	89	80	90
2	52	93	90	88	92
2.5	61	94	91	91	93
3	64	95	92	93	95

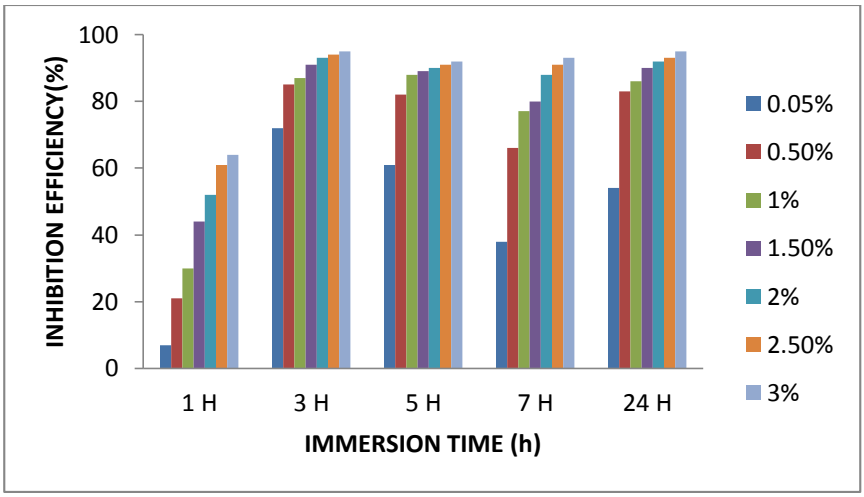

Fig 1: Effect of immersion time on IE of *Dioscorea alata*

3.2. FTIR Analysis

The observed peak values and the corresponding groups are given in Table 2. FTIR spectrum of 3%v/v plant extract is shown in Fig 3. The peak at 3745.76cm^{-1} indicates the presence of O-H group. The peak at 1739.79cm^{-1} indicates the presence of C=O group. The peak at 1369.46cm^{-1} shows the presence of N-O group. The peak at 1219.01cm^{-1} and 1091.71cm^{-1} describes the presence of C-N and C-H groups respectively. This shows that different functional groups in the inhibitor may be involved in the adsorption on mild steel surface suggesting some interaction/ adsorption may be taking place over the metal surface.

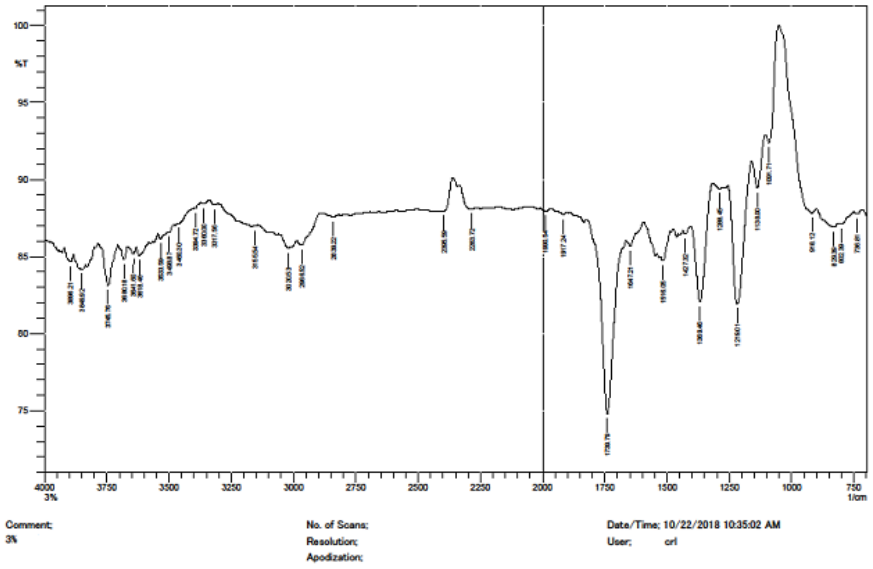

Fig 2: FTIR spectrum of 3% *Dioscorea alata* tuber extract

Table 2: FTIR peak values of *Dioscorea alata* tuber extract

Peak values	Possible groups
3745.76	-O-H in alcohol
1739.79	C=O
1369.46	N-O in nitro compound
1219.01	C-N in aliphatic amines
1091.71	C-H in alkenes

4. Conclusion

The results revealed that these extracts effectively reduce the corrosion rate of mild steel in acid solutions, by showing inhibition efficacy upto 95% and can be safely used without pollution. FTIR study reveals the presence of possible functional groups in the tested plant extract. ***Dioscorea alata*** **tuber** extract has a promising potential as an alternative eco-friendly, non-toxic, readily available inhibitor to replace the non-biodegradable, toxic and expensive synthetic chemicals, which are currently being in use.

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THE INHIBITIVE EFFECT OF LEAVES OF *CLERODENDRUM INERME* ON MILD STEEL CORROSION

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Natural organic inhibitors that can be extracted or synthesized from potential herbs, spice and medicinal plants can be used as corrosion inhibitors of mild steel in acidic solution due to its active chemical activity, low toxicity and low cost. In the present study the inhibition action of the acid extract of *Clerodendrum inerme* leaves against corrosion of mild steel in 1N H_2SO_4 medium was investigated by weight loss method. The corrosion rate (CR) and the inhibition efficiency (IE) of the extract were calculated. The findings show that the extract could serve as an effective inhibitor for the corrosion of mild steel in acid medium. The results reveal that acid extract of *Clerodendrum inerme* leaves could serve as a good corrosion inhibitor and having efficiency of 86.90 % at a concentration of 1.65 % v/v of the inhibitor.
Keywords: Acid, Mild steel, Corrosion rate, Inhibition efficiency

1. Introduction

Plant extracts are viewed as an incredibly rich source of naturally synthesized chemical compounds that can be extracted by simple procedures with low cost. A lot of natural products have been previously used as corrosion inhibitors for different metals in various environments. Literature reviews on corrosion inhibitors have shown that organic inhibitors contain nitrogen, oxygen, sulphur or aromatic rings in their molecular structure. Corrosion inhibition efficiency increases in the sequence of O<N<S<P. The inhibiting action of these compounds is attributed as a first stage, to the adsorption of the additives to the metal/solution interface [1-8]. The adsorption process depends upon the nature and surface charge of the metal, the type of aggressive media, the structure of the inhibitor and the nature of its interaction with the metal surface. In the aim of the research work, the acid extract of *Clerodendrum inerme* is used as corrosion inhibitor for mild steel in 1N H_2SO_4

2. Experimental

2.1. Materials

All reagents used for the study were analar grade and distilled water was used for their preparation. The mild steel specimen of 5×1 cm and 2 mm thickness was used for weight loss measurements. Fresh leaves of the plant material were dried in shade so as to enrich the active principles, by reducing its moisture content. The extract was prepared by refluxing 50g of powdered dry leaves in 1L of 1N H_2SO_4 for 3 h and kept overnight. Then it was filtered and taken as a stock solution. From the stock solution the various inhibitor test solutions of 0.01%, 0.05%, 1%, 1.5%, 2%, 2.5%, 3% v/v concentrations were prepared.

2.2. Methods

2.2.1. Weight loss method:

Weight loss measurements were carried out in sulphuric acid with *Clerodendrum inerme leaves* in the concentration range of 0.05% to 3% v/v for different immersion periods (1h,3h,5h,7h &24h) at room temperature. Polished mild steel specimens were initially weighed in an electronic balance. After that the specimens were suspended with the help of glass hook in 100ml beaker containing acid in the presence and absence of leaves extract. The specimens were removed after the exposure period, washed with water to remove any corrosion products. After

that they were dried and reweighed. From the weight loss measurements, the corrosion rate (CR) and inhibition efficiency (% IE) will be calculated using the following relationships.

$$CR\ (mpy) = 534\ W/\ D\ A\ t$$

$$IE\ \% = [CR_b - CR_i / CR_b] \times 100$$

3. Results and Discussion

3.1. Weight loss method

The corrosion rate of MS and inhibition efficiency of *Clerodendrum inerme* leaves in 1N H_2SO_4 for different immersion periods at room temperature is shown in Table 1. It is observed that the inhibition efficiency increased and corrosion rate of the metal decreased with increasing concentrations of inhibitor. This behaviour could be attributed to the increase in adsorption of inhibitor on the metal or at the solution interface on increasing its concentration. At 1h of immersion the corrosion rate of the metal in blank solution shows 331mpy.But the addition of small concentration of (0.05%) of the plant extract considerably lowers (196 mpy) the corrosion rate of the metal and the IE is found to be 79% at 1h for higher inhibitor concentration. The highest %IE of 98% was obtained at 24h of immersion. This result also showed that the leaves of *Clerodendrum inerme* extract actually inhibited the corrosion of mild steel in sulphuric acid solution. The effect of immersion time against the CR and IE is shown in Figure 1 and Figure 2.The influence of the inhibitor concentrations against the CR and IE is shown in Figure 3 and Figure 4.

Table1: CR of mild steel and IE of plant extract in 1N H_2SO_4

Conc.of extract %v/v	1h		3h		5h		7h		24h	
	CR mpy	IE %	CR mpy	IE %	CR mpy	IE %	CR mpy	IE %	CR mpy	IE %
Blank	331	-	1090	-	845	-	1754	-	1007	-
0.05%	196	41	113	90	87	90	543	69	284	72
0.50%	104	69	81	93	55	93	115	93	48	95
1%	100	70	61	94	49	94	73	96	41	96
1.50%	96	71	60	94	44	95	58	97	28	97
2%	87	74	54	95	43	95	48	97	27	97
2.50%	83	75	50	95	41	95	42	98	25	98
3%	70	79	44	96	32	96	40	98	21	98

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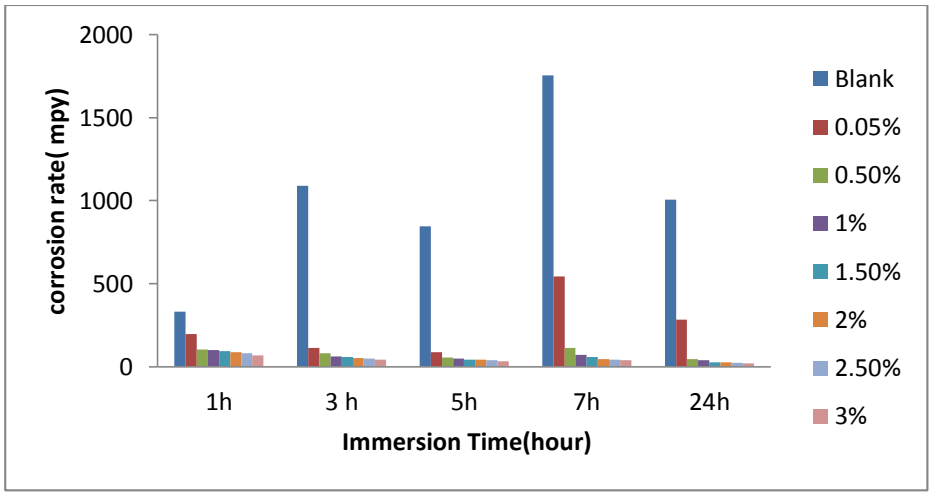

Figure 1: Effect of immersion time against the CR of mild steel

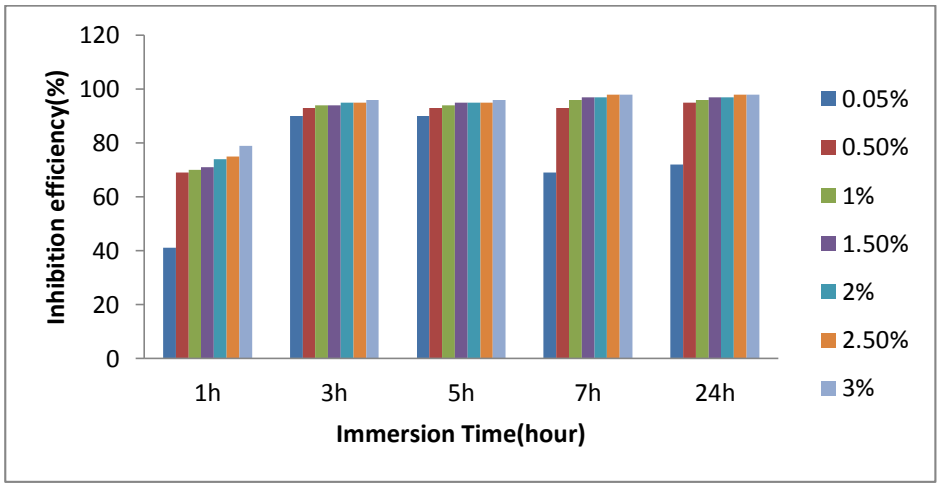

Figure 2: Effect of immersion time against the IE of the plant extract

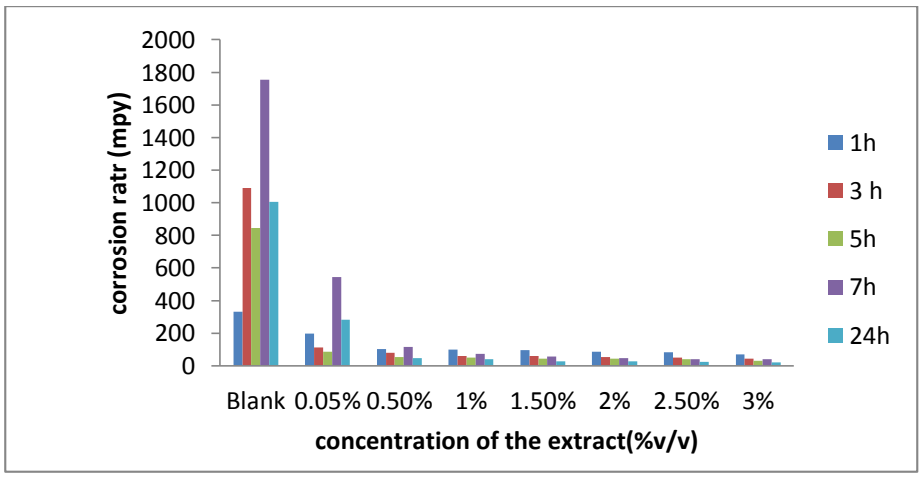

Figure 3: Concentration of the inhibitor against the corrosion rate of the metal

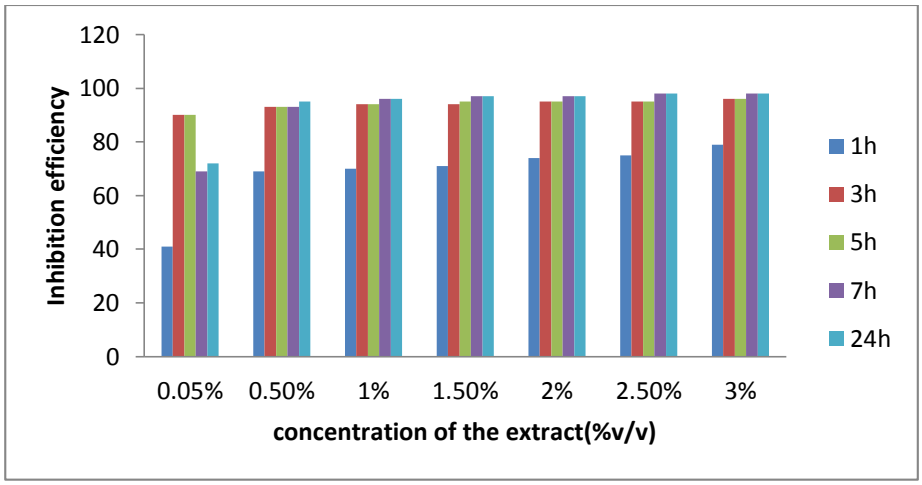

Figure 4: Concentration of the inhibitor against the Inhibition efficiency

4. Conclusions

The main conclusions drawn from the studies are:

- Leaves extract of Clerodendrum *inerme* acts as a good corrosion inhibitor for mild steel in 1N H_2SO_4 medium.
- Inhibition efficiency increases with inhibitor concentration and maximum inhibition efficiency was 98 % at the inhibitor concentration 3% v/v at 24h and 1h of immersion the IE was found to be 79%.
- The corrosion rate decreases as the concentration of the *Clerodendrum inerme* leaves extract increases, indicating that the rate of corrosion is dependent on the amount of inhibitor present.
- Corrosion inhibition may be due to the adsorption of the plant constituents on the mild steel surface.

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INDIGOFERA TINCTORIA EXTRACT AS ECO FRIENDLY CORROSION INHIBITOR FOR MILD STEEL IN ACID SOLUTION

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Green corrosion inhibitors have a promising future for the quality of the environment because they do not contain heavy metals or other toxic compounds. In addition, they are biodegradable and renewable source of materials. This study examine the effectiveness of *Indigofera tinctoria* extract solution to inhibit corrosion of mild steel in hydrochloric acid by weight lost technique and SEM analysis. It was found that the *Indigofera tinctoria* extract act as a good corrosion inhibitor for mild steel in 1N HCl solution. The inhibitive effect has been attributed to the presence of phyto constituents in the extract which leads to slowing down of the corrosion processes on the metal surface.
Keywords: Corrosion, SEM analysis, Mild steel, Phytoconstituents

1. Introduction

Use of inhibitors is one of the most practical methods for protection against corrosion especially in acid solutions to prevent metal dissolution and acid consumption. Mild steel in acid solution is widely used in various industrial processes and corrosion of mild steel known to occur in this environment. One of the effective methods to prevent corrosion is the use of organic inhibitors. A great number of scientific studies have been devoted to the subject of corrosion inhibitors for mild steel in acidic media. In recent years, natural compounds such as herbal plants are employed as inhibitors in order to develop new cleaning chemicals for green environment. Several studies have been reported in the use of natural products as corrosion inhibitors in different media [1-8]. The present work is a trial to find a cheap and environmentally safe inhibitor for mild steel corrosion in the acidic solution.

2. Experimental

2.1. Materials

The long sheet of MS specimen was press cut into 5×1 cm and 2 mm thickness and used for corrosion inhibition study. The blank corrodent 1N HCl was prepared by dilution of analar grade HCl with distilled water. *Indigofera tinctoria* extract solution with a concentration of 5% was made by dilution of 50 ml of extracts solution with 1L of 1N HCl. This represents the stock solution from which different concentrations of plant extract was prepared by dilution with the same acid solution.

2.2. Methods

2.2.1. Weight loss method

The mild steel specimens were completely immersed in 100ml of the test solutions in the presence and absence of the inhibitor for different immersion periods at room temperature. Triplicate samples were used to test reproducibility of results. The mean weight loss values of three identical experiments was used to calculate the corrosion rate (CR) and surface coverage (θ)was calculated by

$$CR\ (mpy) = 534\ W/\ D\ A\ t$$

$$\text{Surface coverage, } \theta = [CR_b - CR_i / CR_b]$$

2.2.2. SEM analysis

The surface morphology measurements of the mild steel specimens with and without inhibitor were examined using Shimadzu make scanning electron microscope in the magnification range of 1000.

3. Results and Discussion

3.1. Weight loss method

The calculated values of corrosion rate (CR) and Surface coverage (θ) for mild steel corrosion in1N HCl in the presence of different concentration of the plant extract from the weight loss measurements are shown in Table 1 and effect of immersion time on corrosion rate of mild steel is shown in Fig 1**.**Results presented in the table indicate that corrosion rate of mild steel in the acid medium was reduced in the presence of *Indigofera tinctoria* extract compared to the blank solution. It is also seen in the table that corrosion rate of metal in the presence of the extract decreases with increase in the extract concentration. Corrosion rate is also observed to increase with rise in temperature. Surface coverage values were found to increase with increase in concentration of plant extract. Maximum surface coverage of 0. 96 was obtained with extract concentration of 3%v/v at 7h of immersion.

Table 1: Corrosion rate and Surface coverage values for mild steel corrosion in1N HCl

Conc.of extract %v/v	1h		3h		5h		7h		24h	
	CR	θ	CR	θ	CR	θ	CR	θ	CR	θ
BLANK	592	-	447	-	286	-	1194	-	105	-
0.05%	240	0.59	148	0.67	104	0.64	156	0.87	47	0.55
0.50%	212	0.64	100	0.78	65	0.77	85	0.93	34	0.68
1%	166	0.72	81	0.82	60	0.79	77	0.94	31	0.70
1.50%	157	0.73	77	0.83	40	0.86	70	0.94	27	0.74
2%	148	0.75	71	0.84	36	0.87	63	0.95	24	0.77
2.50%	144	0.76	68	0.85	34	0.88	60	0.95	23	0.78
3%	135	0.77	58	0.86	29	0.90	45	0.96	21	0.80

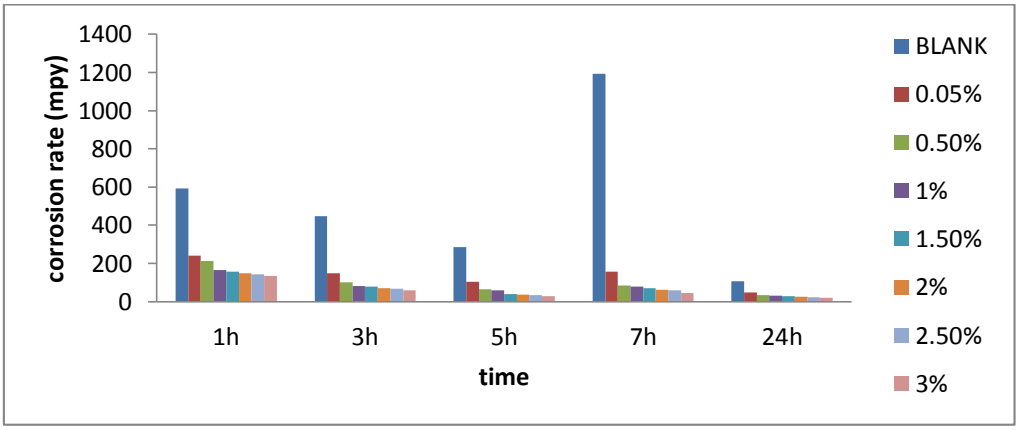

Fig 1: Effect of immersion time on corrosion rate of mild steel

3.2. SEM Analysis

SEM micrographs of mild steel surfaces after immersion for 3h in the presence and absence of *Indigofera tinctoria* extract are shown in Fig 2 and Fig 3. Fig 2 indicates a considerable surface damage on the mild steel, which was dipped in 1NHCl solution. It confirms that the metal surface is highly corroded in blank solution. In Fig 3 the corroded area of the mild steel surface was protected with the addition of 0.05% inhibitor concentration, which shows that there is less damage on the MS surface which further confirms the inhibition action and adsorption of inhibitor on MS surface.

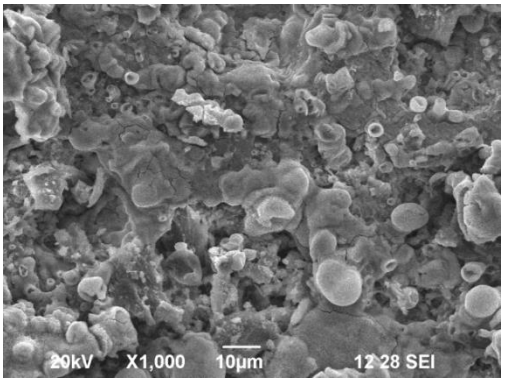

Fig 2: SEM image of mild steel with 1N HCl

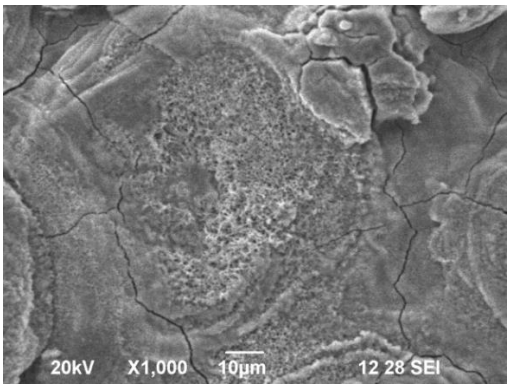

Fig 3: SEM image of mild steel with 0.05% of inhibitor

4. Conclusion

Indigofera tinctoria leaves extract acted as an effective corrosion inhibitor for mild steel in 1N HCl solution. The corrosion rate of the metal atom significantly minimised in the presence of plant extract. Surface coverage of the system increases with increase in concentration of the inhibitor. SEM studies showed the formation of inhibitor film on mild steel surface. It clearly indicates that the mild steel surface was protected from corrosion in the presence of plant extract which is acting as a corrosion inhibitor. The corrosion inhibition is probably due to the adsorption of the phytochemical constituents of the extract on the metal surface.

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ELECTROCHEMICAL STUDIES ON CORROSION INHIBITION PROCESS OF MILD STEEL BY CAESALPINIA CORIRIA IN ACID MEDIUM

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The corrosion inhibition of ***Caesalpinia coriaria*** extract on mild steel using both weight loss and electrochemical methods is determined. The inhibition efficiency increases and corrosion rate decreases with increase in inhibitor concentration. The leaf extract of ***Caesalpinia coriaria*** is an excellent inhibitor showing maximum efficiency 75% in 1M H_2SO_4 at 5 hours. Corrosion kinetic parameters, polarization curve and surface studies involving SEM confirmed the efficiency of the plant extract as corrosion inhibitor for mild steel. Higher the concentration greater is the surface smoothness.
Key words: weight loss, electrochemical methods

INTRODUCTION

Corrosion is an irreversible interfacial reaction of a material with its environment which results in consumption of the material or its dissolution into the material of a component of the environment. It is the natural tendency of the elements of a material to return to their most thermodynamically stable state [1]. It involves an electrochemical process governed by reactions on an atomic level, and basic stress environment variables like pH, temperature, stress etc add to the complexity of corrosion. The term corrosion is sometimes also applied to the degradation of plastics, concrete and wood, but generally refers to metals. Metallic corrosion is the natural process of the metal going to its oxidized state [2]. The metal gets corroded by exposure to corrosive atmosphere like moist air, salty water, refinery oil, various acids etc[3]. The most widely used metal is iron (usually as steel).

Scientific Classification

Kingdom	: Plantae
Division	: Magnoliophyta
Class	: Magnoliopsida
Order	: Fabales
Family	: Caesalpiniceae
Genus	: Caesalpinia
Species	: C.Coriaria

It grows to 9 m (30 ft) tall, often much less and very contorted in exposed coastal sites. In other environments, it grows into a low dome shaped tree. Leaves of ***Caesalpinia coriaria*** are bipinnate, with 5-10 pairs of pinnae, each with 15-25 pairs of leaflets. The individual leaflets are 7 mm long and 2 mm broad. The fruit is a twisted pod 5 cm long. ***Caesalpinia coriaria*** are largely used in tanning industry.

EXPERIMENTAL METHOD

The present investigation deals with the aim of finding out eco-friendly and cost effective inhibitor which can be used in the industry. The study of corrosive inhibitive effect of leaf extract of **"*Ceasalpina coriaria"*** in 1N H_2SO_4 on mild steel.

The inhibitive effect was evaluated using conventional weight loss, electrochemical potentiodynamic polarization and AC impedance techniques.

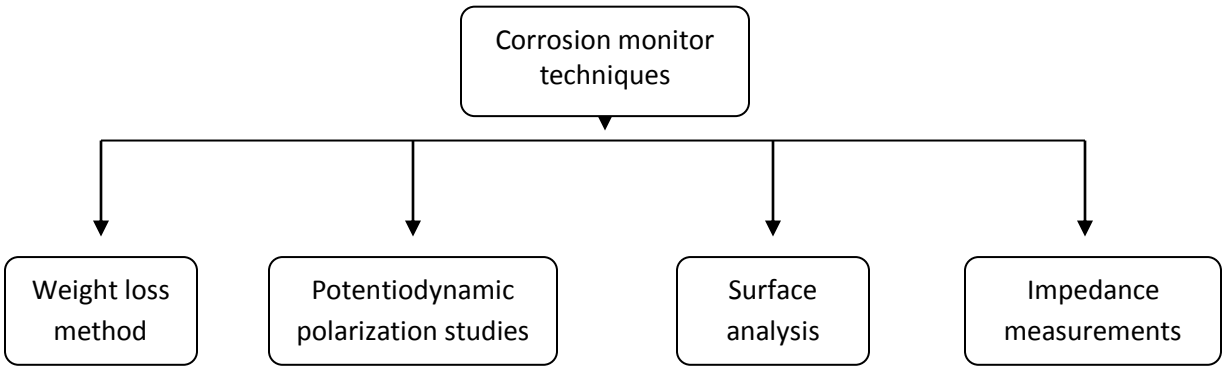
Reagents used

The metal gets corroded by exposure to corrosive atmosphere like moist air, salty, water, refinery oil, various acids etc. Acids are used for de-rusting and picking, clearing of refinery equipment, removal of calcareous deposits from boilers, radiators of vehicles, pipelines carrying water or petroleum products, heat exchangers etc.

Preparation of inhibitor

Leaves of ***Caesalpinia coriaria*** were collected, washed and shade dried. 15 gms of dried powder of leaves was boiled in 500 ml of 1N H_2SO_4 with reflux condenser for three hours and was kept over night. The extract was filtered and the filtrate volume was made up to 500 ml using 1N H_2SO_4 the next day. The extract so prepared is taken as 3% stock solution and from this other concentrations were diluted.

Corrosion monitoring techniques



RESULTS AND DISCUSSION

The results pertaining to the study entitled "Corrosion inhibition of mild steel by ***Caesalpinia coriaria*** extract in acidic media" are discussed below. The performances of leaf extract in 1N H_2SO_4 as inhibitors of corrosion for mild steel is compared.

Weight loss studies

The weight loss determination is used even today because of its versatility (all types of corrosive environment), simplicity (technique) and direct approach (no assumptions or approximations). The weight loss method was conducted using various concentration of inhibitors (0.01%-0.5%) v/v. Here the parameters like inhibitor efficiency, corrosion rate and surface coverage were calculated.

Table 1. Surface coverage (ϴ) for the corrosion of mild steel in 1 N H_2SO_4

Concentration of inhibitor (%)	1 hour (ϴ)	3 hours (ϴ)	5 hours (ϴ)	7 hours (ϴ)	24 hours (ϴ)
0.01	0.0951	0.1176	0.1250	0.1292	0.1710
0.05	0.2619	0.2721	0.2832	0.2921	0.3889
0.075	0.3095	0.3233	0.3333	0.3512	0.4286
0.1	0.4148	0.4118	0.4292	0.4438	0.5127
0.25	0.5476	0.5588	0.5525	0.5787	0.5594
0.5	0.7381	0.7426	0.7600	0.6966	0.6389

Potentiodynamic polarization studies

The electrodynamic parameters of the inhibitor such as corrosion potential E_{corr}, corrosion current density I_{corr}, anodic and cathodic Tafel slopes b_a and b_c in absence and presence of inhibitor were obtained. Results reported in the tables reveal the strong inhibiting effect of the inhibitor[4]. I_{corr} values of the inhibited acids are lower than that of the uninhibited acid, which indicates that the increase in corrosion inhibition property is due to increase in blocked fraction of the electrode surface by adsorption of inhibitor molecules.

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Table 2. Electrochemical parameters for the corrosion of mild steel in 1N H_2SO_4 with various concentrations of inhibitor

S.No	Concentration of inhibitor(%)	$-E_{corr}$ V	I_{corr} µA cm^{-2}	b_a mV/dec	b_c mV/dec	I.E. (%)
1	Blank	0.4513	0.0006546	137.24	235.66	
2	0.05	0.4477	0.0002276	86.98	236.41	65.23
3	0.1	0.4681	0.0002071	45.09	144.54	68.35
4	0.25	0.4582	0.0001874	46.60	164.50	71.37
5	0.5	0.4552	0.0001470	48.66	172.22	77.54

Impedance studies

The impedance parameters derived from the investigations are mentioned in for various concentrations of the inhibitor. The charge transfer resistance (R_{ct}) is calculated from difference in impedance at lower and higher frequencies. From the table it is clear that the double layer capacitance C_{dl} decreases with increase in concentration of the inhibitor. The decrease in the C_{dl} values which can result from a decrease in dielectric constant and / or an increase in the thickness of electrical double layer suggests that the inhibitor molecules function by adsorption at the metal-solution interface[5]. The charge transfer resistance values for the mild steel increases with increase in the concentration of the inhibitor indicating that the increase in concentration of plant decreases the corrosion rate. These are in accordance with the results obtained

Table 3. Impedance parameters for the corrosion of mild steel in 1N H_2SO_4 with various concentrations of inhibitor

S.No	Concentration of inhibitor (%)	R_{ct} (Ω cm^2)	C_{dl} (F cm^{-2})	I.E. (%)
1	Blank	19.01	0.00001597	
2	0.05	37.52	0.00000911	49.33
3	0.1	164	0.00000762	88.41
4	0.25	190	0.00000703	89.99
5	0.5	259.1	0.00000663	92.66

Table 4. Comparison of inhibitor efficiency by electrochemical and non electrochemical methods for the corrosion of mild steel in 1N H_2SO_4

S.No	Concentration of inhibitor (%)	Inhibitor efficiency		
		Weight loss	Tafel polarization	Impedance
1	0.05	28.33	65.23	49.33
2	0.1	42.92	68.35	88.41
3	0.25	56.25	71.37	89.99
4	0.5	75.00	77.546	92.66

CONCLUSION

The present investigation deals with the corrosion inhibition of ***Caesalpinia coriaria*** extract on mild steel. Both weight loss and electrochemical methods were carried out. The adsorption of plant constituents on the surface of mild steel makes a barrier for charge and mass transfer and products further attack by acid.

The following conclusion could be drawn,

- The leaf extract of ***Caesalpinia coriaria*** served to inhibit the corrosion of mild steel in1N H_2SO_4
- The inhibition efficiency increases and corrosion rate decreases with increase in inhibitor concentration.
- The leaf extract of ***Caesalpinia coriaria*** was an excellent inhibitor showing maximum efficiency 75% in 1M H_2SO_4 at 5 hours.
- The leaf extract was found to have more inhibition efficiency probably due to the presence of alkaloids in leaf.
- Corrosion kinetic parameters like I_{corr}, E_{corr}, b_a, b_c, R_{ct} and C_{dl} values were evaluated using electrochemical measurements.
- Polarization curve recorded reveal that the leaf extracts of ***Caesalpinia coriaria*** behave like mixed type of inhibitor
- Decrease in I_{corr}, and C_{dl} values and increase in R_{ct} values confirmed the inhibition action of the inhibitor, owing to increased thickness of the adsorbed layer.
- Surface studies involving SEM confirmed the efficiency of the plant extract as corrosion inhibitor for mild steel. Higher the concentration greater is the surface smoothness.
- The inhibition efficiencies obtained by conventional weight loss method and electrochemical measurements were quite comparable.

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CHARACTERISATION AND REDUCTION OF THE EFFECT OF POLLUTANTS OF MUNICIPAL SEWAGE WATER

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This study was carried out to characterise the municipal sewage water in Ukkadam, Coimbatore city and to assess the possibility of reducing the pollutant and sludge load of sewage water through chemical treatment.

Keywords
Sewage, Sludge, pH, Electrical conductivity (EC), dissolved oxygen, biological oxygen demand (BOD), chemical oxygen demand (COD)

INTRODUCTION

While world attention is focused on the depletion of the atmospheric ozone layer and global warming, a more serious problem is brewing literally under our feet. Many a major city in India is sitting on a short fuse the ticking of which is drowned in the song of ecological romantisists. The real problem is corruption of water resources[1]. Coimbatore city is famous for textile processing and dyeing industries which releases enormous quantity of waste water that mixes with sewage and threaten the environment. Sewage is created by residents, institutions, commercial and industrial establishments. In Coimbatore city there are two systems involved in the transportation of waste water ie., a open drainage system and a subsurface system. The system works without pumps because gravitation is in favour. The open drainage water system goes to tank in the south Coimbatore ie., Valankulam, Chinnakulam and Periakulam. The water collected through subsurface system goes to the sewage farm located in Ukkadam. Due to the diversified source, the sewage water is loaded with variety of pollutants and considerable quantity of sludge.
Hence the study was carried out to characterize the municipal sewage water and various parameters like pH, Electrical conductivity, dissolved oxygen, biological oxygen demand, chemical oxygen demand were studied[2,3]

EXPERIMENTAL METHODS

Sewage water samples (1000 ml) were collected from 20 different locations in and around sewage farm, Ukkadam, Coimbatore and stored in polythene containers.and also a known quantity (5 liters) of sample was collected from sewage farm inlet and outlet separately for analysis. An attempt was made to reduce the total suspended solids TDS, BOD, COD etc using different chemicals like 2% $AlCl_3$, 2% $FeCl_3$ and 2% $FeCl_2$ solutions. The chemically treated water was passed through different adsorbents like activated carbon, charcoal and vermiculite packed with lime, sand and pebbles.

RESULTS AND DISCUSSION

1 Characteristics of sewage water and sludge

The results of physical, chemical and biological characteristics of sewage water and sludge are given in table 1& 2

The sewage farm is using six step treatment plant to treat the sewage water. The sewage water samples were collected before and after the treatment. The sewage water was acidic in pH (6.39) even after the treatment with EC of 1.59 dS m^{-1}. In general the existing sewage water treatment plant reduced the components viz., EC, TDS,TSS, BOD, COD.

Table 1 Characteristics of sewage water

S.No	Parameters	Sewage water inlet	Sewage water outlet
1	pH	6.18	6.39
2	EC (dS m^{-1})	1.61	1.59
3	Total suspended solids (mg L^{-1})	156	152
4	Total dissolved solids (mg L^{-1})	2396	2312
5	Dissolved oxygen (mg L^{-1})	3.21	3.29
6	Biological oxygen demand (mg L^{-1})	49	43
7	Chemical oxygen demand (mg L^{-1})	296	285

Table 2 Characteristics of sewage sludge

S.No	Parameters	Value
1	pH	7.42
2	EC (dS m^{-1})	1.49
3	Total carbon (%)	28.26
4	Total nitrogen (%)	1.46
5	Total phosphorous(%)	0.66
6	Total potassium (%)	0.27
7	C/N ratio	19.35
8	Ca(%)	11.92
9	Mg(%)	1.25
10	Bacteria (X 10^5 CFU g^{-1} sludge)	29
11	Fungi (X 10^4 CFU g^{-1} sludge)	32
12	Actinomycetes (X 10^3 CFU g^{-1} sludge)	7

2. **Effect of alum on the sludge reduction in sewage water**

An experiment was conducted to quantify the coagulant required to remove the sludge from sewage water by using alum at different concentration. The results are given in table 3. The experimental results showed an increase sludge reduction with the increased concentration of alum. Maximum sludge reduction (5.39%) was recorded at 5% alum concentration. But the ability of alum in reducing the sludge was decreased at 4% alum concentration ie., reduction of sludge was increased at decreasing rate. In general 0.75 to 5.39% of sludge was reduced from the total volume of sewage water at different level of alum concentration.

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Table 3. Effect of alum on the sludge reduction in sewage water

S.No	Concentration of alum used (ppm)	Quantity of water used for the treatment (litres)	Quantity of sludge generated g $10\ kg^{-1}$ water	Sludge reduction
1	0	10	75	0.75
2	1	10	276	2.76
3	2	10	495	4.95
4	3	10	520	5.20
5	4	10	528	5.28
6	5	10	539	5.39

3. **Chemical treatment**

Aluminium chloride, ferric chloride and ferrous chloride were efficient in reducing the pollutant load from sewage water. Among the three chemicals used, aluminium chloride was found to be efficient in reducing most components.

Table 4. Effect of different chemicals on the reduction of pollutant load of sewage water

S.No	Parameters	Aluminium chloride	Ferric chloride	Ferrous chloride
1	pH	6.21	6.13	6.26
2	EC ($dS\ m^{-1}$)	1.62	1.65	1.66
3	Total suspended solids ($mg\ L^{-1}$)	112	123	129
4	Total dissolved solids ($mg\ L^{-1}$)	1800	1892	1912
5	Dissolved oxygen ($mg\ L^{-1}$)	6.12	6.03	5.96
6	Biological oxygen demand ($mg\ L^{-1}$)	27	29.2	29.9
7	Chemical oxygen demand ($mg\ L^{-1}$)	189	201	232

COD is the measure of the chemical oxygen demand and BOD is the measure of biological oxygen demand in waste water. These two parameters are used to characterize both the municipal and industrial waste water. BOD tends to be used more frequently in municipal wastewater treatment and COD is used more often in industrial wastewater treatment. The aluminium chloride reduced the BOD of sewage water from 49 to 27 mg L^{-1} and COD from 285 to 189 mg L^{-1}. In both municipal and industrial wastewater treatment applications, there are many types of materials that contribute to BOD and COD. They can be organics, inorganics, oils, fats, etc. BOD and COD can be removed by coagulation and/or filtration when they are in the form of suspended solids. If they are soluble, then adsorption, biological oxidation or chemical oxidation processes are needed to remove them.

CONCLUSION

The present study has revealed that sewage water that is treated has better physico-chemical characteristics and can be used for irrigation. A step to conserve water is the step to secure the future.

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SYNTHESIS AND CHARACTERIZATION OF COPPER (II) COMPLEX OF BENZALDEHYDE BENZOYL HYDRAZONE

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The copper complex was prepared from benzaldehyde benzoyl hydrazone. The yield of the complex was about 70% and the melting point was 204-210°C. The IR spectrum shows different bands at 1600 cm^{-1}, 1500 cm^{-1}, 995 cm^{-1}, 1030 cm^{-1} corresponding to the various functional groups. The electronic spectrum of Cu (II) complex showed only one single broad band at 416 nm, which is attributed to 2T2→ 2E transition indicating tetrahedral coordination environment.

Key Words: Copper chloride, benzaldehyde, hydrazine hydrate.

INTRODUCTION

Coordination chemistry is an important branch of chemistry. It is the study of a class of compounds formed by metal. Several coordination compounds are now routinely used in industries to benefit the mankind. Coordination compounds are compounds in which central metal atoms or ion is linked to a number of ions or neutral molecules by coordinate bonds or which contain complex ions. Examples-$[Cu(NH_3)_4]SO_4$, $Ni(CO)_4$. The neutral or negative ion bound to the central metal ion in the coordination entity is called ligand. They donate a pair of electrons to the central metal ion. Ligands donate electron density to the metal centre to form the coordinate-covalent bond. Ligands may be charged or neutral. Hydrazine is a detonate chemical. The presence of two lone pairs of electrons and four substitutable hydrogen atoms in addition to potent N-N bond. Hydrazine and its derivatives were prepared by Curtius. Hydrazine does not frequently act as reducing agent in reaction with transition metals, but act as a ligand to form complexes. Hydrazine is a dibasic ligand, it can function as unidentate, bidentate or bridging ligands. The monoprotonated hydrazine still retains a basic site and is capable of coordinating to the metal and the complexes containing positively charged hydrazinium ions are well known. The alkyl derivatives of hydrazine such as methyl, ethyl, phenyl and diethyl substituted hydrazine's can also act as ligands. Complexes containing bridging phenyl hydrazines have not been prepared probably due to steric reasons. Present work deals with the preparation and characterization, and SEM analysis of benzaldehyde benzoyl hydrazone copper complex.

MATERIALS AND METHODS

Synthesis of benzoic acid hydrazide (BH) $C_6H_5CONHNH_2$:

The benzoic acid hydrazide, $C_6H_5CONHNH_2$(BH) was prepared by following literature procedure by refluxing together ethanolic solutions of ethyl benzoate (30 ml) and hydrazine hydrate (10 ml) in 1:1 mole ratio for about six to eight hours and the solution was left overnight, thus obtained hydrazide was recrystallized.

$$C_6H_5COOC_2H_5 + H_2N\text{-}NH_2.H_2O \rightarrow C_6H_5CONHNH_2 + C_2H_5OH + H_2O$$

Synthesis of benzaldehyde benzoyl hydrazone (BBH) $C_6H_5CONHNCHC_6H_5$:

Benzaldehyde benzoyl hydrazone, a hydrazide schiff's base is prepared by condensation of benzoic acid hydrazide (5.44 g dissolved in ethanol)with benzaldehyde (4.244 g, m.wt-106.124) in 1:1 molar ratio. After mixing these two solutions it was heated for few minutes which was left over night. The pale yellow crytalline solid formed was then filtered and washed 2-3 times with ethanol and left to dry.

$$C_6H_5CONHNH_2 + C_6H_5CHO \rightarrow C_6H_5CONHNCHC_6H_5 + H_2O$$

Synthesis of the complex:

Ethanolic solution of BBH $CuCl_2$ (5mmol/0.85g in 10 ml) were mixed together and was heated for few minutes on the water bath which resulted in the formation of orange precipitate it was then left over night. The precipitate was filtered was then washed with ethanol and dried over fused $CaCl_2$

$$2(BBH)+CuCl_2.2H_20 \rightarrow [Cu\ (BBH)_2] + 2\ HCl + 2\ H_2O.$$

Characterization of the complex:

Metal content of the complex was extracted iodometrically, for this about 0.1 g of the complex was weighed and digested with aqua regia followed by concentrated H_2SO_4. The white residue was then extracted with few drops of diluted HCl and distilled water into a conical flask to which 10 ml of 10% KI solution was added. It was finally diluted to about 75 ml. the flask was then covered and allowed to stand in dark for few minutes. The liberated iodine was titrated against standard sodium thiosulphate solution using starch as indicator. The amount of copper was calculated by using relation.

1ml of 1N Na_2SO_3 = 0.06354g of copper

11.6 ml of 1N Na_2SO_3 = 0.06354x140 = 0.737064x100 = 73.7%

RESULTS AND DISCUSSION

The ligand, benzaldehyde benzoyl hydrazone in this study form 1:2 (M: L) complexes. The reaction between the ligand and metal salt is represented by following equation: $CuCl_2\ 2H_2O + 2(BBH) \rightarrow [Cu(BBH)_2] + 2HCl + 2H_2O$. The complex is intensely colored and stable powder, which melt around 260 - 264° C. The yield of the complex is found to be 70% (Table 1). The complex is insoluble in water, ethanol, benzene and soluble in dimethyl sulphoxide and dimethyl formamide. The complex corresponds to formula $[Cu(BBH)_2]$. It doesn't contain any anions.

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Physical properties

Complex	Colour	Yield (%)	Melting point(℃)
BH	White	78.9%	176 ℃
BBH	Pale Yellow	73.7%	204-210℃
$[Cu(BBH)_2]$	Orange	75.4%	204-206℃

Infrared spectra

Infrared spectroscopy is one of the most common spectroscopic techniques used for structural elucidation of metal complexes and compound identification. Infrared spectra of the ligand, BBH, have several prominent bands at 3280 and 1630 cm^{-1} due to *v* (N-H). The amide bands of >CONH- group are observed at 1675, 1535 and 1275 cm^{-1} which indicates that the ligand exist in the keto form in the solid state. The amide and *v* (N-H) stretching bands had disappeared in the complex indicating the absence of the >C=O group and loss of the NH proton via enolisation indicating that the ligands are coordinating in the enolic form.

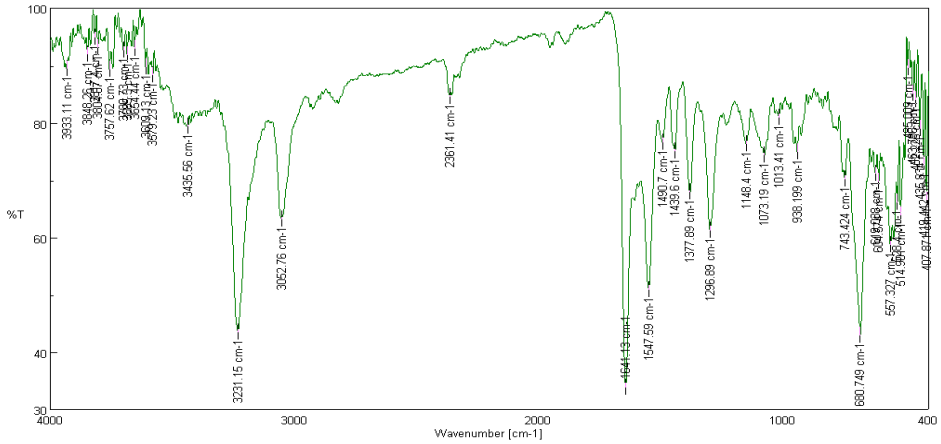

Fig.1 The IR Spectra of Benzaldehyde benzoyl hydrazone

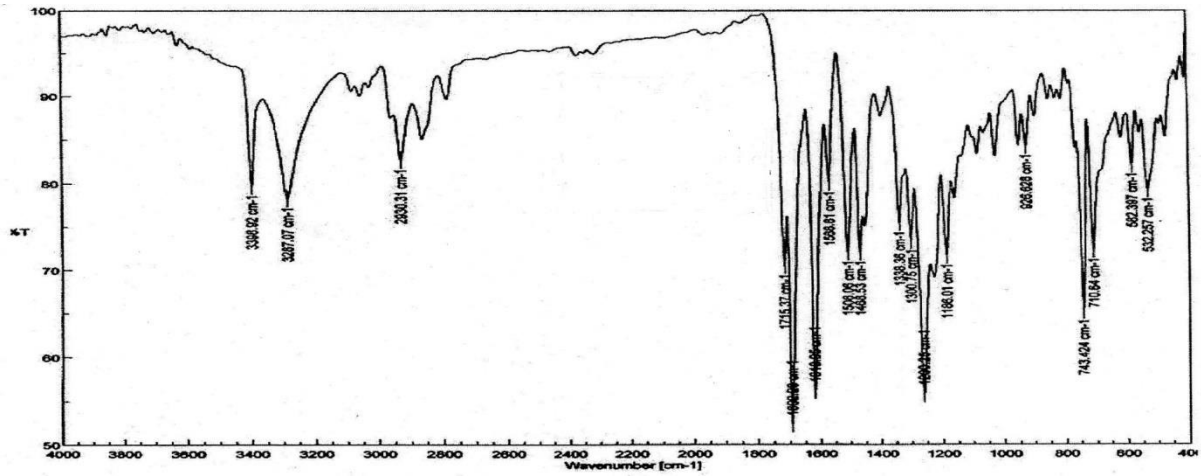

Fig.2 The IR Spectra of Copper(II) Benzaldehyde benzoyl hydrazone

The IR spectra of the complex [Cu(SBH)2] showed some new bands. A sharp band at 1600 cm^{-1} diagnostic of >C=N-N=C< group indicating transformation of the carbonyl group to its enolic form through keto-enol tautomerism and subsequent coordination of the enolic oxygen to metal after deprotonation. Again the appearance of a new band at 1500 cm^{-1} was characteristic of *ν*(NCO-), which further supported the enolic oxygen coordination. A weak band, ν(N-N) appearing at 995 cm^{-1} in the ligand shifted to higher frequency 1030 cm^{-1} in the complex which shows coordination through one of the nitrogen atom of the hydrazide moeity1. A broad band around 3400 cm^{-1} in complex showed non involvement of -OH group of salicylaldehyde in coordination.

Electronic spectra:

The electronic absorption spectra are often very helpful in the evaluation of results furnished by other methods of structural investigation. The electronic spectra measurements were used for assigning the stereochemistry of metal ions in the complexes based on the positions and number of d-d transition peaks.

The electronic spectrum of Cu (II) complex showed only one single broad band at 416 nm, which is attributed to 2T2→ 2E transition indicating tetrahedral coordination environment. This transition results from the hole transfer from t2 to e orbital.

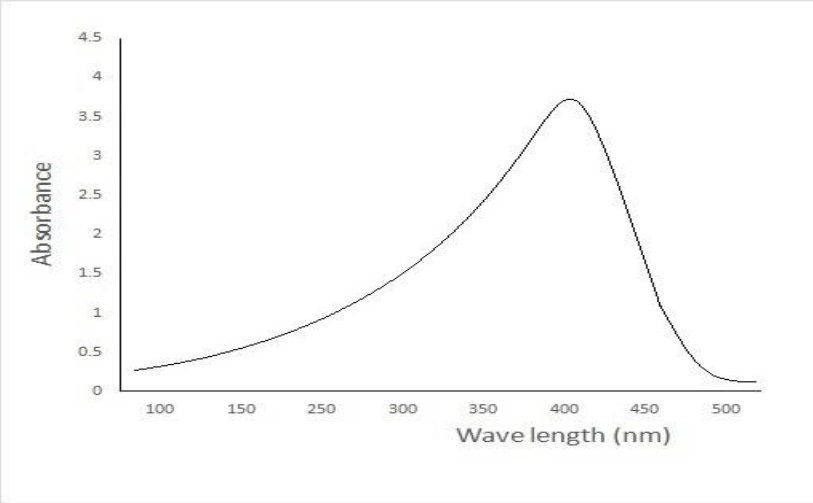

Fig.3 UV Spectrum of the complex

SCANNING ELECTRON MIRCOSCOPE:

The FESEM images of the metal complex are given in the figures. The SEM image of metal complex reveal the rod shape surface nature of the particle.

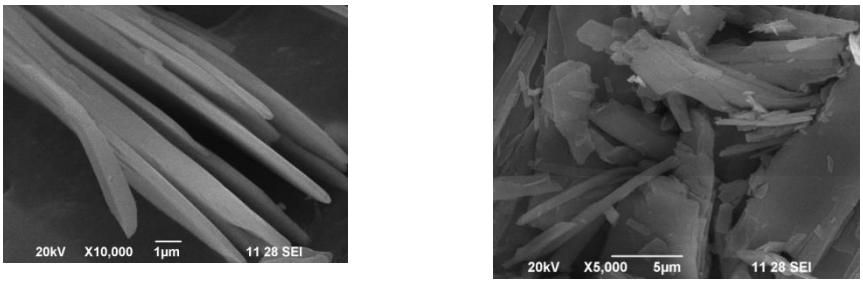

Fig. 4. The rod shape surface nature of the particle

CONCLUSION

Hydrazones belongs to an important class of compound which has drawn significant attention due to remarkable biological and analytical properties. On the basis of the spectral studies the nature as well as structure of complex has been suggested. The complex is insoluble in water, ethanol and benzene and soluble in dimethyl sulphoxide and dimethyl formamide. Complex does not contain any water molecules and anions. The IR spectrum shows the frequencies of C=O and C=N is shifted to lower frequencies indicating the formation of complex. The UV spectrum shows the stereochemistry of metal ions in Cu(II) complex based on position and number of d-d transition peak. The SEM image of metal complex reveal the rod shape surface nature of the particle.

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SYNTHESIS AND CHARACTERIZATION OF TRANSITION METAL COMPLEX

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The complex was formed by reacting benzoic acid and hydrazine hydrate with nickel nitrate in aqueous medium in 1:1:1 molar ratio at pH>6.The product obtained was characterized by various analytical and spectroscopic techniques.The complex $Ni(C_6H_5COO)_2$ $(N_2H_4)_2$ was obtained in 78% yield as violet coloured substance having melting point at 97 ℃.The complex was soluble in organic solvents like ethanol,methanol and DMSO. The IR spectrum shows the stretching frequencies of (C=O) and (C=N) is shifted to lower frequencies indicating the formation of complex and it is further supported by newly formed low frequency bands.The UV spectrum shows to absorption bands in DMSO in which d-d transition is evident.The complex formed can be carried out for further studies.
Key Words: Nickel Nitrate, Hydrazine Hydrate, Benzoic Acid.

INTRODUCTION

Transition metals are found everywhere from vitamin supplements to electroplating baths. Transition metals also make up the pigments in many paints and compose all minerals.[1] Typically, transition metals are found in the cationic form since they readily oxidize or lose electrons, and are surrounded by electron donors called ligands. These ligands do not form ionic or covalent bonds with the metal center; rather they take on a third type of bond known as coordinate-covalent.[2] The coordinate-covalent bond between a ligand and a metal is dynamic, meaning that ligands are continuously exchanging and re-coordinating around the metal center.

The identities of both the metal and the ligand dictate which ligands will bond preferentially over another. In addition, color and magnetic properties are also due to the types of complexes that are formed.[3] The coordination compounds that form are analyzed using a variety of instruments and tools. This experiment explores why so many complexes are possible and uses a spectrochemical (color and chemical) method to help identify the type of coordination complex that forms.

MATERIALS AND METHODS

All the reagents used were of analar grade and were purified and dried according to the standard procedure [4]. The ligand was synthesized according to the procedure [5]. Benzoic acid, Hydrazine hydrate, Nickel nitrate hexahydrate were obtained from Merck and Sigma chemicals India respectively. Melting point was recorded in a Sigma melting point apparatus. Infrared spectra were measured as KBR pellets on a Nicolet nature model FT-IR spectrophotometer in the 400-4000 cm^{-1} range. The electronic spectrum of the complexes has been recorded in DMSO using Perkin Elmer UV- visible spectrophotometer in the 200-800 nm range.

MATERIALS REQUIRED

Benzoic acid.
Hydrazine hydrate
Nickel nitrate hexahydrate

Preparation of transition metal dihydrazine complex M $(C_6H_5COO)_2(N_2H_4)_2$ [M= Ni]

The complex was prepared by dissolving corresponding metal nitrate (2.907gms, 0.01mol $Ni(NO_3)_2.6H_2O$; in 20ml of distilled water) was prepared and poured to ligand solution which was prepared by mixing. Benzoic acid (2.44g, 0.02mol in 10ml water) and hydrazine hydrate (1.032ml, 0.02mol in 10ml water) with constant stirring. Clear solution is obtained initially, and it becomes residue in addition of Nickel Nitrate solution after 30min. When stirred using a magnetic stirrer (Fig.11) at 50^o C and 370 rpm and the it is converted to micro crystalline solids when left undisturbed. The color of the crystal is pale violet. Nickel hydrazine complex (Fig.12) was formed only in 1:1 alcohol medium at pH=5. The solution with the products where cooled, filtered and washed with distilled water, ethanol and then with ether. Then dried in desiccator containing anhydrous $CaCl_2$.

$$M(NO_3)_2 + 2N_2H_4 + 2C_6H_5COOH \rightarrow M(C_6H_5COO)_2(N_2H_4)_2 + 2HNO_3$$

RESULTS AND DISSCUSSION

The present work aims at preparing metal dihydrazine complex. The preparation of metal dihydrazine complex has been carried out in aqueous medium. The metal complex have been characterized by IR, UV studies. The stoichiometric reaction of $Ni(NO_3)_2.6H_2O$ with Benzoic acid and hydrazine hydrate in aqueous medium resulted in the formation of new complex (equation 1). From the analytical data stoichiometry of the new complex was soluble in common organic solvents such as dichloromethane, chloroform, benzene, acetonitrile, methanol, ethanol, DMF and DMSO. All the complexes are formed in acidic medium (pH<7). The chemical reactions can be represented as

$$Ni(NO_3)_2 + 2N_2H_4 + 2C_6H_5COOH \rightarrow Ni(C_6H_5COO)_2(N_2H_4)_2 + 2HNO_3$$

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INFRARED SPECTROSCOPY

The IR bands are shown C=O stretching vibration: The band at 1710 cm^{-1} of the ligand due to C=O stretching lowered to ~ 1688cm^{-1} on complexation. C=N stretching vibration:The band at 1625 cm-1 in the spectrum of the ligand due symmetrical (C=N) stretching decreased to ~ 1616cm^{-1} in the complex, while the band at 1616cm^{-1} was assigned to γ (C=N) frequency shifted to the lower frequency at 1536cm^{-1} in the complex.

The low frequency bands of complexes. New bands which appeared at low frequencies in the spectra of the synthesized complexes were probably due to (M-N) and (M-O) bond vibration frequencies. The facts are further supported by newly formed low frequency bands:

1-The band at 418cm^{-1} have been assigned to γ (M-N).

2-The bands at 545cm^{-1} have been assigned to γ (M-O).

On the basis of the above evidence is an indication of complex formation.

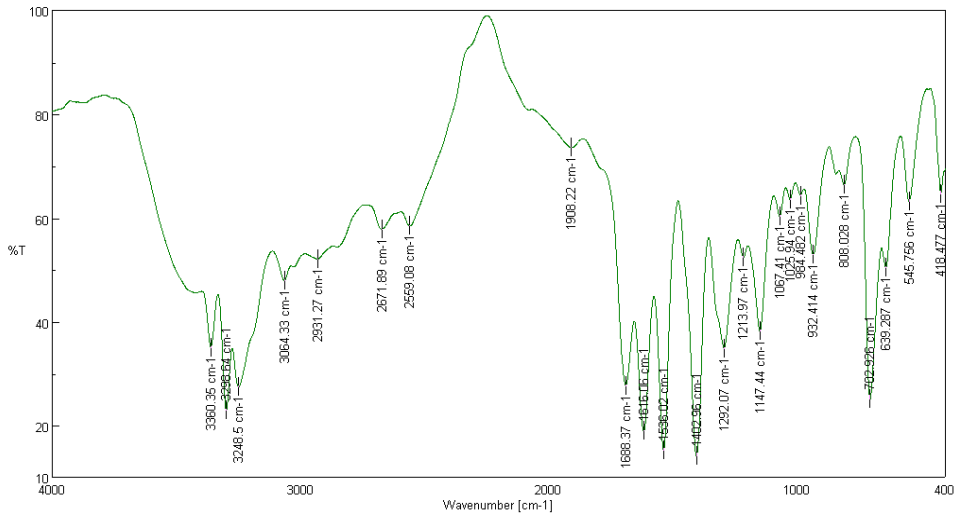

Fig 1. Infrared spectrum of new metal complex

ELECTRONIC SPECTRUM

The electronic spectrum of Ni (II)-complex shows two absorption bands in DMSO solution at 367 nm (LMCT) S → d transition.

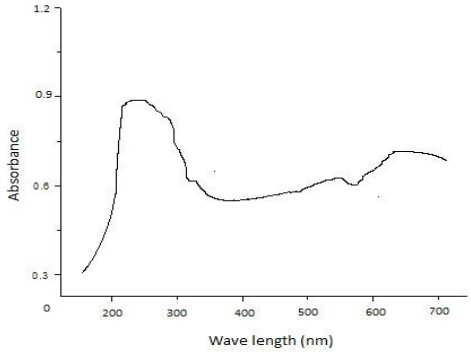

Fig.2. Ultra violet spectrum of the new metal complex

SCANNING ELECTRON MIRCOSCOPE:

The FESEM images of the metal complex are given in the figure. The SEM image of metal complex reveal the rod shape surface nature of the particle.

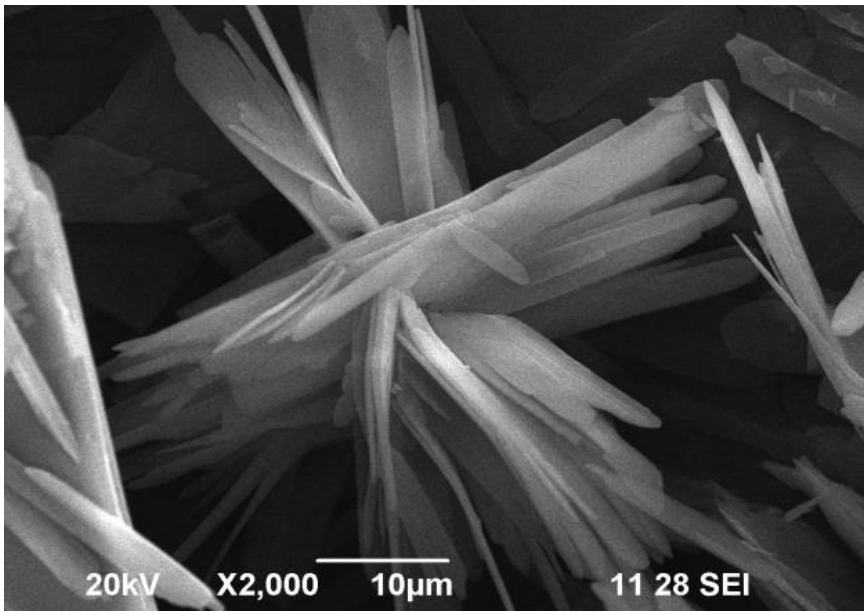

Fig.3. FESEM of the new metal complex

The floral arrangement on the surface of the new metal complex.

PHYSICAL PROPERTIES OF THE NEW COMPLEX

Complex	**Colour**	**Yeild**	**Melting point (℃)**
$Ni(C_6H_5COO)_2(N_2H_4)_2$	**Violet**	**78%**	**97** ℃
Complex	**γ(C=N)**	**γ(C=O)**	**γ(M-O)**
$Ni(C_6H_5COO)_2(N_2H_4)_2$	**1536cm**	**1688 cm**	**545 cm**

CONCLUSION

The new metal complex nickel di hydrazinate complex acts as good anti-microbial agent and it can be subject to futhur studies like NMR,TEM,anti-cancer activity and cyclic voltametry.

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HYDRO GEOCHEMICAL EVALUATION OF GROUND WATER QUALITY IN DIFFERENT LOCATIONS OF COIMBATORE SOUTH, TAMIL NADU, INDIA

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A study was carried out in Coimbatore south taluk, Tamil Nadu, India to know the ground water quality owing to groundwater contamination with increasing population, industrialization and agricultural activities. The ground water samples collected from five locations of Coimbatore south taluk were subjected to ground water quality assessment and compared with the drinking water quality standards prescribed by World Health Organization. Among the five locations studied, ground water collected from Singanallur alone stood well within the ground water quality limits prescribed by the WHO. The ground water collected from Ramanathapuram showed a high range of TDS (1100 – 1210 mg L^{-1}) followed by Uppilipalayam (990 – 1014 mg L^{-1}). The ground water collected from Singanallur exhibited a low TDS (410 – 440 mg L^{-1}).

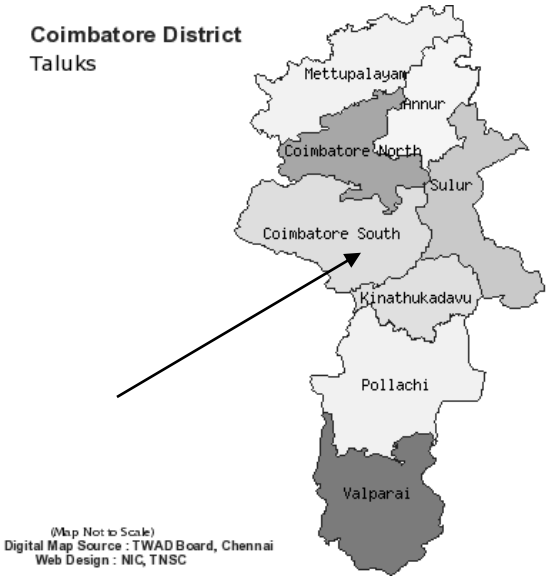
Key words: Ground water, hydrogeochemistry, water quality.

INTRODUCTION

Groundwater quality studies have attracted researchers for a variety of reasons now a days because of their significance related to public health problems, their need in relation to plant growth and the mechanism of metal transport in aqueous environment. The study of quantity of water alone is not sufficient to solve the water management problems because its uses for various purposes depend on its quality. Hence, the hydro geochemical characters of groundwater and groundwater quality in different aquifers over space and time have proven to be important in solving the problems. Water is the basic element of social and economic infrastructure and is essential for healthy society and sustainable development. 97% of Earth's water is in the form of saline water present in ocean and only 3% of fresh water is available (Mahesha, 200). It is scientifically proved that 68.7% of fresh water is found to be stored in the form of glaciers and icecaps and 30.1% is available in the form of groundwater. Groundwater is one of the valuable earth's renewable resources for human life and economic development, which occur as a part of hydrologic cycle (Howard Perlman, 2006). Amongst the natural water resources, groundwater forms an invisible component of the system. In last 50 years it is observed that development of groundwater resources is unpredictable. An estimated 2 billion people worldwide rely on aquifers for drinking water supply. The annual utilizable groundwater resources in India are estimated as 428 km^3 per year. This accounts for about 80% of domestic water requirement and more than 45 % of the total irrigation requirements of the country (Fattesingrao Jadhav, 1998) Groundwater quality is slowly but surely declining everywhere. Hence, an attempt was made to know the ground water of Coimbatore south to know its suitability for present use and to find out a solution for future use. Similar studies on the ground water quality of various locations of Coimbatore districts were done by Ibrahim Bathusha and Saseetharan, (2006); Lenin Sundar and Saseetharan, (2008); Jothivenkatachalam, *et al.* (2010).

METHODOLOGY

The study area, Coimbatore south taluk, Coimbatore District has been selected for this study, which lies between 10 ° 99' N latitudes and 76 ° 94' E longitudes. There are five revenue villages are comes under Coimbatore south taluk covering Coimbatore old town, Singanallur, Ramanathapuram, Souripalayam and Uppilipalayam.



In each location five water samples were collected from the bore wells extensively used for drinking, household and irrigation purposes. The ground water samples were collected in the pre cleaned polypropylene bottles after leaving the motor pumps under running condition for about 10 minutes in order to ensure that the collected ground water samples should be representative of ground water aquifer. The collected samples were labeled properly. The collection, preservation, labeling and analysis of various parameters of water samples from different locations were carried out by following standard analytical methods (APHA, 1998; Saxena, 1994). The results were compared with water quality standards given by World Health Organization (WHO) and India.

Table 1. Analytical methods and equipment used in the present study

Sl. No.	Parameter	Method	Instruments/Equipments
1.	pH	Electronic	pH meter
2.	EC (dS m^{-1})	Electronic	Conductivity meter
3.	Chlorides (mg L^{-1})	Titration by $AgNO_3$	-
4.	Hardness (mg L^{-1})	Titration by EDTA	-
5.	TDS (mg L^{-1})	Electrometric	TDS Meter
6.	Sulphates	Turbidimetric	Turbidity Meter

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Table 2. Drinking water quality standards

Sl. No.	Parameters	Indian Standards		WHO Standards
		Desirable Limit	Permissible Limit	Maximum allowable concentration
1.	pH	6.5 - 8.5	No Relaxation	6.5 - 8.5
2.	EC (dS m^{-1})	<0.25	-	-
3.	Chlorides (mg L^{-1})	250	1000	250
4.	Total hardness (mg L^{-1})	300	600	500
5.	TDS (mg L^{-1})	500	-	500
6.	Sulphates (mg L^{-1})	200	400	400
7.	Phosphates (mg L^{-1})	-	-	0.1
8.	Calcium (mg L^{-1})	75	-	-

RESULTS

The chemical composition of bore well waters collected from the five locations of Coimbatore south is given in Table.1 and 2. The pH of the ground water samples collected from these five locations was slightly alkaline in nature and the average pH values were ranged from 6.91 to 7.93. The EC value is an index to represent the total concentration of soluble salts in water. The average EC value of all the five location was ranged from (0.63 to 1.52 dS m^{-1}). The TDS of ground water collected from Singanallur (429 mg L^{-1}) was within the WHO standard where as the water collected from the other four locations were found higher (640 to 1180 mg L^{-1}) than the desirable limit of WHO (500 mg L^{-1}). The chloride concentration of all the five locations was ranged from 94.50 to 237.81 mg L^{-1}. Two locations namely Uppilipalayam (237.81 mg L^{-1}) and Ramanathapuram (220.55 mg L^{-1}) registered near to the prescribed standards of WHO (250 mg L^{-1}). Though it registered the chlorides lower than the prescribed limit, there are more chances of it cross beyond the prescribed limit due to continuous pumping and improper recharge. With respect to hardness, all the five locations were showed a high hardness value (352 to 633 mg L^{-1}). The hardness of water is mainly because of the presence of carbonates, bicarbonates, chlorides and sulphates of calcium and magnesium. The temporary hardness caused by carbonates and bicarbonates of calcium and magnesium of the ground waters of these locations can be reduced by boiling of water. However, removal of chlorides and sulphates from the ground water by boiling is difficult. The phosphate concentration ranged from 0.36 to 0.44 mg L^{-1}. Kalaivani and Ramesh, (2014) reported that the ground water of Coimbatore south taluk were high and unsuitable for drinking.

CONCLUSION

Our study confirm that all the ground water samples collected from twenty five sampling spots of five locations of Coimbatore south are not suitable for drinking purpose. It is clearly

evident from the past and present study the ground water quality of Coimbatore south taluk is deteriorating which needs further attention.

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Table 1. Hydro geochemical characteristics of ground water samples collected from different locations of Coimbatore south

S. No.	Sampling points	pH	EC (dS m^{-1})	Cl^- (mg L^{-1})	Hardness (mg L^{-1})	TDS (mg L^{-1})	PO_4^- (mg L^{-1})	SO_4 (mg L^{-1})	HCO_3 (mg L^{-1})	Calcium (mg L^{-1})
1	Coimbatore (old Town)	7.64	0.63	199.05	633	640	0.41	17.25	623	54
2	Ramanathapuram	6.91	1.52	220.55	481	1180	0.47	16.13	675	82
3	Singanallur	7.48	0.72	94.50	352	429	0.36	12.31	442	48
4	Sowripalayam	7.12	1.35	178.25	530	846	0.43	19.42	552	74
5	Uppilipalayam	7.93	1.23	237.81	543	1032	0.44	20.12	592	65

Values are mean of five replications

Table 2. Hydro geochemical characteristics (range) of ground water collected from different locations of Coimbatore south

S. No.	Sampling points	pH	EC (dS m^{-1})	Cl^- (mg L^{-1})	Hardness (mg L^{-1})	TDS (mg L^{-1})	PO_4^- (mg L^{-1})	SO_4 (mg L^{-1})	Bicarbonates (mg L^{-1})
1	Coimbatore (old Town)	6.92 - 7.64	0.53 – 0.68	165 - 201	590 - 640	610 - 670	0.39 – 0.45	16.12 – 17.28	610 -640
2	Ramanathapuram	6.91 – 7.41	1.32 – 1.62	190 - 230	460 - 490	1100 - 1210	0.44 – 0.55	15.92 - 16.43	655 - 680
3	Singanallur.	7.11 - 7.48	0.69 – 0.78	85 - 101	345 -352	410 - 440	0.32 – 0.38	12.11 - 12.41	430 - 452
4	Sowripalayam.	7.12 – 7.62	1.27 -1.40	160 - 185	510 -550	822 - 860	0.39 – 0.41	19.21 - 19.55	530 - 561
5	Uppilipalayam.	7.93 – 8.02	1.11 – 1.32	220 - 245	523 -555	990 - 1014	0.37 - .51	19.95 – 20.22	570 - 600

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Phytochemical screening and pharmacological studies of *Acer circinatum* leaf and stem extracts

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The prescribed study showed that the selected *Acer circinatum* stem and leaves extracts containing the various phytochemicals like steroids, coumarins, lactons, flavonoids and alkaloids. Antibacterial and antifungal studies revealed that the phytochemicals of the plant extract inhibited the growth of selected bacteria *Escherichia coli*, *Staphylococcus aureus* and selected fungi *Aspergillus flavus*, *Aspergillus niger*. The phytochemical screening exhibits that the plant extracts states that the plant extracts possess medicinally important secondary metabolites.

Key words
Phytochemical screening, Pharmacological studies, *Acer circinatum*, Ethyl acetate.

Introduction

Natural products are expected to play an important role as one of the major sources of new drugs in the years to come because of their incomparable structural diversity, the relatively small dimensions of many of them, and their drug like properties, that is their ability to be absorbed and metabolized (1). Phyto-constituents are the natural bioactive compounds found in plants and phytochemistry is a distinct discipline somewhere in between organic chemistry, plant biochemistry and closely related to natural products. It deals with a variety of organic substances accumulated in plants. The plants may be considered as a biosynthetic laboratory. Not only their chemical compounds such as carbohydrates, protein, and lipids that are used as food by men, but also a multitude of compounds like glycosides, alkaloids, flavonoids. Obviously natural products will continue to be extremely important as sources of medicinal agents (2-3).

According to their functions in plant metabolism, phytochemicals are basically divided into two groups, Primary constituents: It comprises of common sugars, amino acid, proteins and chlorophyll. Secondary constituents: It comprises of alkaloids, terpenoids, saponins, phenolic compounds, flavonoids, tannins and so on. The chemical compounds formed during the normal metabolic processes of plants are often referred to as "secondary metabolites". However the presence of the secondary metabolites in plants probably explains the various uses of plants for traditional medicine (4-10).

Materials and methods

Collection of plant material

Stems and leaves of *Acer circinatum* were collected from Coimbatore in Tamil Nadu. They were rinsed with tap water followed by distilled water to remove the dirt on the surface. Barks were removed from stems and cut into small pieces. Afterwards the sample was shade dried and then homogenized into fine powder using a mortar and pestle were stored in airtight bottles and were used for all the extraction process.

Preparation of plant extract

The powdered leaves and stem of *Acer circinatum* was soaked in ethyl acetate in 3days. The collected portion was subjected to screening for further studies.

Phytochemical screening

Materials required

Glacial acetic acid, Acetic anhydride, Sulphuric acid (concentrated), 10% Sodium hydroxide, Ferric chloride, Lead acetate, Sodium nitro prusside, Chloroform, Picric acid (saturated), Fehling solution (A&B), Copper sulphate

Procedure

Phytochemical analysis was carried out for all the extracts as per the standard methods.

Test for steroids: liebermann burchard test: A few drops of extract was added with 1ml of glacial acetic acid and 1ml of acetic anhydride and 1-2 drops of conc.H_2SO_4. The solution becomes bluish green, indicates the presence of steroids.

A few drops of extract treated with 2-3 ml of acetic anhydride and was mixed with 1-2 drops of conc. H_2SO_4. The dark green coloration of the solution indicates presence of steroids.

Test for terpenoids: Salkaowski test:

A few drops of extract was added with sulpuric acid shaken well and allowed to stand for 2 minutes. The lower layer turned to yellow colour indicates the presence of terpenoids.

Test for coumarins: A few drops of extract was treated with 1ml of 10% sodium hydroxide. The formation of yellow color indicates the presence of coumarins.

Test for saponins: Froth test: Extract was diluted with 20ml of distilled water and this solution was shaken well in a conical flask for 15minutes. Formation of foam indicates the presence of saponins.

Test for quinones: 1ml of concentrated sulphuric acid was added to the plant extract. Formation of blue color indicates the presence of quinones.

Test for anthracyanins: Few drops of extract was added with 10% Sodium hydroxide. Blue color indicates the presence of anthracyanins.

Test for tannins: $FeCl_3$ test: Few drops of extract was taken in a test tube and ferric chloride solution was added drop by drop. A blue black precipitate was indicates the presence of tannins.

Test for lactons: Few drops of extract was treated with mixture of sodium nitro pruside and glacial acetic acid. The mixture was treated with sodium hydroxide. A deep red colour indicates presence of lactons.

Test for alkaloids: Wagners Test: Few drops of extract was dissolved in chloroform. The chloroform layer was evaporated and the residue acidified and added few drops of Wagners reagent (Iodine in Pottasium Iodide). Orange precipitate indicates presence of alkaloids

Test for carbohydrates: Extracts were dissolved individually in 5ml of distilled water and were filtered extracts were used to test the presence of carbohydrates.

Fehlings Test: Filtrates were hydrolysed with dil. HCL and were neutralized with alkali and heated with Fehlings solution A&B. Formation of red precipitate indicates the presence of reducing sugars.

Test for flavonoids: Sodium hydroxide Test: 5ml of extract is dissolved in water, warmed and filtered. 2ml of extract was added with 10% aqueous sodium hydroxide solution and formation of yellow coloration. Few drops of dil.HCl was added to this solution. A change in color from yellow to colorless indicates the presence of flavonoids.

Test for proteins: Biuret Test: Few drops of extract was treated with copper sulphate solution and sodium hydroxide solution. Violet color indicates the presence of flavonoids.

Test for glycosides: Keller-Killiani Test: Few drops of extract was treated with 1ml of glacial acetic acid and few drops of ferric chloride solution was added. Conc.H_2SO_4 was added through the sides of the test tube. Reddish brown ring at the junction of liquids was indicates the presence of de-oxysugar.

Test for phenol: Ferric chloride Test: Few drops of extract was treated with 3 to 4 drops of ferric chloride solution. Formation of bluish black color indicates the presence of phenol.

Antibacterial analysis

Media Used: Peptone-10 g, NaCl-10g and Yeast extract 5g, Agar 20g in 1000 ml of distilled water.

Analysis method: Agar diffusion method.

Bacteria analyzed: *Escherichia coli, Staphylococcus aureus.*

Method:

The stock cultures of bacteria were revived by inoculating in both media and grown at 37ºC for 18 hrs. The agar plates of the above media were prepared and wells were made in the plate. Each plate was inoculated with 18 hold cultures (100 µl, 10-4 cfu) and spread evenly on the plate. After 20 min, the wells were filled with of compound at different volumes. All the plates were incubated at 37ºC for 24 hours and the diameter of inhibition zone were noted.

Anti-fungal analysis

Media Used: Czapek-Dox Agar: Composition (g/l) Sucrose-30.0; Sodium nitrate-2.0; K_2HPO_4-1.0, $MgSO_4.7H_2O$-0.5; KCl-0.5; $FeSO_4$-0.01; Agar-20.

Name of the analysis method: Agar diffusion method.

Fungi Analysed: *Aspergillus flavus, Aspergillus niger.*

Method:

The stock cultures of were revived by inoculating in both media and grown at 270ºC for 48 hrs. The agar plates of the above media were prepared and wells were made in the plate. Each plate was inoculated with 48 hours old cultures (100 µl 104 CFU) and spread evenly on the plate. After 20 min, the wells were filled with different volumes of samples. All the plates were incubated at 270ºC for 96 hours and the diameter of inhibition zone were noted.

Results and Discussion

Phytochemical analysis

Results of the phytochemical constituents of ethyl acetate extracts of ACL and ACS were reported in table (1), fig: 8, 9, 10 and 11. The phytochemical screening of ACL showed the presence of steroids, coumarins, lactons, flavonoids and alkaloids. Saponins, quinones, phenol, terpenoids, anthracyanins, tannins, carbohydrate, proteins, glycosides are found as absence of positive result. The phytochemical screening of ACS showed the presence of steroids, coumarins, lactons, alkaloids and flavonoids. Saponins, quinones, phenonl, terpenoids, anthracyanins, tannins, carbohydrate, proteins, and glycosides are found as absence of positive result.

Table: 1 Qualitative analysis of ACL EA and ACS EA for the presence of phytochemicals

S.No	Phyto constituents	ACL	ACS
1	Steroids	+	+
2	Terpenoids	–	–
3	Coumarins	+	+
4	Saponins	–	–
5	Quinones	–	–
6	Anthracyanins	–	–
7	Tannins	–	–
8	Lactone	+	+
9	Carbohydrate	–	–
10	Flavonoids	+	+
11	Proteins	–	–
12	Glycosides	–	–
13	Alkaloids	+	+
14	Phenol s	–	–

+presence -absence

Anti- bacterial and Anti- fungal Activity

The leaves and stem of *Acer circinatum* in ethyl acetate extract (ACS EA & ACL EA) was tested for their antibacterial and anti-fugal activity using disc diffusion method. The zone of inhibitions (mm) are mentioned in table:3 shows the antibacterial activities of ACS EA & ACL EA. At higher concentration the stem extract shows the diameter of inhibition zones (DIZ) against *Staphylococcus aureus* was 5mm, *Ecoli* was 5mm. The leaf extract shows lowest activity compared to stem extract. The stem extract shows better activity against the two tested microorganism using *Ciprofloxacin* as standards. Anti-fungal activity of ACS EA & ACL EA not shows any inhibition using *Amphotericin* as standards.

Conclusions

Preliminary phytochemical screening of plant extracts showed the presence of steroids, coumarins, lactons, flavonoids, alkaloids and the absence of saponins, quinones, phenol, terpenoids, anthracyanins, tannins, carbohydrate, proteins and glycosides. Pharmacological study shows that the stem of the plant *Acer circinatum* has good anti-microbial activity due to the presence of various phytochemicals in the plant extracts. Anti bacterial activity shows at 80µl concentration, the stem extract moderately inhibit the growth of the pathogens. Both stem and leaf extract were inactive towards the selected fungi *Aspergillus flavus, Aspergillus niger*. The phytochemical screening and pharmacological evaluation of the plant extracts states that the plant extracts possess medicinally important secondary metabolites. FT-IR analysis shows that the plant extract exhibit various functional groups like O-H, C-H, C=O, N-O, C-X, C-F etc.

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STUDY OF ANT DIVERSITY IN THE COLLEGE CAMPUS

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ABSTRACT

Ants are the most dominant components of the terrestrial ecosystem because of their universal distribution and thus constitute the greater part of biomass. Ants are considered to be very sensitive to habitat transformation and disturbance, and for this reason have been extensively used as indicator species. The aim of the present work is to investigate the ant population in the Disturbed and Undisturbed sites of the college campus and to apply the Shannon Weinner Index and Simpson's diversity index to assess the richness of the ant diversity in the campus. The ants were collected using pitfall traps, scented traps and hand collection methods from July 19th, 2018 to sep 25th, 2018. The Shannon Wiener index is high for undisturbed site and the Simpson's Diversity index is also high for the undisturbed site. On the campus gardening has been done each year as a regular process leading to digging, change of soil, replacement of soil, additional manuring, burning of litter, and change of plants and grass that has resulted in change of topological profile of the ant ecosystem in this campus. Ants the most successful social insects, live in almost all types of habitats. They can with stand various ecological hazards adapting with the situations. Being tiny creatures they have to face all types of anthropogenic activities. Different anthropogenic activities affect the ant community.

Key words: ant diversity, Shannon Weinner index, Simpsons diversity index, Pitfall, scented traps, hand collection, anthropogenic activity.

INTRODUCTION

Ants are the most dominant components of the terrestrial ecosystem because of their universal distribution and thus constitute the greater part of biomass. Ants contribute a conspicuous component of terrestrial biodiversity and are the most divergent group among all social insects. They act as ecosystem engineers. They play a very important role in the ecosystem by improving the soil and assisting in the decomposition process and are considered as good biological indicators due to their mutualistic behavior with both flora and fauna. These eusocial insects lead to high level of interactive lives assisting each other to survive and are highly evolved hymenopterans showing polymorphism.

Ants are found everywhere except in Iceland, Greenland and Antarctica (Holldobler and Wilson, 1990), But the number of species decline with increasing latitude, altitude and aridity (Farji – Brener and Ruggiero, 1994). Some ant species establish mutualistic relationships with many other organisms including invertebrates and vertebrates. For example ants protect aphids and other homopterans from their predators, for obtaining sugar-rich solutions produced by them (Delfino and Buffa, 2000).

Ants can build their nests in leaf litter, rotting logs, underneath the soil, within woody stems or under the rocks and they can also establish fungal gardens in the soils. During activities associated with gallery building of nests by ants, they favor the mixing of organic matter in the soil, as well as increase the aeration properties of soils (Luque *et al.*, 2002). Ants are among the leading predators in terrestrial habitats because they feed on other insects and small invertebrates, so that ants can be used as biological control of insects, pests (Suryanto, 1993).

Ants are considered to be very sensitive to habitat transformation and disturbance, and for this reason have been extensively used as indicator species (Hoffmann and Anderson 2003). Increases in grazing intensity may also result in decline of ant species richness, especially of litter inhabiting cryptic species and specialized predators, and strong changes in species composition, although the relative proportions of different functional groups appear somewhat resilient to grazing pressure (Hoffmann, 2000).

The Western Ghats in India plus the whole island of Sri Lanka is considered one of the 34 world biodiversity hotspots (Gunawardene *et al.*, 2008) of ants. They are also useful indicators in monitoring programs and natural areas restoration efforts because of their fast response to changes in habitat quality, their abundance and relatively easy sampling and identification (Brown, 2000).

The objective of the present work is to investigate the ant population in the Disturbed and Undisturbed sites of the college campus and to apply the Shannon Weinner Index and Simpson's diversity index to assess the richness of the ant population in the campus.

MATERIALS AND METHODS

Study Area

The fieldwork was conducted in the campus of Nirmala college for women, Coimbatore, Tamilnadu. Coimbatore lies at 11 1'6"N, 76 58' 21"E, in south India at 411 meters (1349 ft) above sea level on the banks of the Noyal river, in south western Tamilnadu. The average annual rainfall is around 700 mm (27.6 in) with the northeast and the southwest monsoon contributing to 47% and 28% respectively to the total rainfall. This study was conducted from July19 to September 25 at ten sites from two fragements having various disturbance levels.

Undisturbed area – 10 different plots were selected for ant collection as a representative. These plots are least disturbed areas. Human activities are nearly nil from this area. This region has a large number of trees, shrubs and grasses.

Disturbed area – 10 plots were selected for collection of ants as a representative. These plots are heavily disturbed because of human activities and vehicles. The habitat from this region is adversely affected by human activities. This habitat prominently includes grasses, shrubs and only few tree species here roads and buildings are present.

Sampling protocols

The ants were collected using pitfall traps, scented traps and hand collection methods from July 19th, 2018 to sep25th, 2018. A) The pit-fall traps consisted of a 0.5 liter plastic glasss with an opening of 12 cm in diameter, buried at ground level. At least one pit- fall trap were placed in each of the ten randomly chosen site. Each glass carried 25 ml of ethanol and glycerol mixture. The traps were set up between 15.00 and 17.00 hrs and were collected after 48 hrs (Gadagkar *et. al.*, 1993). B) Scented traps were applied similar to that of pitfal traps but instead of ethanol and glycerol mixture, 25 ml of sugarcane juice and ethanol mixture were added. C) Hand collection of ants from each sampling plot was carried out to collect representative individuals of all species seen in the quadrate after laying the baits. For removal of sampling error we used three different ant collection methods to collect maximum number of ant species from study area. Ants were photographed by using mobile phones.

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Species diversity was calculated using Shannon - Weinner and Simpson's diversity indices. Shannon - Wiener diversity index and Simpson's diversity index. (D) were calculated by using standard formula .

RESULTS AND DISCUSSION

Table 1: Ant Diversity In The Disturbed Sites

LOCATION	SPECIES	ANT DENSITY		
		HAND COLLECTION	PITFALL TRAP	SCENTED TRAP
Infront of the P G Chemistry lab	Camponotus parius	15	27	41
Left side of the Research Department	Camponotus compresses	8	16	30
Near the Rest Room	Tetramorium species	25	42	50
Parking area	Monomorium pharaonis	27	36	47
Front side of the parking area	Tetraponera rufonigra	3	12	33
Open Stage	Solenopsis species	10	28	39
Infront of the Divine Mercy Block	Camponotus species	12	25	42
Left side of the Divine Mercy Block	Crematogaster cerasi	5	18	35
Infront of the Administrative Block	Monomorium minimum	3	11	27
Infront of the Chappel	Solenopsis invicta	30	45	7
TOTAL		**188**	**233**	**310**

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Table:2 Ant Diversity In The Undisturbed Site

LOCATION	SPECIES	ANT DENSITY		
		HAND COLLECTION	PIT FALL TRAP	SCENTED TRAP
Termanalia arjuna tree	Ocycohylla smaragdina	20	38	42
Sappotta tree	Polirachis dives smith	10	21	22
Inside Green house	Pheidole species	15	26	30
Below water tank	Monomorium destructor	17	32	50
Hostel Wall	Camponotus compressus	9	33	20
Back side of the stage 1	Crematogaster cerasi	9	27	28
Back side of the stage 2	Monomorium species	13	17	27
Right side of the stage	Solenopsis germinata	25	37	41
Albizia lebbeak tree	Tetraponera rufanigera	17	28	31
Guava tree	Camponotus species	7	16	21
TOTAL		**142**	**275**	**312**

Table :3 Shannon- Wienner Index

METHOD OF COLLECTION	DISTURBED SITE	UNDISTURBED SITE
Hand collection	2.1613	2.2313
Pit fall trap	1.9699	2.2655
Scented trap	2.2783	2.3440

Table: 4 Simpson's Diversity Index

METHOD OF COLLECTION	DISTURBED SITE	UNDISTURBED SITE
Hand collection	0.1496	0.91574
Pit fall trap	0.8808	0.89302
Scented trap	0.8951	-0.0924

In our study we located 10 sites under the Undisturbed areas and 10 sites under Disturbed areas. The genus / species identified in the undisturbed sites are Crematogaster, Camponotus compresses, Oecophylla smaragdina, Solenopsis germinata, Monomorium destructor, Camponotus sp, Pheidole, Polyrachis dives smith, Monomorium sp. Disturbed sites include

Camponotus sp, Crematogaster cerasi, Monomorium minimum, Monomorium pharaonis, Solenopsis invicta, Solenopsis sp, Tetraponera rufonigra, Tetramorium sp, Camponotus parius, Camponotus sp. The number of species was more in the undisturbed site.

The Shannon Wiener index is high for Undisturbed site. Hand collection (2.231), Pitfall trap (2.265), Scented trap (2.344). The Disturbed site index was lower, Hand collection (2.161), Pitfall method (1.969), Scented trap (2.278).

The Simpson's Diversity index is high for Undisturbed site: Hand collection (0.915), Pitfall trap (0.893), Scented trap (-0.092). The index for Disturbed site is lower; Hand collection (0.149), Pitfall trap (0.880), Scented trap (0.895).

In the campus the location for undisturbed sites include the botanical garden- Termanalia arjuna tree, Sappotta tree, Green house, water tank, Open stage, Albizialeb beak tree, and Guava tree and Disturbed sites are PG Chemistry lab, Research department, Rest room , Parking area, Open stage, Divine Mercy block, Administrative block and the Chapel.

From the above result it is concluded that species richness diversity and abundance were higher in Undisturbed site as compared to Disturbed site. This is due to habitat destruction and increase in disturbances by various anthropogenic activities. Related studies on ants, birds and butterflies have shown that species richness and diversity decreases with increase in disturbance (Andersen 1995; Pachpor and Ghodke 2000-2001).

Studies from different regions of the world have shown that habitat degradation, disturbance and fragmentation have a negative effect on ant diversity and abundance. Undisturbed forest has higher species richness than those in disturbed habitats (Greenslade and Greenslade, 1977). Our results match with Kumat *et al*., (1997) and Pachpor and Ghodke (2001) who mentioned that habitats with abundant trees support high diversity of ants. This is because of habitat complexity and heterogeneity. Habitat complexity provides hiding, nesting and foraging grounds to the many ant species, but disturbed site does not.

On the campus gardening has been done each year as a regular process leading to digging, change of soil, replacement of soil, additional manuring, burning of litter, change of plants and grass that has resulted in change of topological profile of ant ecosystem in this campus.

Ants are polyphagous in nature. They are related to many organisms of the ecosystem. They help in decomposition of plant and animal remains. Rapid urbanization has differential effects on ants depending on their adaptability to human activities.

Diversity of the species of ants reveals the fact that ants withstand human interferences. Since the ant species recorded in this study are mostly carnivorous or omnivorous in nature, their population are directly dependent on their prey species, which in most cases are phytophagous in nature and thereby dependent on vegetation itself. Thus it can be assumed that the vegetation cover on soil might have played indirect influence on the community structure of ants (Ghosh *et al*., 2007).

Pheidole nests in soil, *crematogaster* nests in dead wood on trees, and *Solenopsis* nested under rocks and rotten logs; these findings also coincide with our observation in the campus. *Solenopsis germinata* was found in undisturbed sites. Humidity may influence nest building. *Camponotus* is a frequently occurring species everywhere. *Camponotus* had the greatest individual numbers. These ants are called as carpenter ants because of their "Nesting behaviors'' (Chavhan *et al.,* 2011). Food source may have been important. Solenopsis was found commonly in two sites. The most common among them were *Oecophylla smaragdina*, a truly arboreal

species. These ants nested in shady places and require broad leaves to stitch their nest. All the recorded species of *Polyrachis* were arboreal and found in undisturbed areas. These ants nested on the ground. *Tetraponera* representing *Pseudomyrmicinae* has been recorded. These are solitary foragers and make their nests in fallen dead wood and rotten logs. *Tetraponera rufonigra* has been recorded. *Monomorium* and *Tetramorium* species are also found in the campus.

CONCLUSION

Studies on ants have become centered, mainly around the field of systematic, behaviour and sociobiology. The use of insects as biological indicators to monitor the quality of environment is increasing. The possibility of utilizing ants, in particular, as the index organisms are being explored in different parts of the world. Ants the most successful social insects, live in almost all types of habitats. They can with stand various ecological hazards adapting with the situations. Being tiny creatures they have to face all types of anthropogenic activities. Different anthropogenic activities affect the ant community.

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ANT SPECIES IN UNDISTURBED SITE

Fig1:Camponotus compressus

Fig 2 :Camponotus species

Fig 3: Crematogaster cerasi

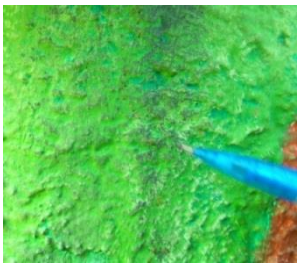

Fig 4:Monomorium destructor

Fig 5 : Monomorium species

Fig 6 : Tetraponera rufonigra

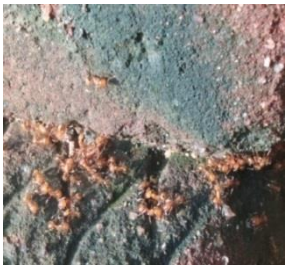

Fig 7: Solenopsis germinata

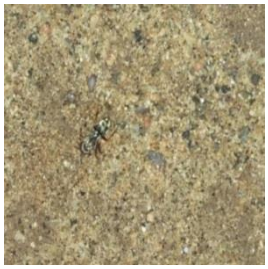

Fig 8: Polyrhachis dives smith

Fig 9 : Pheidole species

Fig 10 : Ocecophylla smaragdi

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ANT SPECIES IN DISTURBED SITE

Fig11:Camponotuscompressus

Fig 12 : Camponotus parius

Fig 13: Camponotus species

Fig 14: Crematogaster cerasi

Fig 15: Monomorium minimum

Fig 16: MonomoriumPharaonis

Fig 17: Solenopsis invicta

Fig18: Tetraponera rufonigra

Fig19: Solenopsis species

Fig 20 : Tetramorium species

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ROLE OF EDIBLE OILS, POWDERS OF GARLIC AND LEMON WASTES IN THE CONTROL OF PULSE BEETLE *CALLOSOBRUCHUS CHINENSIS* LINN in REDGRAM

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ABSTRACT:

Garlic powder, lemon peel extract along with groundnut oil plays a major role in the control of pulse beetles in redgram. The groundnut and the palm oil are used as the main ingredients but are mixed with the above mentioned products along with clay soil but separately. The pellets are introduced into the container with redgram. The whole set up is maintained at room temperature. The mortality rate of the pulse beetles are checked and counted at regular intervals. Then the mortality rate is compared with the containers containing different oils.

Key Words: Gralic powder, Lemon peel, groundnut oil, palm oil, clay soil.

INTRODUCTION:

Pulses 'the gift of nature' plays an important role in Indian economy and its diet. In India, the population is substantially vegetarian, pulses are influential as they are rich in protein, amino acids, energy, minerals and certain vitamins. India is the largest producer, distributor and consumer of pulses. On 239 lakh hectar area India has produced 18.45 million tons of pulses in the year 2016-17. The major pulse producing state in India are Maharastra, Rajasthan, Madhya Pradesh, Orissa and Andra Pradesh. Among pulses the red gram is one of the most widely cultivated pulse crops after pigeonpea and chickpea.

Red gram belongs to the family fabaceae. Red gram ia a native of India and Central Asia. Red gram is an important source of high quality protein for vegetarians and sick persons. Red gram are highly nutritious containing protein, carbohydrates, calcium, iron, vitamins, thiamin, riboflavin, fibre and provides calcium energy. Red gram is a protein rich staple food. The protein content present in red gram is three times greater than that of the cereals. It is distributed and consumed in the form of split pulse as well as whole pulse.

Insect infestation to quality deterioration of durables(cereals, pulses) stored in warm and humid climates. Physical and nutritional loss sustained in our county is because of stored food products by bruchids, weevils and other insects. It is assessed that about 20,000 species of pests abolish approximately 1/3 rd of the worlds food productions, the highest losses ensuing in the developing world. The qualitative and quantitative damage to grains because of the insects pests may amount to 30-40 %. The computation of losses at storage has been an preplexing snags since long. The genus callosobruchus attacks grain legumes during both pre and post harvest stage , but in India , the callosobruchus maculates, c.analis and c.chinensis are the imperious pest species of the genera. They are about 200 pests species that cause damage to stored grains.

C.chinensis is an efficiently important pest of all pulses and causes 50-70% in losses of pulse storage. The entire immature stage of the insect is spent in the legume seeds, in which it causes weight loss, decrease in germination potential and diminish the nutritional value.

Plant material based insecticides are target specific, non-toxic to human being and beneficial organism, less prone to insect forbearance and restoration, biodegradable and less baser and are affirming grain proctectants. There is a much need for knowing the capacity of plant

products against the insect pest in the stored products. Therefore, the present investigation was carried out to calculate the efficacy of plant products and edible oils against pulse beetles infesting stored red grams.

MATERIALS AND METHODS:

The present study "Role of edible oils,Garlic and Lemon peel extract in the control of pulse beetle *Callosobruchus chinensis* in red grams".The details of materials used and methods adopted during the course of investigation have been presented as under:

COLLECTION OF PEST:

The pests were collected from the local mill and are introduced into a separate container containing the red grams. They are allowed to get multiplied into the container for the further purposes.

COLLECTION OF PLANT PRODUCTS:

The garlic bulbs are collected from the local market and the lemon peel is collected from the household products.

COLLECTION OF EDIBLE OILS:

The edible oils such as groundnut oil and palm oil are collected from the oil mill directly to avoid the mixture of unwanted products.

PREPARATION OF POWDERS:

The garlic bulbs are finely chopped and are allowed to dry under shade i.e., away from sunlight so that it does not lose its original capacity and its flavour. The

lemon peel is scraped from the outer layer of the lemon fruit and is allowed to dry in shade to retain its original capacity. After the product gets dried they are collected and are grinded in the mixer till it gets finely powdered.

EXPERIMENTAL DESIGN:

Two products namely the lemon peel powder and the garlic bulb powders are taken and the control treatment was used against pulse beetle on red gram.

The redgram is weighed in the electrical balance for up to 25g each for about five containers. Ten pairs of pulse beetles were introduced into the container containing the pulse. The pellets are prepared using the clay soil as a binder. The clay soil is taken and it is mixed with the powders of garlic as well as the lemon peel powder 5g each. To make the soil in the form of a pellet they are mixed with the edible oils namely the groundnut oil and the palm oil 1ml each. They are mixed together with the manual method. Water is not added to the pellets because when days pass it may easily dry the main binder of the pellet and may loosen the pellet.. The pellets are made with different combinations such one pellet is made with groundnut oil along with the garlic powder and the lemon peel powder. Then another pellet is made with the palm oil along with the garlic powder and the lemon peel powder.

The data was recorded for the 100% mortality and it was counted for all the seven days in a week. The alive pests were counted and are reduced from the total count of ten pairs of pests. The remaining pests are noted in the form of the table.

RESULT AND DISCUSSION:

It was clearly observed from all the above experiments that the groundnut oil plays a major role in the control of the pulse beetle by acting directly on the oviposition of the beetle. They also act on the weight loss of the pulse beetle. The weight loss of the pulse beetle indirectly acts on the activity of the pulse beetles. It has been proven that 100% mortality of the pulse beetle is recorded within 5 days in the groundnut oil and it showed maximum number of mortality in the concentration of 6 and day 5.

In the palm oil the mortality rate was shown from day 6 and concentration 8. Even though palm oil shows good and acceptable result in the mortality rate of the pulse beetle, the groundnut oil shows best result for 100% mortality. The data pertaining to the number of days of 100% mortality showed significant difference.

DAYS	2	4	6	8	10
1	0	0	3	3	6
2	0	3	4	5	8
3	4	6	8	9	9
4	5	7	11	12	11
5	7	9	13	15	14
6	9	12	14	16	15
7	11	13	16	17	17
MEAN	**5.14**	**7.14**	**9.86**	**11.00**	**11.43**
S.D	**4.22**	**4.67**	**5.01**	**5.51**	**4.04**

In **trial one** for groundnut oil with garlic lemon powder, from the 6thand7thday and in concentration 6 the experiment started showing decreased number of pulse beetles and the mean value noticed is 9.86 in 6th day and 11.43 in 10th day .But in concentration 10 from 3rd to 7th it was found that all the insects were found to be dead.

In **trial two** the results were same as that of the results in the trial one. The pulse beetles were found to be dead in the 10th concentration and the mean value is 12.14.From day 3 onwards the death of the pests is noticed.

DAYS	2	4	6	8	10
1	0	0	2	4	6
2	0	4	5	6	8
3	3	6	7	8	10
4	4	8	11	11	11
5	8	9	13	12	15
6	10	11	15	15	17
7	11	12	17	16	18
MEAN	**5.14**	**7.14**	**10.00**	**10.29**	**12.14**
S.D	**4.56**	**4.18**	**5.51**	**4.49**	**4.59**

In **trial one** for palm oil with garlic lemon powder no changes were found during the first and second day in the concentration of 2 and 4 but from day 4 onwards the death of the pest is found to be gradually increasing.

DAYS	2	4	6	8	10
1	3	4	6	8	11
2	6	5	8	10	15
3	7	8	11	11	20
4	9	9	14	13	20
5	11	12	16	17	20
6	12	13	20	20	20
7	14	15	20	20	20
MEAN	**8.86**	**9.43**	**13.57**	**14.14**	**18.00**
S.D	**3.80**	**4.12**	**5.53**	**4.88**	**3.61**

In **trial two** for palm oil with garlic lemon powder the results were same as that of the trial one. Not all the insects were found to be dead in this trial. But the decrease in the amount of insect is noticed.

DAYS	2	4	6	8	10
1	2	3	7	8	12
2	5	5	9	10	17
3	7	7	11	13	20
4	9	9	15	14	20
5	10	13	17	20	20
6	12	14	20	20	20
7	15	16	20	20	20
MEAN	**8.57**	**9.57**	**14.14**	**15.00**	**18.43**
S.D	**4.35**	**4.89**	**5.24**	**5.07**	**3.05**

Therefor in the above experiments, it has been clearly proved that the groundnut oil along with the garlic and lemon peel extract worked well in the control of pulse beetle in the concentration of 10.

SUMMARY AND CONCLUSION:

The experiment was done in the laboratory to calculate the insecticidal studies of botanical powders against the pulse beetle, *Callosobruchus chinensis* in red gram.

The detailed study is summarized below:

- The selected botanical products of garlic bulb and the lemon peel extracts are powdered and used for the treatment of red gram.
- 25 gm of red gram were taken and weighed, they are kept in the containers and treated with 2,4,6,8 and 10gm concentration of botanical products.
- 5ml of groundnut oil and palm oil is taken and mixed along with the botanical products.
- The clay soil is taken as the binder for the pellets. Water is not added to the pellets instead the edible oils are used.
- The mortality of the adult pests was observed for every 24 hours interval for 7 days.
- Mortality of the pulse beetle was recorded for palm oil with garlic lemon powder at 6th day and showed 80% result.
- The mortality of the pulse beetle was recorded for ground nut oil with garlic lemon powder at 3rd day and showed 100% result.
- The present study was to investigate the properties of botanical products, for their safety and efficacy.

- Though synthetic products are used worldwide it cannot be afforded by many of the farmers, the use of the natural botanical products such as garlic powder and lemon peel powder, which are easily available and can also be grown by the farmers themselves.
- The sharp reduction in the adult mortality was noticed in groundnut oil along with garlic lemon powder.
- Among the 5 concentration the adult mortality was high in groundnut oil at 10ml concentration at 3rd day and showed 100% mortality.
- But in the treatment of palm oil with garlic lemon powder recorded acceptable activity against pulse beetles.
- The above results indicated that the groundnut oil showed drastic results in the control of pulse beetle.
- Therefore, the present study proved the possibility of using the garlic lemon powder along with groundnut oil in the control of pulse beetle *Callosobruchus chinensis*.
- The data was subjected to mean and the standard deviation was analyzed.

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ASSESSMENT OF XENOBIOTICS IN THE SELECTED ORGAN TISSUES OF FRESH WATER FISH *OREOCHROMIS NILOTICUS* OF SELECTED LOTIC EXOSYSTEM OF COIMBATORE DISTRICT

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ABSTRACT

Heavy metal contamination of aquatic ecosystems has been long recognized as a serious pollution problem. When fish are exposed to elevated levels of heavy metals in a polluted aquatic ecosystem, they tend to take these metals up from their direct environment. Heavy metal contamination may have devastating effects on the ecological balance of the recipient environment and a diversity of aquatic organism. In the present investigation copper, lead, cadmium, zinc and nickel concentrations were recorded in tissues of *Oreochromis niloticus* from selected study areas. The distribution of heavy metal in the fish organs analyzed were in the order of Zn > Cu > Pb > Ni and Cd. Heavy metal concentration was high in Koolipalayam and Orathupalayam lake. In this study fish gill and liver tissues shows highest tendency to accumulate both zinc and copper metals, while it is less deposited in liver. As the fish *Oreochromis niloticus* is largely consumed by people, it is essential to make awareness about water pollution and effects of heavy metals on human body.

Key words: Heavy metal, Pollution, *Oreochromis niloticus* , Muscle, gill and liver tissue.

Introduction

The pollution of aquatic environment by inorganic and organic chemicals is a major factor posing serious threat to the survival of aquatic organisms including fish. Among the environmental pollutants, metals are of particular concern due to their potential toxic effect and ability to bioaccumulate in aquatic ecosystems. Fish is often at the top of aquatic food chain and may concentrate large amounts of some metals from the water. The presence of heavy metals in aquatic ecosystem is the result of two main sources of contamination; natural processes and anthropogenic activities. Heavy metals including both essential and non essential elements have a particular significance in ecotoxicology, since they are highly persistent and all have the potential to be toxic to living organisms (Adeniyi and Yusuf, 2007).

Heavy metals are considered to be major pollutants as they cause greatest threats to biota because of their persistence and possible bioaccumulation and bio magnification through food chains Uysal *etal*., (2009); Ricart *etal*., (2010). Heavy metals pollutants contain toxic substances derived from sources like industrial waste discharges, sewage effluent, pesticides and agrochemicals etc which when discharged into water bodies will change the surface tension, thermal properties, conductivity, density and pH value along with biodegradable and non-biodegradable pollutants which will cause dermatological diseases, skin cancer and internal cancers (liver, kidney, lung and bladder).

The degree contamination in aquatic environment is frequently assessed by comparing containment concentration in associated biota. Prolonged exposure to water pollutants even in very low concentrations have been reported to induce morphological, histological and biochemical alterations in the tissues which may critically influence fish quality. Water analyses may be inefficient to identify the metal inputs to fluvial systems because of the inherent variability of flow and contaminant concentrations. With this regard, fish can be considered as one of the most significant indicators in aquatic ecosystems to analyze the impact of metal

pollution because they occupy various tropic levels, and are the key species in tropic chains, and concentrate large amounts of metals Barata *etal*., (2010); Lasheen *etal*., (2012) . Mohammad MN Authman *etal*.,(2015) gives a brief account of the toxic effects of heavy metals on fish and the use of fish as bio-indicator of the effects of heavy metals pollution. With this regards the present research work was also carried out to analyze the accumulation of heavy metals (Cadmium, Chromium, Lead, Nickel and Zinc) in selected fish organs of *Oreochromis niloticus* collected from the lakes around Coimbatore district.

MATERIALS AND METHODS

Collection of fish samples

The study species *Oreochromis niloticus* was collected from the selected study areas namely Perur lake, Oratupalayam lake and Koloipalayam lake using gill net from the selected sites. From each sampling sites 10 fishes were collected as sample material with average weight ranging from 250 - 300 g, average length of 8-10cm and the target organs (gills, muscle and liver) were excised for further analysis.

Heavy Metal Analysis from fish samples

Fish samples of 1.0 g dry weight were digested with 6ml o HNO3 (65%) and 2ml of H2O2 (30%) at 280°C on a hot plate for 4hr. To the digested sample 2ml of 1N HNO3 is add to the residue and the solution is evaporated again on the hot plate, till the sample gets completely digested. After cooling, the above sample 10ml of 1N HNO3 was added. This solution gets diluted and filtered through a 0.45µ nitrocellulose membrane filter (Sharma *etal*., 2000). The filtered solution is measured for metal concentrations using Atomic Absorption spectrometer. The entire triplicate sample was analyzed in the Department of Chemistry, South India Textile Research Association (SITRA), Coimbatore.

STATISTICAL ANALYSIS

Heavy metal analysis results were expressed as Mean± SD with 0.05% significant level of significant by DMRT.

RESULTS AND DISCUSSION

The analysis of heavy metals in different organs of fresh water fish *Oreochromis niloticus* is shown in Table 2. All the three organs – muscle, gills and liver shows different accumulated values of heavy metals. In the present study liver tissue shows highest level ($35.40\pm1.28^{a)}$ of metals concentration while muscle sample shows minimum (1.35 ± 0.017^{c}) concentration of metals. In the gills, the sequence of trace metals is Zn > Cu > Ni > Pb and Cd. It is observed that the sequence of trace metal is Zn > Cu > Pb > Ni and Cd in muscle and liver tissues. The values and sequence of heavy metals found in different organs are correlated with the results found by Abida Begum *etal*., 2009. In this study Zinc concentration was high in all the selected areas while Cadmium concentration was low. The concentration of lead and nickel shows fluctuations in all the three organs. Similar results were also reported by Malik *et al.*, (2010), Kumar *etal*.,(2011), Taweel *etal*., (2012) in *Oreochromis niloticus* and Fatima and Usmani ,(2013) in *Channa striatus* and *Heteropneustes fossilis*). In the present study among the selected study areas all the heavy metal concentrations were high in Oratupalayam and Kooloipalayam lakes whereas Perur lake shows comparatively low metal concentration. Except copper and nickel all the three metals (Cadmium, Lead and Zinc) were above the permissible limits. The permissible limits for heavy metals were represented in Table No- 1.

CONCLUSION

In conclusion it may be stated that in order to evaluate the ecological condition of freshwater fish, both fish muscle and inner organs must be monitored regularly. To develop the fishing industry in freshwater reservoirs it is necessary to maintain water quality standards, and to monitor contamination levels of water reservoirs and fish regularly.

Table-1

Heavy metal concentration in muscle tissue prescribed by WHO, FAO

Heavy metals(µg/g-1)	WHO	FAO
Cadmium (Cd)	1.00	0.50
Zinc (Zn)	30.00	35.00
Lead (Pb)	0.50	0.50
Nickel (Ni)	15.00	10.00
Copper (Cu)	30.00	30.00

Table – 2

Heavy metal concentration in fish tissues (muscle, gill and liver) of *Oreochromis niloticus* from selected study areas.

Metals µg/g-1	Samples	Perur	Koolipalayam	Orathupalayam
Cadmium (Cd)	**Muscle**	1.35±0.017^{c}	1.59±0.014^{a}	1.53±0.018^{b}
	Gill	1.57±0.021^{c}	1.85±0.017^{a}	1.78±0.023^{b}
	Liver	1.89±0.022^{c}	2.22±0.023^{a}	2.14±0.026^{b}
Zinc (Zn)	**Muscle**	19.59±1.02^{c}	24.45±1.27	25.94±1.19
	Gill	22.43±1.27^{c}	28.14±1.25^{b}	29.71±1.24^{a}
	Liver	26.73±1.19^{c}	33.37±1.31^{b}	35.40±1.28^{a}
Lead (Pb)	**Muscle**	6.57±0.736^{c}	8.64±0.747^{b}	9.69±0.822^{a}
	Gill	7.66±0.821^{c}	10.08±0.792^{b}	11.30±0.864^{a}
	Liver	8.97±0.799^{c}	11.80±0.827^{b}	13.24±0.872^{a}
Nickel (Ni)	**Muscle**	3.39±0.174^{c}	5.43±0.154^{a}	5.37±0.167^{b}
	Gill	4.06±0.153^{c}	6.51±0.161^{a}	6.44±0.158^{b}
	Liver	4.46±0.189^{c}	7.14±0.165^{a}	7.07±0.171^{b}
Copper (Cu)	**Muscle**	8.61±0.387^{c}	9.69±0.345^{a}	9.63±0.347^{a}
	Gill	10.04±0.410^{c}	11.30±0.385^{a}	11.23±0.372^{b}
	Liver	11.91±0.418^{c}	13.40±0.388^{a}	13.32±0.274^{a}

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Values are mean ± SD of three samples in each group. a-c Row means followed by common superscript are not significant at 5% level by DMRT

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LABORATORY STUDY OF THE LARVICIDAL AND PUPICIDAL ACTIVITY OF SELECTED THREE LEAF EXTRACTS AGAINST THE HUMAN VECTOR *CULEX QUINQUEFASCIATUS* (LIS.)

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ABSTRACT

The present investigation was aimed to investigate the mosquito larvicidal activities of methanol extract of *Madras patensis, Vitex negundo* and *Odenlandia corymbosa* against selected human vector *Culex quinfasciatus* under laboratory conditions. Larvicidal activity of the crude extract or phytochemicals against different cases of vector has been studied extensively when compared to other related aspects. The methanol extract of *Vitex negundo* showed maximum larvicidal avtivity when compared to the other two The 50 ppm plant extract exhibited the larval mortality of about 76.80% in the Ist instar larvae and it was reduced to 63.89%, 49.61% and 30.26% in the 2nd, 3rd and 4th instar respectively. From the present study it is evident that, the higher concentration of plant products promoted high degree of mortality in the case of larvae of *Culex quinquefasciatus* after 24 h treatment. And the results suggests that the methanol extract of *Vitex negundo* have a maximum potential as larvicidal agent against *Culex quinquefasciatus*. The *Madras patensis* shows moderate larvicidal activity and *Oledenlandia corymbosa* showed minimum larvicidal activity against the larvae of *Culex quinquefasciatus.* As naturally occurring insecticides, these plant derived materials could be useful as an alternative for synthetic insecticides controlling field populations of mosquitoes.

Keywords: *Madras patensis, Vitex negundo, Oldenlandia corymbosa, Culex quinquefasciatus,* methanol extract.

INTRODUCTION

Mosquito borne diseases have an economic impact including loss in commercial and labor outputs, particularly in countries with tropical and subtropical climates. However. no part of the world is free from vector-borne diseases[1]

The mosquito is the principal vector of many of the vector-borne diseases affecting human beings and other animals. *Culex quinquefasciatus*, a vector of lymphatic filaiasis and its widely distributed tropical diseases with around 120 million people infected worldwide and 44 million people have common chronic manifestation[2]

The use of plant and plant-derived products to control pests in the developing world is very common and ancient practice in India. Natural products of plant origin with insecticidal properties have been tries in the recent years for control of variety of insect pests and vectors. Plants are considered as a rich source of bioactive chemicals and they may be an alternative source of mosquito control agents. Natural products are generally preferred because of their innate biodegradability. In all probability, these plants are used to control insects contained insecticidal phytochemicals that were predominantly secondary compounds produced by plants to protect themselves against herbivorous insects[3]. Thus botanicals can be used as an alternative source for synthetic insecticides.

Mosquitoes breed in water occasionally depositing eggs directly on water but generally prefer a variety of moist surfaces such as tree holes and containers. Human activities such as the production of a large amount of the environmental debris that holds water pools including disposable bottles cans discarded tires and storage of water in and around living premises. When reliable piped home water supplies are unavailable or unreliable may markedly increase the available mosquito breeding sites[4]

Plant essential oils in general have been recognized as an important natural resource of insecticides[5]. The phyto-chemicals derived from plant sources can act as larvicides, insect growth regulators, repellents and ovipositional attractants and have deterrent activities observed by many researches[6]

In view of the recently increased interest in developing plant origin insecticides as an alternative to chemical insecticide, this study was undertaken to assess the larvicidal potential of the methanol extract of *Madras patensis , Vitex negundo* and *Oldenlandia corymbosa* against the human vector *Culex quinquefasciatus.*

MATERIALS AND METHODS

Selection of plant species

The plant species *Madras patensis*, L. belongs to Euphorbiaceae family and is widely found in the Coimbatore district, Tamil Nadu, India. It was collected from the foot hills of Maruthamalai, Coimbatore District, Tamil Nadu and was authenticated by botanical survey of India (BSI), Coimbatore, India.

Laboratory rearing of mosquitoes

Culex quinquefasciatus eggs were obtained from National Institute of Communicable Diseases, Mettupalayam, Coimbatore, Tamil Nadu. To start the colony the larvae were reared in the plastic and enamel trays containing tap water. Larvae were fed a diet of Brewer's yeast, dog biscuits and algae in the ratio of 3:1:1 respectively. Pupa were transformed from the trays to a cup containing tap water and were maintained in our insect cage (45× 45× 40 cm) where adult emerged.

Adults were maintained in glass cages and were provided continuously with 10 % sucrose solution in a jar with a cotton wick. On day 5 adults were given a blood meal from chicks placed in cages overnight for blood feeding by females. Glass petri dishes with 50 ml of tap water with filter paper was kept inside the cage for oviposition.

Preparation of *Madras patensis* L. extract

The leaves, stem and the flowers of *Madras patensis* L., *Vitex negundo*and *Oldenlandia corymbosa* plant materials were shade dried at room temperature and powdered coarsely by using electric grinder. The 20 g of *Madras patensis* L. powder was placed in the pouch made of Whatmann No. 1 filter paper and placed in the soxlet's apparatus and mixed with 250 ml of 80% methanol and soxlet for 6 h[7]. The concentrated extract was kept in wide mouth glass petridishes and evaporated to dryness at room temperature. The dried material was weighted and dissolved by using the suitable emulsifying agent. The stock solution was prepared dissolving 1.00 gm of dried material with 1 ml of emulsifier (1000 ppm). Different concentrations of plant extract were prepared from the stock solution by using distilled water. The concentration of 50, 100, 150, 200, 250 and 300 ppm were selected on the basis of killing range minimum to maximum larval mortality after 12 h duration.

Bioassay

Larvicidal activity was evaluated by the following WHO method with slight modifications. 30 numbers of first, second, third and fourth instars of *Culex quinquefasciatus* were placed in a separate 500 ml petridish with 249 ml of dechlorinated water and 1.0 ml of the desired plant extract concentrations. Five replicates were maintained for each concentration. Mortality rate was observed at 24 h of the exposure time. The mortality was calculated by Abbots method [8] for computing effectiveness of an insecticide.

RESULTS AND DISCUSSION

The maximum larval mortality was exhibited by *Vitex negundo* plant extract against the larvae of *Culex quinquefasciatus* is presented in the tanle (1). At 50 ppm plant extract showed the larval mortality of 77.80% in the larvae and it was elevated to 88.90% at 300ppm after 24 h. The larval mortality of the II- instar in the 50 ppm was 57.17% . It was gradually increased to 67.88%, 67.88%, 78.58%, 78.58% and 89.29% when treated with the respective concentrations of 100, 150, 200, 250 and 300 over the period of 24 h. III and IV instars showed less larval mortality when compared to I and II instar larval mortality. The LC_{50} values for I and II instar larvae are 13.79 ppm and 33.03 ppm respectively.

The moderate larval mortality was exhibited by *Madras patensis* plant extract against the larvae of *Culex quinquefasciatus* is presented in the tanle (2). At 50 ppm plant extract showed the larval mortality of 55.60% in the larvae and it was elevated to 88.47% at 300ppm after 24 h. The larval mortality of the II- instar in the 50 ppm was 46.46%. It was gradually increased to 57.17%, 57.17%, 67.88%, 67.88% and 77.80% when treated with the respective concentrations of 100, 150, 200, 250 and 300 over the period of 24 h. III and IV instars showed less larval mortality when compared to I and II instar larval mortality. The LC_{50} values for I and II instar larvae are 33.03 ppm and 56.09 ppm respectively.

The minimum larval mortality was exhibited by *Oldeanlandia corymbosa* plant extract against the larvae of *Culex quinquefasciatus* is presented in the tanle (3). At 50 ppm plant extract showed the larval mortality of 42.39% in the larvae and it was elevated to 76.95% at 300ppm after 24 h. The larval mortality of the II- instar in the 50 ppm was 33.40%. It was gradually increased to 46.46%, 57.17%, 57.17%, 67.88% and 77.80% when treated with the respective concentrations of 100, 150, 200, 250 and 300 over the period of 24 h. III and IV instars showed less larval mortality when compared to I and II instar larval mortality. The LC_{50} values for I and II instar larvae are 53.52 ppm and 91.67 ppm respectively.

The increased pattern of larval mortality was recorded in the case of *Culex quinquefasciatus* larvae if they are treated with the higher concentration of plant extracts. The present study showed that the extracts of *Madras patensis, Vitex negundo* and *Oldenlandia corymbosa* were more effective againstl the I and II instars larval mortality of *Culex quinquefasciatus* and also evident that the larval ages were significant factor for the determined larval mortality.

The results reported here open the possibility of further investigations of efficacy on their larvicidal and insecticidal properties of natural product extracts.The results of the present study would be useful in promoting research aiming at the development of new agent for mosquito mosquito control based on bioactive chemical compounds from indigenous plant source.

Table 1: Effect of methanol extract of *Vitex negundo* on the larvae of *Culex quinquefasciatus* after 24 h.

S. No	Concentration of plant extract (ppm)	Number of Larvae/ pupae used	Percentage Mortality			
			Larval Stages			
			I	II	III	IV
1.	50	30	77.80	57.17	37.95	27.61
2.	100	30	77.80	67.88	48.29	37.95
3.	150	30	77.80	67.88	58.63	48.29
4.	200	30	88.90	78.58	68.97	68.97
5.	250	30	88.90	78.58	79.31	79.31
6.	300	30	88.90	89.29	89.65	89.65
LC_{50}			13.79	33.03	-	-

Values are the mean of Five replications

Computed as C-T/C 100, Where T= % damage in treatment

C= % damage in control

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Table 2: Effect of methanol extract of *Madras patensis* on the larvae of *Culex quinquefasciatus* after 24 h.

S. No	Concentration of plant extract (ppm)	Number of Larvae/ pupae used	Percentage Mortality			
			Larval Stages			
			I	II	III	IV
1.	50	30	55.60	46.46	27.61	17.26
2.	100	30	66.70	57.17	37.95	27.61
3.	150	30	66.70	57.17	48.29	37.95
4.	200	30	77.80	67.88	58.63	48.29
5.	250	30	77.80	67.88	68.97	58.63
6.	300	30	88.47	77.80	67.88	68.97
LC_{50}			33.03	56.09	-	-

Values are the mean of Five replications

Computed as C-T/C 100, Where T= % damage in treatment

C= % damage in control

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Table 3: Effect of methanol extract of *Oldenlandia corymbosa* on the larvae of *Culex quinquefasciatus* after 24 h.

S. No	Concentration of plant extract (ppm)	Number of Larvae/ pupae used	Percentage Mortality			
			Larval Stages			
			I	II	III	IV
1.	50	30	42.39	33.40	14.34	17.26
2.	100	30	55.60	46.46	37.95	27.61
3.	150	30	66.70	57.17	48.29	37.95
4.	200	30	66.70	57.17	58.63	48.29
5.	250	30	77.80	67.88	68.97	58.63
6.	300	30	76.95	77.80	67.88	68.97
LC_{50}			53.52	91.67	-	-

Values are the mean of Five replications

Computed as C-T/C 100, Where T= % damage in treatment

C= % damage in control

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ZOOPLANKTON DIVERSITY OF SINGANALLUR WETLAND OF COIMBATORE DISTRICT, TAMILNADU, INDIA

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Abstract

Zooplankton diversity and water quality parameters of two wetlands were studied to adjudge the health and potential threats of those wetlands. Zooplankton species diversity in the selected wetlandwas found to be quite high. Rotifer was the richest group having 13 species, Cladocera species (8), Copepoda (8) species enjoynumerical superiority followed by Ostracoda (5). Only during premonsoon period rotifer and cladocerandiversity was significantly different in these two wetlands. Presence of higher number of copepods in allseasons signifies oligotrophic condition of these wetlands.Water quality parameters indicate prevalence of moderate quality of water in the wetland selected for research analysis.Destruction of natural habitat and local vegetation, eutrophication condition and agricultural practices are thus hampering zooplankton life by adversely affecting their food chain.

Key words: Wetland, water quality, Plankton,

1.0 Introduction

Wetlands are crucial for biodiversity conservation because it is one of the most productive ecosystems. Richness of wetlands depends on its plankton community because they are placed on the base of the food pyramid. Freshwater zooplankton plays an important role in ponds, lakes and reservoirs ecosystem and food chain (Manickam *etal*.,2014). Zooplankton are one of the most important biotic components influencing all the functional aspects of anaquatic ecosystem, such as food chains, food webs, energy flow and cycling of matter (Park and Shin, 2007).Their diversity and abundance plays a major role inmanagement of aquaculture (Boyd,1982).

Zooplankton communities are known to be highly susceptible to a wide range of factors like environmentalchanges, temporal abundance and seasonal variation, and their diversity is a marker of water quality in trophic conditions in cold, temperate and tropical waters. The zooplankton community is composed of both primary consumers (which eat phytoplankton) and secondary consumers (which feed on the other zooplankton). They provide a direct link between primary producers and higher tropic levels such as fish. Nearly all fish depend on zooplankton for food during their larval phases, and some fish continue to eat zooplankton for their entire lives (Madin*et al*.,2001). Moreover, they are also known to play a primary role in functioning and

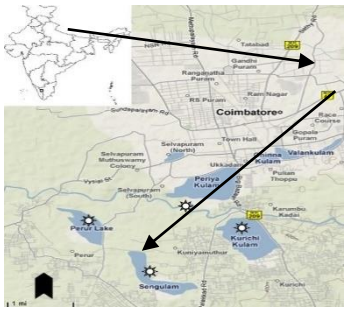
productivity of lake ecosystems, and make up a major portion of its biomass (Gannon and Stemberger,1978).

Due to theirimportance in aquatic ecosystem, much attention was paid on theireco-biology. Zooplankton also have enormous ecological value as theyare primary consumers of phytoplankton, and also recycle thenutrients.Zooplanktons play an integral role and may serve as bio indicator and it is a well-suited tool for understanding water pollution status (Contreras *et al*., 2009).Literature on ecology of zooplankton population from different parts of India is available from the investigation of Sivakumar and Altaff,2004; Mathivanan*et al*.,2007; Ganesan and Khan,2008; Sharma ,2009; Sharma,2010.Keeping in view the importance of such wetlands and generaldearth of literature, the present work was undertaken to assess the quality of water anddiversity, abundance and seasonal variation of zooplankton community of perennial wetland Singanallur at Coimbatore District, Taminadu, India.

2.0 Materials and methods

2.1 Study area

Location: It is situated right side of the Coimbatore – Singanallur road.**Latitude:** 10° 59'46" N and **Longitude:** 77° 01'11" E. **Size of wetland:** Catchment area: 11.776 Sq.milesWater Spread area – 1.153 Sq.km; Length of the Bund – 3102.00 M; Capacity – 52.27 M.cft; Depth – 13.95 Feet. Biodiversity:Found good number of Pelicans, Painted stork, Open-bill stork, Pond herons, Egrets, White-breasted waterhens, Purple Moorehens, Darters, Cormorants, Kingfishers, grebes, Spot-billed ducks and coots***Plate.1 Map showing study area***



2.1 Collection and preservation of samples: The plankton and water sample were collected from selected habitats for one year(Dec2016-Nov2017). Samples were collected periodically for every month first week during morning hours (6.00 A.M to 8.00 A.M). For quantitative analysis, 100 litres of water was filtered through plankton net made up of bolting silk (150 μm) to collect zooplankton. The collected plankton samples were transferred to polyethylene bottles (90 ml) and preserved with 5% of neutral buffer (10 ml) formalin (aqueous solution of formaldehyde). The plankton samples varied both qualitative (by-towing) as well as quantitative (by-filtering) analysis throughout the study period.

2.2 Analysis of water quality and biological parameters: The seasonal wise water quality parameters were estimated by using "Water & Soil Analysis Kit Model 1160". The freshwater zooplankton species were studied under microscope and identification was made referring the standard works (Altaff, 2004). Plankton counting was made by drop method. Quantitative analysis was made using a plankton-counting chamber (Sedgwick Rafter's)under Inverted Biological Microscope (INVERSO 3000 TC-100). 1 ml of sample was taken with a wide mouthed pipette and poured into the counting cell of the Sedgwick Rafter. After allowing for settle some time they were counted. At least 6 such counting was made for each sample of the plankton. The average values were taken. Total number of plankton present in 1 liter of water sample was calculated Santhanam *etal*., 1989 using the following formula:$\mathbf{N = n \times v / V}$Where, N= Total number of planktons perliter of water filtered; n = Average number of planktons in 1 ml of plankton sample; v = Volume of plankton concentrated (ml); V = Volume of total water filtered (liter).**2.3 Statistical analysis and diversity indices:**The statistical analysis was done using software programmed for total zooplankton numbers of individual species, diversity indices

namely; Shannon's diversity index (H'), species evenness and species richness were calculated using PAST software package (PAST; version = 2.02).

3.0 Results and Discussion

In the present experimental analysis, all the mean data of selected water quality parameters (i.e., temperature, pH, salinity, electrical conductivity, total dissolved solid, total suspended solid, carbon-dioxide and dissolve oxygen) obtained seasonal basis and analysis of water samples during December, 2016 to November, 2017 is depicted in Table.1.Water temperature is an important factor in any aquatic environments affecting biological processes, in this study recorded and water temperature 23.0°C to 27.0°C. The maximum of water temperature was noticed in summer and minimum in monsoon. The pH values were ranged for 7.00 to 8.40. In the maximum was noticed in summer and minimum in monsoon. Salinity was variable throughout the study period. The salinity values ranged from 0.642 (mg/L) to 0.917 (mg/L). A maximum salinity of was observed in summer and minimum observed in monsoon. The values of dissolved oxygen were ranged from 5.6 (mg/L) to 8.7 (mg/L). Dissolved oxygen values of the water were higher in summer and lower in monsoon during the study period. In the study period the range of Electrical conductivity was 0.777 (mg/L) to 0.900 (mg/L). The EC were maximum in summer and minimum in monsoon. The total dissolved solid was range in 0.535 (mg/L) to 0.783 (mg/L). The maximum value of TDS was in summer and minimum in monsoon.

Table.1 Water quality parameters of Singanallur wetland for a period of one year (Dec2016-Nov2017)

c	PM	S	PRM	M
Temperature (ºC)	24	27	25	23
pH	7.6	8.4	7.4	7.0
Salinity (mg/L)	0.775	0.917	0.814	0.642
Dissolved oxygen(mg/L)	5.6	8.7	7.4	6.1
Electrical conductivity	0.820	0.900	0.851	0.777
TDS (mg/L)	0.504	0.783	0.636	0.545

* PM-Postmonsoon; S-Summer; PRM-Premonsoon; M-Monsoon

In the present study, all the analyzed parameter was observed to be maximum recorded during summer season and minimum in monsoon season (Table 1). Water temperature influences the plankton of surrounding air temperature (Wang *et al*., 2002) (Table 1). The water body registered an alkaline pH. Aquatic organisms are affected by pH because most of their metabolic activities are pH dependent (Ranjan *et al*., 2007). Salinity acts as major ecological factor controlling the plankton population of freshwater (Abbassi*et al*., 1996). Electrical conductivity is a good indicator of the overall water quality (Abbassi*et al*., 1996). A sudden rise in conductivity in water during monsoon and post monsoon season indicates addition of some pollutants (Jeelani*et al*., 2005). High value of dissolved content is an indication of healthy system in a water body (Krishnamoorthy *et al*.,2007). The present study the recorded highest average value for total dissolved solids might be due to accumulation of the anthropogenic waste which hampered the quality of water.

Table.2 Species diversity indices of zooplankton recorded in Singanallur wetlandfor a period of one year (Dec2016-Nov2017)

Species	Diversity Indices	PM	S	PRM	M
Rotifera	Shannon diversity index	2.62	2.72	2.55	2.53
	Simpson's diversity index	0.91	0.93	0.91	0.90
	Species evenness	0.86	0.85	0.87	0.91
	Margalef species richness	0.57	2.37	0.89	2.64
	Menhinick index	2.40	0.50	2.33	0.69
Cladocera	Shannon diversity index	2.27	2.25	2.38	2.37
	Simpson's diversity index	0.88	0.89	0.87	0.85
	Species evenness	0.92	0.94	0.89	0.86
	Margalef species richness	1.41	1.49	1.55	1.65
	Menhinick index	0.37	0.38	0.50	0.54
Copepod	Shannon diversity index	2.21	2.27	2.18	2.17
	Simpson's diversity index	0.97	0.99	0.89	0.88
	Species evenness	0.88	0.89	0.81	0.79
	Margalef species richness	1.40	1.45	1.49	1.55
	Menhinick index	0.35	0.33	0.42	0.45
Ostracoda	Shannon diversity index	1.85	1.86	1.75	1.74
	Simpson's diversity index	0.83	0.82	0.84	0.79
	Species evenness	0.91	0.90	0.94	0.85
	Margalef species richness	0.94	0.96	1.10	1.15
	Menhinick index	0.29	0.31	0.30	0.58

* PM-Postmonsoon; S-Summer; PRM-Premonsoon; M-Monsoon

In the present study period totally, 13 species of rotiferabelonging to 7 genera were recorded (Table.3). The Shannon diversity index (H) was found to be high (2.72) in summer and low (2.53) in monsoon. Simpson's diversity index was maximum (0.93) during summer while minimum (0.90) in monsoon. The high species evenness (0.85) was found during summer and low evenness (0.71) was noticed in monsoon. The Margalef species richness (R1) was found maximum (2.64) in monsoon and minimum (2.37) in summer. The Menhinick index (R2) values were fluctuated throughout the study period with maximum (R2) (0.69) recorded during monsoon and minimum (0.50) in summer (Table.2). Totally 8 species of Cladocera belonging to 5 genera was recorded during the study period. The Shannon diversity index (H) was found to be maximum (2.38) in the month of premonsoonand minimum (2.25) was noticed in monsoon. Simpson's diversity index was maximum (0.89) in summer and minimum (0.88) in monsoon. Species evenness was recorded to be high(0.94) in summer and low (0.86) in monsoon. The Margalef index (R1) species richness was resulted maximum (1.65) during monsoon and minimum (1.49) was reported in summer. The maximum Menhinick index (R2) (0.54) was recorded in monsoon and minimum (0.38) in summer.

In the current investigation, 8 species of Copepoda belonging to 8 genera (Table-2) were recorded. The Shannon diversity index (H) was found maximum (2.27) during summer and minimum (2.17) in monsoon. Simpson's diversity index was maximum (0.89) in summer and minimum (0.88) in monsoon. The high species evenness (0.89) was found in summer and low evenness (0.79) obtained in monsoon. The Margalef species richness (R1) was maximum (1.55)

during the month of monsoon and minimum was reported as (1.45). The maximum Menhinick index (R2) value (0.45) was recorded during monsoon and minimum (0.33) during summer. In the present study period 5 species of Ostracoda were recorded in belonging to 6 genera. The Shannon diversity index (H) was maximum (1.86) recorded during summer and minimum (1.74) in monsoon. Simpson's diversity index was found higher (0.84) in postmonsoon and minimum (0.79) in monsoon. The maximum evenness (0.94) was noticed in postmonsoon following till summer while low evenness (0.85) was obtained in monsoon. The Margalef index (R1) of species richness was found maximum (1.15) in monsoon and minimum (0.96) were noticed in summer. The Menhinick index (R2) showed maximum (0.58) during monsoon and minimum (0.31) during summer.

Table.3 List of freshwater zooplankton species recorded in in Singanallur wetland for a period of one year (Dec2016-Nov2017)

Rotifera	**Cladocera**	**Copepoda**	**Ostrocada**
1.*Brachionus quadridentatus* 2.*Brachionusrubens* 3.*Keratella cochlearis* 4.*Keratella tropica* 5.*Brachionus falcatus* 6. *Brachionusdiversicornis* 7. *Brachionus caudatus* 8. *Brachionuscalyciflorus* 9. *Lecane papuana* 10. *Asplanchna brightwelli* 11. *Asplanchna intermedia* 12.*Anuraeopsis fissa* 13.*Anuraeopsis navicula*	*1.Diaphanosoma sarsi* *2.Diaphanosoma exci* *3.Daphnia carinata* *4.Daphnia magna* *5.Ceriodaphnia cornuta* *6.Ceriodaphnia reticulata* *7.Moina flagellate* *8.Moina macrocopa*	*1.Mesocyclops leuckarti* *2.Mesocyclops aspericornis* *3.Mesocyclops hyalinus* *4.Sinodiaptomus* *5.Apocyclops sp* *6.Cletocamptus sp* *7.Eucyclops sp* *8.Heliodiaptomus sp*	*1.Cyprinotus nudus* *2.Cypris protubera* *3.Candonocypris dentatus* *4.Cypretta fontinalis* *5.Strandesia elongata*

Rotifers have often been used to indicate trophic status of a water body. The species *Brachionuscalyciflorus* is considered to be a good indicator of eutrophication. The cladocera population was ranked third in order of individuals in the present study. Copepods are in intermediate trophic level among bacteria, algae and protozoa on one hand and small and large plankton predators on the other. The lake rich in organic matter support higher number of cyclopoids, thus suggesting their preponderance in higher trophic state of water. The Ostracoda population was ranked in fourth order of individuals in the present study. High mean value of Shannon's index (H1) was recorded as follows Rotifera>Copepoda> Cladocera > Ostracoda. The presence of 3species of rotifera which includes *B. calyciflorus*, *B. falcatus*, and*Keratellatropica*and 3 species of cladocera (*Diaphanosomasarsi*, *Ceriodaphniacornuta*,and*Moinodaphnia*), 2 species copepoda (*Mesocyclopshyalinus*, *Mesocyclopsleuckarti*) and 2 species ostracoda (*Cypris protubera*and *Hemicyprisanomala*) reveal that the lake is being less polluted. It is understood that the various anthropogenic activities such as entry of agricultural runoffs (eg.insecticides and pesticides) from surrounding agricultural field seem to be the major cause of eutrophication. Therefore, the continuous monitoring is essential for the conservation of this lake ecosystem.

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Nutritional quality of raw and dry samples of marine edible fishes *Scomberomorus guttatus* and *Cynoglossus semifasciatus*

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Abstract:

The marine fish are extraordinarily nourishing food and are affluently accessible fish meat source. The measurement of some proximate profiles such as protein, lipids, moisture and pH contents in raw and dried fishes are often necessary to ensure that they meet the requirements of food regulations in nutrition aspects and commercial specifications. The objective of this work was to analyze the physicochemical and proximate composition of raw and dried fishes of *Scomberomorus guttatus* and *Cynoglossus semifasciatus* collected from Ukkadam whole sale market, Coimbatore. From the results it was observed that the pH contents of raw and dried *Scomberomorus guttatus* and *Cynoglossus semifasciatus* were 7.1, 6.9, 6.4 and 6.5 and moisture contents were 70.02, 69.54, 0.61 and 0.57% respectively. The pH and moisture content of raw *Scomberomorus guttatus* was higher than the dry fish samples. Dried samples of *Scomberomorus guttatus* had higher protein content (4.4 and 6.8mg) than the raw samples (2.6 and 5.0mg). Highest lipid content was found in raw samples of *Scomberomorus guttatus* (1.64 and 1.35mg).

Key words: *Scomberomorus guttatus*, *Cynoglossus semifasciatus*, physicochemical parameters, proximate composition.

Introduction:

Fish is one among the most consumable food worldwide. It is a favourite foodstuff for the majority of societies. Fish meals contain most important nutritional components and serve as a source of energy for human beings (Ojewola and Anand, 2006). Additionally the fish muscle contains little saturated fat and significant amount of vitamin C along with minerals such as calcium, potassium, zinc, iron, phosphorus and copper. Protein is essentials substance of life and exists in the largest quantity of all nutrients as a component of living beings. Lipids are major sources of metabolic energy and essential for the formation of cell and tissue membrane. Majority of the nutritionists recommend that human beings should eat fish every day. Fish is currently being used as a good tool for food therapy and source of therapeutic substance for the treatment of coronary diseases, auto immune disease, protein energy malnutrition and anaemia.

Biochemical composition of flesh is a good indicator of fish quality, physiological conditions of fish and habitat of fish (Aberoumad and Pourshafi, 2010). Moisture, dry matter, protein, lipids, vitamins and minerals are the most important components that act as source of nutritive value of fish meat. In general, the proximate composition, amino acid level and fatty acid composition of fish are varied from one to another species. It depends on age, sex, environment and season variations. The biochemical compositions are closely connected to feeding habit, migration and sexual changes in connection with spawning .

Dried fish is a major component of harvested fisheries in many countries including India. About 25- 30% of the world catch is being used for human consumption as dried, salted, smoked or treated by some combination of these processes. Seafood products are currently in high demand as they are considered healthy and nutritional. Dried fish is a traditional part of the diet of a large section the world's population. However, the gap between the demand and supply of fish

is widening due to increase in population poor post harvest handling, lack of processing, storage facilities and utilization of unconventional fish species (Balachandran, 2001).

Because of health consciousness, the modern day man is interested in taking sea food more in view of its nutritional superiority than all other sources of food accessible. Oparaku and Nwaka, (2013) studied the effect of processing on the nutritional qualities of three fish species (*Synodontis clarias, Trachurus trecae* and *Clarias gariepinus)*. Mohanty *et al*., (2015) analysed the proximate composition of three marine fishes of Chandipur, Bay of Bengal, India. Merline and Chitra (2017) investigated the nutritional content and isolation of amine forming bacterias of commercially important dry fish *Sardinella longiceps* collected from local market in Coimbatore, Tamil Nadu. Hence the present study was designed to investigate the proximate composition of some highly consumable marine raw and dry fishes available in Coimbatore City.

Materials and methods:

Samples collection:

Raw vanjaram (*Scomberomous guttatus*) and nangu (*Cynoglossus semifasciatus*) fish were collected from whole sale fish market, Ukkadam, Coimbatore. The dry fish samples were procured from retail shop at Coimbatore.

Sample preparation:

The collected raw fish samples were immediately placed in an ice box containing crushed ice, kept cold and transported to the laboratory. The samples were beheaded, gutted, washed and filleted. Then the known weights of muscle samples were homogenate and filtered and then used for further analysis. Similarly the muscle samples were prepared from dry fish.

Physicochemical analysis:

For measuring the pH, fish muscle samples (10g) were homogenized in sterile blenders with 10ml of distilled water to make thick slurry. The pH of this slurry was then measured using a pH meter (Eco tester pH1) (Ronald and Ronald, 1991). Moisture content of the raw and dried samples was tested using the method of Jain and Singh (2000).

Proximate composition:

Protein contents (Lowry *et al*., 1975) and lipid contents (Folch et al., 1957) of the muscle tissues of raw and dried samples of *Scomberomous guttatus* and *Cynoglossus semifasciatus* were estimated.

Results and discussion:

The knowledge on biochemical composition of any edible organisms is extremely important since the nutritive value is reflected in its biochemical contents. A new species should be recommended for human consumption only after assessing the nutritive value of the species with regards to its nutritional qualities.

The demand for protein rich food is increasing, especially in developing countries, stimulating the exploration of unexploited or non-traditional resources. Marine fish are commercially valuable species and easy to cultivate in coastal areas. Marine fish are important for marine ecology and human diet, since it is an important source of nutrients. The results of the

present investigation give a clear detail about the nutritional value in edible marine species and it's depletion during drying.

Nutritional quality is an important aspect of fish quality and it influences both the keeping quality and technological characteristics of the fish. The findings of many researches revealed that these were a remarkable correlation between the p^H and the fish rawness (Abbas *et al*., 2008). p^H is an important factor that affects the microbial growth and spoilage of foods. In this present investigation the p^H values recorded in raw *Scomberomorus guttatus* and *Cynoglosus semifasciatus* values are 7.1 and 6.9 respectively and in dry samples it is 6.4 and 6.5 respectively (Figure 1).

The moisture determination is one of the most important and widely used measurements in the processing and testing of food. The moisture content of raw *Scomberomorous guttatus* and *Cynoglossus semifasciatus* found to be 70.02% and 69.54%. In dry fish sample the moisture content found to be 0.61% and 0.57% respectively (Figure 2). The moisture content indicates that the percentage of moisture was in acceptable level (70-80 %), which may be due to the stable levels in the environmental locations, where fish was collected. The moisture content seen to be exact indicators of the susceptibility of a product to undergoes microbial spoilage. Moisture content of raw fishes was higher than that of dried fish as a result of dehydration of water molecules present in dry fish.

The fish received increased attention as a potential source of animal protein and nutrients for human diets (Fawole *et al*., 2007). Protein forms the largest dry matter in fish. It is the essential substance of life and accordingly exists in the largest quantity of all nutrients as a component of the living beings. Fish proteins are rich in essential amino acids. They are required for the maintenance of growth, reproduction and synthesis of vitamins. In this present investigation the protein values in raw fish *Scomberomorus guttatus* and *Cynoglossus semifasciatus* showed 4.4mg/100g and 2.6mg/100g respectively (Figure 3). Dry fish samples showed 6.8mg/100g and 5.0mg/100g of protein content in their muscle tissues. Decrease of moisture content and increase of protein and fat contents were the most prominent changes in all the fishes after drying. This trend was in agreement with findings of Chukwu (2009), who observed that decreased moisture content in dry samples than the raw samples collected from fish market at in Muscat, Oman. There was an increase in protein levels in dried fish when compared with raw fish which protein nitrogen was not lost during drying. This result was in accordance with findings of Gokoglu *et al*., (2004)

The increase in drying time and loss of moisture content leads to protein denaturation. In the present work dried fish had higher protein which may be due to dehydration of water molecules present between thereby causing aggregation of protein and resulting in the increase in protein content of dried fish then the raw fish.

Lipids are the major source of metabolic energy and essential materials for the formation of cell and tissue membrane. Lipid content of the raw samples (*Scomberomorus guttatus* and *Cynoglosus semifasciatu*) was found to be 1.64 gm and 1.35gm respectively (Figure 4). Lipid is quite important to overcome malnutrition problems in our country and for those with cardiovascular problem to be overcome by effective utilization of nutrient rich sea food which is an excellent source of high biological value.

The lipid content of dry samples (*Scomberomorus guttatus* and *Cynoglosus semifasciatus*) was found to be 0.32 gm and 0.16gm. The fat content may be reduced with the evaporation, and temperature could be attributed to possible loss of fat due to increase in temperature by long exposure of species. Fat content also varies among the fishes species.

Changes observed in lipid content during storage may have been due to leaching out of some extractable soluble protein fraction and hydrolysis of some of the lipid fraction. The protein content of the sun dried fish was higher but lipid content observes was recorded low according to Priya *et al*., (2011). This could be associated with the oxidation of fat during the period of sun drying.

Fish lipids are well known to be rich in long-chain (cc) n-3 polyunsaturated fatty acids (ccn-3PVFA), especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). The lipids are highly efficient as source of energy in that they contain more than twice the energy of carbohydrate and proteins.

Conclusion:

In the present study the knowledge of the chemical composition of edible marine fishes is extremely important since the nutritive value is reflected in its biochemical contents. Even though large numbers of marine fish, shrimp, crabs and mussel are suitable for human consumption, our knowledge on its nutritive value is fragmentary. In this respect biochemical assay play a major role in recent years. The biochemical composition raw and dried fishes are the yardstick to measure and assess the nutritional quality of food resources. In conclusion, raw fish consumption is recommended for children because of less percentage of crude fibre which is responsible for its faster digestibility compared to that of dry fish. The proximate composition of different marine dry fishes revealed that dry fish have good nutritional value. The collected samples were very rich in protein and lipid contents. However, the nutritional value of dry fishes are greatly deteriorates due to the longer storage. Therefore, the dry fish industries should be kept more precautionary steps during storage of dry fish in the warehouse and in the sale centre.

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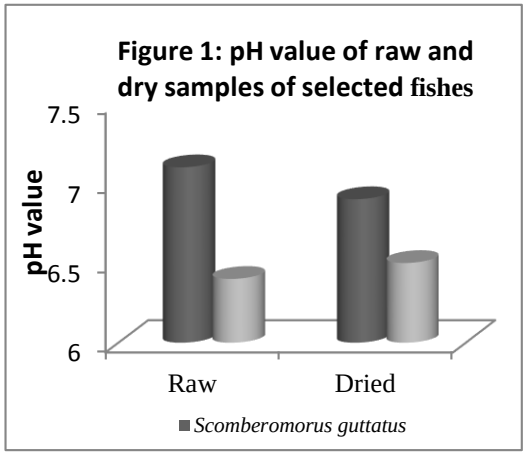

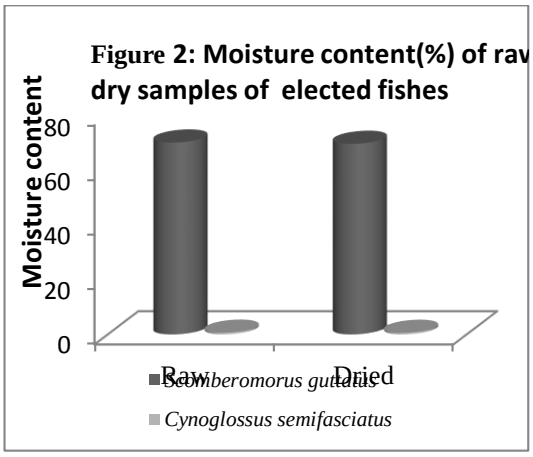

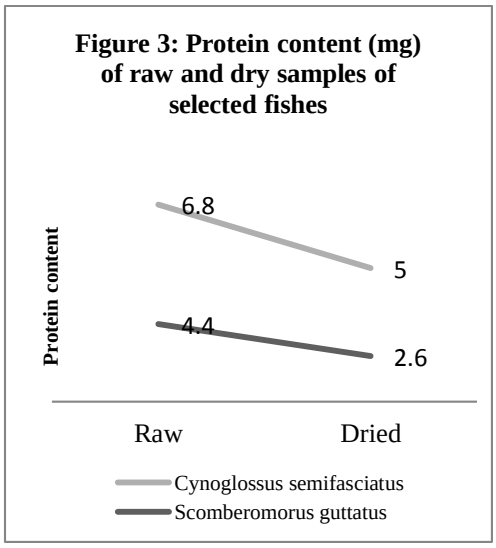

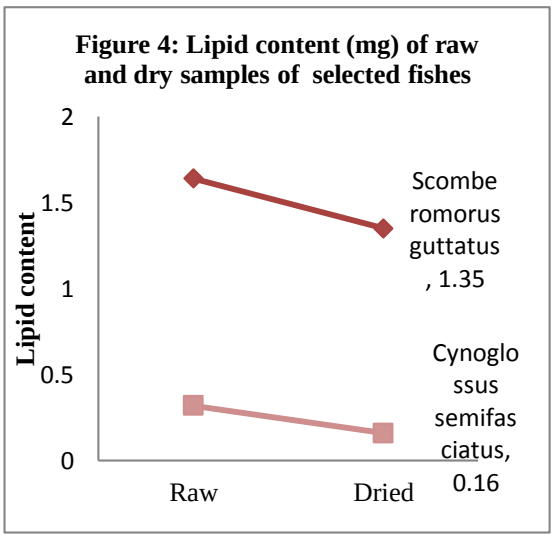

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Haematological parameters of *Labeo rohita* fingerlings supplemented With *Ocimum basilicum* and *Piper betle*

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Abstract

An investigation was carried out to evaluate the effect of selected plant leaves of (*Ocimum basilicum* and *Piper betle*) as supplemented feed on the hematological parameters such as total erythrocyte count, total leukocyte count, haemoglobin count, platelets count and Mean Cell Haemoglobinof *Labeo rohita* fingerlings. Four supplemented feed were prepared for each plant leaf powder at 5% and 10% concentration, the feed without the plant leaf powder was considered as control. The fishes were supplemented with these feed for 90 days. The results were obtained after 90 days of experiment. The data were analyzed using one way analysis of variance (ANOVA). The fishes fed with *Ocimum basilicum* showed maximum increase in total erythrocyte count, total leukocyte count, haemoglobin count, platelets count and Mean Cell Haemoglobin when compared to control. This study suggests that inclusion of plant leaves in fish feed result in increase in the blood parameters and this can be used as immunostimulants to raise the cellular immune response of *Labeo rohita* fingerlings.

Keywords:*Labeo rohita*, plant supplement feed, Haematologicalparameters.

Introduction

Aquaculture has been one of the fastest growing agricultural industries worldwide (Hishamunda and Ridler, 2002). It is gaining considerable importance all over the world as a mean of improving world fish production. Its productivity constitute significant portion of national income of many countries of Asia (Michel, 1997). The production rate of this industry has increased dramatically over the past decades.

Fish is highly liked as food fish in the South and Southeast Asian countries (Wee and Tacon, 1982). The aquaculture and fisheries have a promising role to play in social development by providing nutritional security for Indian population and contributing to the economic advancement of the farmers and the fishery workers as more than 14.66 million fisher man and fish farmers are totally depend on fisheries for their livelihood in India (Pavaraj*et al*., 2011). According to Food and Agricultural Organization reports, the production value reached from 1million tons in the early 1950s to 7/ 51 million tons with a value equal to 8/ 78 billion dollars in 2006 (FAO, 2008). Over the years, the total World fishery production decreased slightly and the human consumption for aquatic products increased(FAO, 2012).

Due to increasing demands for more proteins, aquaculture the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants has increased worldwide between 1970 and 2010 at approximately 7 % per annum (FAO, 2009). Aquaculture production was 10% in the 1970s globally but today it produces about 50% of total fish output (Diana, 2009). The increase in the productivity in fish culture has been accompanied by stressful conditions and problems related to fish disease (Pavaraj*et al*., 2011).

The growth of intensive aquaculture production has led to a growing interest in treating or preventing fish diseases. Protecting the fishes from disease can be done through two ways. One is by strengthening the immune power of the organism to fight the invasion of pathogens and the second is through medication (Stephen *et al.,* 2006). The use of disinfectants and anti-microbial has shown limited success in preventing or curing aquatic disease (Subasinghe, 1997). The use of antibiotics and chemotherapeuticfor treatment in intensive aquaculture has been widely criticized for its negative impact (Criteae*t al*., 2012) and research on interactions between immunity, growth and development of eco- friendly alternatives to antibiotics that may keep fish healthy such as probiotics and plant based immune- stimulants has increased.

Indigenous technological knowledge for treating disease is receiving attention in fish health and disease management. The term applies to any compound that modulates the immune system by increasing the host's resistance to disease. Immuno- stimulants mainly facilitate the function of phagocytic cells and increase their bactericidal activities. Several immune- stimulants also stimulate lysosomes and the antibody response of fish (Sakai, 1999). Immuno- stimulants include a wide range of chemical agents, bacterial components, polysaccharides, animal or plant extracts, nutritional factors and cytokines.

Plant extracts with antimicrobial and immuno- stimulant properties have been used as therapeutic and prophylactic agents against fish pathogens (Fyzul and Austin, 2015). The medicinal plants are rich in secondary metabolites and essential oils of therapeutic importance (Ak*et al.,* 1999). The important advantages claimed for therapeutic uses of medicinal plants in various ailments are their safety besides being economical, effective, fewer side effects and their easy availability (Bhandari*et al*., 2008, Singab*et al*., 2005). Many of the medicinal herbs and their chemical components are used as an immune stimulant which reused in artificial diet preparation, aquaculture research and their practices (Dugenci*et al*., 2003).

In plants there are many sources of safer and cheaper chemical compounds such as alkaloids, flavonoids, pigments, phenols, terpenoids, steroids and essential oils that possess diverse range of bioactivity (Cook and Samman, 1996; Velioglu*et al*., 1998; Iwalewa*et al.,* 2007). The compounds produce definite physiological action in the body like anti- stress, growth promotion, appetite stimulation, antimicrobial activities and immune stimulation (Citarasu, 2010).

So with this point of view, the leaves of *Ocimum basilicum* and *Piper betle* plants are selected as immunostimulants and incorporated in the fish feed to boost up the immunity of fish, *Labeo rohita* fingerlings.

Collection of plant leaves

Fresh leaves of selected plants*O.basilicum* known as basil belonging to the family Lamiaceae and *P.betle* known as betle belonging to the family Piperaceae (Plate 2) were collected for feed preparation in and around Coimbatore.

Preparation of plant powders

The collected leaves were washed, shade dried and powdered using pulverizer. The powdered leaves were sieved to remove the large (granules) fiber particles and used for fish feed preparation.

Preparation of fish feed

Fish feed was prepared by adding equal proportion of wheat flour and coconut oil cake in the ratio of 1:1and corn flour was added as binder. These ingredients were mixed using hot water and made into soft dough. The dough was steamed for 10 minutes and then cooled to room temperature. Four experimental feeds were prepared by adding the plant additive (*O. basilicum* and *P. betle* at 5 % and 10 %) separately and the feed without plant leaves is kept as control. The pellets were prepared by using domestic appliances with pore size 0.5 mm diameter and stored in refrigerator for further use.

Experimental design

The laboratory experiments were laid in completely randomized design (CDR).Three replication for each treatment and control were maintained simultaneously. The experiment was conducted using 15 liter plastic troughs. The troughs were stocked with 10 fishes with mean initial weight of 5 to 5.5 grams. The fishes were starved for a night prior to the experiment. The experiment was conducted for 90 days and fishes were fed with prepared control and experimental feed. The medium was changed daily in order to remove fecal and unconsumed feed.

Haematological parameter

After 90 days experimental period the haematological parameters were examined both in the control and experimental fishes. The parameters analyzed were

1. Total erythrocyte count/ RBC count (haemocytometer)
2. Total leucocyte count/ WBC count (haemocytometer)
3. Haemoglobin count (Shali's haematin method)
4. Platelet count (haemocytometer).
5. Mean cell hemoglobin (MCH)

Result and Discussion

After 90 days of treatment the haematological parameters of *L. rohita* were determined. Fig 1 to Fig 5 clearly illustrates that the haematological parameters such as total erythrocyte count, total leukocyte count, haemoglobin count, platelets count and mean cell haemoglobin, were significantly higher ($p < 0.05\%$) in treatment groups when compared to control. Among the treatments the fishes fed with *O. basilicum* 10% concentration supplemented feed showed maximum increase in RBC (0.89 million/ cu.mm), WBC (700 million/ cu.mm), haemoglobin (0.93 gm%), platelets (47.07 thousand/ µl) and MCH (100 pg), whereas control recorded a minimum of (RBC- 0.4 million/ cu.mm, WBC- 260 million/ cu.mm, Haemoglobin- 0.3 gm%, platelets- 20.2thousand/ µl and MCH- 37 pg).

Figure 3
Effect of plant leaves as immunostimulant on Haemoglobin count of *Labeo rohita* fingerlings

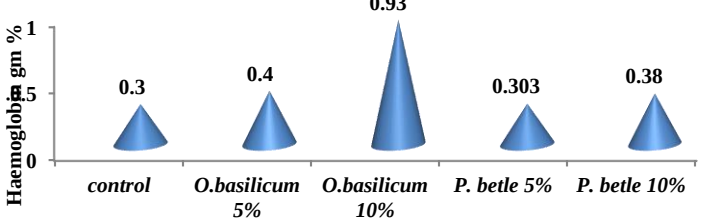


Figure 1
Effect of plant leaves as immunostimulant on Erythrocyte count of *Labeo rohita* fingerlings

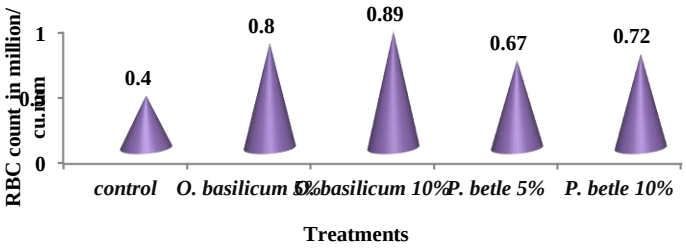


Figure 2
Effect of plant leaves as immunostimulant on Leukocyte count of *Labeo rohita* fingerlings

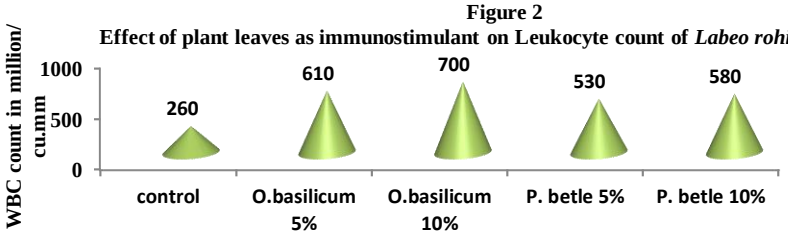


Figure 4
Effect of plant leaves as immunostimulant on Platelet count of *Labeo rohita* fingerlings

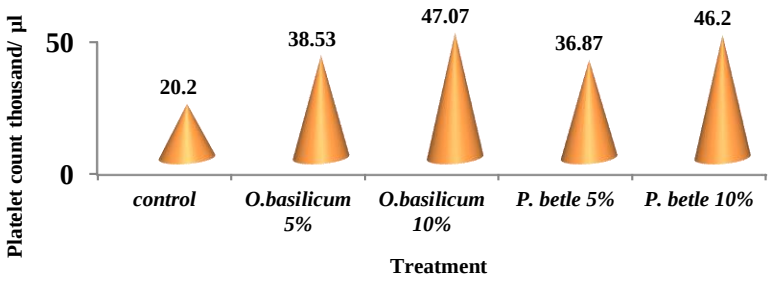
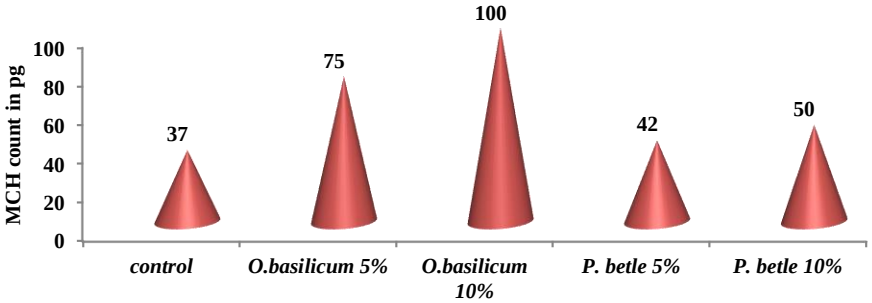


Figure 5
Effect of plant leaves as immunostimulant on MCH of Labeo rohita fingerlings



Haematological parameters of fish are used as indicators of their physiological state and their study has become wide spread in the control of pathogens and manipulation of stress in fish (Logambal*et al.*, 2000, Adiguzel*et al.*, 2005, Ardo*et al.*, 2008*).*

The result of the present study correlates with the findings of Sahu*et al.*, 2007 who reported that increased RBC and WBC in *L.rohita* fingerlings fed with *M.indica* indicated cellular immunity. Haemoglobin in the blood carries oxygen from the respiratory organs (lungs or gills) to the rest of the body. Similar to our results Harikrishnan*et al.*, 2003 reported that there was an increased level in the haemoglobin content in *C.carpio* treated with *A.indica*.

The blood indices such as MCV, MCH and MCHC are particularly important for the diagnosis of anemia in most animals (Colesh, 1986).Aruldoss*et al*., 2014 stated that MCV, MCH, MCHC were significantly higher in *O. mossambicus*treated with *C. dactylon*.

Conclusion

In the present study, the raise in the haematological parameters in the experimental fishes were mainly due to the direct action of components present in the plant leaves. So this study proves the possibilities of using these plant leaves as immunostimulants.

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Nutritional value and oil yielding capacity of the seeds of *Holoptelea integrifolia*, Planch.; (Family-Ulmaceae)

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Minerals are inorganic compounds needed for the body to regulate chemical reactions and maintain structures. Medicinal plants are said to have high nutritive value and as a result of that they are prescribed for their therapeutic values. Medicinal plants contribute major part in the economic value of India. The seeds of *Holoptelea integrifolia* are rich source of minerals and oil. Phytochemical screening was carried out on the oil extract. The study revealed that the terpenoids and saponins are present and flavanoids and alkaloids, phenols, tannins, glycosides, anthraquinones, carbohydrates and proteins were completely absent. Total mineral content of the seeds were determined by the standard methods. Minerals analysis of the seeds reveals that the presence of phosphorus, potassium, calcium, magnesium, sulphur, copper, iron and zinc. The quality and quantity of the oil in the seeds of *Holoptelea integrifolia* clearly suggest that the oil yielding capability of this plant can fulfill the future demands of the edible oil in the country and seeds are also balance our nutrition. The aim of the present study was to investigate the presence of nutritional value and to determine the oil yielding capacity of the seeds of *Holoptelea integrifolia*. Seed oil was extracted by n-hexane solvent by using Soxhelt apparatus.
Key words: seeds, n-hexane, phytochemical, minerals.

INTRODUCTION

India is rich in two levels of biodiversity, namely species diversity and habitat diversity. In India, thousands of species are known to have medicinal properties and the use of different parts of several medicinal plants to cure specific aliments has been in vogue since ancient times. Herbal medicine is still in the run of about 75 – 80% of the whole population, mainly in developing nations. For primary health care because of (Mahalingam *et al*., 2011) better cultural acceptability with the human bodies, it reduces side effects. Sixteen nutrient elements are essential for the growth the reproduction of plants. Nutrients are classified in to two types a) macronutrients and b) micronutrients. Carbohydrates, fats and proteins are usually called macronutrients. Minerals and vitamins are micronutrients. The vitamins and minerals are equally important to our well being although they are needed in very small quantity. Nutrients are substances derived from food during the process of digestion. A nutrient is a chemical that an organism needs to live and grow or a substance used in organism metabolism which must be taken in from seeds (Ezeagu Ikechukwu, 1996).

MATERIALS AND METHODS

Study Area: (Plate-1 and 2)

Tamilnadu is one of the 29 states in India. Its capital is Chennai, the largest city. Tamilnadu is bordered by the union territory of puducherry and the states of Kerala, Karnataka and Andhra Pradesh. It is situated in the southern most part of the Indian peninsula. Coimbatore is the city in Tamilnadu, South India. The Nirmala College is situated in the district of Coimbatore, which has a salubrious climate due to the presence of forests to the north and the cool winds blowing through the Palakkad gap in the Western Ghats. The college campus is pollution free and eco-friendly. It is filled with trees and has a rich Botanical garden. Temperature of the study area was 28^0 C.

Plate-1: Location Map

Plate-2: Study Area

Collection of the Sample

The seeds of *Holoptelea integrifolia* were collected from Nirmala College, Coimbatore. For the present study Holoptelea integrifolia, Planch.; is selected in Nirmala College campus to find out the qualitative phytochemical and mineral profile of seed of Holoptelea integrifolia were analysed. Leaves were collected in the month of January and seeds were collected during the month of April. The data were then processed and represented in tables and chart.

Plate-3: Habit of *Holoptelea integrifolia*

Systematic position

Division : Phanerogams
Class : Dicotyledons
Order : Urticales
Family : Ulmaceae
Genus : Holoptelea
Species : *H.integrifolia*, Planch.;

Holoptelea integrifolia, Planch.; is a native to Asian-tropical region including India, Nepal, Srilanka, Cambodia, Laos, Myanmar, Vietnam and china. It is a large deciduous tree. It has spreading branches and grows up to 30 to 35m height and 3m girth. Bark is whitish, yellow, grey, covered with blisters, peeling in corky, exfoliate with regular intervals. Leaves are simple, alternate, elliptic ovate, entire glabrous with cordate base, acuminate, nerves 5-8pairs, 5-13cm long and 3.2 to 6.3cm wide. The bark when cut and the leaves when smashed emit an unpleasant smell. Flowers are polygamous greenish yellow to brown in short racemes or fascicles. In bisexual flowers, 5 stamens and in male flowers, 8 stamens are present, basally adnate to tepals, ovary is unilocular and stalked, style very short and its length is 2.5 to 4mm; stigmas 2 in number. The flower appear at the scars of fallen leaves on the tree, from February to March. Fruits are, light brown, obliquely elliptic or orbicular, one seeded samara winged and stalked, indehiscent, 2.5 to 3.5cm long 1.5 to 2.5cm wide. The plant produces a large number of fruits in the month of

April-May. It is used traditionally for the treatment of inflammation, gastritis, dyspepsia, colic, intestinal worms, vomiting, wound healing, leprosy, diabetes, hemorrhoids, dysmenorrhoea and rheumatism. Bark and leaves are used as better astringent, thermogenic, ant-inflammatory, digestive, carminative, laxative, anti-helmintic, depurative, repulsive urinary astringent and in rheumatism.

PREPARATION OF PLANT EXTRACTS:

The collected seeds were washed with running tap water followed by sterilized distilled water and were air dried at room temperature in laboratory for 50-60 days. The dried seed materials were powdered by using an electric blender and then stored in air tight containers until further use. N-hexane was used for extraction. 45g of leaf powder packed with a Whatman filter paper. It is placed into the thimble of a soxhelt apparatus and extracted using N-hexane. Appearance of the colourless solvent in the siphon tube was indication of exhaustive extraction and based on that further extraction was terminated. The extracts were then transferred into the previously weighed empty Petri dishes and allow evaporating the solvent. The oil extracts is finally obtained.

I. PRELIMINARY PHYTOCHEMICAL ANALYSIS

The phytochemical screening of methanol extract of analysed by standard methods and shown various phytochemical constituents such as saponins, phenols, alkaloids, protein, tannins, flavonoids, carbohydrates and terpenoids (Harbone, 1984 and Wagner *et al*., 1984).

II. ANALYSIS OF MINERAL PROFILE

The minerals like phosphorus, potassium, calcium, magnesium, sulphur, copper, iron and zinc were estimated in the standard laboratory by employing Atomic Absorption Spectrophotometer, the results were recorded by following the methods of Issac and Johnson (1975).

RESULTS AND DISCUSSION

Phytochemical compounds are analysed in the oil of the seed of *Holoptelea integrifolia*. The study reveals that the oil extracts of *Holoptelea integrifolia* seeds are showed the high presence of terpenoids but adequately saponins, flavanoids, alkaloids, phenols, tannins, glycosides, anthraquinones, carbohydrates and proteins were completely absent. The detailed investigations of phytochemicals in n-hexane solvent are showed (Table-1). The seeds contain high percentage of oil which can be an alternative source of edible oils. The seeds contain about 50% oil having palmitic and oleic acids. Seeds are easily available and it has the capacity to produce oil seeds for a longer period of time. The result indicates that production of edible oil in India increases and reduces dependency of the country on importing edible oils from other countries. The plant extracts shows the consist saponins which are known to produce inhibitory effect on inflammation (Just *et al*., 1988). Saponins have the ability of precipitating and coagulating red blood cells. Some of the notable characteristics of saponins include formation of foams in aqueous solutions, hemolytic activity, cholesterol binding properties and bitterness (Sopido *et al.*, 2000 and Okwu, 2004). Potent water-soluble antioxidant and free radical scavenger, flavonoids are also present, which prevent oxidative cell damage and also have strong anticancer activity (Rio et al., 1997 and Salah *et al*., 1995). Nutritional analysis of the seeds of Holoptelea integrifolia reveals that the seeds contain nitrogen (1.47%), phosphorus (948.0 mg), potassium (813.0 mg), calcium (632.0 mg), magnesium (108.0 mg), sulphur (28.50 mg), copper (0.22 mg), iron (9.87 mg) and zinc (3.50 mg). Evaluation of mineral profile of these seeds

extracts was recorded (Table- 2). Proximate and ultimate analyses of plant seeds were done. Oil from the seeds was extracted by solvent extraction method. Micro-nutrients viz., Ca, Mg, Fe, Zn, Cu etc. were determined atomic absorption spectrometry and P was determined by phosphor molybdate method AOAC. The results of the present analyses are showed (Table-2). These seeds are excellent sources of nitrogen, phosphorus, potassium and iron but poor sources of copper, magnesium and zinc. The high contents make these seeds attractive as a natural source of calcium supplementation for pregnant and lactating women, as well as for children and the elderly people. The amount of minerals we needs is actually very small- much smaller than the amounts of carbohydrates, proteins and fats required for a healthy diet. Most adults need about 1000 milligrams of calcium per day (IOM, 2011), but only about 10 to 15 milligrams of iron and zinc per day (IOM, 2001). Recommended Dietary Allowance (RDA) and adequate intakes (Al), the daily intakes that should meet the needs of most healthy people.

Table-1: Qualitative analysis of phytochemical constituents present in the n – hexane extract of the seeds of *Holoptelea integrifolia*

S.No	PHYTOCHEMICAL CONSTITUENTS	N-HEXANE
1	Alkaloids	-
2	Flavonoids	+
3	Saponins	++
4	Phenols	-
5	Tannins	-
6	Glycosides	-
7	Anthraquinones	-
8	**Terpenoids**	**+++**
9	Carbohydrates	-
10	Protein	-

Table - 2: Mineral analysis of the seeds of *Holoptelea integrifolia*

S.No	Parameter	Results	Daily Value
1	Potassium	813.0 mg	3,500 mg
2	**Phosphorus**	**948.0 mg**	**1,000 mg**
3	Calcium	632.0 mg	1,000 mg
4	Sulphur	28.50 mg	980 mg
5	Magnesium	108.0mg	400 mg
6	Iron	9.87 mg	18 mg
7	Zinc	3.50mg	15 mg
8	**Copper**	**0.22 mg**	**2mg**

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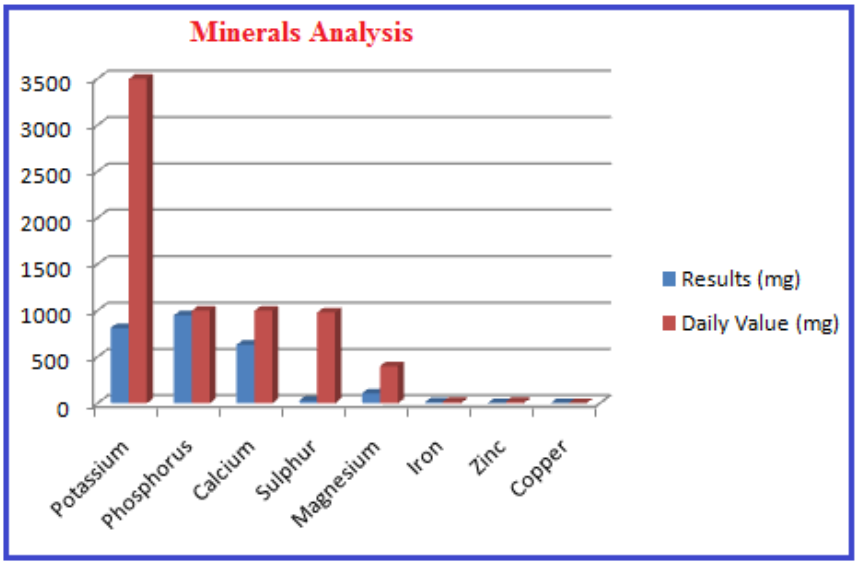
Chart- Mineral analysis of the selected sample



Conclusion

Good nutrition has plays a major role in human survival. Under-nutrition is often a major problem in most of the developing countries of the world. Consequently the cases of under-nutrition are common in these countries. Nutrients e.g. oils, fats, carbohydrates, proteins etc. are substances derived from food during the process of digestion. A nutrient is a chemical that an organism needs to live and grow or a substance used in organism metabolism which must be taken in from seeds. Plant seeds have been reported to contain oils and fats, carbohydrates, proteins, amino acids, vitamins and minerals with good nutritive value. These seeds are easily available in our common peoples. These seeds included daily diet; they can change their nutritional deficiency. The seed contains all the macronutrients and micronutrients. The results revealed the presence of oil yielding capacity and minerals of the seeds studied. Therefore, oil extracts from these seeds could be used as edible oil.

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A STUDY ON COMPARISON OF STOMATAL TYPES IN DICOT AND MONOCOT LEAVES COLLECTED FROM THE COLLEGE CAMPUS

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In Botany stomata is a tiny opening or pore that is used for gaseous exchange they are mostly found on the under surface of plant leaves. In a stoma there is the chloroplast, cell wall, a vacuole cell nucleus. Air enter the plant through this opening the CO_2 is used in the photosynthesis some of the O_2 produced is used in respiration. Surplus O_2 exit trough these same opening also water vapour goes into the atmosphere through these pores in transpiration. The pore is formed by a pair of cells known as guard cells. These adjust the size of the opening by a opening or closing. To open a guard cell, proton (H+) are jumped into guard cell. Water enters in to them, the cells get hard and they push opens

INTRODUCTION

Plants have certain opening on the outer and lower surface of the leaves that allow water to escape are called stomata. They are usually found on the underside of the leaves to reduce excess water loss and they are surrounded by guard cells that open and close the pores. stomata release water their main purpose is to exchange of gases. Plants need to breathe CO_2 from the atmosphere in order to photosynthesize or change into usable chemical energy. They also need to release O_2 back into the atmosphere as a waste product of cellular process. This gas exchange occur through the stomata and while this happens, some water is lost from the plants. Stomata are small force present in the epidermal cells of leaves in plants. Stomata during are open during the day and close during the night. Stomata take in CO_2 required for the photosynthetic activity the day. They give out excess water released in the process of respiration during night along with CO_2.Openig and closing of stomata is controlled by concentration of solute in guard cells.

Solute from neighbouring epidermal and mesophyll cells enter the guard cells lowering its osmotic and water potential. This lowered water potential and osmotic potential will allow movement of water in guard cell from neighbouring cell. Guard cell become turgid and swell in size resulting in the stomata opening due to water accumulation in them.

As the stomata open the solute concentration is reduced. This make the water from the guard cell to move away in to the neighbouring cell and making them flaccid with no water. They collapse against each other and result in the closing of stomata.

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Blue light causes stomatal opening where red light has no effect at all. stomata open in the presence of blue light cause movement of potassium ions. Stomata open in the presence of light and closed in darkness. Light intensity required to open the stomata in very low as compared to the intensity required for photosynthesis. In CAM (Crassulacean acid metabolism) plants stomata open during dark and remained closed during the day even moonlight is sufficient to keep the stomata open is some plant species. Rise in Temperature induces stomata opening while fall in Temperature caused its closing. At 38 ^{0}C to 40 ^{0}C, stomata open even in darkness. In some plant species, stomata remain closed even under continues light at 0^{0}C. Low concentration of CO_2 induces stomata opening and high concentration induces its closure. O_2 is essential for stomatal opening. Water stressed plant induces stomata closure due to the formation of Abscisic acid (ABA) and lowering of water potential in epidermal cells. Influx of potassium ions caused opening of stomata while efflux of potassium ions from guard cell caused closure of stomata. Mechanical Shock causes closing of stomata. ABA brings about closure of stomata and cytosine is required for keeping the stomata open. Deficiency of certain mineral element like Nitrogen, phosphorus and potassium has some effect on the opening and closing of stomata. The aim was to study different types of stomata found in selected Monocot and Dicot leaves, and to compare the type of stomata.

MATERIALS AND METHODS

The leaves of dicot and monocot plant were collected from the college campus (Nirmala College for Women, Coimbatore). The collected leaves were washed using distilled water, then peeled off and stained it using safranin, then observed in a trilocular microscope. The observations were recorded.

PLANT DESCRIPTION

1) Tradescantia spathacea sw

Plant Family : Commelinaceae

Plant Form : Herb:

Habit : A short-stemmed low herb.

Leaves : Densely imbricated, long, narrow-lanceolate, base vaginate, steel blue and red-brown or purplish below.

Inflorescence : Umbel

Flowers : Flowers many in a dense umbel

Fruit : A capsule

2) Epiprenum pinnatum (L) Engl.

Synonyms : *Monstera dilacerata* (K. Koch & Sello) K. Koch, *Pothos pinnatus* L.

Common Name : Tonga Vine, Variegated-Philodendron, Surpankha, Dragon Tail Plant

Plant Family : Araceae

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Plant Form : Climbers Habit : An ever green climber with long slender stems.

Leaves :Shiny, heart-shaped, pinnately-lobbed into regular segments.

Small pores are also along mid-rib.

Inflorescence : Spathe

Flowers : Green flowers generally produced during summer

3) Pancratium triflorum (Roxb)

Habit : Pankusum is a herb, 30-40 cm tall, arising from a bulb. Bulb is spherical, 4-5 cm, without a neck

Leaves: Thin linear-lancelike leaves, 20-45 cm long, arise with the flowers. The scape (stem carrying flowers) is slender, 15-23 cm tall, flattened, with longitudinal lines. Stalkless flowers : arise in an umbel of 3-8 flowers, enclosed in a spathe.

Flowers: white, 4-5 cm across, fragrant. Petals are narrow, linear, 2-3 cm - tube is 3-5 cm long. The cup holding the stamens is small, with teeth divided into two, between short filaments. Anthers are prominent and yellow.

Fruits: are ovoid, 3-angled. Flowers open at night, fade by morning. Flowering: May-June.

DICOT PLANTS

4) ***Hibiscus rosa –sinensis L***

Common name : Shoe-flower

Family: Malvaceae

Habit : shrub, it is an ornamental evergreen shrub having branched tap root system.

Stem: woody and solid but herbaceous at upper portion, aerial, erect, branched, cylindrical, solid and glabrous.

Leaves : simple, alternate, serrate, ovate, unicostate reticulate venation.

Fruit : drupes globose.

5) *Euphorbia tetraphylla* L.

Family : Euphorbiaceae

Habit : annual perennial herb, shrubs, tree, most of the plants are xerophytic

Stem : herbaceous and fleshy ; spiny

Roots : tap root

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Leaves : sessile,or petiolate; alternate, simple

Inflorescence : cyathium

Flower : regular, actnomorphic, hypogynous, unisexual

Fruit : shizocarpic fruit regma, rarely capsule

Seed : endospermic

6*) Santalum album* L.

Family : santalaceae

Habit : small evergreen glabrous tree with slender drooping branches with sap wood white and odourless, heartwood is yellowish brown

Leaves : elliptic-lanceolate, entire thin

Inflorescence : terminal and axillary paniculate cyme

Flower : complete actinomorphic, hermaphrodite, hypogynous

RESULT AND DISCUSSION

Table 1- Types of Stomata

S. No	Name of the plant	Family	Type of Stomata
1	*Epiprenum pinnatum* (L)engl	Araceae	Paracytic
2	*Pancratium triflorum* Roxb	Amaryllidaceae	Paracytic
3	*Tradescantia spathacea* S	Commelinaceae	Paracytic
4	*Hibiscus rosa-sinensis* L.	Malvaceae	Anomocytic
5	*Euphorbia tetraphylla* L.	Euphorbiaceae	Anomocytic
6	*Santalum album* L.	Sandalaceae	Anomocytic

Fig 1 –Monocot Leaves

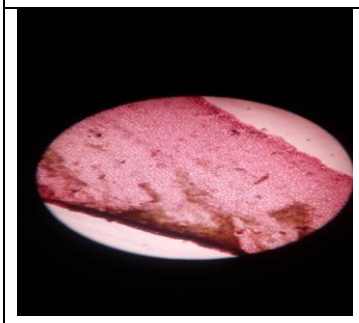
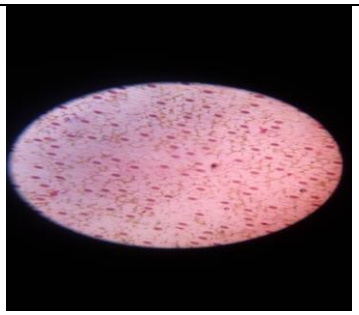
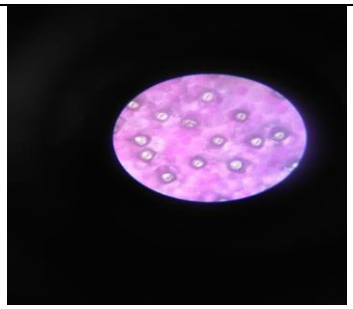
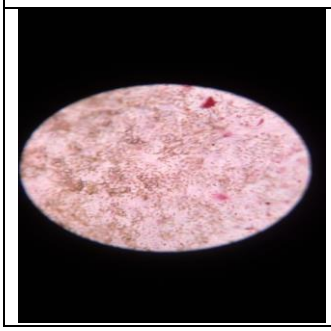
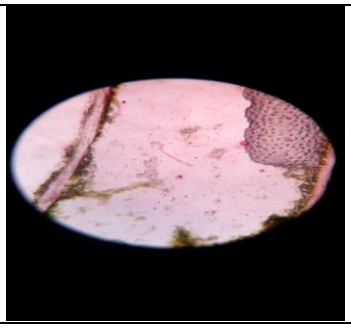
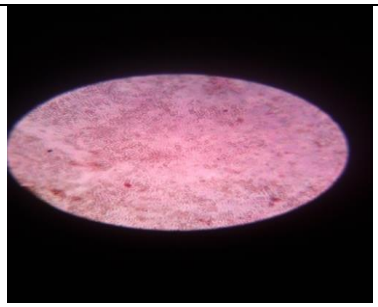
MONOCOT LEAVES		
Epiprenum pinnatum Type of stomata : Paracytic	***Pancratium triflorum*** Type of stomata : Paracytic	***Tradescantia spathacea*** Type of stomata : Paracytic
		

Fig 2 –Dicot Leaves

DICOT LEAVES		
Hibiscus rosa-sinensis Type of stomata : Anomocytic	***Euphorbia tetraphylla*** Type of stomata : Anomocytic	***Santalum album*** Type of stomata : Anomocytic
		

From the microscopic observation of the peelings of the leaves collected from college campus, all the monocot leaves showed paracytic type of stomata. All the dicot leaves posessed anomocytic type of stomata.

Summary

The study was conducted to find out the types of stomata found in some of the dicot and monocot leaves. Dicot leaves showed Anomocytic and monocot leaves showed paracytic stomatal type.

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Indigenous Knowledge on medicinal plants used by the Kota Tribes of Sholur area, Nilgiri District, Tamil Nadu, India

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An ethanobotanical survey of medicinal was carried out among the ethinic group of Kota tribes in Sholur, Nilgiri district, Tamil Nadu. The plants were collected and identified using Floras. Herbarium were prepared and deposited in the Department of Botany, Nirmala College for Women, Coimbatore. The ethanobotanical data were collected from 23 traditional healers in the area of Sholur of Nilgiri District by means of questionnaire focusing on the local names of the medicinal plants. The survey identified 35 medicinally important plants from 28 families and 33 genera. The most often recurring ailment treatment by the healers was anemia, bone strengthening, burns, diabetics, fever, kidney stone, tooth ache, piles, snake bite, urinary infection, wound healing, obesity, head ache, vomitting, skin allergy and sprain. The habit revealed that about 36% of Herbs and 31% of shrubs, 29% of tree and 4% of Climbers were used as remedial plants. The reported potentially important medicinal plants are to be considered for further validation and to be conserved for further utilization.
Key Words: Ethanobotany, Diabetics, Kota tribes, Sholur,

INTRODUCTION

India is one of the richest floristic region of the world and has rich source of plant products and many of these plant species is used for medicinal purpose (Sudeesh, 2012). The Western Ghats of India is one such high bio-cultural variety region, which is one of the global biodiversity hot-spots (Myers *et al*., 2000). In recent times studies on ethanobotany gaze at the

primitive tribes in the region. Every tribal community in the world has a unique sense and knowledge that they develop from birth (Rajan and Sethuraman., 1991.) They subside on food such has Milk, honey, fruits and tubers besides other variety of cereals. Tribal population provides abundant knowledge about the uses of plants and their plant parts as medicine.

An extensive understanding of the concept involves and indirect interaction between the plants and people. The use of herbal medicine in Asia represents a long history for mankind. Plants used for traditional medicine that can be used to treat chronic as well as infectious diseases. Only the tribal people have got the vast knowledge of using plants against different illness that will be supportive to the biological system. The present work is focised to document and analyze the traditional knowledge regarding the practice and the use of plants in treatment of various disorders.

Study area

Sholur is a panchayat town in the Nilgiri District of Tamil Nadu located at the altitude of about 1980 meters above mean sea level. This village consists of six small hamlets named Ooratty, Kotatty, Bickaikkandy, Hosatty, Thattaneri and Backodai. The place is covered with large area of grassland and patches of thick forest vegetation which habitats wild animals as Tiger, Panther, Black Panther, Elephant, Deer, Bear, Bioson, Nilgiri thar, small fishes, frogs, crabs, water spiders etc.

Kota Tribes

Kotas are said to be the oldest inhabitants of Nilgiri District. They are distributed in several areas in and around Nilgiris *viz* Kothagiri, Kundha, Sholur, Kokkal, Gudalur and Trichigadi. These people have their own unique Kota language and they are living in forest area in habitat of wild animals and they are able to sense the smell of the animals nearby or on the way. They have been maintaining their life style as a jack of all trades such as potters, agriculturalist, leather workers, carpenters and black smith. They build their houses inside the shola forest on the patches of grasslands.

METHODOLOGY

Data Collection: The ethanobotanical field survey was conducted during February 2017-September 2018 with the help of the knowledgeable local healer. For authentication and proper verification of the plants some of the tribal inhabitants were taken to field.

The collected plant specimens were identified with the help of the local floras: Flora of British India (Hooker, 1875 – 2006); Flora of the Presidency of Madras (Gamble and Fischer, 1915 - 1936); Flora of Tamil Nadu (Nair and Henry, 1983; Henry *et al*. 1987, 1989; An Excursion flora of Central Tamil Nadu, India (Matthew, 1991); Flora of Tamil Nadu Carnatic 1983.

The specimens were then poisoned, pressed and labeled by standard herbarium method (Santapau, 1955; Fosberg and Sachet, 1965). The correct identity of the herbarium specimens were then confirmed by further critical study with the help of authentic specimens deposited in the Madras Herbarium (MH), of Botanical Survey of India (BSI), Southern Circle, Coimbatore. Descriptions were made from the fresh materials. Vegetation types and many interesting plants were photographed, important observations and any other relevant field data were noted in the field itself.

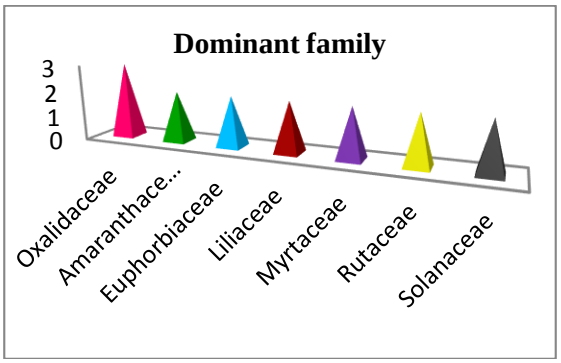
Ailment category

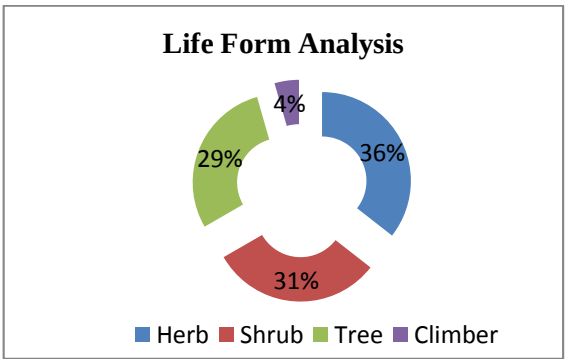
Based on the information obtained from the traditional healers of the study area, all the reported ailments were categorized to cure various disorders such as kidney stones, cancer, circulatory system, dermatological infection, endocrine disorders, eye infection, fever, piles, snake bite, respiratory system disorder and skeleto muscular system disorder.

Results and Discussion

Documentation of indigenous Ethnomedicinal knowledge

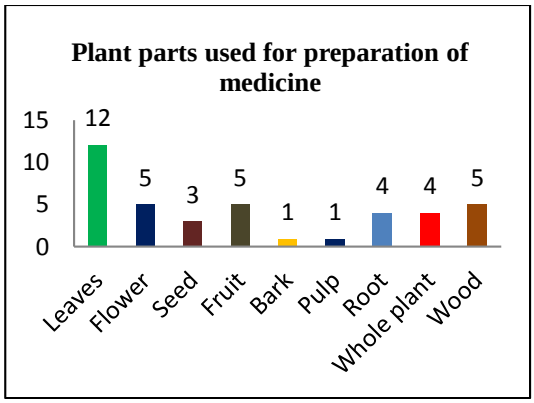
During the study it was noted that 35 plant species belonging to 28 families and 33 genera were documented and are used as herbal remedy for the treatment of several ailments (Table 1). Oxalidaceae family was the most commonly used plant family representing 3 plants species followed by Amaranthaceae, Euphorbiaceae, Liliaceae, Myrtaceae, Rutaceae and Solanaceae with 2 species and other families were represented by single species (Fig 1).

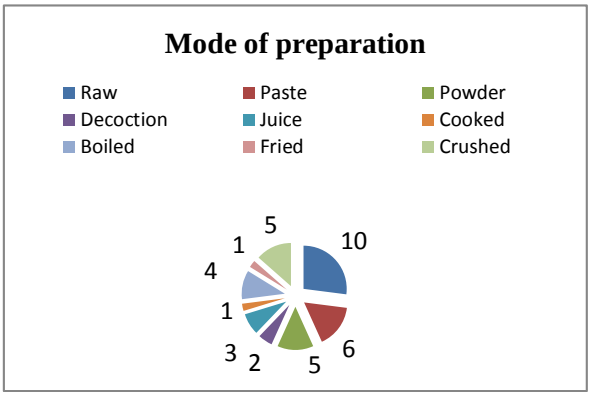




Life form and parts used

Amoung the collected plants species 36 were herbs, followed by 31 shrubs, 29 Tree, and 4 climbers (Fig 2). Kalaiselvan and Gopalan (2014) has reported 28 plants belonging to 23 families of which they have resulted herbs to the dominant life form used by the Irula tribes of Bolampatty village, in Nilgiris. It is found that the most widely used medicine preparation part is leaves (12), followed by flower, fruit, wood (5), seeds (3), Root, whole plant (4), pulp and bark (1) Fig 3. It is also reported that leafy crude drug preparation is mostly recommended in ethanic medicine followed by flower, fruit, wood, root, whole plant, pulp bark and seeds. The same findings has been reported by Maria *et al*. (2014) and they weer studied about traditional knowledge of in Paliyar tribes leaves were most frequently used in preparation of medicine.





Method of preparation and mode of administration of plants

The preparation and usage of plant parts were categorized as raw 27% followed by paste 16%, crushed 14%, powder 13%, boiled 11%, cooked 3%, Decoction 5 and juice 8% and fried 3% (Figure 4). The decoctions were prepared by boiling the plants in water and the water level reduce to about required amount. Most of the fruits and vegetable that are edible are intaken raw by the tribal people living in the area. The preparation of decoction is one of the common ailment practices among some tribal in Tamil Nadu (Thirumalai *et al.*, 2012). The paste was prepared by grinding the fresh leaves in water or milk.

Ingredients added

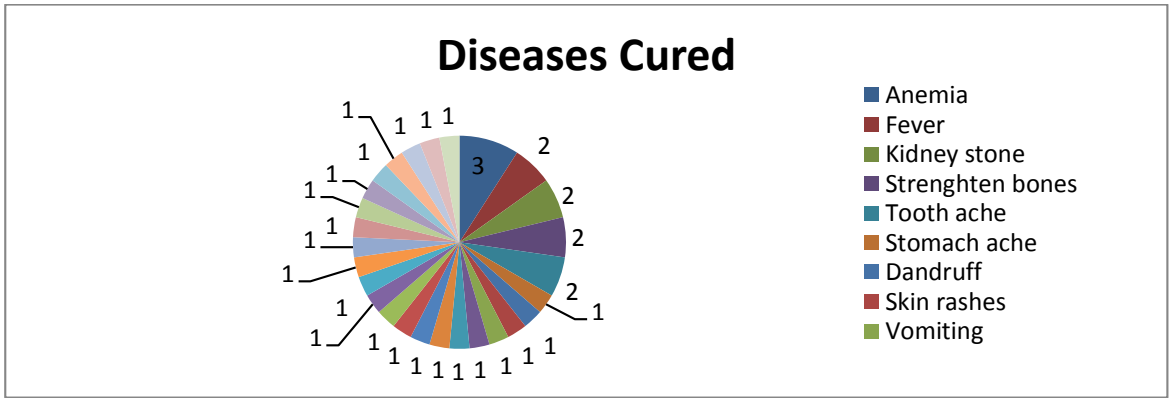
The medicines were prepared by the Kota tribal healers by adding more than one plants and other ingredients such as honey, goat milk, coconut oil, mustard oil, salt, pepper, Fenugreek, turmeric, onion, thulsi and sand to improve the tolerability and medicinal property of certain remedies (Table 2). Xavier *et al.* (2014) have been supported the present findings. Honey and Goat milk are used while intake of prepared medicine in powder and juice. Oral medicines are prepared mostly using water, goat milk, honey based on the needs.

Table 2: Ingredients added while preparation of medicine.

S.No	Botanical Name	Other plants added in medicinal preparation	Other ingredients added
1	*Anona squamosa*	Fenugreek	-
2	*Ruta graveolens*	Turmeric and thulasi	-
3	*Biophytum sensitivum*	Turmeric	-
4	*Andrographis paniculata*	Onion	Coconut oil
5	*Ricinus Communis*	-	Sand
6	*Mimosa pudica*	-	Honey
7	*Citrus limon*	-	Salt
8	*Althernanthera sessilis*	Onion	Mustard oil
9	*Cardiospermum halicacabum*	Pepper	-
10	*Curcilogo orchioides*	Pepper	Goat milk
11	*Psidium gujava*	-	Salt
12	*Urena lobata*	*Aloevera*	-

Ailment categories

On the bases of the information gathered from the tribal healers in the study area all the reported ailments were categories *viz.*, kidney stones, cancer, circulatory system, dermatological infection, endocrine disorders, eye infection, fever, piles, snake bite, respiratory system disorder and skeleto muscular system disorder (Fig 5). Based on the report submitted by Lakshmana and Sreenath, (2014) medicinal plants such as *Andrographis, Butea monosperma, Curcuilogo orchiodes, Gloriosa superb, Strachy nux-vomica, Mimosa pudica* and *Ruta graveolens* are used as Phyto-Antidotes. Ramesh and Kumud (2015) have reported about 33 plants that are useful in treatment of various health disorders and stated that the traditional knowledge is only handed over orally from generation to generation.



Conclusion

The traditional knowledge of medicinal plants is becoming vanished as there is no written material. Some medicinal plants are vanishing in alarming rate due to over exploitation, harvesting, trade value, grazing, industrialization learning of forest for agriculture, Megaprojects and anthropogenic influences. Thus the documentation of traditional medicinal plant is important.

Andrographis paniculata

Solanum sisymbrifolium

Solanum nigrum

Kalanchae pinnata

Leucas aspera

Oxalis corniculata

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Anti-Atherosclerotic activity of 7, 3', 4'-Trimethoxy Quercetin from *Solanum incanum* – A Molecular Docking approach

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[2] Assistant Professor in Bioinformatics, Nirmala College for Women, Coimbatore

Medicinal plants are potential sources for the development of novel drugs with no adverse effects. Plants have free radical scavenging molecules, including flavonoids, phenols, anthocyanins and vitamins, which show antioxidant activity. Earlier studies show that secondary metabolites of phenolic nature including flavonoids are responsible for a variety of pharmacological activities. Flavanoids are polyphenolic compounds which are one of the abundant secondary metabolites in plants. Flavonoids consist of a large group of polyphenolic compounds having a benzo-γ-pyrone structure and are ubiquitously present in plants. In the present study, a flavonoid namely 7, 3', 4' -Trimethoxy Quercetin identified in the methanolic extracts of the fruits of *Solanum incanum* was tested for anti-atherosclerotic activity by molecular docking approach.

Keywords: Autodock, Herbal Drugs, Atherosclerosis

1. Introduction

Solanum incanum (L) is one of the important traditional medicinal plant belongs to Solanaceae family and it is one of about 1,500 Solanum species in the world. It is also known as the bitter garden egg. It is perennial bushy herb or shrub up to 1.8m of height with spines on the stem, leaves, stalks and calyces and with velvet hairs on the leaves (Sambo *et al*., 2000).

Flavonoids are hydroxylated phenolic substances which are known to be synthesized by plants in response to microbial infection (Dixon *et al*., 1983). Their activities are structure dependent. The chemical nature of flavonoids depends on their structural class, degree of hydroxylation, other substitutions and conjugations, and degree of polymerization (Kelly *et al*., 2002). Recent interest in these substances has been stimulated by the potential health benefits arising from the antioxidant activities of these polyphenolic compounds.

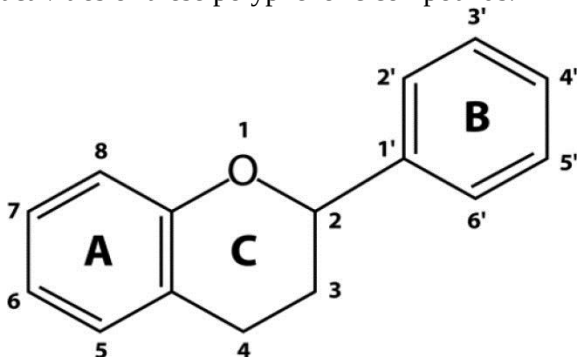

Fig 1: General Structure of Flavonoid

Atherosclerosis is a condition in which the arteries are narrowed due to Cholesterol plaques. Oxidative modification of low-density lipoproteins (LDL) by free radicals is an early event in the pathogenesis of atherosclerosis. The rapid uptake of oxidatively-modified LDL via a scavenger receptor leads to the formation of foam cells. Flavonoids may directly scavenge some radical species by acting as a chain breaking antioxidant. The ability of quercetin and the

quercetin glycosides to protect LDL against oxidative modification has shown a significant protective effect (Fuhrman *et al*., 1995). Furthermore, a Japanese study reported an inverse correlation between flavonoid intake and total plasma cholesterol concentrations (Arai *et al*., 2000).

2. Methodology

Molecular Docking was performed using autodock by following the below protocol:

2.1 Preparation of Receptor and Ligand files

Autodock entails both the receptor and ligand in PDBQT format for assessing the binding affinity between them. PDBQT format restrains the atomic coordinates, partial charges and atom types. Initially, the receptor file in PDB format obtained from Protein Databank was accessed in Autodock Workspace. The water molecules in the receptor file were removed and implicit Hydrogen atoms were added. Finally, partial charges were added and the receptor file was saved in PDBQT format. Similarly, the ligand files in PDB format was retrieved by Autodock and saved in PDBQT format.

2.2 Preparation of Grid and Dock Parameter files

Autogrid 4.2 program in ADT was used to perform the grid computation. The grips maps with a dimension of 90X90X90 and spacing of 0.375 A^{o} were centered along the ligand binding site. For each type of receptor, adjustments were made in the grid dimensions to select its active site for binding. The receptor and ligand files in PDBQT format along with the grid maps were saved as the grid parameter file to execute the Autogrid program. After the autogrid calculation, autodock parameter file was created with the receptor, ligand and selection of autodock parameters.

2.3 Docking and Visualization

Docking was performed using Lamarckian Genetic Algorithm with 10 independent runs per ligand with an initial population of 150 randomly placed ligand on the receptor binding site.

A maximum of $2.5X10^5$ evaluations on the energy will be carried out for $27X10^3$ generations with a mutation rate of 0.02 and a cross over rate of 0.80. The local-energy-minimization algorithm was limited to 100 steps for 6% of the population. To explore the conformational space of ligands, the overall translation steps was set to 0.2 Å, and the overall rotation and torsion rotation step were set to 5 in the docking studies. The autodock 4.0 program in ADT was executed and the docking scores were reported using binding free energy energies in kcal/mol. The bound complex with the receptor and ligand was visualized using Pymol.

3. Results and Discussion

The flavonoid present in the methanolic extracts of the fruits of *S. incanum* was identified using GC-MS analysis. 7, 3', 4' Trimethoxy Quercetin was the flavonoid present whose structure is presented in Figure 2.

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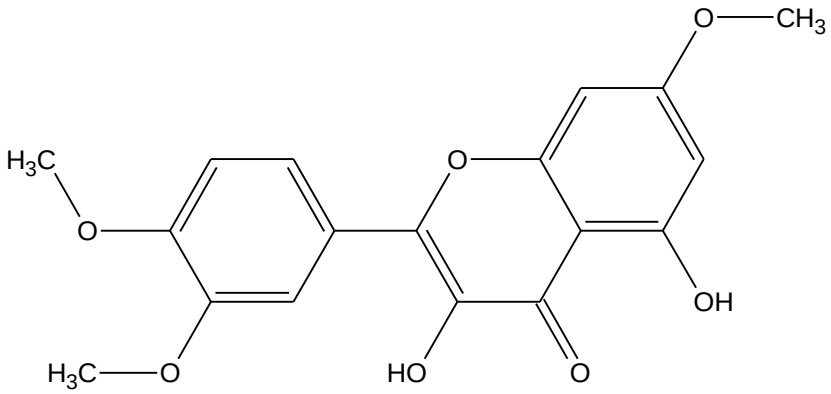

Fig. 2 Structure of 7, 3', 4'-Trimethoxy Quercetin

Macrophage migration inhibitory factor (MIF or MMIF), also known as glycosylation-inhibiting factor (GIF), L-dopachrome isomerase, or phenylpyruvate tautomerase is a protein in humans is encoded by the *MIF* gene. It is an important regulator of innate immunity and acts as an inflammatory mediator in rheumatoid arthritis. In addition, Zernecke *et al* (2008) demonstrated the involvement of macrophage migration inhibitory factor MIF in the inflammatory pathogenesis of atherosclerosis. Inhibiting MIF with small molecule inhibitors has been shown to interfere in its biological activity (Dickerhof *et al*, 2014). Hence, we attempted to dock MIF with 7, 3', 4'-Trimethoxy Quercetin and tried to compute its inhibition for treatment of atherosclerosis.

MIF 3D structure was retrieved from PDB with the PDB ID, 1CA7. Molecular docking was performed with MIF as receptor and 7, 3', 4'-Trimethoxy Quercetin as the ligand.

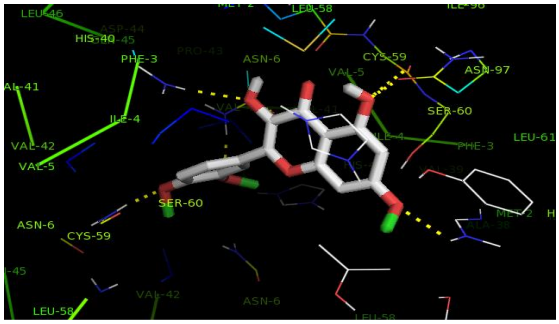

Fig 3: Docked conformation of Macrophage migration inhibitory factor(MIF) with 7,3',4'-Trimethoxy Quercetin

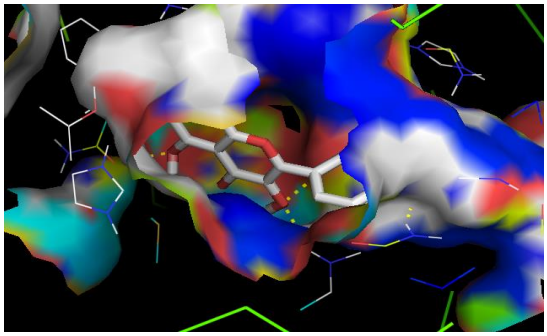

Fig 4: Surface representation of Docked conformation of Macrophage migration inhibitory factor (MIF) with 7, 3', 4'-Trimethoxy Quercetin

The results are tabulated in Table 1 and docking conformations are displayed in Figures 3 and 4.

Table 1 Docking results of Macrophage migration inhibitory factor (MIF) with 7, 3', 4'-Trimethoxy Quercetin for Anti-atherosclerosis activity

Pose	B.E	L.E	IC	Tot IE	No. of H bonds	Bonding formation
1	-6.14	-0.25	31.45	-1.9	1	ASN6:HD21
2	-6.03	-0.24	38.3	-1.92	1	ASN6:HD21
3	-6.0	-0.24	40.0	-1.9	2	A:ASN6:HD21 B:ASN6:HD21
4	-5.96	-0.24	42.44	-1.89	2	B:ASN6:HD21 C:ASN6:HD22
5	-5.92	-0.24	45.52	-1.88	1	B:ASN6:HD21
6	-5.77	-0.23	59.31	-1.89	1	C:ASN6:HD22
7	-5.65	-0.23	72.11	-1.89	1	C:HIS62:HE2
8	-5.65	-0.23	72.63	-1.86	0	-
9	-5.41	-0.22	108.02	-1.84	2	C:ASN6:HD22 C:TYR99:HH
10	-5.25	-0.21	142.79	-1.69	2	B:ASN6:HD21 B:HIS40:HD21

BE-Binding Energy; LE-Ligand Efficiency; IC-Inhibitory Constant; IE- Internal Energy;

Docking of 7, 3', 4'-Trimethoxy Quercetin with Macrophage migration inhibitory (MIF) resulted in 10 different docked conformations with binding energy ranging from -6.14 to -5.25kcal/mol. Among the 10 different docked conformations, Conformation 3, 4, 9 and 10 had 2 hydrogen bonds each with different binding energies. The best conformation having a binding energy of -6.14 kcal/mol showing one hydrogen bond were visualized in Pymol and the result is displayed in Figures 3 and 4. It can be concluded that 7, 3', 4' trimethoxy Quercetin can inhibit MIF thus aiding in the treatment of Atherosclerosis.

4. Conclusion

The present study which started with the aim to identify the pharmacological activities of 7, 3', 4' trimethoxy Quercetin present in the methanolic ripe fruit extracts of *Solanum incanum* has ended with suggesting potential leads against Atherosclerosis. Although, it is a preliminary study the results are promising towards a successful lead discovery. Further studies with 7, 3', 4' Trimethoxy Quercetin including Drug Likeliness, ADMET will enhance its application in the treatment of Atherosclerosis.

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A STUDY ON GROWTH AND PERFORMANCE OF MSMEs IN INDIA

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The paper reveals the growth and performance of MSMEs in India. A significant feature of the Indian economy since independence is the rapid growth of Micro and small enterprises (MSEs) sector, the then small scale industries (SSIs) sector. After attaining independence in 1947, the government of India had a great task for rapid industrialization of the country. In the industrial policy resolutions of 1948 and 1956, the small scale industrial sector was given a special role for creating additional employment with low capital investment. Now, the Micro, Small and Medium Enterprises sector has emerged as a highly vibrant and dynamic sector of the Indian economy over the last few decades and it is also recognized as the real engine of growth for the Indian Economy (Udaykumar Varma, 2011). The sector is highlighted as a breeding ground for entrepreneurship at the grass root level and continues to show dynamism in terms of employment generation, contribution to GDP and export earnings (Shyam Agarwal, Virbhadra Singh, 2011)
Keywords: SSI, MSMEs, entrepreneurs, etc.,

Introduction:

In India, small scale industries play an essential role in industrial economic development. This sector has been exhibiting a sound, stable and strong positive growth. By realizing the importance of this sector in the economic, industrial and social development of the country, the government of India has been encouraging, emphasizing and supporting the promotion of micro, small and medium enterprises since independence through deliberate policies such as protection from large scale industries, capital subsidies, differential tax treatment, reservation of specific items of production for small scale sector etc. Finance has been considered as the life blood of all the business and industrial activities. Timely and adequate credit is the most crucial input that can make micro and small enterprises sector more competitive. The increase in the competitiveness of small scale industry will also be determined by the availability and quantum of finance. The requirement of finance for SSI will be substantial considering its size, structure, growth pattern, need for its restructuring and technology development.

REVIEW OF LITERATURE:

- Chew R. et al (2008) has conducted study on the SME's of Singapore. The objective of this study was to appreciate the difficulties faced by small and medium enterprises (SMEs) in a small open economy such as Singapore where there is very little margin for comfort. The approach used for the purpose of study, was analytical and statistical in nature. Comparing key ratios over time to reinforce the findings was done. The study came out with the conclusion that SMEs in Singapore are price-takers in the product markets and they are also price-takers in the input markets. When there is substantial increase in costs, SMEs will be in trouble as they cannot pass the increased costs to the buyers of their products and services.
- Latha L.K et.al. (2009) has conducted the study on problems faced by small scale entrepreneurs. This study has been conducted with an objective of finding out the problems faced by small scale entrepreneurs of Nellore district and the opinions of entrepreneurs as to influential factors for the success of entrepreneurship. For the purpose of this study primary data had been used with the help of structured questionnaire and informal interview having sample size of 196 registered units of Nellore district. Analysis

has been done with the help of ANOVA and Z-test. – It was found that high price of raw materials, lack of marketing information and marketing of products are major problems faced by the entrepreneurs, followed by competition from small industries and absenteeism of labour. The majority (about 90.3 per cent) of the respondents did not want to make any complaint to government agencies.

- Sharma R. (2012) has conducted her research on the problems and prospects of small scale industrial units. The study has been conducted with the objective to examine the policies and practices relating to small scale industrial units. To find out the differences between problems and prospects of exporting and non-exporting units following policies and practices. To identify the gaps in those practices which have failed to receive acceptance and to specify the problems in the existing practices of exporting and non-exporting units. It was descriptive research design. The data had been collected from 60 exporting and 240 non -exporting units for the purpose of the study. It has been found from the study that the major problems faced by exporting units are technology up gradation, marketing efficiency and negotiations on terms of payment. Finance and technology up gradation are the problems faced by non-exporting units also because they are facing competition from the large industries as well as from MNC's.
- Mohammad N.A (2008) The objective of the study was to demonstrate a comparative study of financing small and cottage industries (SCIs) by interest-free banks in different countries like Turkey, Cyprus, Sudan and Bangladesh. The objectives are achieved by analyzing data based on an institutional theoretical framework of references. The methodological approach used in the research is of qualitative nature. The research result shows that the lender–borrower network relationship, especially in case of financing rural-based SCIs by interest-free banks, differ from one country to the other even though the basic principles of interest-free financing remains the same
- Ramjaneyulu (2003) in his work "An Impact of Structural Adjustment Programme" on the policies of small-scale industries in India stressed the need to promote small enterprises. The main remarks of his presentation were to facilitate industries in rural backward areas and to promote stronger linkages between agriculture and industry. A new scheme of Integrated Infrastructural Development for small-scale industries should be implemented with the active participation of financial institutions. He also stressed the need for various policy reforms to boost these enterprises in the economy.

OBJECTIVE OF THE STUDY:

- To study about growth and performance of MSMEs in India.

RESEARCH METHODOLOGY:

The study is based on secondary data to find the growth and performance of MSMEs in India. The data were collected from the annual reports of MSMEs. It is collected from the year 2006-2007 to 2016-2017. The Annual Growth Rate and Compound Annual Growth Rate are used to find the growth year by year.

Compound Annual Growth Rate:[4]In order to find out the year to year growth rate of MSMEs in India during the study, the CAGR was calculated. The formula is,

$$CAGR = \left\{ \left[\frac{\text{End value}}{\text{Beginning value}} \right] \wedge \left(\frac{1}{\text{no of years}} \right) \right\} * 100$$

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Annual growth rate: To analyze the year to year change in the flow of growth inMSMEsin India, in this study annual growth rate was calculated. The formula is,

$$\text{Annual Growth Rate} = \frac{\text{Current year value} - \text{Previous year value}}{\text{Previous year value}} \times 100$$

ANALYSIS AND INTERPRETATION:

GROWTH AND PERFORMANCE OF MSMEs IN INDIA

SL.NO	YEARS	TOTAL WORKING ENTERPRISES (in Lakhs)	EMPLOYMENT (in Lakhs)	MARKET VALUE OF FIXED ASSETS (Rs. in Crores)
1	2006-07	361.76 (4.31)	805.23 (4.57)	868,543.79
2	2007-08	377.36 (4.33)	842 (4.61)	920,459.84
3	2008-09	393.7 (4.34)	880.84 (4.65)	977,114.72
4	2009-10	410.8 (4.36)	921.79 (4.70)	1,038,546.08
5	2010-11	428.73 (4.41)	965.15 (4.82)	1,105,934.09
6	2011-12	447.64 (4.45)	1,011.69 (4.91)	1,182,757.64
7	2012-13	467.54 (4.47)	1,061.40 (4.98)	1.268,763.67
8	2013-14	488.46 (4.53)	1,114.29 (5.12)	1,363,700.54
9	2014-15	510.57 (-1.78)	1,171.32 (-7.45)	1,471,912.94
10	2015-16	501.49 (26.40)	1084.11 (2.38)	1,996,642.10
11	2016-17	633.88	1,109.89	1,936,788.23
	TOTAL	**5021.93**	**10967.71**	**12,862,399.97**
	CAGR	**5%**	**3%**	**8%**

Sources: annual report of MSME.

INTREPRETATION:

It is clear from Table that the total number of working enterprises has increased from 361.76lakhs in the year 2006-07 to 633.88 lakhs in the year 2016-17 with the compound annual growth rate of 5 per cent. It was noticed from the table and worth mentioning that the number of persons employed in this sector rose from 805.23 lakhs in 2006-07 to 1,109.89 lakhs in 2016-17 with the CAGR of 3 per cent. The table also represents an increase in market value of fixed asset which rose from 868,543.79 in 2006-07 to 1,936,788.23 in 2016-17 with the CAGR of 8 per cent.

Conclusion:

Micro and Small Enterprises sector in particular essentially need adequate finance to flourish in their activities which in turn contribute to the economy in terms of Gross Domestic Product and providing employment opportunities. It was concluded from the study that the growth and performance of MSMEs in India shows a tremendous increase in growth among working enterprises, persons employed and in market value of fixed asset. In future MSMEs sector will play a major role for the developing countries like India.

Acknowledgement:

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THE IMPACT OF FOREIGN DIRECT INVESTMENT EQUITY INFLOWS TO INDIA IN SERVICE SECTOR

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The Foreign Direct Investment in India has undergone a drastic change since the economic reforms in 1991. The positive changes can be particularly attributed to the evolving policy framework. In 1991, Liberalization, Privatization and Globalization aimed at making the Indian economy a faster growing economy and globally competitive. Foreign investments gives the Indian industry a chance for technological up gradation, access to global managerial skills and practices, optimum utilization of human capital and natural resources, and to compete efficiently in the international market. FDI inflows to service sector have been phenomenal in the past few years. The service sector is not only the dominant sector in India's GDP, but has also attracted significant foreign investment inflows, contributed significantly to exports as well as provided large-scale employment. India's services sector covers a wide variety of activities such as trade, hotel & restaurants, real estate, business services, transport, storage & communication, financing, insurance, community, social & personal services and services associated with construction. The present paper highlights the impact of service sector in Foreign Direct Investment Equity Inflows to India in Service Sector.

Keywords: Foreign Direct Investment, Foreign Direct Equity Investment, Service Sector, GDP.

INTRODUCTION

India is one of the most stirring and promising market in the globe. Technical and skilled human resources are the finest available resources in the world. Due to economic crisis in 1991, economic environment at global level was changed. India recognized the need for advanced technology in science and business and therefore made a new economic policy in July 1991. Under new policy, restrictions for foreign Direct investment was liberalized, and consequently India started attracting foreign direct investments, joint ventures and collaborations. Before the introduction of economic reforms in the 1990's FDI inflows were concentrated in the manufacturing activities in India, which was due to the import substitution industrialization programmes that encouraged the tariff-jumping investments to capture the protected domestic market. However, the trends clearly changed towards an increase in FDI mainly in the service sector. The service sector is the key driver of India's economic growth. It is remarkable to mention that this sector has contributed 55% of India's GDP in 2018-19.

The services sector is one of the largest and fastest-growing sectors in the global market. Over the past two decades, the services sector has expanded rapidly and has come to play an increasingly important role in national economy and in the international economy. Services accounts for large shares of production and employment in most economies around the world. The structure of FDI worldwide has also shifted towards services. In the early 1970s, services sector accounted for only one quarter of the world FDI inflows. In the year 1990 the share was less than one half and by 2018, it has risen to about 70 per cent. India opens doors to foreign companies in the export-oriented services which could increase the demand of unskilled workers and low skilled services and also increase the wage level in these services.

REVIEW OF LITERATURE

Dr. Jonadankoner, Dr. Dipuyan Roy & Prof. Avinashpurandare (2018), the paper examined "The impact of FDI inflows on the services, constructions, trading, mining and agriculture sector in India. The data were analyzed through Hausman Test & Panel Regression Model and it was concluded that if the inflow of FDI increases then the growth of that sector will also be positive.

Jyoti Gupta, Dr. Rachna Chaturvedi (2017), the researcher analyzed "FDI inflows in India from 1991 to 2016 and to make predictions for next 5 years using least square method. Further FDI inflows were studied on the basis of top countries investing in India and the top sectors in which the investments are received. It was found that Mauritius alone contributed 33% of total FDI inflows to India. The top sectors receiving FDI inflows are services, construction development, computer software, telecommunications, automobile, drugs & pharmaceuticals, trading, chemicals, power, Hotel and tourism. The researcher concluded that some policy changes could be recommended so that India could attract still higher FDI inflows.

OBJECTIVES OF THE STUDY

- To study the impact of FDI equity inflows to India's service sector.
- To analyze the trend of FDI equity inflows in service sector in India.

METHODOLOGY

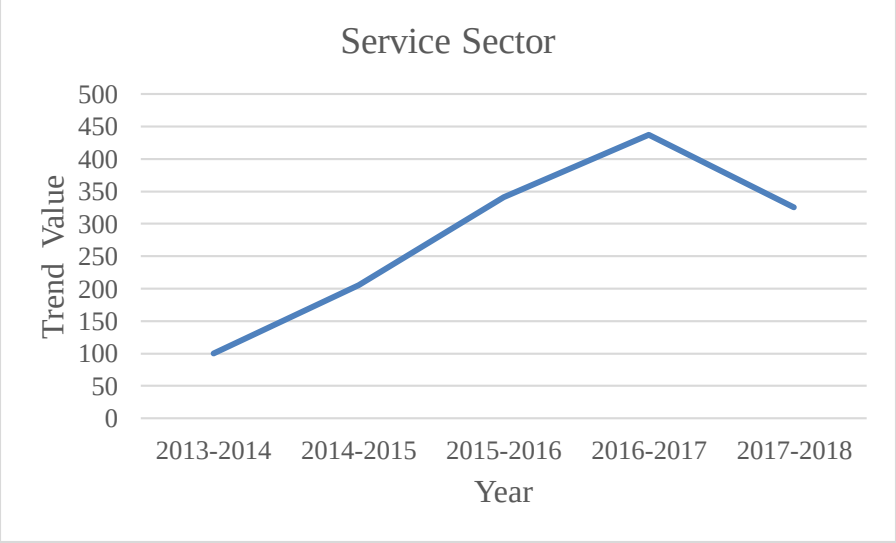
- **Source of Data:** The study is based on secondary data. The required data have been collected from the Bulletin of RBI.

- **Period of the Study:** The study covers a period of 5 years from 2013 to 2018. The accounting years starts from 1st April and ends with 31st March.
- **Tools used for Analysis:**
    1. Compounded Annual Growth Rate
    2. Trend Analysis
    3. Correlation Analysis

ANALYSIS AND FINDINGS

Analysis: FDI EQUITY INFLOWS IN INDIA (Amount in Crores)

YEAR	SERVICE SECTOR	TOTAL INFLOWS	TREND PERCENTAGE	% ON TOTAL INFLOWS
2013-2014	13,294	1,47,518	100	9%
2014-2015	27,369	1,89,107	205	14%
2015-2016	45,415	2,62,322	341	17%
2016-2017	58,214	2,91,696	437	20%
2017-2018	43,249	2,88,889	325	15%
CAGR	**26.6**			
CORRELATION	**0.94**			



Findings:

- The largest recipient of FDI Equity inflows in India is the service sector (Financial and Non-Financial services).
- The compound annual growth rate of Foreign Direct Equity Investment into India in service sector is found to beat 26.6 per cent.

- It shows that there is a positive correlation (+0.94) between the total FDI equity inflows with the inflows of FDI Equity in service sector.
- The inflows of FDI equity in service sector place a major investment and it shows increasing trend and there is downfall in the year 2017-2018 because of investments re-routing to countries like US which witnessed an increase in interest rates together with a stronger dollar value.

CONCLUSION

India has been one of the developing countries and has managed to show a positive GDP growth even during the recession period. India is now rated as the second most favoured destination for FDI in the world after China, but it is expected that in future India would out beet China as it has a larger proportion of young population with one of the fastest growing economies. The service sector is the sector in which the largest investments are received from different countries in the world. The proportion of service sector's cumulative FDI equity inflows is 18% of the total foreign direct equity investment in India. FDI equity inflows in service sector have a positive and significant impact in Indian economy.

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A STUDY ON COLLEGE STUDENTS' PERCEPTION ON FACTORS BUILDING THE BRAND IMAGE OF AUTONOMOUS ARTS AND SCIENCE COLLEGES IN COIMBATORE

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The identity of institutions resonates with branding in higher education. The reputation of an institution has an immense role in how it is succeeding, which directly associates to their brand. If the performance is not highly regarded, the brand and the institution will be directly affected in terms of the popularity, along with recognition. Brand owners may feel they understand exactly what their brand represents. Thus, students would be less likely to be involved with a College that has a bad reputation, along with poor branding initiatives, beyond their mere attendance. Branding is the process of creating a distinctive and appropriate visual representation of an organization and what it stands for and ensuring that it is used consistently across all communication platforms. The aim of this study is to explore the various aspects of awareness of the brand image of a College and the factors which influence a student while selecting his College based on brand marketing by today's higher educational institutions.

Keywords : Higher education, brand perception, brand promises

Introduction

Customer Perception is a marketing concept that encompasses a customer's impression, awareness and /or consciousness about a company or its offerings. Customer perception is typically affected by advertising, reviews, public relations, social media, personal experiences and other channels. In HE, reputation describes the image (of quality, influence, trustworthiness) that the institution has in the eyes of others. Perceived quality refers to students' and graduates' judgments about a higher education institution's overall excellence or superiority while reputation is the overall value, esteem, and character of a brand.

Institutions must deliver on their brand promise. Specifically, a brand should be consistent with the lived experience of students, faculty, and other stakeholders at the institution. An institution that delivers on its brand promise will build positive, long- term relationships with its constituents, and these relationships help the institution build reputation over time. Institutional reputation correlates with brand awareness. An institution with a good reputation, but little brand awareness outside its internal community, is missing opportunities to connect with a broader base of potential students, donors, and funding agencies. While traditional marketing methods such as direct mail and print ads remain popular, many institutions report increasing spending on social media marketing and email marketing to reach a broader audience.

Significance of the Study

Students form their perceptions of brand image, identity, and meaning before enrolling at a University and they continue evolving during their study and even after graduation. Brand identity should include not only visual expressions but also verbal ones. Brand image, which is the consumer's perceptions of a brand as reflected by the brand associations held in their memories, and it will depend on the type of institution that will command a different approach to marketing the university to potential students.

Statement of the Problem

Higher Educational Institutions should focus on activities that enhance their brand image rather than simply create awareness, as brand image has a more significant effect on brand equity compared to brand awareness. An attempt has been made to explore the promises suggested by a College brand, the objective circumstances of an institution, and its symbolic and external representation. Linkages between the favorability of the sample members' perceptions of the main components of a College's brand and the participants' conative, affective, and cognitive responses (including those related to a University's reputation) were examined

Objectives of the study

1. To study College students' perception of the factors building their College's brand image.
2. To understand the respondents' opinion on the significance attached by their College on building the brand image and its components.
3. To examine how strongly the students feel about their College's brand image and whether the branding message has reached the students.

Research Methodology

The present study is empirical based on survey method.

Sources of Data

Both Primary and Secondary data have been used in the present research work.

Primary Data : Primary data was collected with the help of structured Questionnaires.

Secondary data: Secondary data was collected from online sources, journals, magazines and newspapers.

Sampling Design

Sampling method

The population for the present study consists of students of 19 Autonomous Arts and Science Colleges under Bharathiar University in Coimbatore District. Two stage Random Sampling was adopted for the study. In the first stage out of 19 Colleges, 10 college's student population was obtained. In the second stage proportionate random sampling method was adopted to get a total sampling unit of 750 students who were selected using random numbers.

Sample size:

The questionnaires were distributed to 750 respondents from selected Autonomous Arts and Science Colleges in Coimbatore District.

Statistical Tools

Socio Economic Demographic profile and ANOVA

Area of Study

Coimbatore District has been taken as the area of study.

Period of Study

The period of study is **6 months.**

Limitations of the Study

1. The study is restricted to selected Colleges in Coimbatore District.
2. The respondents are from Autonomous Arts and Science Colleges only.
3. There is no comparitive study.

Review of literature

Balais (1975) explored the perception of students with respect to the college administration, faculty, students, and college in general**.** The results of this study showed that the freshers were the most satisfied group and the seniors were the least satisfied. The females scored significantly higher than the males on the four satisfaction scales. Also, students with a high level of total college satisfaction obtained significantly higher grades than students whose satisfaction with college in general was low.

Samsinar et al (2003) concluded that a student faces the hard choice of which particular discipline of study and institution of higher learning to enroll after completing secondary education. It is therefore critical for private institutions for higher education to influence the student decision making process by service offerings that are highly valued by the students.

Analysis and Interpretation

Table 1
Demographic, Socio-economic profile of the Respondents

S.NO	PROFILE	Details	RESPONDENTS	
			NO	%
1	Gender	Male	327	43.6
		Female	423	56.4
2	Age	17-19 yrs	422	56.3
		20-22 yrs	305	40.7
		23 yrs and above	23	3.1
3	Type of family	Nuclear	430	57.3
		Joint	320	42.7
4	Family size	Up to 3	204	27.2
		4-6	460	61.3
		7-9	60	8.0
		10 and above	26	3.5
5	Family income per annum	Up to Rs.2,00,000	368	49.1
		Rs.2,00,000-5,00,000	312	41.6
		Rs.5,00,000 and above	70	9.3
6	Parental education	Illiterate	125	16.7
		Matric	142	18.9
		HSC	163	21.7
		Graduation	153	20.4
		Post graduation	167	22.3
7	Parental occupation	Agriculture	129	17.2
		Business	369	49.2
		Profession	73	9.7
		Self-employment	79	10.5
		Govt. Servant	26	3.5
		Private sector employment	74	9.9
8	Place of residence	Rural	125	16.7
		Semi-urban	210	28.0
		Urban	415	55.3
10	Course currently pursuing	UG	413	55.1
		PG	335	44.7
		Research Scholars	2	0.2

Source : Primary Data

From the above table it can be understood that among the respondents, majority (56.4%) are females, 56.3 % of them belong to 17 -19 years of age group, 57.3 % of the respondents belong to nuclear family, 61.3 % of have a family size of 4-6, 49.1 % of them belong to upto two lakhs annual income group, 22.3 % of the respondents' parents are post graduates, 49.2 % of the respondents' parents are business men, 55.3 % of them are urban residents, 55.1 % of them are undergraduates.

OPINION ON THE SIGNIFICANT FACTORS IN BUILDING THE BRAND IMAGE OF THEIR COLLEGE

To estimate and compare the mean opinion score among the students on the significanct factors in building the brand image of their College, weighted average analysis is performed using five rating score by assigning 5 for Highly significant; 4 for Significant; 3 for Neutral; 2 for moderately significant and 1 for least significant and the results are presented in the following tables.

Null Hypothesis:

There is no significant difference in the mean opinion scores among the students on the significant factors in building the brand image of their College.

ANOVA TABLE

SOURCE	DF	S S	M S	F
Between groups	11	1823.281	165.753	117.50**
Within groups	8988	12678.470	1.411	

**- Significant at 1 % level

Since the F is significant the null hypothesis of no significant difference in the mean opinion scores among the students in building the brand image of their College is rejected and it is concluded that there is significant difference in the mean scores among students. The mean scores among the students are furnished below:

OPINION ON SIGNIFICANT FACTORS IN BUILDING THE BRAND IMAGE OF YOUR COLLEGE

S.No	FACTORS	Mean score	Rank
1	Name and symbolism	4.42	1
2	Recognition of degree	4.35	3
3	Length of existence	4.20	5
4	Prestigious alumni base	4.33	2
5	New programme offerings	4.28	6
6	Value added courses	4.12	7
7	Co-curricular activities	4.10	8
8	Educational partnerships	4.03	9
9	Competition for student enrolment	3.92	11
10	Tuition fees	2.65	12
11	Values and vision	4.01	10
12	College ranking and ratings	4.32	4

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The above table showed that among the 12 significant factors in building the Brand image of a College, the mean score ranged from 2.65 to 4.42. The factor 'Name and symbolism' secured the highest mean score and stood at top, followed by 'Prestigious alumni base'in the second position, 'Recognition of Degree in the third position, 'College rankings and ratings' in the fourth place, 'Length of existence 'in the fifth position, 'New programme offerings' in the sixth place, 'Value added courses' in the seventh position, Co-curricular activities in the eigth place, Educational partnerships in the ninth position, 'Values and vision' stood in the tenth position,' Competition for student enrolment' in the eleventh position and 'Tuition fees 'stood at last securing the least score.

Null Hypothesis:

There is no significant association between Gender of the students and opinion on the significant factors in building the brand image of their College.

TABLE 2

Gender and opinion on the significance of factors in building the brand image of their College

Gender group	Level of significance score			Total
	Low	Medium	High	
Male	117	103	107	327
Female	139	137	147	423
Total	256	240	254	750

$X^2_{CAL.\ VAL\ (FOR\ 8\ DF\ =}$ .730 ns $X^2_{TAB.\ VAL\ FOR\ 2\ DF}$ = 5.99

The Chi-square indicates that there is no significant association between gender group and opinion on the significance of factors in building the brand image of their College and it is concluded that opinion on the significance of factors in building the brand image of their College is independent of the gender group of the respondents.

Conclusion

Branding serves at least four important functions: Creating instant recognition of a College's name within target audiences, differentiating a College from its competitors, promoting an understanding of what the College does and the value of that work, establishing an emotional connection with current and prospective stakeholders that motivates them to place their trust in the College and support it. History of Excellence and academic reputation stood as the first factor in building the brand image of a College in the eyes of the student customer. Hence quality education with excellent faculty, infrastructure and ample placement opportunities should be provided to create a strong brand awareness and brand equity in the Higher educational market for a College to survive in today's competitive world.

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A STUDY ON LEVEL OF CUSTOMER AWARENESS TOWARDS ONLINE BANKING (WITH SPECIAL REFERENCE TO NIRMALA COLLEGE STUDENTS)

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Online banking allows customers of a financial institution to conduct money transactions on a secured website operated by the institution, which can be a retail bank, credit union or building society. Online banking is growing in this modern era as it is widely used by banks all over the world. Online banking is becoming much more common in these days. Users can pay their bills through online and access a record of their checking account transactions in online also. Online banking makes everything easier. Users can access the information anywhere that they have access to the Internet. It makes their financial life much easier to manage. Online bank provides the financial service for the individual client by internet. Customers find this method more convenient and satisfactory as they can check their account details and make transactions from their homes and offices or wherever at any point in time. This satisfaction from customers has made this approach even more reputable and popular.

KEY WORDS
Online Banking, Electronic Banking, Internet Banking, Internet Based Banking, Mobile Banking.

INTRODUCTION

According to the American Marketing Association (AMA) Board of Directors, "Marketing is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large"

AN OVERVIEW OF ONLINE BANKING

Online banking was first introduced in 1980 but wasn't available to clients until 1995. Ever since then, the increase in demand for online banking systems and services has vastly increased. Internet banking arrived in India in the late 1990s. ICICI was the first bank to champion its usage and introduced internet banking to its customers in 1996. With lower internet costs and increased awareness about electronic media, online banking established itself only in 1999.

OVERVIEW OF ONLINE BANKING IN NIRMALA COLLEGE FOR WOMEN

On 8 November 2016, "The Government of India announced the demonetization of all □500 and □1000 banknotes of the Mahatma Gandhi Series. It also announced the issuance of new □500 and □2000 banknotes in exchange for the demonetized banknotes". On the time, Nirmala College for Women implemented Online Banking (for the payment of tuition fees will be pay through online also) to encourage the students to know the Online Banking activities. During that time, it was most helpful for the students. Since 2016 to till now Nirmala College for women adopted online banking which is useful for both students and society. This study indulged on online banking among Nirmala College students.

OBJECTIVES OF THE STUDY

- To study the level of customer awareness of online banking towards Nirmala College students.
- To find out the challenges in online banking
- To analyze the banking activities of the students.

RESEARCH DESIGN

Descriptive research is used in this study.

SOURCES OF DATA

- **Primary Data:** The primary data was gathered by questionnaire from the users of **online** banking
- **Secondary data:** The secondary data was collected through extensive books, reading Journals, newspapers and various websites.

SAMPLING TECHNIQUES

The sampling techniques used for this study is **convenience sampling.**

SAMPLING TOOLS

- Percentage analysis
- Chi squire

SAMPLE SIZE

The sample size of this study is **125**

AREA OF THE STUDY

A Study on Level of Customer Awareness towards Online Banking has been collected from the customers of Online banking among Nirmala College.

MATERIALS AND METHODS

The statistical tools are applied for the analysis of data. The tools used **are Percentage Analysis, Chi-Square**

RESULTS RELATED TO PERCENTAGE ANALYSIS

- Majority **52%** of the respondents are between **18-20 years**.

- **37.6%** of the respondents are **arts** students.
- **30.4%** of the respondent are pursuing their **UG 1st year**
- Majority **58.4%** of the respondents are **not the first generation learner**.
- **100%** of the respondents have their individual **bank account**.
- Majority **52%** of the respondents are using online banking **less than 1 year**.
- **29.6%** of the respondents got awareness for online banking through their **friends**.
- The majority **52.8%** of the respondents are using their **mobile** for their online banking transactions.
- **29.6%** of the respondents are using online banking as **twice in a year**.
- **44.8%** of the respondents are generally transact funds with their **family.**
- The majority **88%** of the respondents are using online banking for their **online fee payment**
- Majority **75.2%** of the respondents are **aware** about banking charges.
- The majority **65.6%** of the respondents **accept** that the service charges for online banking are fair.
- **38.4%** of the respondents are trying to avoid using cash for the payment method.
- **15.2%** of the respondents are represent **hackers** are the main problem of online banking.
- **38.4%** of the respondents said that **free transactions** would encourage them to use more of online banking services.
- **39.2%** of the respondents are **agreed** that online banking is more convenient than manual banking.
- **33.6%** of the respondents have purchased **3 to 8 times** through online banking in the last 12 months.
- **33.6%** of the respondents feel that transactions through internet is **somewhatsecure**.
- **43.2%** of the respondents are recorded that **less than 10 minutes** taken for online banking transactions.
- The majority **52%** of the respondents are **satisfied** with the using of online banking.

RESULTS RELATED TO CHI-SQUARE

Ho: The various challenges related factors and the level of awareness are **independent.**

H_1: The various challenges related factors and the level of awareness **are dependent.**

RESULT:

It can be concluded that the various challenges related factors and the level of awareness **are dependent.**

Ho: The various factors in online banking and the level of awareness are **independent.**

H_1: The various factors in online banking and the level of awareness are **dependent.**

RESULT:

It can be concluded that the various factors in online banking and the level of awareness **are dependent.**

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CONCLUSION

This study investigates customers of online banking are. 125 survey responses were collected through convenience sampling method giving a response rate of 100 percent. This study reveals over half of the online banking users have an aware of banking charges and also face some challenges and problems while using online banking. However the users facing difficulties, majority of them feel that online banking is more convenient and satisfied also.

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A STUDY ON PERCEPTION TOWARDS SMARTPHONE

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The increasing trend in Smartphone among the people is the main reason that has amplified the interest to research on the topic. People's obsession about the Smartphone has been increasing rapidly. The aim of this research is therefore to find out consumer behaviour of Smartphone buyers in Indian Market. The research is trying to find out that why do people desire

to purchase a smartphone, what influence people in purchasing a smartphone and what motivate them in making the purchase decision. Different consumers have different characteristics in their life that also influences their buying behaviour. Social factors such as family, groups, roles and status) and personal factors (such as age, occupation, lifestyle, personality and self-concept) are those characteristics that could influence the buyer behaviour in making final decision. Nowadays cheaper smart phones are also available in the market. But why people buy expensive smartphones? Price, quality, brand, country of origin, marketing, sales, word of mouth etc. could be several factors that a consumer may think before buying a Smartphone.
Keywords: Smart Phone, Consumers, Market study.

INTRODUCTION

India is currently the world's second-largest telecommunications market with a subscriber base of 1.05 billion and has registered strong growth in the past decade and half. The Indian mobile economy is growing rapidly and will contribute substantially to India's Gross Domestic Product (GDP), according to report prepared by GSM Association (GSMA) in collaboration with the Boston Consulting Group (BCG). The country is the fourth largest app economy in the world. The liberal and reformist policies of the Government of India have been instrumental along with strong consumer demand in the rapid growth in the Indian telecom sector. Today, almost all the Smartphone's has a high-density screen resolution allowing the handset to display almost all the websites in their standard formats as they appear on the computer screens. Nowadays most of the websites are launching their mobile versions as well, and several applications which can be run on the Smartphone OS directly. For better connectivity, hi-speed data is also made available through WI-Fi, 3G and 4G data connections. In the past 2-4 years, the rapid development of mobile – applications has caused a birth of the new mobile applications market, allowing a lot of trade to happen through mobile platform as well, which has been a major reason for people to adopt the Smartphone.

OBJECTIVES OF THE STUDY

- To examine the socio-economic status of the selected respondents.

METHODOLOGY OF THE STUDY

Descriptive research study has been used in this research. Around 125 respondents were selected by using simple random sampling method in Coimbatore city. The study is based on primary data as well as secondary data. Questionnaire is the main tool for collecting the opinion of the respondents about the smart phone. The collected data were subdued into tables and charts by using statistical tools like simple percentage analysis, has been used in this research study.

RESULTS AND DISCUSSION

The socio-economic factors of the selected respondents are given below table.

Table 1 : Socio-Economic factor of the selected respondents

No.	Factors	Number of Respondents	%
1	**Age**		
	a) Upto 20 Yrs.	49	39.2
	b) 21 – 23 Yrs.	51	40.8
	c) Above 23 Yrs.	25	20.0
	Total	**125**	**100.0**
2	**Gender**		
	a) Male	21	16.8
	b) Female	104	83.2
	Total	**125**	**100.0**
3	**Educational Status**		
	a) UG Degree	67	53.6
	b) PG Degree	42	33.6
	c) Research Degree	16	12.8
	Total	**125**	**100.0**
4	**Monthly Family Income level**		
	a) Below Rs.15000	19	15.2
	b) Rs.15000 – Rs.25000	39	31.2
	c) Above Rs.25000	67	53.6
	Total	**125**	**100.0**
5	**Period of using Smartphone**		
	a) Below 1 Year	27	21.6
	b) 1-2 Years	41	32.8
	c) Above 2 Years	57	45.6
	Total	**125**	**100**
6	**Time spent in using Smartphone in a day**		
	a) Below 2 hours	42	33.6
	b) 2-4 hours	59	47.2
	c) Above 4 hours	24	19.2
	Total	**125**	**100.0**
7	**Brand of Smartphone using now**		
	a) Sony	11	8.8
	b) Samsung	25	20.0
	c) LG	23	18.4
	d) Xiomi Redmi	19	15.2
	e) Apple	10	8.0
	f) Micromax	7	5.6
	g) Karbonn	9	7.2
	h) Lenova	16	12.8
	i) Others	5	4.0
	Total	**125**	**100.0**
8	**Buying Location of the Smartphone**		
	a) Retailer	37	29.6
	b) Exclusive showroom	52	41.6
	c) Online	29	23.2
	d) Others	7	5.6
	Total	**125**	**100.0**

It could be found from the above analysis as follows:

- Around 39.2 percent of the respondents belong to upto 20 years age category, 40.8 percent of the respondents belong to 21-23 years age category and remaining 20.0 percent of the respondents belong to above 23 years.
- Approximately 16.8 percent are male and 83.2 percent are female.
- The respondents have been studying UG degree level as 53.6 percent, PG degree level as 33.6 percent, and above PG degree level as 12.8 percent.
- Among the 100 percent, 15.2 percent respondents' family earns below Rs.15000, 31.2 percent earns Rs.15000 to 25000 and remaining 53.6 percent earns above Rs.25000.
- 21.6 percent of the college students have using smart phone below 1 year, 32.8 percent are using 1-2 years and 45.6 percent are using above 2 years.
- Around 33.6 percent of the college students spent below 2 hours for using smart phone, 47.2 percent spent 2-4 hours and 19.2 percent spent above 4 hours.
- Majority (20.0%) of the respondents are using Samsung smart phone followed by LG as 18.4 percent, Xiomi Redmi for 15.2 percent, Lenovo for 12.8 percent, Sony for 8.8 percent and Apple for 8.0 percent.
- Approximately 29.6 percent of the respondents purchased their smart phone from retailers, 41.6 percent purchased exclusive showroom, 23.2 percent purchased through online and 5.6 percent through some other sources.

FINDINGS

- It is found from the analysis that majority of the respondents belong to 21-30 years, female, UG degree level education, above Rs.25000 income earned family, above 2 years using smart phone, 2-4 hours daily using smart phone, Samsung smart phone users and purchase through exclusive showroom.
- It could be noticed from the analysis that majority of college students, who belongs to 21-23 years aged, perceived their perception at the maximum level, PG degree level educated, Rs.15000 to 25000 earned as monthly family income, 1 to 2 years of using and 2 to 4 hours spent in using smartphone daily.

SUGGESTIONS AND CONCLUSION

From the research, 21-23 years aged college students have perceived their utilization of smart phone at the high level when compared to other respondents. This is proved approximately majority of the PG degree college students' perception level is higher than other students. So, the age category college students should carefully use their smart phone with effectively. Also, around 1-2 years usage level of the respondents have perceived the maximum levels than other respondents. Hence, it is suggested to the other category of the respondents that they have to use the smart phone in an efficient way.

Accordingly, future studies need to use more diverse samples from all segments of the population to explore similarities and differences between groups, thereby increasing the external validity of the study. It is suggested to the college students that the key attributes of Smartphone technology that enhance users' perception towards smart phone applications, as well as their intention of initial adoption.

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THE EFFECT OF E-LEARNING

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E-learning enhances the academic excellence of the learning community. The enthusiastic reception of e-books gave the manufacturers sufficient impetus to publish e-books on a massive scale. E-books stand for qualitative education and cover a wide range of syllabi thereby meeting the academic needs of students. This paper has examined the effect of e-learning on students as well as its advantages and disadvantages.

1. INTRODUCTION

We have a lot of technologies to communicate faster, better, clearer, sharper and more convincingly. Permanence has died and our society is in the midst of tremendous changes. There would be a flood of novelty, information overload, sensory bombardment and an increase in the tempo of daily life. Technology changes things today. The greatest challenge now is to keep up-to-date with the latest technology. We can make the best use of its potential by using it intelligently.

ADVANTAGES OF E-LEARNING ON STUDENTS' BEHAVIOUR

Increasing educational quality is a critical challenge that every forward looking educational institute needs to address to equip their children to be effective in the world of growing demands, rapid and wide spread and globalization shrinking of the world to a global village. A paradigm shift e-learning through the use of ICT-Information and Communication Technology could be the sought after solution to this challenge. That raises the following questions: Are there only positive impacts or the technology supported e-learning has any negative impacts too? Can we make all students and teachers techno-savvy in the shortest span of time? In addition to these questions there remains a fundamental question – are all the educational institution capable enough to have adequate funds to upgrade their institute and the teachers to the level of requirement that the modernization of technology demands?

- **Instils Curiosity**

Good learners are curious. They wonder about all sorts of things, often about things way beyond their areas of expertise. They love the discovery part of learning. Finding out about something they didn't know satisfies them for the moment, but their curiosity is addictive.

- **Autonomous Learning**
  Students search out information and diverse studying resources and be presented by hyper–text. They read, analyse and evaluate the information they have found. E-learning extensively facilitates and enriches the learning process. They make the concepts more clear and can be repeated over and over again.

- **Multidimensional Study Materials**
  E-learning, e-books, smart class rooms are conquered one chalk and talk" method. Information covering words sound cartoon and radios are included in the study materials this helps to improve the quality of education. It can reinforce learning and support learning. They are there to assist, to complement and supplement what the presenter is doing.

  - They make class room teaching effective.
  - They make learning easy.
  - They make use of more sensory organs.
  - They create interest and motivate students.

- **Systematic Presentation**
  E- Learning is professional in approach it helps the students to acquire process and store information precisely and accurately. It is done in sequential ways. The materials include use of charts, maps, graphs, diagrams, pictures, filmstrips, slides etc are presented meaningfully. Enhance learning, memory and increases decision making accuracy. It is sophisticated and is apt in the present scenario. Encourages the students to observe, compare and contrast the facts presented to them.

E-learning can be used by teachers to explain concepts in an innovative way. They are much easier to remember and review because of their visual quality.

- It is easy to link. They make a high impact in the minds of the students.
- Makes a particular concept clear. Students develop interest to know exactly the concept
- Creates long lasting memory/correlation of a concept.

- **Enhancing Life Skills**
  E- learning equipped the learner, with life skills to be competitive in the 21st century. Helps to integrate the curriculum with skills such as critical thinking and problem solving and creativity and imagination citizenship, students leadership and personal development, collaboration and communication. E-learning is an effective devise to prepare competent students.

The teacher uses multimedia to modify the contents of the material. It will help the teachers to represent in a more meaningful way, using different media elements. These can be modified and customized. By incorporating digital media elements, the students are able to learn better since they use multiple sensory modalities, which would make them more motivated to pay more attention to the information presented and retain the information better.

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- It enable students to be creative, think critically, analytically and to solve problems
- It is dynamic and subject to changes.
- It improves the learning skills of students.
- It is professional in approach.
- It promotes interactive learning.
- Helps students to acquire process and store information.

- **Quantum Leap in Development and Technology is E-learning**
  The great psychologist Piaget and Vygolsky ‘’believed that children actively construct their knowledge”. Students are get in the freedom to learn through e-learning act anytime and anywhere without the help of teachers. The e-learning provide a wide range of perspectives regarding cultural background values and experiences. The ultimate aim enable students to exercise their rights and mange their own lives.

- **Global citizenship**
  E- learning helps to active – globally – aware citizens who have the skills, knowledge and motivation to address the issues of human and environmental sustainability and work towards a fairer world. Global awareness helps students to be sensitive to other cultures disparities. Global citizenship mould respect for diversity.

3. REVIEW OF LITERATURE

- ✓ **S.A.Kelkar (2012)** - IT Service Management- A Concise Study has analysed the use or the deployment of IT services that differentiate companies from each other. IT services are at the heart of every company’s success. Service requirements are shaped by technology, business models and customer expectations.

- ✓ **Wang and Woo (2011)** – claimed that the face book group had the potential to be used as Learning Management System. It has pedagogical, social, technological affordance. Technological support brings a lot of creativity among the learners.

- ✓ **Steven Alter (2011)** – Foundation of E- Business – E-learning has become a buzzword for businesses over a past few years, with increased awareness about the use of computer and communication technologies to simplify business procedures and increase efficiency.

- ✓ **Jonathan Reynolds (2010)** – In E- Business, a management perspective reveals social and behavioural network resources and its effect in massive participation both nationally and internationally. The implementation of e-business technologies within society has fatal flaws which undermine the original goals of their developers.

3. RESEARCH METHODOLOGY

The study is based on primary and secondary data. Primary data is collected by using questionnaires. Questionnaires are given to both the learners and the tutor simultaneously. Sample selected is analysed by using Mean and Standard Deviation.

No.	Questions	Yes	No
1.	I like using E-learning for conceptualization of the content		
2.	I think E- learning in teaching content helps me to improve my skill		
3.	I think my grades will improve by using E-learning		
4.	I hope teaching with the help of E-learning is more effective than traditional method		
5.	E-learning makes my learning more interest		
6.	By using E-learning develop my interactive skill		
7.	I think E-learning make my class more live		
8.	By using E-learning encourages myself pacing than tutor oriented learning		
9.	Using internet helps me to update my learning		
10.	I find E-learning an easier and fast method of conceptualization of the content		

4. ANALYSIS

The study is based on primary data of sample of 600 students and 100 teachers from high school and higher secondary level. The researcher applied closed questionnaires for collecting samples. The sample of questions included in the questionnaire is given below:

Mean value on Students Perception based on E-learning			**Mean value on Tutors Perception based on E-learning**		
Arithmetic Mean	Standard Deviation	Coefficient of Variance	Arithmetic Mean	Standard Deviation	Coefficient of Variance
7.576	1.674	22.09	8.405	0.244	2.914

5. INTERPETATION OF THE DATA

Sample collected from the students and teachers regarding E-learning based on the conceptualization of the content reveals that the majority of the data are scattered around the mean. That is the effect of E-learning. E-learning positively influences the learning process. Tutors also preferred the technology based learning. They prefer to blend E-learning with traditional method in subjects like Maths, Physics, Science and Computer etc.

6. CONCLUSION

E-learning enables the students to understand the concepts easily and effectively. They have keen insight into student learning difficulties and so design them to enable deeper understanding of the concepts. A renowned team of educators, teachers, linguists, artists and experts work closely for years to evolve the e-books. It is skillfully done applying the principles of didactics.

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A Comparative Study of Bajaj Holding and Investment and India bulls Venture Ltd

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The economy is reflected by the growth of stock market. Over the years the Indian stock markets have become stronger. The study has done by comparing two companies which is listed in S&P BSE Sensex. This paper captures the relation and returns between the companies. The companies are Bajaj Holding and Investment Limited and India bulls Venture Ltd. These companies were taken according to the market capitalization. These two companies fall under the category of investment under finance sector which has free float market capitalization of 39.48%.

Keywords: Stock market, BSE, Market Capitalisation, Correlation, Returns.

Introduction

The segment of a financial market of an economy wherefrom long-term capital is raised via instruments such as shares, securities, bonds, debentures, mutual funds is known as the security market of that economy. A stock exchange, securities exchange or bourse is a facility where stock brokers and traders can buy and sell securities, such as shares of stock and bonds and other financial instruments. Stock exchanges may also provide for facilities the issue and redemption of such securities and instruments and capital events including the payment of income and dividends. A stock exchange is often the most important component of a stock market. Supply and demand in stock markets are driven by various factors that, as in all free markets, affect the price of stocks. There is usually no obligation for stock to be issued through the stock exchange itself, nor must stock be subsequently traded on an exchange. Such trading may be off

exchange or over-the-counter. This is the usual way that derivatives and bonds are traded. Increasingly, stock exchanges are part of a global securities market. Stock exchanges also serve an economic function in providing liquidity to shareholders in providing an efficient means of disposing of shares.

Market Capitalization

Market capitalization (market cap) is the market value of a publicly traded company's outstanding shares. Market capitalization is equal to the share price multiplied by the number of shares outstanding. As outstanding stock is bought and sold in public markets, capitalization could be used as an indicator of public opinion of a company's net worth and is a determining factor in some forms of stock valuation. It is used by the investment community in ranking the size of companies, as opposed to sales or total asset figures. It is also used in ranking the relative size of stock exchanges, being a measure of the sum of the market capitalizations of all companies listed on each stock exchange. In performing such rankings, the market capitalizations are calculated at some significant date, such as June 30 or December 31. The total capitalization of stock markets or economic regions may be compared with other economic indicators.

Free Float Market Capitalisation

Free float market capitalization means the value of the company is calculated by excluding shares held by the promoters. These excluded shares are the free float shares. Free float market capitalisation is lower than total market capitalisation as shares held by promoters or those that are locked in are excluded.

Objective of the Study

- The main objective of the study is to analyse the relation between the companies.
- To find the returns of the company.

Research Methodology

This paper is based on the secondary data and compared two companies Bajaj Holdings and Investment Limited and India bulls Venture Ltd., which is listed S&P BSE Sensex under the finance – investment category. For the analysis 10 year data have been taken. This paper compares the relation and returns between the companies.

Review of Literature

DebjibanMukerjee (2007) has done a comparative analysis of Indian Stock market with International markets. This paper captures the trends, similarities and patterns in the activities and movements of the Indian stock market with international market. It has been found that Indian market is more integrated with the global market and has impact with each other. It can be safely being said that the markets due react to global cues and any happening in the global scenario be it macroeconomic or country specific affect the various markets.

Dr.Girbal Singh Lodhi and Dr.Kaustubh Jain (2013) have done a comparative study on Bombay Stock Exchange and National Stock Exchange during the year 2001-2013. A ready market for investments was need of the hour and this was how the Stock Exchange came into being. Presently, the Bombay Stock Exchange Limited and National Stock Exchange of India Limited put together account for 80% of the total turnover as compared to 10% by the other stock

exchanges. So the researcher decided to compare these two most prominent stock exchanges of India. They found that stock market is consistently increasing in NSE than BSE. The average execution cost in NSE is less than half the average value of the cost in BSE and also they found that trading frequency in NSE is higher than BSE.

Shivi Khanna (2016) examined the price behavior of Indian stock market with UK and Japan stock market prior and post global financial crisis and concluded that during the pre -crisis period both Japan and UK markets are integrated with Indian market, while in post crisis Indian markets were influenced by UK stock market, but not by Japan market.

Neeraj and Prasanta K. Panigrahi (2016) have done a comparative analysis on causality and correlations between BSE and NYSE indexes using Janus faced relationship. They found that Janus faced relationship shows smaller stock exchanges may provide a natural setting for simulating market fluctuations of much bigger exchanges. This possibly arises due to the fact that high frequency fluctuations form a universal part of the financial time series and are expected to exhibit similar characteristics in open market economics. They concluded that there is no linear Granger casualty was found between the averaged behavior of the two stock exchanges and high frequency fluctuations of BSE were found to be manifested in NYSE with a time lag.

Sukhmander Singh and Deepak Kumar (2018) have done a comparative analysis of Indian Stock Market with International stock markets. They have prepared this paper with the intention of capturing the global trends and patterns and also the flow of global stock market as the Indian stock market has been integrated with world's top stock market. They concluded that Indian stock market which has linked with stock markets of all the countries globally integrated over the next 10 to 15 years; need to move towards far greater integrated global financial world and policy makers in India need to rethink the frame work for such integration.

Findings, Interpretation and Conclusion

Analysis of Return and Standard deviation

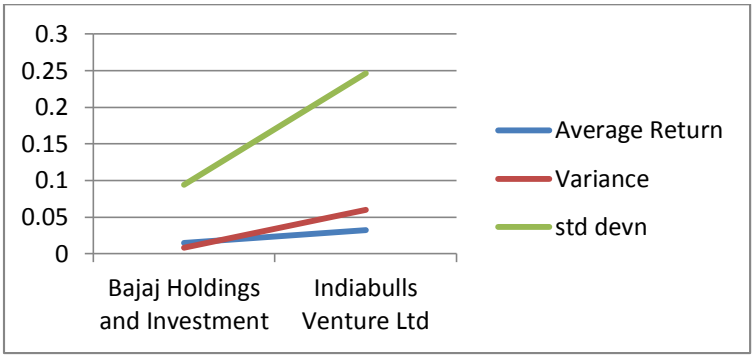
Table: 1

	Bajaj Holdings and Investment Limited	%	India bulls Venture Ltd	%
Average Return	0.015	1.59	0.032	3.83
Variance	0.008	0.88	0.060	6.07
Standard Deviation	0.094	9.41	0.246	24.64

Interpretation

The above table shows the average return, variance and standard deviation of Bajaj Holdings and Investment Limited and India bulls Venture Ltd. When comparing these two companies, the average return of India bulls is 3.83% which is higher than Bajaj Holdings and Investment Limited which is of 1.59% which means India bulls venture ltd has higher return. Regarding the standard deviation India bulls venture ltd has a value of 24.64% which is higher than Bajaj Holdings and Investment Limited value of 9.41%.

Exhibit: 1



Analysis of Covariance and Correlation

Table: 2

Company Name	Covariance	%	Correlation	%
Bajaj Holdings and Investment Limited	0.005	0.56	0.242	24.22
India bulls Venture Ltd				

Interpretation

The above table shows covariance and correlation of Bajaj Holdings and Investment Limited and India bulls Venture Ltd. When comparing these two companies the covariance is 0.005 and correlation is 0.242 which shows positive relation that exists between these two companies.

Conclusion

With favorable industrial output and inflation data the Indian equity market witnessed a strong rebound. The study has done on comparative analysis between Bajaj Holdings and Investment Limited and India bulls Venture Ltd which is listed in S&P BSE Sensex under finance sector - Investment category. These companies where taken based on the market capitalisation. It is concluded that India bulls Venture Ltd has higher returns and higher standard deviation value when compare to Bajaj Holdlings and Investment Limited. According to correlation, there exists a positive relation between these two companies. India bulls Venture Ltd continued to trade on a positive trajectory.

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A STUDY ON EMPLOYEES ATTRITION AND RETENTION IN THE AVE MARIA SPINNING MILL PVT LTD KANNAMPALAYAM.

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Human resource management (HRM or simply HR) is the management of human resources. It is a function in organizations designed to maximize employee performance in service of an employer's strategic objectives. HR is primarily concerned with the management of people within organizations, focusing on policies and on systems

Companies in India as well as in other countries face a formidable challenge of recruiting and retaining talents while at the same time having to manage talent loss through attrition be that due to industry downturns or through voluntary individual turnover. Losing talents and employees result in performance losses which can have long term negative effect on companies especially if the departing talent leaves gaps in its execution capability and human resource functioning which not only includes lost productivity but also possibly loss of work team harmony and social goodwill.

This study reveals the employees attrition and the process where the organization involved in retaining them.
Keywords: Attrition, Retention, Employees, Organisation.

INTRODUCTION TO ATTRITION AND RETENTION

Attrition may be defined as "gradual reduction in membership or personnel as through retirement, resignation or death". In other words, attrition can be defined as "the number of employees leaving the organization which includes both voluntary and involuntary separation."

Employee retention refers to policies and practices companies use to prevent valuable employees from leaving their jobs. Not too long ago, companies accepted the "Revolving door policy" as part of doing business and were quick to fill a vacant job with another eager candidate. A process in which the employees are encouraged to remain with the organization for the maximum period of time.

FACTORS OF RETENTION

- Compensation
- Environment
- Growth

- Relationship
- Support

OBJECTIVES OF THE STUDY

1. To study the economic profile of the employees in Ave Maria Spinning Mill.
2. To know the reasons for attrition occurs in the organization.
3. To know the satisfactory level of employees towards their job and working conditions.
4. To provide suggestions and recommendations.

SCOPE OF THE STUDY

- The scope of this study is confined to manufacturing industries in small scale industries category located industrial parks of kannampalayam.
- The study throws light through valuable suggestion to decrease attrition level in the organization.
- This study can help the management to find the weaker parts of the employee feels towards the organization and also helps in converting those weaker part in to stronger by providing the optimum suggestions or solutions.

RESEARCH METHODOLOGY

The study of conducting research is research methodology.

Search for knowledge. Systematic and scientific search for getting relevant answers on any taken up specific topic. Scientific enquiry into a subject. Research is a movement from the unknown to known. It is the voyage of discovery.

RESEARCH DESIGN

A research design is purely and simply the frame work or the plan for the study that guides the combination of descriptive and exploratory research design has been explored.

SAMPLE SIZE

The study is mainly based on convenient random sampling method for the purpose of the study 100 respondents. In the study the Primary data collected by means of questionnaire.

TOOLS USED

The SPSS package has been used for statistical analysis

- Percentage analysis.
- Chi square test.
- Rank Analysis.

FINDINGS

PERCENTAGE ANALYSIS

$$\text{Percentage of Respondents} = \frac{\text{No. of respondents}}{\text{Total no. of respondents}} \text{ X } 100$$

- Majority (65%) of the respondents are Male.
- Majority (52%) of the respondents are the age group of 31-40 years.
- Majority (69%) of the respondents are undergone the attrition.

- Majority (51%) of respondents are selected agree to state that the Company does an excellent job of keeping employees informed about matters affecting the employees.
- Majority (60%) of the respondents are chosen extension and benefits to dependents as retention policy.

CHI-SQUARE

$$\text{Chi-square} = \frac{(Oi-Ei)^2}{Ei}$$

Oi= Observed frequency
Ei=Expected Frequency
Degree of freedom=(c-1)(r-1)

H_O: There is no significant relationship between the Personal Factors Gender, Age, Educational Qualification, Monthly Income with the Employees Opinion about the Organization @ 5% Level of significance.

RANK ANALYSIS

$$R= \frac{1-6 \sum D^2}{N (N^2-1)}$$

Respondents with an average rank score of 3.89 have given 1st rank to the Working hours and fluctuating targets.

CONCLUSION

It is revealed from the research that the organization has to concentrate on workload and lead time, relationship between colleagues and supervisors, internal recruitments to retain the employees and reduce attrition. This research gave insight knowledge about the HR practices of the organization and retention strategies of the concern innovation. Thus, Organizations should create an environment for the growth opportunities, appreciation for the work accomplished and a friendly cooperative atmosphere that makes an employee feel connected in every respect to the organization. This study concludes that to reduce attrition in mill and it should create some opportunities for the growth of their employees within the organization by adopting new Innovative Technologies and Effective training programs

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CHALLENGES AND ISSUES FACED BY BANKING SECTOR ON COIR INDUSTRIES – WITH SPECIAL REFERENCE TO COIMBATORE DISTRICT

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India is the largest coir producer in the world accounting for more than 80 per cent of the total world production of coir fibre. Countries like India, Sri Lanka, Mexico, Vietnam, and Caribbean Countries produce Coir. Coir's global production is about 350,000 tonnes. India and Sri Lanka being the major producers of coir, account for 90 per cent of the world production.

The coir industry is contributing significantly for creation of livelihood in major coconut growing States and union territories of India like Kerala, Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, Goa, Orissa, Assam, Andaman and Nicobar, Lakshwadeep and Pondicherry. Kerala had exported 73,665 tonnes of products valued at Rs.709.58 crore in 2013-14. In India, Allepy district in Kerala state is the coir hub and is the major deciding factor of coir trade in India. The rate of coir is mainly fixed in other markets of India on the basis of Allepy market. Tamil Nadu is the second largest producer of Coir fiber in the country after Kerala.

INTRODUCTION

Tamil Nadu produces 60 per cent of the total coir yarn, but only a little is being used for making value-added products. The total area of the coconut cultivation in Tamilnadu is 3, 57, 100 hectares and production is 3243.50 million and the productivity is 9083 nuts per hectare which surpasses the all India average productivity of 6632 nuts per hectare. There are about 1300 coir processing units in the State out of 10000 units in the country.

In Tamilnadu, coir is mainly produced in Pollachi taluk of Coimbatore district, Kanyakumari and Nagercoil districts due to its large area under cultivation of coconut which is due to suitable climatic conditions available in these regions for fibre production. Besides these, coir rope making cottage industries are available in Dindigul taluk, Palani taluk and some regions of Salem district. As per the data available with Coir board regional office in Pollachi, there are 600 coir industries in Pollachi taluk.

The main products obtained from these industries are coir fibre (white and brown) and coir pith blocks. In the brown coir fiber sector, Tamil nadu occupies the first place with a production of 1.33 lakh Million Tonne per annum and contributing to 65 per cent of total production in India. This speaks of the immense potential of the coir industry in Tamil Nadu especially in Pollachi district. But enough studies are not available on the economics of investment in this industry and also the export analysis of this sector and hence the present study was taken up in Pollachi district.

COIR PRODUCTS

Coir Fibre

Coconut husk is the basic raw material for the coir industry. There are two methods employed for extraction of fibre from coconut husk. The fibre obtained from the retted husk is known as White fibre". The fibre taken from the dry semi dray, green husk after soaking them in cement tanks for a period of 7 to 10 days in known as Brown fibre. Industrial units extract coir fibre from green husk with the help of combining machines and other mechanical devices.

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Coir Yarn

Coir yarn is a semi finished raw material which is spun out of coir fibre. The coir yarn may be of three types viz., single ply yarn, two ply yarn, and three ply yarn. Single ply yarn is wheel spun yarn consisting of only one ply spun from coir fibre. Two ply yarn is a wheel spun yam consisting of two plies, spun from white fibre and brown fibre. The important characteristics by which the quality of coir yarn is judged are its colour, absence of impurities, fineness, texture and type of fibre used. Three ply yarn, a very thick variety is also called" Muppriyarn". It is defined as wheel spun yarn consisting of three plies spun from coir fibre. The three ply yarn is also known by special names such as "Airmal" Balamony, special coir etc.,

Coir Rope

Coir rope is made up of three or more strands, the strands themselves being an assemblage of yarn twisted together. Coir rope originates from Malabar and Trivandram in Kerala.

Rubberised Coir

Rubberized coir needs brown curled coir fiber as basic raw material. The rubberized coir is used in automobile sector for seat and back cushion and mattress.

Mat and Mattings

Mat and mattings are woven on handlooms. Similar to these used in the textile industry. For weaving the product firstly, the coir yarn is sorted out according to scourge, color etc., Hanks of uniform quality are the special together to obtain continuous lengths. They may be classified into four types;

1. brown mats
2. fibre mate
3. matting mat and
4. various speciality mats like sinnet, coir or rope mats made on boards of frames using braids or ropes.

STATEMENT OF THE PROBLEM

One of the major problems of the coir units of Coimbatore region is lack of finance, the smaller the unit, the larger the problem of capital fund. They need more money as working capital as well as long term capital to run the units efficiently. Units need to borrow money but due to various legal processes and paper works they are not willing to borrow from Bank. Most of them are not aware about the different financial schemes of the Government and the Coir Board. This analyses such financial related problems of the coir units in Coimbatore region.

SCOPE OF THE STUDY

Coir societies play an important role in providing the employment of rural poor. The present study is an in depth attempt which comes out with an economic analysis of coir societies and their operational behaviour. The major findings on the realities of the coir societies at grass root level, the suggestions and policy implication of the study would be helpful to the operation

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of coir societies, policy makers and the Government. This would enable them to devise strategies and approaches for the sustained growth and development of this agro-based industry.

OBJECTIVES OF THE STUDY

¬ To find out the various problems faced by the coir industry in India

¬ To indicate the future prospects for the coir industry in India

Review of Literature

Satya Sundaram (2006) in his article, "Coir Products in Demand", had pointed out that the major problems of coir industry in India such as inadequate knowledge of the product and its end uses, non-availability of local skill and lack of accessibility to technology, lack of innovation, unskilled workers, low rate of wages, advantages of coir products are not explained to the people, proper channels of distribution is not available, agents are not appointed and target is not fixed.

According to Vijayachandran Pillai (2002) in his study, "Marketing Problems of Rural Coir Co-operatives in Kerala", the private sector coir units 82 percent depends mainly on the private agents for marketing, 10 percent depends on government agencies and remaining 2 percent depends on direct sale and private exports for marketing. Further, he had stated that lack of sufficient orders and competition from other units are the chief problems of the private sector coir units

PROBLEMS OF COIR INDUSTRIES IN INDIA

Despite of favourable contribution to employment and income of the people and country's economy in innumerable ways, the Coir Sector does not get the required support from the government, banks, financial institutions and other lending institutions in order to provide quality goods and services, to meet the competition, to create demand and to attract customers in both. National as well as International markets. Even though the Coir Sector has potentials in India, they are facing a number of problems. The major problems faced by the coir industries in India are enumerated below.

Material Problems

Material is the basic and prime input to any industrial concern. The operation of the coir units depends on the availability of the coconut husk (basic raw materials). Further, the coir units are facing several problems day by day in procuring and using the raw materials. Coir industry in India is suffering a number of material problems like non-availability of materials, shortage of materials, poor quality of raw materials and high cost of materials.

Labour Problems

Labour is one of the most fundamental factors of production which determine the success of an industrial unit. There are a number of unskilled workers engaged in coir units and their productivity is very low when comparing other village industries. A major portion of the workers in coir industry are women especially in the spinning as well as manufacturing sectors and their productivity is very low when comparing men workers. Labour absenteeism, low rate of wages, labour turnover, routine work, low labour productivity are the major problems of labour in coir industry.

Financial Problems

The coir units have more borrowed funds rather than the owned funds for its establishment as well as operation purposes. They depend on State Financial Corporations, Commercial Banks and Creditors for its requirements of both long-terms and short-term capital requirement purposes. They have no access to other sources of long-term funds like capital markets. The financial problem of coir units are timely non-available of borrowings, higher rate of interest, security, bank's rigid procedures. The credit worthiness of coir borrowers is generally weak and therefore they face reluctant creditors who may be induced to lend only at a very high rate of interest.

Production Problems

Coir units are unable to compete with other small scale industries due to non-availability of modern technology. Most of the coir units are using traditional methods and ratts to the coir production. The traditional methods and techniques lead to low productivity. Thus, Poor labour productivity, machine breakdowns, low rate of demand, power cut problems and higher rate of power charges are the chief production problems of coir units.

Marketing Problems

Marketing of finished products is another major problem faced by the industrial units. A number of marketing problems faced by coir industry like transport expenses, salesman expenses, involvement of agent, middlemen charges, substitute goods, market rate fluctuations and inadequate storage facilities for coir and coir products are some of the hardships faced by the industry.

Infrastructure Problems

Inadequate infrastructure facilities are the major problems for slow growth and development of coir industries in India. Most of the coir units working in rural areas encounter several problems like lack of power supply, water, roads, communication, canteen facilities and transports. Therefore, the inadequate infrastructure facilities will affect both quality and quantity of coir production and that leads to under-utilization of machine capacity and natural resources.

PROSPECTS OF COIR INDUSTRY IN INDIA

The perspective issues relating to the industry is that support because it gives livelihood for lakhs of workers by utilizing the discarded material of coconut. The industry also fetches crores of foreign exchange by export of coir and coir products. It is expected that the export will cross more than 1000 crores in 11thPlan Period. Government of India is providing a number of assistance to the coir units in the form of subsidies and training to the coir entrepreneurs for promoting coir industry in India. The Government of India is providing a wide net work of developmental institutions for promoting coir industry in the country like Coir Board, DIC, TIIC, SIPCOT etc. "The District Industries Centre have been acting as a nodal agency at pre-investment and post-investment stages and providing all the essential facilities to SSI entrepreneurs under one roof".6

Employment Opportunities

Being labour-intensive industry, coir industry provides self-employment opportunities to the people with small size of investment and little efforts and reduces unemployment and under employment problems. "The extensive improvement in the utilization of coconut husk from 50

percent to 60 percent will lead to employment generation up to 8,00,000 workers during the end of 11thFive Year Plan Period".7

Entrepreneurship Development

Coir industry is a great opportunity to the people for establishing as well as operating the industrial units without experience. It creates a good amount of savings and entrepreneurial skill among the people particularly in rural areas. Coir entrepreneurs also improve social welfare of a country. Thus, large amount of human resources is not only mobilised but also utilized by the coir sector for emerging as well as promoting entrepreneurship especially in rural areas and thereby improving the country's economy.

Income Generation

Coir industry generates income to the people viz., owners and workers. It generates more income to the entrepreneurs with low capital investment and training. Further, it also generates income to the people those who are engaged in coir industry. The Coir industry enormously contributes to reduce unemployment, to alleviate poverty, to improve the standard of living of the people, to provide income and to protect wealth of the people in the Indian society. It is the social uplift to the people especially those who are living below poverty line. Out of 80 percent of the women workforce, a major portion of the women workers are economically very weaker sections of the society. In India, alone, about half a million people depend on this industry for their livelihood.

Regional Dispersal of Industries

The migration of people from rural to urban areas for employment and earning more income leads to many evil consequences like overcrowding, pollution, creation of slums, etc. These problems in the Indian society can be solved by establishing and operating coir industry in terms of utilizing local and available natural resources and bring about dispersion of industries in various parts of the country and thereby promoting balanced regional economic development.

Technological Development

During initial stage, Coir industry was started as well as operated on traditional way. Now-a-days, it is avenue for absorbing innovation. They provide ample opportunities for the development of technology and technology in turn, creates an environment conducive to the development of coir units. They also facilitate the transfer of technology from one to the other. As a result, the economy reaps the benefit of improved technology.

Promotion of Exports

India exports 14 items of coir and coir products to more than 105 countries in the world and India has earned more foreign exchange through exports of coir and coir products to foreign countries. Indian coir and coir products have greater demand in the international markets due to its special features like colour, design, quality, uses, price, attractiveness and craftsmanship. Therefore, coir industries in India have potential for better overseas marketing.

Better Industrial Relations

Industrial disputes are reduced and efficiency of employees has increased through better industrial relations between the owner and workers. The waste of production and working days are comparatively less in coir units. Therefore, the better performance of coir industries in India

in terms of number of units, investment, production, employment and exports leads to the growth and development of the country's economy.

Government Supports

The government of India provides various assistances through Coir Board and DIC for promoting the coir industry in the form subsidies and trainings. The subsidies include power subsidy, capital subsidy and machinery subsidy and tax concessions. Further, Government is conducting various training programmes to the coir entrepreneurs or the coir manufacturer for promoting coir industry. Special training programmes have been formulated for women artisans. Modern traditional rats would be provided to the trained women so as to increase employment and earnings.

Hypothesis

H1: coir industry faces various problems in Banking sector

H2: There is no significant relationship between various problems faced by the coir industry and the future prospects for the coir industry.

METHODOLOGY

In Tamil Nadu, the Pollachi taluk in Coimbatore was purposely selected for the study because Pollachi taluk is the leading producer of coir in Tamil Nadu and it has largest number of coir industries namely 600 industries which engaged in coir fibre production (Brown & White) and coir pith production. Twenty industries were selected for primary data collection from this taluk. The secondary information such as export of coir and related products from India both product wise and country wise was collected for the period from 1998-2014 from the website of coir board. The tools of analysis used in the study are

1. **Break even output (BEO)**

   Break even output is the quantity at which all cost allocated to a product are equal to all revenue from its sale. If quantities produced is smaller than BEO, there is loss and vice versa. The BEO for the coir production units was calculated by using the following formula. Break even output = F / (P – V) Where, F = Fixed cost (Rs.); P = Unit output price (Rs. /ton) ; V = Unit variable cost (Rs. /ton).

2. **Investment Analysis**

   The discounted methods of analysis namely Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) were used to study the technical feasibility and economic viability of the coir industries. 3. The annual growth rate of quantity and value of export of coir products was estimated with compound growth rate analysis. The instability of coir products was measured by Coppack instability index. 4. Markov chain analysis was attempted to analyze the direction of trade and change in the export of coir products.

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MULTIPLE LINEAR REGRESSION ANALYSIS ON TOTAL COST INCURRED FOR TREATMENT OF ALCOHOL RELATED HEALTH PROBLEMS

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Health is defined as physical, mental and social well-being; not merely the absence of disease or disability. People constitute the valuable human resources needed for the development of any country. It is needless to say that the development of the national economy rests on the health, ability and well being of its people. This paper aims that alcohol is one of the causes of morbidity and mortality around the world. The complex relationships between policies, economics and politics of alcohol and public health and between governments, industry and individuals call for a thorough review of the current situation. While public health implications of policies concerning alcohol have long been accepted, the failure to implement many of these policies demands a more balanced and nuanced approach to the problem. Average volumes consumed and patterns of drinking are two dimensions of alcohol consumption that need to be considered in efforts to reduce the burden of alcohol-related problems. It is up to both governments and concerned citizens to encourage debate and formulate effective public health policies that minimize the harm caused by alcohol. This paper examines a multiple linear regression analysis on total cost incurred for the treatment among alcohol patients in Coimbatore. A survey method was adopted to collect data from 486 participants using interview schedule. Multiple linear regression models were used to analyze the data. The result showed that expenditure has increased significantly (at different levels) with an increase in the sample respondents' educational status, monthly income, total value of income from all sources and number of health problems from which they suffered.

Key Words: *Alcohol, Health, Socio-Economic Cost, Multiple Linear Regression.*

Introduction

The cost of illness is dependent on many variables. These include the type of disease, the number and severity of complications as well as the demographic characteristics of the study population. In a heterogeneous society like India, with great disparity in earning, access to medical care, as well as, differing quality of care, it is very crucial that all factors are taken into account to get the correct picture. The lack of medical records makes it even more difficult to carry out such studies (Kapur, A., 2001).

Review of Literature

In India, Government health policy is devolved to the individual States, and most often control is executed by restricting licenses to sellers. State monopolization of alcohol sales has been used in several countries including developing countries such as India. However, as one of the poorest states in India, West Bengal suffers from deep corruption and has failed to stop the production of illicit liquor. Illicit liquor is a hugely profitable industry in West Bengal, where bootleggers pay no taxes and sell enormous quantities of their product. Coupled with creating a stringent policy for the alcohol market, the West Bengal government should invest in designing socially and culturally sensitive interventions to avert alcohol use-related morbidity and mortality. The state of Gujarat in India, where alcoholic drinks are banned, recently approved a serious penalty for making, transporting or selling illicit liquor that leads to death (The Guardian, 2011). The government of West Bengal could review Gujarat's policy, and see if the programme is feasible to adopt.

Area of the study

Although studies have been conducted to assess Alcoholics and its risk factor burden in many regions of India, the data was not compiled together. Understanding this problem the researcher planned to conduct her survey in Coimbatore city. This city has a multi-cultural society, most of cosmopolitan nature. Its inhabitants are largely conservative and traditional, retaining their roots in their native villages. It is a Municipal Corporation as well as the District Headquarters. The city has numerous hospitals. Apart from the Government hospital, several multi-facility hospitals function in the city. The district health department is amongst the best in terms of implementing government-initiated health schemes. Also, several rare surgical procedures have taken place here. The city also has numerous homeopathic clinics run by Non-Governmental Organizations. Fast pace of industrialization, spiraling population and the increase in the health awareness have led to the growth of the healthcare industry in Coimbatore. The city stands second to Chennai in the Tamilnadu State for highly affordable and quality healthcare deliveries of international standards. Coimbatore is also the preferred health care destination for the floating population from nearby towns, districts and also nearby districts of Kerala. The growth of the hospitals in the city can be attributed to the vision of the industrialists here to bridge the gap between growing health needs and the existing services. Many of the private hospitals in the city are promoted by industrialists as an extension of their business portfolio and their service to society.

Table – 1

Results of Multiple Linear Regression Analysis on Total Cost Incurred for Treatment of Alcohol Related Health Problems

Explanatory Variables	Standardised Coefficient (ß)	t-value	p-value
Age (in Years)	-0.010	-0.224	0.823
Educational Status (7 Categories)	0.106	2.154	**0.05**
Monthly Income (in Rs.)	0.171	3.568	**0.001**
Total Value of Income from All Sources (in Rs.)	0.104	2.290	**0.05**
Alcohol Related Health Problems (Actual Nos.)	0.151	3.462	**0.001**
Nativity (Ref. Rural) Urban	-0.101	-2.257	**0.05**
Migration Status (Ref: *Migrated*) Not-migrated	0.117	2.697	**0.01**
Debt Position (Ref: *No Debts*) Have Debts	0.146	3.186	**0.01**
R^2 (in %) **Total Sample**	**14.2** **486**		

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Determinants of Total Cost Incurred for Treatment of Alcohol Related Health Problems

In the preceding section, gross differentials in the (average) total cost incurred for treatment for health problems are examined through cross-tabular analysis with one-way ANOVA. These straightforward tabulations provide us a general understanding of the nature of relationship between the independent variables (background characteristics of respondents) and dependent variable (total cost incurred for treatment for health problems) on one to one basis and therefore, these are less decisive. But in general context, at a point of time, any dependent variable would not only be influenced by one independent variable but also by several other such variables. Under these circumstances, multivariate analysis allows us a more accurate assessment of each of the explanatory variable by taking into account the potential confounding effects of other variables used in the model. Such an analysis would help us to know the crucial determinants of the dependent variable under consideration, which would be very useful to suggest policy implications and programmes for lessening the health problems related to drinking alcohol.

In view of the discussion stated above, an attempt is made here to analyse the principal determinants of total cost incurred for the treatment of alcoholic ill-health (problems) with the help of a multivariate technique. The dependent variable, total cost incurred for treatment of alcoholic related health problems, treated here as a continuous variable in nature (i.e., actual amount spent in Indian Rupees) and hence, multiple linear regression analysis is felt to be the most appropriate. The independent (explanatory) variables considered for analysis are based on the theoretical importance as well as their levels of significance with the dependent variable (except the age and educational status). Out of the 8 variable included in the model, 5 are continuous in nature and the other 3 are dummy variable type. More details about the multiple regression analysis are provided in the chapter on Methodology. Results based on multivariable analysis are provided in Table 1.

Data provided in Table 1 highlights that, among the total sample respondents, all the eight variables included in the model together have explained about 14.2 percent variation in total cost incurred for the treatment alcoholic related health problems. Controlling for all the variables included in the model, the total const incurred for treatment related alcoholic health problems of the respondents tend to increase significantly with an increase in their monthly income as well as with the total number of health problems from which they suffered ($p<0.001$ and $p<0.001$, respectively). Thus, the results indicate that, on the one side, the tendency to spend more and more money for the treatment of health problems is higher as their monthly income increasing ($\beta=0.171$), mainly due to accessibility and affordability of monetary resources. Likewise, it is pertinent to note that respondents are tend to incur large sum amount of money for the treatment of alcoholic health problems with an increase in the number of health problems from which they suffered ($\beta=0.151$). Such finding is obvious because of the need and human tendency to take treatment at the earliest for one or the other diseases, even with more amounts of money either from their personal income and/or money raised from different sources and/or borrowed from others.

Another striking finding noticed here is that the total cost for the treatment related to alcoholic health problems is observed to be fairly increasing with an increase in the their educational status, but the results are turned out as moderately significant ($\beta=0.106$; $p<0.05$). This is finding is also on the expected lines in the sense that as the level of education increases, respondents will have better knowledge to take sophisticated treatment even by paying large sums of money and further, those who have higher education are likely to be placed in better positioned jobs and thereby, earning higher amounts of money so as to have the affordability to take

treatment. Yet another major finding of this analysis is the positive net effect of total value of money raised from all sources for treatment on their cost of treatment. This finding is moderately significant (β=0.104; p<0.05) and thus, suggesting that respondents are able to spend comparatively higher amounts of money for treatment of alcoholic related health problems by pooling money from different sources.

Among the role of categorized variables on the cost incurred for treatment, it is conspicuous to note that the net positive effect of non-migrant status on the total cost spent for the treatment of alcoholic ill-health is significantly high (ß= 0.117; p<0.01) and thus, specify that respondents who are residing in the city of Coimbatore are spending lot of money for treatment for alcoholic ill-health as compared those who migrated to the Coimbatore and its surroundings. Another noticeable fact here is that those who have debt showed a higher tendency to spend higher amount for the treatment of alcoholic related health problems as compared to those who didn't have such debt, and this finding is also turned out as statistically highly significant (ß=0.146; p<0.01). Yet another interesting finding noticed here is that the sum of money spent for the treatment of alcoholic ill-health is reasonably much lower among those who born and brought up in urban areas than those whose nativity is rural areas and this finding also emerged as moderately significant (ß=-0.101; p<0.05). Finally, the amount of money spent for the alcoholic ill-health appears to be decreasing with an increase in their current age (ß=-0.010), but the t-test results didn't turned out significant.

Conclusion:

This study concludes that alcohol consumption has got negative impact on human health and burden of economy. The pattern of alcohol intake around the world is constantly evolving. There is thus a strong justification for the health profession to step up its health advocacy with respect to policies to reduce rates of alcohol consumption. Although India is generally considered a dry country, drinking practices differ considerably among people living in the southern, and even among members of different castes residing in the same region. In sum, the multiple regression analysis results on the total cost incurred for treatment of health problems among alcoholic respondents revealed that such cost has increased significantly (at different levels) with an increase in the sample respondents' educational status, monthly income, total value of income from all sources and number of health problems from which they suffered. Likewise, it is also conspicuous to note that the total cost incurred for the treatment of alcoholic ill-health (significant at different levels) is higher among those who have not migrated to Coimbatore city and who have debts than their respective counterparts. Conversely, such cost is lower among those respondents who born and brought up in urban areas as against to those whose nativity is rural areas. Current age percent has exhibited somewhat positive net effect on the total cost for treatment, but the t-test results turned out as insignificant.

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POTENTIALS OF FOOD GRAINS PRODUCTION AND IMPLICATIONS OF FOOD PROCESSING INDUSTRY

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INTRODUCTION

Food is a material consisting essentially of protein, carbohydrate, and fat used in the body of an organism to sustain growth, vital processes and to provide energy. The food also contains supplementary substances like minerals, vitamins and condiments.[1] India is one of the key food producers in the world, with the second largest arable land area. It is the largest producer of milk, pulses, sugarcane and tea in the world and the second largest producer of wheat, rice, fruits and vegetables.

TOTAL FOODGRAINS PRODUCTION[2]

The 4th Advance Estimates of production of major crops for 2016-17 have been released by the Department of Agriculture, Cooperation and Farmers Welfare on 16th August, 2017. The assessment of production of different crops is based on the feedback received from States and validated with information available from other sources. The following tables shows the estimated production of various crops as per the 4th Advance Estimates for 2016-17 vis-a-vis the comparative estimates for the years 2003-04 onwards.

[1] https://www.merriam-webster.com/dictionary/food

[2] Foodgrains production Report, (2018). Total Foodgrains production is estimated at record 275.68 million tonnes. *Press Information Bureau, Government of India, Ministry of Agriculture & Farmers Welfare,* 1-3.

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Agricultural Statistics Division Directorate of Economics & Statistics
Department of Agriculture, Cooperation and Farmers welfare
Fourth Advance Estimates of Production of Foodgrains for 2016-17 As on 16.08.2017 Million Tonnes

Crop	Season	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16		2016-17	
														4th Advance Estimates	Final	Targets	4th Advance Estimates
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Rice	Kharif	78.62	72.23	78.27	80.17	82.66	84.91	75.92	80.65	92.78	92.37	91.50	91.39	91.31	91.41	93.00	96.39
	Rabi	9.91	10.90	13.52	13.18	14.03	14.27	13.18	15.33	12.52	12.87	15.15	14.09	13.01	13.00	15.50	13.76
	Total	88.53	83.13	91.79	93.36	96.69	99.18	89.09	95.98	105.30	105.24	106.65	105.48	104.32	104.41	108.50	110.15
Wheat	Rabi	72.16	68.64	69.35	75.81	78.57	80.68	80.80	86.87	94.88	93.51	95.85	86.53	93.50	92.29	96.50	98.38
Jowar	Kharif	4.84	4.04	4.07	3.71	4.11	3.05	2.76	3.44	3.29	2.84	2.39	2.30	1.71	1.82	3.00	1.85
	Rabi	1.84	3.20	3.56	3.44	3.81	4.19	3.93	3.56	2.69	2.44	3.15	3.15	2.70	2.42	3.00	2.72
	Total	6.68	7.24	7.63	7.15	7.93	7.25	6.70	7.00	5.98	5.28	5.54	5.45	4.41	4.24	6.00	4.57
Bajra	Kharif	12.11	7.93	7.68	8.42	9.97	8.89	6.51	10.37	10.28	8.74	9.25	9.18	8.06	8.07	9.50	9.80
Maize	Kharif	12.73	11.48	12.16	11.56	15.11	14.12	12.29	16.64	16.49	16.19	17.14	17.01	15.24	16.05	17.50	19.24
	Rabi	2.25	2.70	2.55	3.54	3.85	5.61	4.43	5.09	5.27	6.06	7.11	7.16	6.56	6.51	7.00	7.02
	Total	14.98	14.17	14.71	15.10	18.96	19.73	16.72	21.73	21.76	22.26	24.26	24.17	21.81	22.57	24.50	26.26
Ragi	Kharif	1.97	2.43	2.35	1.44	2.15	2.04	1.89	2.19	1.93	1.57	1.98	2.06	1.79	1.82	2.00	1.40
Small Millets	Kharif	0.56	0.48	0.47	0.48	0.55	0.44	0.38	0.44	0.45	0.44	0.43	0.39	0.37	0.39	0.50	0.42
Barley	Rabi	1.30	1.21	1.22	1.33	1.20	1.69	1.35	1.66	1.62	1.75	1.83	1.61	1.51	1.44	1.85	1.74
Coarse Cereals	Kharif	32.22	26.36	26.74	25.61	31.89	28.54	23.83	33.08	32.44	29.79	31.20	30.94	27.17	28.15	32.50	32.71
	Rabi	5.39	7.10	7.33	8.31	8.86	11.49	9.72	10.32	9.58	10.25	12.09	11.92	10.77	10.37	11.85	11.48
	Total	37.60	33.46	34.07	33.92	40.75	40.04	33.55	43.40	42.01	40.04	43.29	42.86	37.94	38.52	44.35	44.19
Cereals	Kharif	110.84	98.59	105.01	105.78	114.55	113.45	99.75	113.73	125.22	122.16	122.70	122.34	118.48	119.56	125.50	129.10
	Rabi	87.45	86.64	90.21	97.30	101.46	106.45	103.70	112.52	116.98	116.63	123.09	112.53	117.28	115.66	123.85	123.63
	Total	198.28	185.23	195.22	203.08	216.01	219.90	203.45	226.25	242.20	238.79	245.79	234.87	235.76	235.22	249.35	252.73
Tur	Kharif	2.36	2.35	2.74	2.31	3.08	2.27	2.46	2.86	2.65	3.02	3.17	2.81	2.46	2.56	3.62	4.78
Gram	Rabi	5.72	5.47	5.60	6.33	5.75	7.06	7.48	8.22	7.70	8.83	9.53	7.33	7.17	7.06	9.60	9.33
Urad	Kharif	1.20	0.95	0.90	0.94	1.12	0.84	0.81	1.40	1.23	1.43	1.15	1.28	1.39	1.25	1.45	2.17
	Rabi	0.27	0.38	0.35	0.50	0.34	0.33	0.42	0.36	0.53	0.47	0.55	0.68	0.81	0.70	0.70	0.63
	Total	1.47	1.33	1.25	1.44	1.46	1.17	1.24	1.76	1.77	1.90	1.70	1.96	2.20	1.95	2.15	2.80
Moong	Kharif	1.43	0.81	0.69	0.84	1.25	0.78	0.44	1.53	1.24	0.79	0.96	0.87	1.02	1.00	1.22	1.62
	Rabi	0.28	0.25	0.26	0.28	0.27	0.26	0.25	0.27	0.40	0.40	0.65	0.64	0.59	0.59	0.65	0.55
	Total	1.70	1.06	0.95	1.12	1.52	1.03	0.69	1.80	1.63	1.19	1.61	1.50	1.60	1.59	1.87	2.16
Other Kharif Pulses	Kharif	1.18	0.61	0.54	0.70	0.96	0.80	0.49	1.33	0.93	0.62	0.71	0.77	0.67	0.72	0.96	0.86
Other Rabi Pulses	Rabi	2.48	2.32	2.31	2.29	2.00	2.23	2.31	2.27	2.40	2.73	2.53	2.77	2.37	2.47	2.55	3.02
Total Pulses	Kharif	6.16	4.72	4.86	4.80	6.40	4.69	4.20	7.12	6.06	5.91	5.99	5.73	5.54	5.53	7.25	9.42
	Rabi	8.74	8.41	8.52	9.40	8.36	9.88	10.46	11.12	11.03	12.43	13.25	11.42	10.93	10.82	13.50	13.53
	Total	14.91	13.13	13.38	14.20	14.76	14.57	14.66	18.24	17.09	18.34	19.25	17.15	16.47	16.35	20.75	22.95
Total Foodgrains	Kharif	117.00	103.31	109.87	110.58	120.96	118.14	103.95	120.85	131.27	128.07	128.69	128.06	124.01	125.09	132.75	138.52
	Rabi	96.19	95.05	98.73	106.71	109.82	116.33	114.15	123.64	128.01	129.06	136.35	123.96	128.21	126.47	137.35	137.16
	Total	213.19	198.36	208.60	217.28	230.78	234.47	218.11	244.49	259.29	257.13	265.04	252.02	252.22	251.57	270.10	275.68

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Fourth Advance Estimates of Production of Commercial Crops for 2016-17

As on 16.08.2017 Lakh Tonnes

Crop	Season	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16		2016-17	
														4th Advance Estimates	Final	Targets	4th Advance Estimates
Groundnut	Kharif	68.60	52.62	62.98	32.94	73.62	56.17	38.52	66.43	51.27	31.87	80.58	59.30	53.40	53.68	64.30	62.21
	Rabi	12.67	15.12	16.95	15.69	18.20	15.51	15.76	16.22	18.37	15.08	16.56	14.71	14.30	13.66	20.70	13.43
	Total	81.27	67.74	79.93	48.64	91.83	71.68	54.28	82.65	69.64	46.95	97.14	74.02	67.71	67.33	85.00	75.65
Castorseed	Kharif	7.97	7.93	9.91	7.62	10.54	11.71	10.09	13.50	22.95	19.64	17.27	18.70	16.50	17.52	22.00	14.21
Sesamum	Kharif	7.82	6.74	6.41	6.18	7.57	6.40	5.88	8.93	8.10	6.85	7.15	8.28	8.66	8.50	9.00	7.84
Nigerseed	Kharif	1.09	1.12	1.08	1.21	1.10	1.17	1.00	1.08	0.98	1.02	0.98	0.76	0.77	0.74	1.15	0.83
Rapeseed & Mustard	Rabi	62.91	75.93	81.31	74.38	58.34	72.01	66.08	81.79	66.04	80.29	78.77	62.82	68.21	67.97	85.00	79.77
Linseed	Rabi	1.97	1.70	1.73	1.68	1.63	1.69	1.54	1.47	1.52	1.49	1.41	1.55	1.32	1.25	1.60	1.54
Safflower	Rabi	1.35	1.74	2.29	2.40	2.25	1.89	1.79	1.50	1.45	1.09	1.13	0.90	0.64	0.53	1.60	0.78
Sunflower	Kharif	3.06	4.31	4.56	3.66	4.63	3.57	2.14	1.92	1.47	1.87	1.54	1.11	0.68	0.66	2.40	0.97
	Rabi	6.24	7.56	9.83	8.62	10.00	8.01	6.36	4.59	3.69	3.57	3.50	3.23	2.63	2.30	6.10	1.43
	Total	9.30	11.87	14.39	12.28	14.63	11.58	8.51	6.51	5.17	5.44	5.04	4.34	3.31	2.96	8.50	2.41
Soyabean	Kharif	78.18	68.76	82.74	88.51	109.68	99.05	99.64	127.36	122.14	146.66	118.61	103.74	85.92	85.70	136.15	137.94
Total Nine Oilseeds	Kharif	166.72	141.49	167.67	140.12	207.13	178.08	157.28	219.22	206.91	207.91	226.12	191.89	165.93	166.80	235.00	224.01
	Rabi	85.14	102.04	112.11	102.77	90.42	99.11	91.53	105.57	91.08	101.52	101.37	83.21	87.10	85.71	115.00	96.96
	Total	251.86	243.54	279.78	242.89	297.55	277.19	248.82	324.79	297.99	309.43	327.49	275.11	253.04	252.51	350.00	320.97
Cotton #	Total	137.29	164.29	184.99	226.32	258.84	222.76	240.22	330.00	352.00	342.20	359.02	348.05	301.47	300.05	360.00	330.92
Jute # #	Total	102.52	93.99	99.70	103.17	102.20	96.34	112.30	100.09	107.36	103.40	110.83	106.18	99.38	99.40	110.00	100.88
Mesta # #	Total	9.21	8.73	8.70	9.56	9.90	7.31	5.87	6.11	6.63	5.90	6.07	5.08	5.28	5.83	7.00	5.12
Jute & Mesta # #	Total	111.73	102.72	108.40	112.73	112.11	103.65	118.17	106.20	113.99	109.30	116.90	111.26	104.66	105.24	117.00	106.00
Sugarcane	Total	2338.62	2370.88	2811.72	3555.20	3481.88	2850.29	2923.02	3423.82	3610.37	3412.00	3521.42	3623.33	3521.63	3484.48	3550.00	3067.20

Lakh bales of 170 kgs. each
Lakh bales of 180 kgs. each

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The following are the estimated production of major crops during 2016-17.

- Foodgrains – 275.68 million tonnes (record)
  - Rice – 110.15 million tonnes (record)
  - Wheat – 98.38 million tonnes (record)
  - Coarse Cereals – 44.19 million tonnes (record)
  - Maize – 26.26 million tonnes (record)
  - Pulses – 22.95 million tonnes (record)
  - Gram – 9.33 million tonnes
  - Tur – 4.78 million tonnes (record)
  - Urad – 2.80 million tonnes (record)
- Oilseeds – 32.10 million tonnes
  - Soyabean – 13.79 million tonnes
  - Groundnut – 7.56 million tonnes
  - Rapeseed & Mustard – 7.98 million tonnes
  - Castorseed – 1.42 million tonnes
- Cotton – 33.09 million bales (of 170 kg each)
- Sugarcane – 306.72 million tonnes

[3]As a result of very good rainfall during monsoon 2016 and various policy initiatives taken by the Government, the country has witnessed record foodgrain production in the current year. As per Fourth Advance Estimates for 2016-17, total Foodgrain production in the country is estimated at 275.68 million tonnes which is higher by 10.64 million tonnes (4.01%) than the previous record production of Foodgrain of 265.04 million tonnes achieved during 2013-14. The current year's production is also higher by 18.67 million tonnes (7.27%) than the previous five years' (2011-12 to 2015-16) average production of Foodgrains. The current year's production is significantly higher by 24.12 million tonnes (9.59%) than the last year's foodgrain production.

Total production of Rice is estimated at record 110.15 million tonnes which is also a new record. This year's Rice production is higher by 3.50 million tonnes (3.28%) than previous record production of 106.65 million tonnes achieved during 2013-14. It is also higher by 4.74 million tonnes (4.49%) than the five years' average Rice production of 105.42 million tonnes. Production of rice has increased significantly by 5.74 million tonnes (5.50%) than the production of 104.41 million tonnes during 2015-16.

Production of Wheat, estimated at 98.38 million tonnes is also a record. This year's wheat production is higher by 2.64% than the previous record production of 95.85 million tonnes achieved during 2013-14. Production of Wheat during 2016-17 is also higher by 5.77 million tonnes (6.23%) than the average wheat production. The current year's production is higher by 6.10 million tonnes (6.61%) as compared to Wheat production of 92.29 million tonnes achieved during 2015-16. Production of Coarse Cereals estimated at a new record level of 44.19 million tonnes is higher than the average production by 2.85 million tonnes (6.88%). It is higher than the previous record production of 43.40 million tonnes achieved during 2010-11 by 0.79 million

[3] http://pib.nic.in/newsite/PrintRelease.aspx?relid=170036

tonnes (1.82%). Current year's production is also higher by 5.67 million tonnes (14.72%) as compared to their production of 38.52 million tonnes achieved during 2015-16.

As a result of significant increase in the area coverage and productivity of all major Pulses, total production of pulses during 2016-17 is estimated at 22.95 million tonnes which is higher by 3.70 million tonnes (19.22%) than the previous record production of 19.25 million tonnes achieved during 2013-14. Production of Pulses during 2016-17 is also higher by 5.32 million tonnes (30.16%) than their Five years' average production. Current year's production is higher by 6.61 million tonnes (40.41%) than the previous year's production of 16.35 million tonnes. With an increase of 6.85 million tonnes (27.11%) over the previous year, total Oilseeds production in the country is estimated at 32.10 million tonnes. The production of Oilseeds during 2016-17 is also higher by 2.84 million tonnes (9.72%) than the five year's average Oilseeds production.

Production of Sugarcane is estimated at 306.72 million tonnes which is lower by 41.73 million tonnes (-11.98%) than the last year's production of 348.45 million tonnes. Despite lower area coverage during 2016-17, higher productivity of Cotton has resulted into higher production of 33.09 million bales (of 170 kg each), i.e. an increase of 10.29%, as compared to 30.01 million bales during 2015-16. Production of Jute & Mesta estimated at 10.60 million bales (of 180 kg each) is marginally higher (0.73%) than their production of 10.52 million bales during the last year.

SCOPE OF FOOD PROCESSING INDUSTRY IN INDIA[4]

As per an estimate, India's current food processing industry is estimated at USD 130 Billion and expected to attract huge domestic and foreign investment. Some of the key factors which are likely to increase the demand for processed food and consequently the food processing industry in the coming years are -

- India is a country of over 1.25 billion population. With rising middle class having a considerable disposable income, the domestic market offers 1.25 billion opportunities for the sector.
- India ranks no 1 in the world in the production of milk, ghee, ginger, bananas, guavas, papayas and mangoes. Further, India ranks no 2 in the world in the production of rice, wheat and several other vegetables & fruits. If the surplus production of cereals, fruits, vegetables, milk, fish, meat and poultry, etc are processed and marketed both inside and outside the country, there will be greater opportunities for the growth of the sector.
- Due to rapid urbanization, food habits are changing rapidly towards value-added foods. The change is accentuated by the fact that over 65% of India's population is 35 or under, who are inclined to have processed food.
- Next to China, India is among the fastest growing economies in the world. The recent quantum jump in the ease of doing business ranking of the World Bank (from 130 to 100) indicates the conducive business climate in the country and it is expected to attract foreign investment into this sector.

[4] IBEF India Brand Equity Foundation. Food Processing, Market & Opportunities. *Report, Fastest growing free market democracy*, 1-25.

- As per an estimate, around 40 percent of total food production is wasted due to the inadequate facilities for transportation, storage, processing and marketing. If these deficiencies are addressed, there is a huge scope for the development of the sector.

IMPORTANCE OF FOOD PROCESSING[5]

Food has been processed and packaged since the earliest days of man's history on earth. Meat and fish were salted, smoked and dried. Herbs were dried and stored for use as medicines. Alcoholic beverages were made from fruits and cereals. In the early days of traditional food processing the main aim was preservation to maintain a supply of wholesome, nutritious food during the year and in particular to preserve it for hungry periods, for example when hunting was poor. Food was seldom sold but traded and bartered. While food processing still has the main objective of providing a safe nutritious diet in order to maintain health, other aspects, particularly the generation of wealth for the producer and seller, have become increasingly important.

With the change from traditional to industrial food processing there has also been a change in the types of product processed. Traditional processors worked with foods that grew locally and the methods they developed were in harmony with the climate in which they lived. Only simple packaging using leaves, animal skins and pottery was possible and necessary to protect the food for its planned storage life. Nowadays non-traditional crops are grown all over the world. For example, the potato which originated in Peru, rice which came from Asia, and numerous fruits and vegetables are now grown away from their area of origin. This together with consumer demand influenced by radio, advertising and television has lead to a demand for non-traditional foods that are not appropriate to the local environment. They need special processing and packaging to protect them for their required storage life.

While most people in the world still rely on traditional foods for their basic diet, those in industrialized centres tend more and more to purchase processed and packaged foodstuffs for convenience. The increasing number of women who now work away from home adds additional pressure for such changes. Even people with a heavily traditional diet are demanding external products either as occasional treats, such as gassy drinks or basic commodities such as white sugar and flour. To meet these demands the industrial food processing sector has emerged. Food and crop processing is generally considered to be the largest industry in most countries.

1.9 BENEFITS OF FOOD PROCESSING[6]

Throughout the history of humanity, man has been mostly limited to consuming foods either readily available or preserved in limited fashion via smoking, salting and pickling. It was not until the Industrial Revolution and mass-producing techniques that processed, preserved foods became widely available. Food processing has numerous benefits as well as some drawbacks.

Preservation

When you process foods, you often make them far easier to store and preserve. Some food processing techniques, such as freezing, preserve the nutritional content, according to the European Food Information Council. Other methods, such as cooking, can also improve nutritional content. Further, preserved food is available for much longer time periods than non-

[5] http://collections.infocollections.org/ukedu/uk/d/Jto01ae/3.1.html

[6] https://www.livestrong.com/article/454626-what-are-the-benefits-of-food-processing/

preserved foods, making them easier to keep and store without the consumer having to make more frequent purchases.

Safety

Another key benefit to processing foods is the ability for producers to ensure food safety and remove or prevent dangerous toxins. Milk pasteurization, for example, removes harmful bacteria from raw milk, making it suitable for human consumption. Food processing methods that remove water, such as drying and smoking, reduce or limit the possibility of bacterial growth because the bacteria rely on the water to grow and multiply.

Convenience and Marketing

Processing enables manufacturers to provide a mostly uniform product. This means that if you buy a bottle of name-brand beer today, the bottle of the same beer you buy tomorrow will be the same product. Processing also allows for quicker and easier consumption. Eating a pre-made and processed meal, for example, allows the consumer to spend much less time in preparation and cooking.

DRAWBACKS

While there are many benefits to processed foods, that doesn't mean no drawbacks exist. One significant downside is that food processors must often add salt in the preservation process. Thus, people who eat a lot of processed foods have much higher sodium levels. Elevated sodium levels can lead to significant health problems, including high blood pressure and a higher risk of strokes and other serious medical conditions.

CONCLUSION

Industrialization is the process of manufacturing consumer goods, capital goods and building infrastructure in order to provide goods and services to both individuals and businesses. Out of various manufacturing industries, food processing involves the conversion of raw ingredients into more acceptable food farms. In India, potential for agro-processing industrial development depends on the availability of abundant raw materials and low labour cost. Indian food processing industry is the World's second largest producer of food next to China and has the potential of being the biggest in the food and agricultural sector. At the same time, with the growth of the economy, a change is also seen in the food basket of cereals to a more varied and nutritious diet of fruits and vegetables, milk, fish, meat and poultry products. Due to its diverse agro-climatic conditions, it has a wide-ranging and large raw material base suitable for food processing industries. Presently, a very small percentage of these are processed into value added products. Food processing industries can absorb a major share of workers from the agriculture sector, who face disguised unemployment. It can lead to better productivity and GDP growth. Thus, a strong and dynamic food processing sector plays a vital role in reduction in the wastage of perishable agricultural produce, enhancing shelf life of food products, ensuring value addition to agricultural produce, diversification & commercialization of agriculture, generation of employment, enhancing income of farmers and creating surplus for the export of agro & processed foods. In the era of economic liberalization, all segments including; private, public and co-operative sectors have defined roles to play and only their active participation will make this endeavor a success. Hence, the Indian food processing industry has a huge potential for the growth and boost countries competitiveness.

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CRITICAL EVALUATION OF IMPLEMENTATION OF INDIRA AWAAS YOJANA (IAY)

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Housing is accepted as basic need for the survival of human beings. Housing could be an elementary human need and it is a basic demand for human survival similarly as for a good life. Ownership of a house provides significant economic security and social status for a citizen in the society. The identity and social recognition associated with ownership of a house provides an individual with immense confidence to get involved into many social activities. A person deprived of this basic need faces all odds of life and remains discriminated and marginalized in the society. The Indira Awaas Yojanaa (renamed as Pradhan Manrti Grameen Awaas Yojana on 20th November 2016) centrally sponsored scheme of Ministry of Rural Employment, Government of India is one of the most important poverty alleviation programme in the country which play a vital role in the upliftment of the living standard of poor people in rural areas. The Indira Awaas Yojana (IAY) was launched keeping the basic need of millions in mind. Almost half of the Indian population resides in villages, villages which often lack basic infrastructure. This scheme aims to reduce the number of homeless people in the country and fulfilling basic criteria of accommodation for millions. This paper has made an analysis on the evaluation of the IAY scheme over the beneficiaries and their satisfaction level.
Keywords: Housing, Survival, Indira Awaas Yojana (IAY), Millions

Introduction

Housing is one of the basic requirements for the survival of human beings. Ownership of a house provides significant economic security and social status for a citizen in the society. The identity and social recognition associated with ownership of a house provides an individual with immense confidence to get involved into many social activities. Stable, affordable and accessible housing is directly and indirectly linked to human well-being. One can easily understand the socio-economic status of a family just by watching physical attributes of their housing. Good housing and its surroundings indicate the standard of living of the family. It provides facilities for education, recreation and many other facets of life. A person deprived of this basic need faces all odds of life and remains discriminated and marginalized in the society.

Housing contributes significantly towards the configuration of cultured human existence. Around one third of the human populations in urban as well as rural areas in the country are deprived of adequate housing facilities. Out of the estimated 200 million families in India, approximately 65 to 70 million families do not have adequate housing facilities. They are not able to procure a house for want of financial resources. The situation of the Scheduled Tribes, Scheduled Castes and the other socially and economically backward class families are worst affected by poor housing conditions. Hence, fulfilling the need for rural housing and tackling housing shortage particularly for the poorest is an important task to be undertaken as part of the poverty alleviation efforts of the government.

The Indira Awaas Yojana (renamed as Pradhan Manrti Grameen Awas Yojana on 20th November 2016) centrally sponsored scheme of Ministry of Rural Employment, Government of India is one of the most important poverty alleviation programme in the country which play a vital role in the upliftment of the living standard of poor people in rural areas. This scheme is being implemented in all the districts of the state through Rural Development Department, Tamil Nadu on 75:25 cost sharing basis between Centre and State respectively.

Objective

The objective of IAY is primarily to provide grant for construction of houses to members of Scheduled Castes/Scheduled Tribes, freed bonded labourers and also to non-SC/ST rural poor below the poverty line.

Implementation of Indira Awaas Yojana

The Seventh Five Year Plan recognized radical reorientation of all housing policies and stated that "major responsibility of house construction would have to be left to the private sector, in particular the household sector". Furthermore, it stated that the government should be involved in housing "not so much to build but to promote housing activity". The public-private partnership concept for housing provision was put to test bed during the nineties. In this direction, the Eighth Plan envisaged "housing essentially as a private activity" but also recognized the need for state intervention "to meet the housing requirements of a majority of vulnerable sections as well as to create an enabling environment for accomplishing the goal of 'shelter for all' on a self-sustaining basis".

Indira Awaas Yojana, which used to be a component of Jawahar Rozgar Yojana became an independent Scheme from 1997-1998 onwards. The beneficiaries are selected from the Below Poverty Line (BPL) list approved by the Grama Sabha. Atleast 60% of the total IAY allocation during a financial year should be utilized for construction/ upgradation of dwelling units for SC/ST BPL rural households. A maximum 40% of allocation is for non- SC/ST BPL rural households. 3% of the above categories should be allocated for physically and mentally challenged persons. Government of India has also asked the States to earmark 15% of the beneficiaries from amongst minorities. It is funded by the Centre and State in the ratio of 75:25. From the year 2011-2012 to 2015-2016, 4,41,637 houses have been taken up at the cost of Rs.4875.728 crore. Further, the sharing pattern of Central and State has been changed as 60:40 from the year 2015-16 onwards. From the year 2015-16 onwards, payments to the beneficiaries are being credited to their bank account through Public Financial Management System (PFMS). For the year 2015-16, 45,788 houses have been allotted under Pradhan Mantri Awaas Yojana (Gramin).

Identification of Beneficiaries

The District Panchayat/ Zilla Panchayat/ District Rural Development Agencies (DRDAs) on the basis of allocations made and targets fixed, decide the number of houses to be constructed/ upgraded Panchayat-wise under IAY, during a particular financial year. The same is be intimated to the Gram Panchayat concerned. Thereafter, the Gram Sabha selects the beneficiaries from the list of eligible BPL households, restricting this number to the target allotted as per the Programme Guidelines. Selection by the Gram Sabha is final. No approval by a higher body is required. Zilla Parishads/ DRDAs and Block Development Offices should be sent a list of selected beneficiaries for their information. The allotment of house unit is made in the name of the female member of the household. Alternatively it could be allotted in the name of both wife and husband. Prioritization of beneficiaries is as follows:

- Members of Scheduled Castes and Scheduled Tribes(SC/ST)
- Members belonging to minorities
- Members who fall below the poverty line
- Widows
- Family members of defense personnel who lost their during lives in action
- Ex-servicemen/women and members of the paramilitary forces

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Allotment of Houses

Allotment of houses should be in the name of female member of the beneficiary household. Alternatively, it can be allotted in the name of both husband and wife.

Location of IAY houses

The houses under IAY should normally be built on individual plots in the main habitation of the village. Landless labourers which were given Rs.10,000 for buying land would now be given Rs.20,000. The houses can also be built on micro habitat approach or in a cluster within a habitation, so as to facilitate the development of infrastructure, such as, internal roads, drainage, drinking water supply etc. and other common facilities. Care should always be taken to see that the houses under IAY are located close to the village and not far away so as to ensure safety, security, nearness to work place and social communication.

Involvement of beneficiaries

The construction of the houses should be done by the beneficiaries themselves from the very beginning. The beneficiaries may make their own arrangement for the construction, engage skilled workmen on their own and also contribute family labour. The beneficiaries will have complete freedom as to the manner of construction of the house which is their own. This will result in economy in cost, ensure quality of construction, lead to satisfaction on the part of beneficiaries and acceptance of the house. The responsibility for the proper construction of the house will be on the beneficiaries themselves. A Committee of the beneficiaries may be formed to coordinate the work.

Provision of house sites

The landless poor are particularly vulnerable as they bear the double disadvantage of being unsheltered and with no land to build a house on. Assistance as per Schedule would be provided for the purpose of providing house sites.

State Governments may notify the entitlements for house sites in their respective States. If justified, this could vary within the State. Different extents of land may be prescribed for different localities based on the availability of land and its cost. Ideally 10 cents of land should be provided.

For the house sites component, the District Collector should identify public lands available in the habitations and allot them to the eligible landless. In case public land is not available the required land may be purchased by following the procedure prescribed by the State government. If this is not possible, land acquisition may be undertaken as the last resort.

While selecting land, it should be ensured that it is fit for construction of houses especially in terms of connectivity, availability of drinking water, access to public institutions, etc. The State should ensure that site is chosen with the involvement of the people for whom it is meant and is fully acceptable to them.

If money provided under the scheme is not sufficient, additional funds may be provided by the State Government. If the beneficiary is willing to purchase the land she may be reimbursed the eligible amount after due verification. States should issue detailed guidelines for this component.

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The States may prepare projects for providing houses to all such landless people who have been given land sites and give special priority to them under IAY. Once the details of such landless people to be given housing sites are available, Ministry of Rural Development would earmark a stream of IAY funds exclusively for the benefit of this group based on a formula and this amount would be non-divertible.

Conclusion

The Indira Awaas Yojana has been renamed as Pradhan Manrti Grameen Awaas Yojana on 20th November 2016. The main objective of the scheme is to provide a finance aid to the members of scheduled castes/ scheduled tribes freed, bonded labourers and also to other non Scheduled Castes/ Scheduled Tribes rural poor below the poverty line for the construction of their dwelling units by providing a lump sum amount as financial assistance. It may be concluded that IAY has benefited a number of families living in rural areas. Almost all the beneficiaries were satisfied with the implementation of the scheme.

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IMPEDIMENTS IN MARKETING OF AGRICULTURAL PRODUCTS – A STUDY

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India has been an agricultural country since time immemorial. Agriculture has been the main source of livelihood of the people of this country. Agricultural marketing plays an important role not only in stimulating production and consumption but in accelerating the pace of economic development. Its dynamic functions are described as the most important multiplier of economic development. Efficient marketing plays a very important role not only in rising economic activity but also in making economic use of what is produced. India's prosperity depends upon the agricultural prosperity. The Indian council of Agricultural Research defined it as Agricultural marketing involves three important functions, namely assembling (concentration) preparation for consumption (processing) and distribution (dispersion).This paper highlights the various problems in marketing of agricultural products. It covers the importance of agricultural marketing, functions of agricultural marketing and the reforms required to rectify the problems.
Key words: Marketing, Economic development, Products, Sales.

Introduction

The term agricultural marketing is mixing Agricultural marketing means the economic process under which agricultural goods are exchanged. The Agricultural marketing system is a link between the farm and non-farm sectors. Agricultural marketing is a specific part of marketing. It is related to agricultural products only. It is the base of most of the economic activities of a country. It brings marketable surplus to the market for sale. Farmers will keep a portion of their produce for self. Consumption and cattle and the remaining portions are left for sale. Higher level of marketable surplus leads to greater economic development.[1] Marketing is essential to all types of production, but in agriculture it is all the more important due to its peculiarities which require special arrangement for sale. Marketing of agricultural produce is considered as an integral part of agriculture, since an agriculturist is encouraged to make more investment and to increase production.[2]

Ancient and Modern Marketing

Agricultural marketing involves in its simplest form the buying and selling of agricultural produce. This definition of agricultural marketing may be accepted in olden days, when the village economy was more or less self-sufficient, the marketing of agricultural produce presented no difficulty, as the farmer sold his produce direct to the consumer on cash or a barter basis. But, I modern times, marketing of agricultural produce is different from that of olden days. In modern marketing agricultural produce has to undergo a series of transfers or exchanges from one hand to another before it finally reaches the consumer.[3]

[1] Dr. D. Amutha, *Agricultural Economics, Managalam Publications,* Delhi, 2016, p.122.

[2] Ibid., p.278

[3] Pratap mal, *Infrastrturcal Development for Agriculture and Rural Development*, Mohit publications, New Delhi,2001,p.141.

Functions of Agricultural Marketing

The major marketing functions involved in agricultural marketing are;

- Concentration
- Grading
- Processing
- Warehousing
- Packaging
- Distribution.[4]

Facilities Needed for Agricultural Marketing

In order to have best advantage in marketing of his agricultural produce farmers should enjoy certain basic facilities like

- They should have proper facilities for storing their goods.
- They should have adequate and cheap transport facilities which could enable them to take their surplus produce to the mandi rather than dispose it of in the village itself to the village money – lender-cum-merchant at low prices.
- They should have clear information regarding the market conditions as well as about the ruling prices, otherwise may be cheated.[5]

Importance of Agricultural Marketing

The importances of agricultural marketing are:

- Provides raw materials for industries.
- Provides food grains for the entire population and fodder for cattle.
- Provides a base for expansion of internal market of a country.
- Helps in the expansion of international market also when marketable surplus found in excess of the demand of a country fetches a considerable amount of foreign exchange.

At present most of the farmers sell their produce through village level markets, fairs and mandies. [6]

Defects of Agricultural Marketing

1. Lack of transport facilities

This problem has many dimensions lack of transport service in reasonable agricultural marketing areas, seasonality of transport service, high freight charges due to inadequacies, lack of all – weather roads and transport vehicles, unsuitability of the present transport facilities for transportation of some products like fruits, vegetables, eggs, etc. In some cases there are insufficient vehicles to carry goods from the farms to the rural markets to the towns. In other

[4] Ibid.,p.278

[5] Dr. V. Vijayalakshmi, *Development of Indian Agriculture*, Sreeranga printers Pvt.Ltd, Banglore, 2011, p.45.

[6] Ibid.,p.46

cases, transport accounts for a large proportion of marketing costs. In some instances, there are no roads or where they exist, they might be seasonal. Feeder roads are usually few and, in most cases, have to be constructed and maintained by communal efforts.[7]

2. Growth of urban centres

The Growth of urban centre creates more marketing problems concerned with inadequate supply to meet the increase in size; the need to create new markets, storage and even parking problems for prospective buyers who own cars.

3. Inadequate storage facilities

The Indian farmer is very poor, illiterate and ignorant. First of all he does not have facilities for storing his produce. The storage facilities which are available in the villages at present are so poor that 10 to 20 per cent of the produce is eaten away by rats.

4. Forced sales

The average farmer is so poor and indebted that he has no sufficient time to wait for better prices. He is forced to sell his yield to the money lender or to the trader so as to clear his debts. Such distress sales weaken the already miserable position of the average Indian farmer further.[8]

5. Multiplicity of Weights and Measures

Through the use of false weights and measures, through unnecessary deduction on the plea that his produce is of inferior quality the farmer often loses in going to the mandis. There is lack of standard weights and measures. Weights made of sticks, stones, bits of old iron are commonly used in the villages and markets.

6. Too many intermediaries

The number of intermediaries and middlemen between the farmer and the final consumer of his produce is too many and the margin going to them too large.[9]

7. Lack of communication on market

The farmers are not getting information about the ruling prices in the big markets. As a result the farmers have to accept whatever price is quoted to them and have to believe whatever the traders tell them.

8. Lack of organization

There is lack of organization among producers. Producers are small and scattered. They have no collective organization of their own to protect their interest.[10]

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[7] Op.cit., D. Amutha, p.125.

[8] Dr. Jeevan kumar Motiram Talathi, *Agricultural Economics and Agribusiness Management*, Ane Books pvt. Ltd, Delhi, 2011, p.133.

[9] Ibid., p.136.

[10] Op.cit., D. Amutha, p.128.

9. Malpractices of Markets

- Malpractices in scales and weights.
- Arbitrary deduction for religious and charitable purposes.
- Large quantity of produce is taken away as sample.
- Secret bargain between the seller's agent and the buyer's agent.
- The broker is in more contact with the buyer than the seller. As such he in favour of the buyer.

10. Adulteration

Adulteration is often restored by the middlemen which affects the health of the people. Due to adulteration the quality of the produce is reduced.[11]

Steps taken to improve the agricultural marketing

The government has taken various steps to improve the conditions of agricultural marketing. Its setup the all India ware Housing Corporation to construct and manage a whole network of warehouses in all towns. To promote warehousing in villages the cooperative societies are given necessary financial and technical facilities. Cooperative marketing and processing societies have been started to market the agricultural goods of the formers. Rural transport has been given importance under the five year plans and considerable progress has been made. Regulated markets are in operation and the interest of the formers has been well safeguarded in these markets. Considerable publicity is given to market information food grain prices are being stabilized by the government through the recommendations of the agricultural prices commission. Yet only 35-45 percent of the formers use these facilities.[12]

Remedial measures for improvement of Agricultural Marketing

- Establishment of regulated markets.
- Establishment of co operative marketing societies.
- Extension and construction of additional storage and warehousing facilities for agricultural produce of the farmers.
- Make arrangement for education for education and awareness program for rural farmers in order to improve their knowledge in improving agro produce and its marketing process.
- Implement the rural development program in fast track to develop the infrastructural facilities such as road facility, communication facility, electricity, etc., in rural areas. This will be help for easy transportation of agro produce to the market place.[13]

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[11] Balaji, *Improving Agricultural Productivity is Crucial*, The Economic Times, July 21, p.15.

[12] Dr. Rais Ahamed, *Agriculture and Food security*, Regal Publications, New Delhi, p.28.

[13] M.S. Randhawa, *A History of Agriculture in India*, Indian council of agricultural Research, New Delhi, 1980, p.42.

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Conclusion

The Government must frame and formulate new regulations according to the situation in the country. They must fix the price for the certain goods. Government must check and verify the functioning of co-operative Marketing and processing societies in rural areas. Wider publicity is must about agricultural marketing information. The defects of Agricultural Marketing can be removed by periodic evaluation and monitoring of functioning of Regulated Market, Use of Standard Weights and Measures, Storage and warehousing facilities Improvement in Transport Facilities, Provision of Marketing Information and development of Co-operative Marketing. Government should facilitate a link between the University of Agricultural Sciences and farmers. Periodical awareness programs mode of scientific farming training conducted by these universities would help the farmer in better cultivation.

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THE ROLE OF THE KOTAR WOMEN IN THE NILGIRI DISTRICT

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Kota or Kothar are one of the many tribal people indigenous to the Nilgiri mountain range in Tamilnadu. The other tribal people are Todas, Irulasand Kurumbas. Todas and Kotharshave been subject to intense anthropological, linguistic and genetic analysis since the early 19th century, numerically, Kotar have always been a small group not exceeding 4000 individuals spread over seven villages for the last 150 years. They have this own unique language that belongs to the Dravidian language family. The Government of India consider them to be a Scheduled Tribe (ST). But Kotasare relatively successful people who make their living as agriculturalist, doctors, postmasters and availing themselves of any government and private rector employment. It is agreed by linguists and anthropologists that Kotar may have entered the Nilgiri massif from Kerala or Karnataka in centuries BCE and developed in isolation from the rest of the society. Kotar women had their own rights in choosing their marriage partners. They would also help out in many economic activities. They were also exclusively engaged in making pottery. They always maintained a distance from outsiders. Here my research findings will highlight the role of Kotar women in the socio-economic sectors associated with the District of Nilgiri.
KEYWORDS: Kothar women, tribal people, scheduled tribe.

INTRODUCTION:

The term "tribe" and "tribal" means a human social group that tangles with their own customs, traditions, common language, territory, background and their own way of living. Many countries have different tribes. This paper is going to forecast mainly on Kota tribe from the 6 primitive tribal communities of the Nilgiri District. This presentation highlights and showcases the kota tribe in detail especially in the Nilgiri District. Kotas, also called askothar orkov by self-designation, they have allied themselves in all facilities, improvised their socio-economic status and not depending on the traditional services for living their life. Women constitute the silent of the world population. Empirical studies on women started, only during 19thcentury. The kota women are of the moderate height of fair built body and not nearly so good looking as the men. In this context an attempt has been made by the investigator to study the " Role of the Kota Women in Nilgiri District".

Among the 6 primitive communities, Toda and Kota plays most significant role among the others. One of the several communities thought to be indigenous to the Tamil Nadu District of Nilgiris Hills is Kota in South India. The government classified it as a scheduled tribe. The word "Kota" was given by the outsiders, they call themselves asKov. In this modern world, the settlement of Kota's success is somehow related to the maintenance jack – of – all trades.

KOTA'S SETTLEMENT:

Kota's occupyseven villages distributed rather widely throughout the Nilgiri District. They are classified under seven domains:

1. New Kotagiri (PorgadKokkal):

The new village is "Porgad Kokkal" as New Kotagiri which is situated near Kotagiri Public School. The speciality of this village is the people over here were a unique traditional dresses and sing praises to their deity in a most grand way.

2.Trichigadi (ThickandKokkal):

Trichigadi village or Thickand Kokkalis the biggest among all the other seven villages of Kota tribes of Nilgiri district, situated near Kaguchi. A tremending personality of fame is date ShriLakshman, a scholar, who worked in HOF as Hr. Manager. He had contributed and done so many improvements in for all the Kota village, which replenish the fame of this village.

3.KilKotagiri(KeynadKokkal):

KeynadKokkal otherwise called as KilKotagiri which is on the way to Sholurmattum. The proudness of this village lies on the mass blooming of the "neelakuriniji" (StrobilanthesKunthianus) which blooms its petals once in every 12 years. According to The Hindu, " The neelakurinji, from which the Niligiri mountains got their eponymous name, was last seen to bloom in the same area in 2006.

4.Kolimalai (KolmelKokkal):

KolmelKokkal, widely known as Kollimalai. The fascinating one in kolli hills is that the tourist people cannot miss. The shandyas it is located strategically opposite to the Highways Travellers Bangalow, where the tourists witness and negotiate nearly 70 hairpin bends to reach the next tourist destination, Solakadu.

5. KundahKotagiri (MenadKokkal):

The first settlement in Kotapuranas is Kundah. It is also called as MenadKokkal. It is situated near Bikkati, ooty Taluk is 34kms from ooty bus stand. Breeks (1873) has viewed that sholur is the oldest of all Kota villages (varadharajan, 1979).

6. Kokkal (KalgaasKokkal):

Ancient name of their village is (KalgaasKokkal).It is presently addressed as Upper Gudalur. It's taluk is 4kms far away from Gudalur bus stand nearly 10.

7. Sholur (KurgochKokkal):

Sholur is also known as KurgochKokkal. It is situated in ooty taluk just 16kms from ooty bus stand.

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SOCIAL LIFE:

The social organisation of any society involves mutual relation obligations, elements of idea behaviour anticipated behaviour and accrual behaviour of the community members. Thus social organisation is the network of relations existing among individuals and groups in a society.

The historical aspects of kota polyandry frame a significant problem. Before, the English came up to the Nilgiri plateau, its inhabitants were relatively isolated from the main currents of South Indian life. Contact with the people of the lowlands were few, since the honey up the hills was hard and hazardous. Soon after the Europeans discovered that the climate to the plateau was a life saving refuge from the fevers of the plains, roads and later railroad were built. In the wake of the English came Tamilians and other lowland Hindus. Within the last fifty years, the advent of these newcomers has effected significant changes in the tribal culture. New deities have been adopted, new methods of cultivation practiced. It is striking that there has been no change in the practice of polyandry. Other of the tribal institutions, economic, religious, political, have been affected, yet polyandry flourishers with full vitality.

ROLE OF KOTHAR WOMEN:

A man have more than one wife and so the kota martial system includes true polygamy as well as fraternal polyandry. A women lives only in the house of her legal husband and he is recognized as the father of the children these bears. The husband has precedence to his wife's attention and favours. However, in the absence of the husband, any of his brothers have the right and the obligation to act in his stead. It is a right in the sense that a husband may not attempt to interfere and may not exhibit any signs of jealousy, when he finds so brother with his wife.

It becomes an obligation when the husband is away from the villager overnight. No women will sleep alone in a house lest the sorcerers' from the nearby kurumba tribe find her an easy prey. Although any of a man's brothers may be the biological father of his wife's child, only the husband is recognized as the sociological father. The kinship system further reflects the operation of the principle of fraternal equivalence. A man calls the chidden of his brother by the same terms as he uses for his own sons and daughters. This is true for the children of classificatory brothers as well as for the children of real bothers. In South India, polyandry is of especially frequent occurrence.

Pemukkaduthvai means a place to the left of fireplace (adupu) or stove for a woman to sit. Wives of Kota priests also had importantroles in religious functions. Kotar women also had specialised roles in cultivation, domestic chores and other social functions.

IMPORTANCE OF WOMEN EDUCATION:

Equal education for women is permitted by their parents and these days we could see that women doctors, engineers, teachers, bankers, other government and private employees, etc. They learn English, hindi, tamil in their school education. Many government scheme like central and state governments are sponsoring the kothar through Niligiri Adivasi Welfare Association (Nawas).

BIRTH AND MARRIAGE:

During a women's pregnancy, the husband leaves his hair and nails uncut. Three houses built for women to occupy after the birth of children, or at other times when they considered unclean. Immediately after birth, the mother, and child are removed to the first hut, a temporary erection of bough called Vollugudu, from Vollumeans inside and gudu means nest, where they remain for thirty days. The second and third months are spent in two permanent huts called Telulu. A women

with her first child, on leaving the vollugudufor the firsttelulu, must make seven steps backwards among seven kind of thorns strewerdon the found. SomeKotagiri, however have only the vollugudu in which the women remains for a month, and he treading on thorns takes place, when she leaves the volluguduto return home. This is Mamul, no other reason is of course discoverable. On leaving the second telulu, the mother generally goes to a relative's house for three days; if this is not convenient, she returns home. Her husband purifies the house on her return by sprinkling it with cow – dung and water. On the seventh day after this, a feast is given to the relatives, the child is fed with congee and the parental grandfather names it.

When a boy is from 15 to 20 years old, his parents ask in marriage for him some girl of six or eight. If her parents' consent to the betrothal the boy with his parents goes to their house, salutes the boy bowing his head and clasping their feet, and presents them with a Birianhana of gold and ten or twenty rupees amongst well – to – do. Some of the Kota jewels are presented to the girl at this time. This ceremony is calledbalimed – deni from bali, bracelet, and med-deni, when the girl becomes a age, she is sent at the request of the boys relations to his father's house, a feast is given with music, and the bridegroom mother ties on thetali, in this case asilver necklace made by Kotas. In some places the bridegroom goes to the brides house and presents with thetali, two madige or brass armlets, and Bali or bracelets.

The Kotas marry only one wife, unless she should be barren, when they may take another. In this case, the two wives live in the same house. Widows may remarry. Kotas professto have no traditions of any kind. They even pretend ignorance of the story of Koten, though it is evident from their manner that they do know it. Some declare that they were born on these hills, others that the inhabitants of each Kotagiri came from a different part of the neighbouring plains.

ECONOMIC LIFE:

Next to the todas in point to interest, and probably also in antiquity of race, as well as of settlement on the hills, stand the kotas, though the two races have nothing in common either as regards physical development, countenance, usasge, or dwellings.

The name is found variously spelt, Kota, kotar, koter, kohatur, the deviation is uncertain. Kohata or Gohata, cow killer, has been suggested, but this seems doubtful. The todascall them kouf, or cow-people. They recognize no caste among themselves, but are divided intokeris (streets), and men of one kerimust seek a wife in another. They are very industrious tribe and devote themselves to agriculture and to various they excel as carpenters, smiths, tanners, basket makers. They are well formed of average height, not bad features and fair skinned.

Thetoda and kotas lived near each other before the settlement of the latter on the Nilgiri. Their dialects too betray a great resemblance. The kotasare the only hill people who are not affair of the todas, and they treat them occasionally even with bare courtesy, though, as a rule, a kota, when meeting a toda and badaga, lifts both his handsto his face and makes hisobeisance from a distance. They do also not, like the other hill tribes, greatly admire the mysterious power of witchcraft, with which thetodas are credited.

Kotas lived in seven villages of 30 to 60 detached huts, at the center of Toda and Badaga spheres "the size of the kota population is almost the same as that of the todas".They are that artisans and musicians of the Nilgiri society. Though all classes look down on the kotas, all agreed that they are excellent artisans. The Badagas invite tokota Musicians for their ceremonies and joyful event. They are skilled at black smithy, carpentry, rope, and umberalla making, gold and silver jewellery making, and are indispensable to other tribes.

THE MAIN OCCUPATIONS OF KOTA:

The incredible occupations of Kotas are pottery, agriculture, buffalo, rearing, carpentry and often work as postmasters, doctors, government employees, bankers and in other professional positions. In olden days hunting was considered as their main occupation but due to the government law hunting is prohibited at present.

RELIGIOUS RITES:

Their priests are from their own tribe. There are two priest in a village. One is called Devadi, whose officeis hereditary. If the family fails entirely, recourse is had to inspiration for the choice of another. The Devadi appoints the second. Neither lives in the temple; they cool food before it at the feast of Kamatarya, and distribute it to the householders, sow and reap the first handfuls of grain at the proper seasons, and make the first obeisance other corpse at a funeral. Th edevadi is liable to be possessed by the deity. Generally, they recognize but one God, under the name of Kamataraya, and his wife, each represented by a thin silver plate.

Traditions say of Kamatarayathat perspiring profusely; he wiped from his foreheads three drops of perspiration and out of them formed the three most ancient of the hill tribesmen the Todas, Kurumbas, and Kotas. The chief Kota festival, however is the annual feast of Kamataraya, called Kamabataor Kamata. This lasts for about a fore night. On the first evening, the priest lights a fire in the Swami house, and then brings it to the principal street of the village where it is kept up during the whole of the feast. On the second day no work may be done, except digging clay and making pots but not particular ceremonies tak eplace on this or the three following days. On the sixth day men are sent to detchbamboos and rattan, and on the seventh day the two temples are newly thatched and decorated; it's essential that this should be accomplished before nightfall.

On the eighth and ninth days are spent in feasting. Contribution of grain and ghee are demand from the entire neighbouring Badaga village and cooked in the enclosure of the temples. Only boiled grain, ghee and a sort of pea soup are eaten on this occasion. A portion is laid before temple, then the priests eat and afterwards at the rest of the villagers all sitting in a row before temple. The tenth day is passed in dancing the kota dress up to the occasion wearing the long robes and borrowing jewels of all sorts from the Badagas, who are obliged to propitiated their artisans by attending and contributing on this occasion.

On the eleventh day, they decorate themselves with leaves, tie buffalo horns to their heads, and go through various appropriate pantomimes. The women also dance at this feast only; they sing at the same time, which is an improvement on the drum and horn accompanied of the men's dancing. On the twelfth day they make a fire inside their temple, by drilling a pointed stick round and round in an hole in a piece of wood, bring a bit of iron, and go through the form of heating and working it up by way of asking 'shastras' and say to the god, "let all be well and prosper".

UNIQUE PRACTICES OF KOTA:

The Kotas have their own calendar months and they are twelve in number. Some of the important months are Koodal, Allanni, Adhar, Avanni and Potadhi. Koodal is the first month which begins either in the end of December last week or the first week of January after 3rd day next to new moon day. There is no dowry system in practice.

CONCLUSION:

Thus, Kotas are very much dependable with the nature all time and also live along with the nature. They practice herbal medicines to treat various diseases, bone fracture etc. many of the

plants used in Kota medicine are becoming difficult to find because the Nilgiri ecology has been altered drastically in the last half – century.

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PROBLEMS AND CHALLENGES FACED BY MIGRANTS: WITH SPECIAL REFERENCE TO COIMBATORE CITY

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Under the wave of economic upswing, the developmental state of India has been casting a low beam on the sector of people moving from place to place in search of a new livelihood. The unavoidable economical condition of marginal people forces them to move from their homeland in search of job opportunities to support the family economically. This paper discusses the issue of the migrant workers. Though they are open to many opportunities they end up with limited access to their needs. Such short comings in our social condition narrow their path. COIMBAOTREA self-made industrial city, as most Coimbatoreans would proclaim, Coimbatore is among the most industrially developed and commercially vibrant districts in Tamil Nadu. People from all over the country come in search of a new beginning. This paper highlights the difficulties and problems faced by the immigrants who move from place to place in search of a better life.

KEY WORD: Migrants, daily wagers, huddles, economical condition.

INTRODUCTION

India is a vast South-Asian country with diverse terrain and history reaching back 5 millennia. Its culture and tradition is way too ancient and has influenced many Eastern nations. India is a Federal republic governed under a parliamentary system consisting of 29 states and 7 union territories, a pluralistic, multilingual and multi-ethnic society. Despite its varied features the most common aspect is "Migration". In an era where travel means mere

Pleasure seeking, there are people who move from one place to another in search of a better job opportunity and a stable livelihood.

"Migration" by Wikipedia is the movement by people from one place to another with the intention of settling permanently or temporarily in a new location. The movement is often over long distances and from one place to another seeking a new opportunity for the betterment of their economic status. The cause for migration has always been poverty. Lack of education is

another most common reason. And when in interrogation asked why they choose migrating out of all the other choices possible, the reason is a fact said plain- they are not able to support their families or use their skills efficiently. They migrate because they do not have access to public transfers. They migrate because they see others in their social network migrating and they realise that migration is another option to make a living.

Migration occurs for many reasons. Many people leave their home countries in order to look for economic opportunities in another country. Others migrate to be with family members who have migrated or because of political conditions in their countries. There are international migrants as well as state to state migrants. One thing common among all is that they migrate in search of a better settlement. This paper focuses on the aspect of migrants from the northern states to Coimbatore, especially with high scope of earning a better living.

Hailed as the 'Manchester of the South', Coimbatore houses a large number of small and medium textile mills.it is a hub of new opportunities, secure jobs, comfortable enough to begin a new life for the people lost in nothingness. A vibrant city itself with challenging job and a place with access to an affordable survival in the bad tidings of life.

FACTORS AFFECTING MIGRATION

Migration is a decision that impacts the welfare of the household, the home community, and in the end the whole economy in various ways. Migrant workers experience many different situations in unknown land to cover up for the welfare of the household, but in most cases moving from one place to another and being away from one's immediate family is at a considerable emotional cost. Especially temporary work related migration increase the risk for family breakdown, fragmentation of social networks and psychological stress. The emotional impact is not just limited to the migrants themselves, but also the family left behind.

Fewer job opportunities are another factor that causes unemployment in the case of a migrant. This state forces them to take up odd jobs with less income. A job with no proper income or steady pay becomes another issue to deal. They end up financially dependent and are forced to seek money lender. This is one of the main reason through which migration alleviates poverty and is high due to remittances.

REASONS FOR MIGRATION

"The socio-economic development of the southern states is considerably higher and that attracts people. Another factor is that because of better education levels and awareness, local residents of these areas get drawn towards better economic opportunities. This vacuum that gets created gets filled up by people from outside. These developed areas face a crisis of manpower, especially for low-skilled jobs, which leads to migration," says Dr. Abdul Shaban, chairperson of the Centre for Public Policy, Habitat and Human Development at the Tata Institute of Social Sciences.

STATES WITH HIGH MIGRANT GROWTHRATE

STATE	2001	2011%	GROWTH %	GROWTH OF STATE POPULATION
TAMILNADU	1.58cr	3.13cr	98%	15.6%
MANIPUR	0.037cr	0.073cr	97%	18.7%
MEGHALAYA	0.037cr	0.077	108%	27.8%
KERALA	0.92cr	1.63cr	77%	4.9%
J&K	0.18cr	0.28cr	55%	23.7%
ASSAM	0.67cr	1.02cr	52%	16.9%
KARNATAKA	1.66cr	2.50cr	51%	15.7%
ANDHRA PRADESH	2.34cr	3.32cr	42%	11.1%
INDIA	31.45cr	45.36cr	44%	17.64%

MIGRANT'S LIFE IN TAMIL NADU

Migrating people in TN initially face high challenges. There are many barriers to break and cross for the survival of an outsider. Language is the very first obstacle they face. Communication is necessary for better connectivity. Without proper communication one cannot convey his ideas or understand anything that's said.

They are treated with less respect and regard. Migrant people due to less opportunity in work sector face the hard side of unemployment. They take up different jobs with less pay for their daily survival. The jobs taken up for instance are:

- Porter
- Street food chain stalls
- Vendors
- Daily wagers (construction helpers)
- Pedestrian sellers
- Sewage cleaners

Due to lack of education they face many problems in their working sector, and very less potions available in case of job opportunities. They are forced to take up such menial jobs for their needs, which later on turns to be the only option left for their survival. The odd jobs that they do drains them out mentally and physically. This leads them to take up unwanted and unhealthy habits like smoking and consumption of alcohol.

The percentage of people who consume alcohol is very high among the migrating worker. Their job that needs physical draining forces them to take up such habits as a distraction or relaxation. There are people who fall prey to such habits in due course of time and are unable to detach them. This leads to health issues and problems in the family.

WHY THEY MOVED Work and Education are the top priority to many migrants. They migrate with the hope for a better future. Anticipating financial stabilization in the family and improving their status in the society. The other reasons like to provide proper education to their children and help them grow in a healthy society.

REASON	MEN	WOMEN	TOTAL
WORK	3.90cr	0.74cr	4.64cr
BUSINESS	0.32cr	0.11cr	0.43cr
EDUCATION	0.48cr	0.32cr	0.80cr
MARRIAGE	0.60cr	21.79cr	22.39cr
MOVED WITH HOUSEHOLD	3.15cr	3.83cr	6.98cr
MOVED AT BIRTH	2.85cr	1.94cr	4.79cr
OTHER	2.80cr	2.53cr	5.33cr
TOTAL	14.10cr	31.26cr	45.36cr

SUGGESTIONS

- It is found from the study that the most of the migrated workers are not influenced by any political or governmental aids. So, equality must be given to all the sectors equally.
- Job opportunities and wages must be equally provided to both men and women. Equality in work oriented places must prevail.
- It could be noted that most of the migrated workers are influenced by alcohol and smoking. Proper awareness must reach them regarding the hazardous effect of Tabaco and alcohol to live a healthy life.
- From the study findings, it is evident that lack of education is the main reason for such job seeking. Equality in education must be brought and seen that it reaches the neediest.

CONCLUSION

This paper has highlighted the life of the migrated people and their struggle in day to-day life. Each person wishes to see a better tomorrow, likewise people who are not happy with their current scenario try their best to bring in a change. MIGRATED WORKERS are such sector of people who work really hard to bring in some stander in their living. Change in the place of living and coming out of their comfort zone, leaving back home and family are some sacrifices they do to build a new world for their future generation to simply live in comfort.

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HISTORICAL IMPORTANCE OF SANGAM PERIOD IN THE NILIGIRIS

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Sangam period (Tamil: Sangakālam) is the period of history of ancient Tamil Nadu and Kerala spanning from 3rd century BC to 3rd century AD. It is named after the famous **Sangam** academies of poets and scholars centered in the city of Madurai.

The current estimate is that the Sangam period lasted between 400 BCE until 300 CE. The earliest mention of the Sangam is to be found in the 8th century commentary on the Irayanar Agapporul. It mentions three Sangams lasting, at long intervals, for a total of **9990 years**.

The Tamil Country, during the Age of Sangam, which according to K.G. Sesha Aiyar and others flourished in the first three centuries of the Christian era, was ruled by the Cheras, Cholas and the Pandyas. The Chera country of the Sangam period comprehended the extreme south of the Malabar Coast or Travancore, Wayanadu, the Nilgiris, southern portion of Coimbatore and part of Tirunelveli. But for sometimes the Nilgiris was under the rule of the Satavahanas who had built their empire in the Deccan. The Satavahanas King who was contemporary to Cheran Sanguttuvan was in friendly terms with the Cheras. P.T. Srinivasa Iyengar, who did an extensive research in the "Paditrupathu" and "Silappathikaram", while describing the Northern exploits of Senguttuvan, says that the one- Nutruvar kannar, whose sways extended from the Nilgiris, the Northrn boundary of the Chera country to the Gangetic region, offered his help to Senguttuvan in his Northern conquest. He futher says that the termwas a bad translation of 'Satakarni'. K.G. Sesha Aiyar also says the 'Sarakarni' was a friend of the Chera king Senguttuvan.

Key words: Sangam Age- Rashtrakutas-Gangas-Pallavas-Kings

INTRODUCTION:

The Tamil Country, during the Age of Sangam, which according to K.G. Sesha Aiyar and others flourished in the first three centuries of the Christian era, was ruled by the Cheras, Cholas and the Pandyas. The Chera country of the Sangam period comprehended the extreme south of the Malabar Coast or Travancore, Wayanadu, the Nilgiris, southern portion of Coimbatore and part of Tirunelveli. But for sometimes the Nilgiris was under the rule of the Satavahanas who had built their empire in the Deccan. The Satavahanas King who was contemporary to Cheran Sanguttuvan was in friendly terms with the Cheras. P.T. Srinivasa Iyengar, who did an extensive research in the "Paditrupathu" and "Silappathikaram", while describing the Northern exploits of Senguttuvan, says that the one- Nutruvar kannar, whose sways extended from the Nilgiris, the Northrn boundary of the Chera country to the Gangetic region, offered his help to Senguttuvan in his Northern conquest. He futher says that the term Nutruvar Kannar was a bad translation of 'Satakarni'. K.G. Sesha Aiyar also says the 'Sarakarni' was a friend of the Chera King Senguttuvan.

The period of Senguttuvan was fixed by K.G. Sesha Aiyar between 125 and 180 AD. During this period, the Satakarnis, who ruled Deccan were Pulumayi-II and Yajan Satakarni. The coins of Pulumayi-II have been found in Cuddalore, too, which confirm his supremacy over Tamil Nadu. Moreover, it is inferred that Senguttuvan might have started his second Northern Expedition on the later part of his reign and Sri Yajna Satakarni reigned his country from AD 170 to 199, probably either Pilumayi-II or Sri Yajan Satakarni might be the friend of Senguttuvan who invited him to his country on his way to North and assisted him.

THE RASHTRAKUTAS OR RATTA KINGS:

'Kongudesa Rajakkal' a Tamil work gives an account of some of the kings who ruled the region of 'Kongu'. They had their capital at Skandapura, identified with a place near the Gajalhatti pass of the present Karnataka State. It is said that their rule extended over South West Mysore, including, the Nilgiris. The following reasons may be attributed for including the Nilgiris within their domain.

1. The Rattas ruled the Kongu Region comprising of – modern districts of Coimbatore, Periyar, Salem and Dharmapuri – with their capitals in Karnataka, not far beyond the western borders of the Nilgiris. The Nilgiris was situated between their capital Kongu region. Hence, before extending their rule over Kongu region, they should have conquered the Nilgiris region also. Some scholars now view that the Nilgiris also was included in the Kongu country.
2. The Rattas were a martial race and were delighted in the fight mounting on horses and elephants. Their culture affected the Nilgiris people and it can be seen from the numerous figures of these animals found in the Nilgiris cairns and cromlechs.

There were seven Ratta rulers whose tentative chronology has been fixed by M. Arokiasamy as follow:

1. Vira Raya Chakravarthi, (AD – 250-270)
2. Govinda Raya -I, (AD-270-290)
3. Krishna Raya (AD- 290-310)
4. Kala Vallabha Raya (AD- 310-330)
5. Govinda Raya – II (AD – 330-335)
6. Kannara Reva (AD – 335-380)
7. Thiruvikramadeva (AD – 380-405)

Of all the Ratta Kings mentioned, Thiruvikramadeva is said to have conquered the 'Dakshin' country and overcome the Chola, Pandya, Kerala and Malayala countries. Thiruvikrama, as his predecessors, belonged to Jain religion. Later, he became a Saivite by faith which brought on a crisis to his kingdom. The Jaina monks could not tolerate his conversion and they withdrew their blessings and support extended to him. This became a death-knell to his dynasty and it made its exit from the political scene of South India, making way to the Gangas.

THE GANGAS

The Gangas ruled over a great part of Karnataka from second to the eleventh century. But their rule was extended to Kongu and the Nilgiris only after the death of last Ratta ruler Tiruvikrama. Their grants have been found in all parts, from Coorg in the West North Arcot and Tanjore in the east and from the extreme south of the then Mysore State in the South to the Belgaum district of Bombay in the North. The territory of the Gangas was known as Gangavadi. At the time of founding of Gangas Kingdom, its chief city was Kolar but the capital was removed in the 3rd century to Talakad on the Cauvery in the South east of the Mysore district.

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As their boundaries in the north, east west and south were, Marandale Tondainadu and Chera country and Kongu respectively, the Nilgiris formed part of the kingdom of the Gangas. The first ruler of this dynasty was Madhava who was also called Konganivarma, the title used by all the subsequent kings of the line as a suffix to their names. The Ganga kings were termed as 'Dharma Maha Rajathi Rajas' in their inscriptions.

Dr. M.Arokiasamy, after a careful study to related source fixes a tentative chronology which slightly differs from the views of his predecessors who had specialised this subject.

GANGA'S RULE IN THE NILGIRIS

Konganivarma (AD 405 – 460):

Konganivarman, the first Ganga king who distinguished himself in many battles and won many victories over the Banas, had carved out a petty kingdom in South India. His successor Madhava-I was not a warrior king and his region was marked by peace and prosperity. He was an eminent scholar and also a patron.

Harivarman (AD 460-480):

Konganivarman was succeeded by Harivarman whose period was marked for the division of the Ganga dynasty into two rival Houses, one headed by Harivarman ruled from Skandapura and other, the "Paruvis" from Kolar. The Pallavas, the great force, who ruled from Kanchi supported the cause of the Gangas at Kolar against Harivarman. Hence, Harivarman allied with the Kadambas, other South India force, shifted his capital from Skandapura to Talakad, which is identified with modern Dharapuram in Coimbatore district.

Vishnugopa (AD 480 – 525) and Madhava (AD 525 – 535):

The divided Ganga dynasty re-joined under Vishnugopa, the son and successor of Harivarmam. Vishnugopa had no sons and so he adopted Madhava, a 'Paruvi' Ganga. But later a son was born to Vishnugopa. After Vishnugopa, the Ganga kindom was ruled by Madhava, the adopted son and after him by Krishnavarman, his own son. Krishnavarman was succeeded by his sister whose name is not known. During her rule, one Dandikara acted as her regent. She was succeeded by her son Konganivarman-II. Along with Konganivarman -II, Avinita, a scion from the 'Paruvi' ganga dynasty co-ruled the country.

Durvinita (AD 655-660):

Konganivarman -II and Avinita were succeeded by Durvinita, the son of the later. Durvinita is said to have usurped the throne as the royal intention was to crown the son of Konganivarman – II. Durvinita, thus brought back the power to the Paruvi Ganga, fought several battles and establishd his sway over the modern districts of the Nilgiris, Coimbatore, Salem, Dharmapuri, Periyar and even extended it to the region of Tondaimandalam. He allied with the Western Chalukyas, another major contemporary dynasty ruling in South India. He married his daughter to Pulikesin-II of Western Chalukya kingdom and cemented the alliance. He also become the 'Lord of Punnata' by conquering it from Ravidatta, a Chera feudatory.

MUSHIKARA (AD 660-665):

After the death of Durvinita, who transformed the Ganga Kingdom into Ganga Empire in AD 655 Mushikara his son became his successor to the Ganga throne. For Mushikara, his illustrious father left him a vast dominion comprising the whole of Gangavadi and the entire region of Kongu, including the Nilgiris. At this time, Mushikara was the greatest king of South India. He ruled over for five years and was succeeded by his son, Thirvikrama who also had ruled for five years. The Bendirur grant mentions that Thirukrama had married a Chola princess but the

indentification of the Chola princess could not be made.

BHUVIKRAMA (AD 665-725):

Thiruvikarama's son was Bhuvikrama who seems to have ascended the throne of Gangavadi in AD 665. His region was marked by many wars and conquests. He sided with the Chalukyas in the 'Pallavas-Chalukyas conflict' of that time and he fought a battle with the Pallava King Parameswaravarman-I, and snatched the royal necklace of the Pallava, which was said to have been retried from the Gangas, later, by Nandivarma Pallava.

KONGANIVARAMAN-III (AD 725-750):

Bhuvikarma was succeeded by Konganivaraman III. Though no clear evidence is there to say that he was the son fo Bhuvikarma, some scholars computing certain available records surmise so. His region witnessed peace and prosperity. He was also known as Sivamara.

THE DISINTEGRATION OF THE GANGAS:

The end of the rigion of Bhuvikrama witnessed the disintegration of the central power of the Gangas. Bhuvikrama divided his entire empire into sizable units and left them incharge of the members of the royal family to be governed by them in subordination to the centre. One of such division was the Kongu region which included the Nilgiris. The rulers of this region were termed Kongu Gangas. The first Kongu Gangas was Vallabharaya, the brother of Konganivarman-III in whose time the division of empire occurred and the branch of rulers went upto Madhava-II. The exact relationship between these Kongu Gangas and the Central authority is not exactly known.

PANDYAN INROADS:

As the Gangas Kingdom become weak, the neighbouring powers began their inroads into Gangas territory. Pandyan King Sadayan Ranadhira conquered parts of Kongu country. His son Arikesari Maravarman is said to have crossed the river Cauvery and subdued certain hilly parts of the Kongu country. Pandya Neduncheliyan is also said to have captured the powerful king of western Kongu with his elephants and subdued Kongubhumi so that the noisy drum was sounding his fame throughtout the Kanakabhumi. Kanakabhumi literally means, the land of gold. There is a reference that there were gold mines in the Nilgiris which attracted the Romans to trade with the country in early centuries of the Christian era. Hence, the view that 'Kanakabhumi' mentioned to have been conquered by Pandya Neduncheliyan was the Nilgiris, cannot be altogether ruled out.

THE PALLAVAS:

The Pallavas whose powers were on the rise in the 7th and 8th centuries were also constant foes to the Gangas. Pallavamalla, with the assistance of his general Udhaya Chandra occupied a half of the Kongu country. By this time, there was a political crisis in the territory and the regime of the Kongu was on the decline.

But, by AD 930, the Nilgiris continued to be under the Ganga rule which is proved by an inscription which shows that the Wayanad was then part of the territories of the well known Ganga dynasty of Mysore. This record relates, how on the death of Ereyappa, the then king of the Gangas, his sons, Rachamalla and Butuka both claimed to succeed to the throne. Rachamalla was in Wayanad at the time and Butuka sent for him and proposed that they should settle their differences by dividing the country-between them. But Rachamalla's envoy replied that they did not wish any one other than Rachamalla to rule over the Kingdom of Wayanad. Hostilities between the brothers naturally followed in which Rachmalla was killed and Butuka become the undisputed master of Wayanad.

CONCLUSION:

The Sangam works give a fairly much informaton on political changes in ancient Tamilagam. As in any other society the Tamils were divided into tribes with their own leaders, habits and pursuits. Through progress in settled life they came to possess particular territories and through conflicts and alliances transformed themselves into political powers. Tolkappiyar refers to twelve political divisions called nadus.

The Pallavas with the assistance of his General Udhaya Chandra occupied a half of the Kongu country. Pandyan King Sadayan Ranadhira son Arikesari Maravarman is said to have crossed the river Cauvery and subdued certain hilly parts of the Kongu country.

H.B. Grigg, W. Francis and some other writers have remarked that the Nilgiris had no history prior to the British occupation of the district. This may be true, perhaps partially with regards to the political history. According to a contemporary author who has, besides many books on the Nilgiri Hills and its people, published A Bibliography for the Nilgiri Hills of South India. In this chapter an attempt is made to present the history of the district chronologically, by culling out historical episodes relating to the Nilgiris, from the standard and authentic works.

Though it was true that the Nilgiris was not a cynosure to lure the invaders and the rulers, the fact remains that it formed part of the kingdoms of the Cholas, Cheras, Kongu kings, Kadambas, Gangas, Nolambas, Hoysalas, Ummattur chiefs, Mysore Odeyars, Nayaks and others.

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◆

திருத்தொண்டர் காப்பியத்தில் அறம்

திருமதி. ஜோ. எப்சிபா
முனைவர் பட்ட ஆய்வாளர் உதவிப் பேராசிரியை,
தமிழ்த்துறை புனிதபேதுரு கல்வியியல் கல்லூரி, கருமத்தம்பட்டி.

முன்னுரை

இலக்கிய உலகில் காப்பியம் ஒரு தனி இடத்தைப் பெற்றுள்ளது. இலக்கிய வளம் நிறைந்த பழமையான மொழிகளில் முதல் இலக்கியமாக "காப்பியம்" அமைவதைக் காணலாம். இலக்கிய வகைகளில் ஒன்றான கிறிஸ்துவ இலக்கியம் மேலைநாட்டு திருத்தொண்டர்களால் தோற்றுவிக்கப்பட்டு நம்மவர்களால் வளர்க்கப்பட்டு அதன் எல்லையானது பரந்து விரிந்து சென்று கொண்டிருக்கின்றது. கிறிஸ்துவ இலக்கியம் இயேசு கிறிஸ்துவை மட்டுமே மையமாகக் கொள்ளாமல் அவரின் சீடர்கள் மற்றும் அவரின் கொள்கைகளையை பின்பற்றிவோரை மையமாகக் கொண்டும் விளங்குகின்றது.

திருத்தொண்டர் காப்பியம்

பேராசிரியர் இன்னாசி அவர்களால் 2007-ம் ஆண்டு எழுதி வெளியிடப்பட்ட காப்பியம் திருத்தொண்டர் காப்பியம் ஆகும். இவர் புதுக்கோட்டை மாவட்டத்திலுள்ள திருமயம் எனும் ஊரில் 1934-ஆம் ஆண்டு பிறந்தவர். இவர் பாளையங்கோட்டையிலுள்ள தூய சவேரியார் கல்லூரி தமிழ்த்துறைத் தலைவராகவும், சென்னைப் பல்கலைக்கழகத்தில் கிறிஸ்துவத் தமிழ் இலக்கியத்துறை தலைவராகவும் பணியாற்றியவர். திருத்தொண்டர் காப்பியம் இந்திய துணைக் கண்டத்தின் வரலாற்றில் குறிப்பாக கேரள மாநிலத்தின் "திருவிதாங்கூர்" என்னும் குறுநிலப்பரப்பில் வாழ்ந்த தேவசகாயம் பிள்ளையின் வாழ்வியல் கூறுகளை இலக்கிய நயங்களுடன் எடுத்துகூறும் நூலாகும். இந்நூலில் சொல்லப்பட்டுள்ள அறம் பற்றியக் கருத்துகளைக் காண்போம்.

அறம்

மானிட நடத்தை நெறிபட்டதாக அமைந்திருப்பதனை அறம் என்கிறோம். அறம் என்ற கேள்வி எழும்போது நமது முன்னோர்கள் விட்டுச்சென்ற வளங்கள், வழிகாட்டுதல்கள், பகுத்தறிவு மற்றும் மனச்சான்றின் படியான நடத்தைகள், அனைவரின் நலன், அகிம்சை, உண்மை என பலவற்றின் கூட்டாகவும் நமது பின்பற்றலுக்கு உகந்தவைகள் அனைத்தும் அறம் என காந்திய ஆய்வாளர் திரு. செயப்பிரகாசம் கூறுகின்றார்.

உண்மையும் உள்ளத்தூய்மையும்

நம்பிக்கைக்கு அடிப்படையானது உண்மையும், உள்ளத்தூய்மையும் ஆகும். பொறாமைக் கொண்டு பிறரைத் துன்புறுத்தினால் நாமும் துன்புற நேரிடும் என்பதை உணர்ந்த திரு. நீலகண்டன் அவர்கள் மார்த்தாண்டவர்மனின் அரசவையில் மன்னனுக்கு தெரியாமல் நடைபெற்றுக் கொண்டிருந்த ஊழல்களை கண்டறிந்து உள்ளது உள்ளவாறே மன்னனிடம் தெரிவித்துள்ளார். இதனை,

" பழிசுமத்த விரும்புவனேல் பின்னோர் நாளில்
பழியேற்க வேண்டிவரும் என்பதறிவேன்
அழித்தொழிக்க விரும்புவனேல் பின்னோர் நாளில்
அழிந்தொழிவேன் என்பதனை அறிவேன் நானே"
(திருத்தொண்டர்காப்பியம் - பா.1040)

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என்பதை அறுதியிட்டு கூறுகிறார். கருவூலப் பொறுப்பாளரின் களவுச் செயலை அறிந்த மன்னன்,

"உருவினிலே தூய்மையனாய் இருந்தால் போதா!
உள்ளத்தில் தூய்மையதும் வேண்டும் என்றான்"
(திருத்தொண்டர் காப்பியம் - பா. 1044)

என்ற கருத்தை கூறி, சுரண்டல் பேர்வழிகளுக்கு சாட்டையடி அளித்து உள்ளத்தூய்மை மனிதனுக்கு மிகவும் அவசியமானது என்று வலியுறுத்துகிறார்.

பிணிபோக்கும் மருத்துவம்

மனித உயிர் விலைமதிப்பற்றது. மனிதனுக்கு நோய் வந்தால், மருத்துவரிடம் செல்வது வழக்கம் மருத்துவர் நோய்க்கு தகுந்த மருந்துகளை வழங்கி நோயாளி விரைவில் நலம் பெற உதவுவார். இத்தகைய உயிர்காக்கும் மருத்துவத்துறை இன்று பணம் சம்பாதிக்கும் நோக்கில் செயல்பட்டு வருகின்றது. நீலகண்டப்பிள்ளை காலத்திலும் இதே அவலம் இருந்துள்ளது. மருத்துவம் அறம் என்பதையும், அதனை அவலமாக்குபவர் அத்துறைக்குத் தகுதியற்றவர் என்பதையும்,

"வரன்முறையை மீறுபவர் எவரே யாயின்
வகுத்துள்ள தண்டனைக்கே உரியர் ஆவர்
உரமுடைய தலைவருடைய மகளாய் இருப்பின்
உரியதொரு தண்டனையே இருமை யாகும்.
தரம்பார்த்துத் தண்டனைகள் வழங்கல் கூடா
தவற்றுக்கே உரியவாறு தண்டம் வேண்டும்.
(திருத்தொண்டர்காப்பியம் - பா. 1087)

என்ற வரிகள் மூலம் அறிய முடிகின்றது. படைத்தலைவர் மகள் ஒருவர் அரசனின் மருத்துவமனையில் செவிலியராக பணிபுரிந்தார். இவர் மருத்துவமனையின் இலவச மருந்துகளைக் காசுக்கு விற்பதைக் கண்டனர். படைத்தலைவர் மகள் என்பதால், மக்கள் இதனை அரசனிடம் கூறப்பயந்தனர். ஆனால் நீலக்கண்டபிள்ளை இச்செய்தியை அரசனின் கவனத்திற்கு கொண்டு வந்தார். இதனையறிந்த மன்னன், படைத்தலைவரின் மகளாயினும் தவறு செய்தால் தண்டனைக்கு உரியவர் ஆவார் என்று கூறினார்.

பொறையுடைமை

ஒருவர் தனக்கு எதிராக தீங்கு செய்தால் அதைப்பற்றி எண்ணி மனசோர்வடையாமல் அதை மனதில் வைத்துக் கொள்ளாமல் மன்னித்து மறக்க வேண்டும் என்னும் கருத்தை

"பொறையுடைமை கொள்வதுவே நன்மையாகும்
பொறுக்காதோர் பேச்சினையே மறக்க வேண்டும்
மறைவாகப் பேசுவதை மனத்துட் கொள்ள
மனமதனை உறுதியாகக் கொள்ள வேண்டும்"
(திருத்தொண்டர்காப்பியம் - பா. 1140)

என்ற வரிகள் வழியாக அறிய முடிகின்றது. தான் செய்யும் பணிகளைக் கண்டு பொறாமைக் கொண்டு, மறைவாகப் பேசும் அமைச்சர்களின் எண்ணத்தை அறிந்த நீலகண்டன் எதைப்பற்றியும் கவலைக் கொள்ளாமல் மனதை உறுதியாக வைத்து பணியை செவ்வனே செய்து மன்னனின் பாராட்டைப் பெற வேண்டும் என்று எண்ணினார்.

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இதன்மூலம் பிறர் மறைவாகப் பேசுவதை மனதில் வைத்து கொள்ளாமல் மன்னிக்கும் நீலகண்டனின் மனதினை அறிய முடிகின்றது.

ஏழைக்கு உதவுதல்

ஏழைக்கு உதவுதல் இறைவனுக்கு உதவுதல் போன்றதாகும். நாம் காணும் ஏழை, எளியவர்கள், நோயுற்றோர் துன்பத்தில் வாடுவோர், தேவையிலிருப்போர் போன்றோரின் தேவையறிந்து தங்களிடம் உள்ளவற்றை இல்லாதவர்க்கு பகிர்ந்தளிப்பதன் மூலம் மனநிறைவு அடைய முடியும். பிறருக்கு உதவும் பண்பு ஒவ்வொருவருக்கும் அவசியம் என்பதை,

"எரியும் நெருப்பைத் தண்ணீர் அவிக்கும்
ஏழையின் வாழ்வை உதவிகள் காக்கும்
எரிச்சல் பசியரை என்றும் வதைக்கும்
ஏழையின் கசப்புணர் வுன்னைச் சபிக்கும்
உரிய நீதியைப் பெறுதல் வேண்டும்
உழன்றால் வறுமையில் உதவல் வேண்டும்
உரிமை வாழ்வில் ஒடுக்கப்பட்டால்
உறுதியாய் அவரை விடுக்க வேண்டும்"
(திருத்தொண்டர்காப்பியம் - பா. 1294)

என்று விவிலியத்தில் சீராக் நூலில் கூறப்பட்டுள்ள கருத்துக்கள் மூலம் எரியும் நெருப்பை தண்ணீர் அணைப்பது போல் ஏழைகளுக்கு நாம் செய்யும் உதவி அவர்களின் வாழ்வை காக்கும். பசியால் வாடும் ஏழையின் கசப்புணர்வு நம்மை சபிக்கும். மேலும் ஏழைகளுக்கு உரிய நீதியைப் பெற்று தருதல், வறுமையில் உதவுதல், ஒடுக்கப்பட்டவர்க்கு உரிமை வாழ்வளித்தல் போன்ற உதவிகளை செய்ய வேண்டும் என்ற கருத்து வலியுறுத்தப்பட்டுள்ளது.

பகைவனுக்கு இரங்கும் பேரறம்

தன்னை சிலுவையில் அறைந்தவர்களுக்காக இயேசு இறைவனிடம் மன்றாடினார் என்பது உலகறிந்த செய்தி. ஆனால், பகைவனுக்கும் இரங்கும் அதே பேரறத்தை உலகோர் பின்பற்ற வேண்டும் என்று திருத்தொண்டர் காப்பியம் வலியுறுத்தும் பார்வை முற்றிலும் புதியதாகும்.

"அடிப்பதற்காய் யானடியை வாங்கவில்லை
அன்பினுக்காய் அடியேற்று வாழ வைப்பேன்"
(திருத்தொண்டர்காப்பியம் - பா. 1977)

என்ற வரிகள் பிறர்தரும் வலிகளுக்கு எதிர் வினையாற்றாமல் அன்பையே தர வலியுறுத்துகிறது.

செய்வன திருந்தச் செய்தல்

நேர்மை திறத்தை நெஞ்சில் நிறைத்து அரசன் பணித்த அனைத்துப் பணிகளையும் திருத்தமுற நிறைவேற்றிய நீலகண்டர் மன்னன் மனதில் நம்பிக்கை மையமானார்.

"இதனை இதனால் இவன்முடிப்பான் என்றாய்ந்து
அதனை அவன்கண் விடல்"

என்ற குறளுக்கேற்ப அரண்மனையைக் கட்டும் பெரும் பொறுப்பை மன்னன் நீலகண்டரிடம் ஒப்படைத்தார்.

"இடிப்பதற்கே எவராலும் இயலா வாறும்
இடிக்கவரின் கடப்பாரை ஒடியு மாறும்
அடிப்படையே வலிமையுடன் அமையு மாறும்
அதற்கேற்ற கற்களையே வரவழைத்தான்"
(திருத்தொண்டர்காப்பியம் - பா. 1147)

என்ற வரிகள் நீலகண்டர் கட்டிய அரண்மனையின் உறுதித்தன்மையும் அவரது திருத்தச் செய்யும் செயலின் நேர்மையையும் வெளிப்படுத்துகிறது. **"செய்வன திருத்த செய்"** என்ற ஔவையின் வாக்கு இதனை உறுதிப்படுத்துகிறது.

மன்னிக்கும் மனம்

இறைவன் வாழும் இடமான கோயிலில் பணியாற்றுவொருள் சிலர் மட்டும் அன்றாட பூசைகள் செய்வதில்லை, கடவுளுக்குரிய மந்திரங்களை மாறாமல் சொல்வதில்லை. வாசனை மலர்களுக்குப் பதில் வாசனையற்ற மலர்களைக் குறைந்த விலையில் வாங்குதல், வாசனை மலர்களுக்குள்ள காசுதனைத் தனியாக வாங்கிக் கொண்டு கணக்குகளைக் கூடுதலாக எழுதும் நிலை போன்றவை இருந்தன. பக்தர்கள் தரும் காணிக்கைகளைக் கைச்செலவுக்கு எடுப்பதும், அந்தக் கணக்கு வழக்குகளில் செலவு கூட்டிக் கணக்குகள் காட்டப்பட்டதும் கண்டுபிடிக்கப்பட்டன. இவை அனைத்தும் காப்பியத்தலைவன் நீலனால் அரசருக்குத் தெரிவிக்கப்பட்டன. சம்பந்தப்பட்ட தலைமை அர்ச்சகரை விசாரித்துச் சினம் கொண்டான் அரசன். அதற்கு அமைச்சன்,

"பொய்யுரைத்துப் பயனில்லை என்று ணர்ந்தார்
போகுமுயிர் திரும்பிவரா தென்று ணர்ந்தார்
மெய்யுரைக்கத் தெம்பில்லை மேலும் பொய்யால்
மேற்பதவி தனையிழக்க விருப்பம் இல்லை
செய்தொழிலால் சேர்த்த பொருள் தொகையைக் கூறிச்
செஞ்சோற்றுக் கடன்தீர்க்கா நிலையும் கூறி
மெய்தரையில் விழவணங்கிப் பொறுக்கு மாறு
மேனோக்கி மன்னன்முகம் பார்த்து நின்றார்".
(திருத்தொண்டர்காப்பியம் - பா. 1077)

இனிமேல் தவறு செய்யகூடாது என்று கூறி மன்னன் மன்னித்தார்.

மக்கள் நலன்

நாட்டில் மக்கள் குறைவின்றி வாழ்க்கையை நடத்த சிறந்த ஆட்சியாளர் தேவை. அவ்வகையில் திருவிதாங்கூர் பகுதியை ஆண்ட மார்த்தாண்ட வர்மன் அருகிலிருந்த சிற்றரசுகளை கையகப்படுத்தி மற்றவர்களைக் காட்டிலும் சிறப்பாக ஆட்சி செய்தான். மக்கள் குறை தீர்க்கும் மாமன்றமாகவே மார்த்தாண்டவர்மனின் அரசவை அமைந்தது. மக்களின் குறை தீர்ப்பதோடு மக்கள் நலப்பணிகளும் மேற்கொள்ளப்பட்டன.

கோயில் மூலம் ஆன்மீக நெறிகள் மக்களைச் சென்று அடையக் கோவிலில் சரியான பணியாளர்களை நியமித்து பூசைநடத்துதல், தற்போதுள்ள காவல்துறை போன்று மக்களின் அமைதியான வாழ்க்கைக்கு ஊர்க் காவலர்களை நியமித்தல் ஆகிய அரும்பணிகள் மேற்கொள்ளப்பட்டன. நிர்வாகம் திறமையுடன் செயல்படப் பல்வேறு துறைகளாகப் பிரிக்கப்பட்டு, ஒவ்வொரு துறையும் தனித்தனி அமைச்சர் பொறுப்பில் ஒப்படைக்கப்பட்டது.

உயிர்களிடத்தில் அன்பு

இவ்வுலகில் வாழும் அனைத்து உயிர்களையும் ஒன்றிணைப்பது அன்பு. தாய் குழந்தையிடம் காட்டும் அன்பு, உயிர்களிடத்தில் காட்டும் அன்பு என அன்பினை வாரி வழங்கும் பொக்கிஷமாக திகழ்பவள் பெண். இதனை,

"தாயொருத்தி மட்டுமங்கே தடுத்து நின்றாள்
தயைக்கூர்ந்து பிளக்காதீர்! மகனை என்றாள்
போயொருத்தி யிடமாகப் பிள்ளை வாழ்ந்தால்
போதுமது என்றழுதாள்"
(திருத்தொண்டர்காப்பியம் - பா. 1286)

என்ற வரிகள் வழியாக குழந்தைக்காக போராடும் தாயானவள் தனது குழந்தை உயிரோடு மற்றொருப் பெண்ணிடம் வளர்ந்தால் போதுமானது என்று எண்ணும் தாயின் அன்பினை அறியமுடிகின்றது.

தன் திருமணத்தின் போது சீராகக் கொண்டு வந்த பசு இறந்ததை தாங்க முடியாத காப்பியத்தலைவி

"சீராளன் உன்றணக்கு மணநாள் தன்னில்
சீராகக் கொண்டு வந்த பசுதான் அன்றோ?
காராளும் கழனிதனில் விட்டாற் கூடக்
கணமேனும் வாய்வைக்க விரும்பி பாத
பாராளும் வேந்தகுந்தான் விருப்பம் கொள்ளும்
பாற்சுவைதான் கொண்டதிந்த ஆவே அன்றோ?
யாராலும் குழவியதும் துன்பம் காண
யாங்கணுமே கண்டதில்லை என்றே அழுதாள்
திருத்தொண்டர்காப்பியம் - பா. 2033

என்பதிலிருந்து தாய்க்கு குழந்தையின் மீதுள்ள அளவு கடந்த அன்புண்டு என்பதை அறிவதோடு மட்டுமின்றி, ஐந்தறிவு உயிர்களிடம் காட்டும் அன்பினை பற்றி ஆசிரியர் எடுத்துரைத்துள்ளார்.

முடிவுரை

"உள்ளமே கோயில் ஊன் உடம்பு ஆலயம்" என்ற திருமூலரின் கூற்றுக்கேற்ப இறைவனை உள்ளக் கோயிலில் வைத்து வழிபட்டவர் தேவசகாயம் பிள்ளை. எனவே தான் அவரும் திருத்தொண்டராகித் தெய்வநிலை அடைந்தார். உண்மையும் உள்ளத்தூய்மையும், பிணிபோக்கும் மருத்துவம், பொறையுடைமை, ஏழைகளுக்கு உதவுதல், பகைவனுக்கு இரங்கும் பேரறம், செய்வன திருந்தச் செய்தல், மன்னிக்கும் மனம், மக்கள் நலன், உயிர்களிடத்தில் அன்பு ஆகிய அறநெறிகளே திருத்தொண்டர் காப்பியம் காட்டும் வாழ்வியல் நெறிகளாகும்.

"நெஞ்சமே கோயில் நினைவே சுதந்திரம்
அன்பே அஞ்சன நீர்
பூசை கொள்ள வாராய் பராபரமே"

என்று தாயுமானவர் போற்றிய அறநெறி வாழ்வை நீலகண்டப் பிள்ளை வழியாக திருத்தொண்டர் காப்பியம் காட்டுகிறது. காப்பியம் முழுவதும் விரவிக் கிடக்கும் அறக் கோட்பாடுகளை காகிதத்தில் விரிப்பது கடலைக் கட்டுமரத்திற்குள் அடைக்கும் முயற்சிக்கு ஒப்பாக அமைந்துள்ளது.

◆

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விண்ணரசி.
முனைவர் பட்ட ஆய்வாளர், தமிழ்த்துறை,
நிர்மலா மகளிர் கல்லூரி(தன்னாட்சி), கோவை -18

முகவுரை:

இலக்கியங்கள் மக்களின் பாரம்பரியத்தையும் பண்பாட்டையும் எடுத்துரைக்கும் இயல்புடையன. சமயங்கள் மக்களின் வாழ்க்கை முறையினை நெறிபடுத்தும் கருவியாகச் செயல்படுகின்றன. தனிமனிதனையும் சமுதாயத்தையும் சீர்படுத்துவதிலும் ஒழுக்க நெறியை எடுத்துரைப்பதிலும் காப்பியங்கள் முக்கிய இடம் பெறுகின்றன. உலக சமயங்கள் அனைத்தும் ஒவ்வொரு பண்பாட்டுப் பின்னணியில் பிறந்தவை. இவ்வகையில் தமிழர்தம் பண்பாடு பல நெறிகளை வகுத்துள்ளது. இத்தகைய தமிழ்மொழியில் தோன்றிய கிறித்தவ இலக்கியங்கள், இயேசு கிறித்துவின் வாழ்வினையும் விழுமியங்களையும் மனித குலத்திற்கு எடுத்துரைக்கின்றன. அவ்வரிசையில், இருபத்தொன்றாம் நூற்றாண்டில் **புலவர்.ம. அருள் சாமி அவர்கள் இயற்றிய 'இதோ மானுடம்'** என்னும் காப்பிய நூல் கூறும் **வாழ்வியல் விழுமியங்கள்** பற்றி இக்கட்டுரையில் எடுத்தியம்பப்படுகின்றன.

வாழ்வியல் விழுமியம்:

விழுமியங்கள் எனப்படுபவை (Values) ஒரு பண்பாட்டைச் சார்ந்தோரின் வாழ்வியலுக்கும், செயல்களுக்கும் நடத்தை முறைகளுக்கும் (Behaviour Pattern) அவசியமானவை ஆகும். விழுமியங்கள் நாட்டிற்கு நாடு, பண்பாட்டிற்குப் பண்பாடு மாறுபடும். ஒவ்வொரு பண்பாடும் ஒரு குறிப்பிட்ட விழுமியத்திற்கு முக்கியத்துவம் தருகிறது. ஜப்பானியருக்கு அழகும், ஸ்பெயின் நாட்டவருக்கு ஆண்களின் வீரத்தன்மையும், ஜாவா தீவினருக்கு அமைதித்தன்மையும், இந்தியர்களுக்கு ஆன்மீக உணர்வும் இன்றியமையா விழுமியங்களாகும். தமிழர்கள் அகவாழ்வையும், அகம்சார்ந்த புற வாழ்வையும் மையப்படுத்தி வாழ்வின் விழுமியங்களை வகுத்துள்ளனர், இதனை,

"அறத்தான் வருவதே இன்பம் மற்றெல்லாம்
புறத்தே புகழும் இல"
(அறன் வலியுறுத்தல்:9)

என்ற குறளின் வழி அறச்செயல்களால் வருவதே உண்மையான இன்பமாகும். அதற்கு மாறான செயல்களால் அமைவது இன்பமுமாகாது என்றும் அறம் செய்வதே வாழ்வியல் விழுமியமாகும் என்பதையும் அறிய முடிகிறது.

காப்பியங்களில் விழுமியம் :

கடவுளையும், அரசனையும், தனிமனிதனையும், மையப்படுத்தி அந்தந்த காலச் சமுதாயத்தைப் பின்னணியாகக் கொண்டு காப்பியங்கள் படைக்கப்பட்டுள்ளன. பாரதமும், இராமாயணமும் கடவுள் அவதாரங்களை மனித நியதிகளுக்குட்படுத்தி, எழுதப்பட்டவையாகும். சீவக சிந்தாமணி, பெருங்கதை போன்றவை அரசனைத் தலைமைப்பாத்திரமாகக் கொண்டு இயற்றப்பட்டதாகும். சிலப்பதிகாரம் - மனிதவாழ்வின் விழுமியங்களையும், மணிமேகலை - துறவு வாழ்வையும் நிலையாமையையும் எடுத்தியம்பும் காப்பியங்களாகும். கடவுளைப்பற்றியதாக இருந்தாலும், மனிதனை மையப்படுத்தியதாக இருந்தாலும், அனைத்துவகை காப்பியங்களும், மானுடத்திற்கு,

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நல்லறமும், மனிதநேயமும், ஈகைகுணமும், இன்றியமையாதது என்பதை வலியுறுத்தும் வகையில் எழுதப்பட்டுள்ளன என்பது குறிப்பிடத்தக்கதாகும்.

இல்லறம் :

மனிதனும் சமுதாயமும் நலம்பெற வேண்டுமானால் குடும்ப நிறுவனம் சிதையாமல் இருத்தல் வேண்டும். குடும்பக் கட்டமைப்பைச் சரியான முறையில் நிலை நிறுத்துபவர்கள் கணவனும் மனைவியும் ஆவர். இவர்கள் மனம் ஒன்றுபட்டுச் செயல்பட்டால் வாழ்க்கை இனிதாக அமையும். இருவரும் அன்போடு இணைந்து வாழும் நிலையில் மட்டுமே விருந்தோம்பல், ஈகை, மற்ற அறத்தை கடைபிடிக்க முடியும் என்பதை இலக்கியங்கள் எடுத்துக்காட்டுகின்றன. கணவனும், மனைவியும் மனம் ஒன்றி வாழ்வதே சிறந்ததாகும். இதோமானுடத்தில், அன்பும் அறமும் கொண்டு வளனும் மரியும் வாழ்ந்த இல்லற வாழ்வு சூரியனும் சந்திரனும் போன்று அமைந்ததனை,

" .... அன்பில் மூழ்கி
அன்னையும் தந்தை ஆக
வாழ்ந்தார்கள் கதிரும் மதியும்
வார்த்தையின் பொருளைப் போலே"
(இதோ மானுடம் பக்:31)

என்ற வரிகளின் வழி, அறியமுடிகிறது. **'அன்பின் வழியது உயிர்நிலை'** என்பதற்கேற்ப அன்பின் வழி நடத்தல் என்பதே இல்லறத்திற்குரிய சிறந்த அறமாகும் என்பதை உணர்த்தும் வகையில் வளனும் மரியும் வாழ்ந்தார்கள் என்பதை அறிய முடிகிறது.

இறையுணர்வு:

மனதை ஒருமுகப்படுத்திட உண்ணாமலும் உண்ணும் அளவினைக் குறைத்துக் கொண்டேனும் உள்ளத்தாலும் சொற்களாலும் கடவுளை மெய்யன்போடு விதிப்படி வழிபடும்போது நம்மில் இறையுணர்வு மேலோங்குகிறது. இதனால் வளர்கின்ற பக்தியே நோன்பாகிறது.
இதனை,

"மனதாலே நோன்பு நோற்பின்
புனிதர்க்கு நிகராம்."
(இதோ மானுடம் பக்:154)

என்ற வரிகளானது,நோன்பிற்கு புறத்தூய்மையைக் காட்டிலும் அகத்தூய்மையே மிகவும் இன்றியமையாதது என்பதை எடுத்துரைப்பதாக அமைந்துள்ளது. மேலும், அகத்தூய்மையோடு நோன்பு மேற்கொள்ளும் போது புனிதர்க்கு நிகராகப் போற்றப்படுவர் என்பதையும் உணரமுடிகிறது.

மனித நேயம்:

மனிதனை மதித்து அன்பு செய்யும் உயரிய குணமே மனித நேயமாகும். இது மனிதாபிமானம் எனவும் அழைக்கப்படும். ஆங்கிலத்தில் இதனை 'Humanisum' என்று அழைப்பர். நல்ல சிந்தனையுடன் பிறரை வாழவைத்துத் தானும் வாழ்வதே மனித நேயத்தின் மாண்பாகும். இதனை

"உற்றவர் காத்தல் வேண்டும்
உதவி செய்து மீட்டல் வேண்டும்"
(இதோ மானுடம் பக்:352)

என்ற வரிகளின் வழி தம்மை நம்பி தஞ்சம் புகுவோரை பாதுகாக்க வேண்டும். அவர்களின் வாழ்வு உயர உதவி செய்ய வேண்டும். இவ்வாறு, பிறரின் வாழ்வு மேம்பட முன்வரும் போது மனித நேயம் மிளிரும் என்பதை, உணர முடிகிறது.

மன்னிப்பு:

உலகில் படைக்கப்பட்ட மனிதர்கள் அனைவரும் பகையின்றி, மன்னித்து, அன்பு செய்து, வாழ வேண்டும். இதனை இயேசு தம் வாழ்வில் தன்னை துன்புறுத்தியவர்களை மன்னித்து அவர்களுக்காக தந்தையிடம் செபித்தார், அவ்வழியில் வாழ்ந்தும் காட்டினார். இதனை,

"மன்னியுங்கள் இவர்கள் குற்றம்
மன்றாடுவேன் தந்தை உம்மை"
(இதோ மானுடம் பக்:675)

என்ற வரிகள் இயேசுவின் அன்பு வழியில் மன்னித்து, ஏற்று மகிழ்வோடு வாழ வேண்டும் என்பதை, அறிய முடிகிறது.

அன்பு:

நாம் செய்யும் தவம், நம் உயிர்த் தன்மையைத் தொட வேண்டும். நம் உயிர்த்தன்மை எந்த அளவு அன்புமயமாக இருக்க வேண்டுமெனில், எவ்வித எதிர்ப்பார்ப்புமின்றி தன்னையே தருவது தான் உண்மையான அன்பு. இதனை, கருவரை முதல் கல்லறை வரை தன் வாழ்வாலே வாழ்ந்து காட்டியவர் இயேசு.

"தன்னையே இழந்தே தியாகம் - செய்யேல்
தரணியில் மாற்றம் தோன்றாது
தன்னையே இழந்தே தியாகம் - செய்தால்
தரணியில் மாற்றம் புதிதாகும்"

(இதோ மானுடம் பக்:706)

மேற்கண்டவரிகளானது, இவ்வுலகில் தீமைகள் குறைந்து நன்னைகள் பெருகி, சமூக மாற்றம் நிகழ வேண்டுமெனில், தன்னையே தியாகம் செய்யும் உள்ளம் உள்ளவரால் மட்டுமே உயர்ந்தோராக முடியும் என்பதற்குச் சான்றாக வாழ்ந்து காட்டியர் இயேசுபிரான் என்பதை தெளிவுறுத்துகிறது.

"பொல்லாத பகைதான் வேண்டாம்
புனிதமாம் நண்பு வேண்டும்
எல்லாரும் நட்பாய் வாழ்வோம்:"

(இதோ மானுடம் பக்:137)

பகையின்றி வாழ இனிய சொற்களைப் பேசுவதே சிறந்ததாகும், இனியசொல் உள்ள போது, இன்னாதவற்றை கூறுவது, கனியிருக்க காய் கவர்ந்தற்றாகும் என்ற வள்ளுவர் குறிப்பிடுவது போல, பயன்தரும் சொற்களைப் பேசி பகையின்றி நட்புடன் வாழ்தல் வேண்டும். அவ்வாறு வாழும் போது அறத்தின் செயல்கள் நிறைந்து காணப்படும். இன்சொல் பேசி, பகையின்றி அன்பு செய்து நட்புடன் வாழ்வதே நட்பின் உச்சமாகும் என்பதை இதோமானுடம் விளக்குகிறது.

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பயன் கருதா உதவி:

பிறவியின் பயனே பிறர் நலன் பேணுதல் என்னும் உண்மையைத் தமிழர் அன்றே, தம் வாழ்வியற் கொள்கையாகக் கொண்டிருந்ததை உளந்தொறும் இன்பம் தருவதாக உள்ளது. மனிதனாகப் பிறந்த ஒவ்வொருவரும் ஏதோ ஒருவகையில் பிறருக்கு உதவி செய்ய வேண்டும். யாரும் தனித்து வாழ முடியாது. ஒருவர் மற்றொருவரைச் சார்ந்து வாழ்வது வாழ்வியல் முறையாகும். பயனை எதிர்பார்க்காமல் செய்கின்ற உதவிதான் உதவியாக கருதப்படும். இத்தகைய பயன் கருதா உதவியே சிறந்ததாகும். கல்வியறிவு பெற்ற அறிஞர்கள் பொருளில்லாத வறியவர்களுக்குச் செய்வதுதான் உதவி என்று நன்னெறி குறிப்பிடுகிறது, இதனை,

"கைமாறு உகவாமல் கற்றறிந்தோர் மெய்வருத்தித்
தம்மால் இயலுதவி தாம் செய்வார்."

(நன்னெறி:27)

என்ற பாடல்வரிகளின் வழி அறியலாகிறது

அன்னை மரியாள் எலிசபெத்தின் இல்லத்திற்கு விரைந்து சென்றார். கருவுற்றிருந்த எலிசபெத்திற்கு தேவையான பணிகள் அனைத்தையும் செய்து தம் இல்லம் சென்றதை,

"எலிசபெத்து இல்லத்தில்
உளம்மகிழ்ந்தே மரியாளும்
இருந்தார் பலநாட்கள்
விருந்தார் நாளெல்லாம்
பணிவிடைகள் பாங்காக"

(இதோ மானுடம் பக்:35)

என்ற வரிகளானது மற்றவருக்காக வாழ்வதே சிறந்த வாழ்வாகும் என்பதை உணர்த்துகின்றன..

விருந்தோம்பல்:

வாழ்வியல் நெறிமுறைகளில் முக்கிய கூறான இல்லறத்தில் விருந்தோம்பல் இன்றியமையாத ஒன்றாகும். தமிழர் பண்பாட்டில் போற்றுதலுக்குரிய பண்பாடு விருந்தோம்பல் தன் இல்லத்தை நாடி வந்தவர்க்கு இல்லையென்று சொல்லாது மனம் மகிழுமாறு உபசரித்தலே, சிறந்த பண்பாகும். இயேசுவின் போதனைகளை இரவெல்லாம் கேட்டு, மக்கள் ஆன்ம பலம் பெற்றனர். மக்களின் வயிற்றுப்பசியினை ஆற்றிட இயேசு விரும்பியபோது முன்வந்த சிறுவனின் பகிர்வினை,

"சின்னதொரு சிறுவன் இங்கே
சிறப்பான அப்பம் ஐந்து
தன்னுடனே மீன்கள் இரண்டு தருகிறான்"

(இதோ மானுடம் பக்:322)

என்ற பாடல் வரிகள், உணவைப் பகிர்ந்து உண்பதே மானுடப்பண்பாகும் என்பதை விளக்குகின்றன.

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திருவிழா:

சமூகத்தில் மக்கள் பல பிரிவுகளாகப் பிரிந்து வாழ்ந்தாலும் அவர்கள் அனைவரையும் ஒன்று சேர்ப்பது விழாக்களே ஆகும். சமுதாயத்தில் பசி, பிணி, பகை போன்ற இன்னல்களிலிருந்து விடுபட்டு, இன்பமுடன் வாழ விழாக்கள் கொண்டாடப்படுகின்றன.

"பசியும் பிணியும் பகையும் நீங்கி
வசியும் வளனும் சுரக்கென வாழ்த்தி
அணிவிழா அறைந்தனன் அகநகர் மருங்கென"
(மணிமேகலை, விழாவரைக்காதை:70-72)

என நவில்கிறது மணிமேகலை.

இஸ்ரயேல் மக்கள் அடிமை நிலையிலிருந்து உரிமை வாழ்வுக்கு அழைத்துச் செல்லப்பட்டதை நினைவுறுத்தும் விழா பாஸ்கா விழா ஆகும். இவ்விழாவினைக் கொண்டாட அன்னை மரியாவும் சூசையும் இயேசும் சென்றனர்.

"சென்றார்கள் எருசலேம் நோக்கி
சிந்தையெல்லாம் பாஸ்கா விழாவில்"
(இதோ மானுடம் பக்:93)

என்ற பாடல்வரிகள் காப்பியங்களில் இடம்பெறும் விழாக்களின் வாயிலாக மனிதப்பண்பு மேலோங்கியிருப்பதை அறியமுடிகிறது.

நிறைவாக:

இன்றைய உலகில் மனிதன் பல ஆக்கப்பூர்வமான உத்திகளைக் கையாண்டு தனக்கென ஒரு வாழ்க்கை முறையை வகுத்துக்கொள்கிறான். இத்தகைய செயல், அவனது வாழ்க்கையில் பல மாற்றங்களை ஏற்படுத்துகிறது. மாற்றங்கள் பல ஏற்படினும், நல்லறத்தால் வாழும் மனிதனே புகழோடு என்றும் நிலைத்து நிற்பான் என்றும், அவ்வாறு நிலைத்து நிற்க, ஒரு மனிதன் தன் வாழ்வில் பின்பற்ற வேண்டிய வாழ்வியல் விழுமியங்களான **'பயன் கருதா உதவி, இறையுணர்வு, இல்வாழ்க்கை, விருந்தோம்பல், மனித நேயம், மன்னிப்பு, அன்பு'** போன்ற பண்புகளைக் கடைபிடித்து, சுவையூட்டும் உப்பாக, வழிகாட்டும் ஒளியாக வாழ **'இதோ மானுடம்'** என்ற நூலின் வழி ஆசிரியர் தெளிவுபடுத்தியுள்ளதை இக்கட்டுரை வழி அறியலாகிறது.

துணை நின்ற நூல்கள்

1) **இதோ மானுடம்** - **புலவர்.ம.அருள்சாமி**
தனலெட்சுமி பதிப்பகம்
சென்னை 600 014
2) **அபிதான சிந்தாமணி** - **ஆ.சிங்கார வேலுமுதலியார்**
ஏசியன் எடுகேஷன் சர்வீஸ்
புதுடில்லி – 110016
3) **திருக்குறள்** - **சாரதா பதிப்பகம்**
சென்னை 600 014

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பெரும்பாணாற்றுப்படையில் நிலவியலும் சமூக அமைப்பும்

பா. மோகன்
முனைவர்பட்ட ஆய்வாளர்(முழுநேரம்),
நிர்மலா மகளிர் கல்லூரி(தன்னாட்சி), கோவை -18.

முன்னுரை:

உலகில் இன்று வழக்கில் இருக்கும் தொன்மையான மொழிகளுள் ஒன்று தமிழ்மொழி. இம்மொழி மிகவும் பழமையான இலக்கண, இலக்கிய வளங்களைத் தன்னகத்தே கொண்டுள்ளது. இலக்கிய வகைகளுள் முதன்மையாக வைத்துப் போற்றத்தக்கது சங்க இலக்கியம் ஆகும். இச்சங்க இலக்கியமானது பதினெண்மேற்கணக்கு,பதினெண்கீழ்க்கணக்கு எனும் இருபிரிவுகளைக் கொண்டதாகும். அவற்றுள், பதினெண்கீழ்கணக்கில் பத்துப்பாட்டு நூல்களுள் ஒன்றாக அமைவதே பெரும்பாணாற்றுப்படையாகும். இந்நூல் வாயிலாக சங்ககால மனிதன் தான் வாழ்ந்த நிலவியலும் அவற்றின் மூலம் அமையும் சமூக அமைப்பும் குறித்து விளக்குவதாக இவ்வாய்வுக்கட்டுரை அமைகிறது.

பெரும்பாணாற்றுப்படை விளக்கம்:

பரிசில் பெற்ற பாணன் தன்னைப் போன்று பரிசில் பெறவிருக்கும் மற்றொருவனை ஆற்றுப் படுத்துவதே ஆற்றுப்படையாகும். இதனை தொல்காப்பியம்,

> **"கூத்தரும் பாணரும் பொருநரும் விறலியும்**
> **ஆற்றிடைக் காட்சி உறழத் தோன்றிப்**
> **பெற்ற பெருவளம் பெறாஅர்க்கு அறிவுறீஇச்**
> **சென்றுபயன் எதிரச் சொன்ன பக்கமும்"(தொல்.பொருள்:36)**

என்று எடுத்துறைக்கின்றது. பெரியயாழினை, அதாவது பேரியாழினை வைத்துள்ள பாணன் பொரும்பாணன் என்றழைக்கப்பட்டான். பெரும்பாணன் ஆற்றுப்படுத்தும் விதத்தில் இந்நூல் அமைவதால் பெரும்பாணாற்றுப்படை என வழங்கப்பட்டது. வறுமை நிலையிலிருக்கக் கூடிய பாணனை தொண்டைமான் இளந்திரையனிடம், பரிசில் பெற்ற பாணன் ஆற்றுப்படுத்தும் வித்தில் அமைந்துள்ளது. அப்பாணன் தான் பெற்ற பரிசு பற்றியும் கடந்து வந்த நிலத்தின் தன்மைகளையும் அங்கு வாழும் மக்களின் வாழ்வியல் சூழல்கள் போன்றவற்றை எல்லாம் 500 அடிகளில் கடியலூர் உருத்திரங்கண்ணனார் விளக்கியுள்ளார். இந்நூல் ஆற்றுப்படை நூல்களில் அளவில் பெரியதாகவும் ஆசிரியப்பா வடிவில் அமைந்துள்ளது.

பெரும்பாணாற்றுப்படையில் நிலவியல்:

மனித இனம் தோன்றிய காலந்தொட்டே அவர்களின் வாழ்க்கையானது இயற்கையோடு இயைந்த வாழ்க்கை முறையாக இருந்துள்ளது. மனிதன் தான் வாழும் இடத்தின் சூழலுக்கு ஏற்றவாறு தன்னுடைய இருப்பிடம், தொழில், உணவுமுறை போன்றவற்றை ஏற்று வாழ்ந்துள்ளான். அதனை புலப்படுத்தும் நோக்கில் பெரும்பாணாற்றுப்படையின் ஆசிரியர் பாணன் பரிசு பெற கடந்து சென்ற நிலங்களின் தன்மைகளை எடுத்துக்கூறியுள்ளார்.

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பாலை:

சுரமும் சுரம் சார்ந்து, வறண்ட நிலப்பகுதியாகக் காட்சியளிப்பது பாலை நிலமாகும்.இங்கு எயினர், எயிற்றியர் இந்நிலமக்களாக வாழ்ந்துள்ளனர். இவர்களின் வீட்டமைப்பானது பாலை நிலத்தின் தன்மைக்கு ஏற்ற வகையில் அமைந்திருந்தது. அதில் அணிலும் எலியும் நுழைய முடியாதபடி நெருக்கமாக ஈச்ச இலையில் வேயப்பட்ட குடிலை அமைந்திருந்தனர். இதனை,

"வேற்றலை யன்ன வைந்நுதி நெடுந்தகர்
ஈத்திலை வேய்ந்த எய்ப்புறக் குரம்பை" (பெரும்.87,88)

என்ற அடிகள் குறிப்பிடுகின்றன. எயினர்கள் உணவிற்காக புல்லரிசியினை சேகரித்து வந்துள்ளனர். அதனை எயிற்றியர் உலக்கையில் இடித்து சமைத்து கருவாட்டுக் குழம்போடு தேக்க இலையில் உணவு உண்டதனை,

"தெய்வ மடையில் தேக்கிலைக் குரைஇறும்
பைதீர் கடுக்பொடு பதமிகப் பெறுகுவிர்" (பெரும். 104, 105)

என்ற அடிகளால் அறியமுடிகிறது. இவ்வாறு பாலை நிலமானது வறண்ட மணற்பாங்கான இடமாகக் காணப்பட்டாலும் கிடைத்த பொருளினைக் கொணடு வறியவர்களுக்கு உணவளித்தது புலப்படுகிறது.

குறிஞ்சி:

குறிஞ்சி நிலமென்பது மலையும் மலை சார்ந்த பகுதியாக விளங்குவதாகும். இப்பகுதியில் வாழும் ஆண்கள் தங்களின் தொழில்களில் ஒன்றான ஆநிரைகளைக் கவர்ந்துள்ளனர். பின் அதனால் கிடைக்கக் கூடிய பொருளினைக் கொண்டு கள்ளுண்டு மகிழ்ந்திருந்த நிலையினை,

"செல்நா யன்ன கருவிற் சுற்றமொடு
கேளா மன்னர் கடிபுலம் புக்கு
நாளா தந்து நறவுகொடை தொலைச்சி
இல்லடு கள்ளின் தோப்பி பருகி" (பெரும். 139-142)

என்ற பாடலடிகள் வழி அறியமுடிகிறது. குறிஞ்சிநில மக்கள் ஆநிரை கவர்தலின் மூலம் கிடைத்த பொருளினையும் கள்ளினையும் மற்றவர்களுக்கும் பகிர்ந்தளித்து மகிழ்ந்தது புலப்படுகிறது.

முல்லை:

முல்லை நிலத்தில் வாழும் மக்கள் கோவலர்கள் என்றழைக்கப்பட்டனர். அவர்களின் வீடானது, ஆடுகள் தின்னுவதற்காகத் தழைகள் கட்டப்பட்டிருக்கும் சிறய தூண்களை உடைய குடிசையினையும் மூங்கில் கொண்டு செறிவாகக் கட்டப்பட்ட கதவினையும் கொண்டிருந்தது என்பதனை,

"..... மறிய
குளகரை யாந்த குறுங்காற் குரம்பைச்
செற்றை வாயிற் செறிகழிக் கதவிற்
கற்றை வேய்ந்த கழித்தலைச் சாம்பின்" (பெரும்.147-150)

என்ற பாடல் அடிகள் வெளிப்படுத்துகின்றன. ஆயர்குலப் பெண்களான ஆய்ச்சியர்கள் ஆநிரைகளிலிருந்து கிடைக்கும் பாலினைக் கொண்டு மோர், வெண்ணெய் போன்றவற்றை எல்லாம் விற்று வாழ்ந்துள்ளனர். இதனைச் சிலப்பதிகாரம்,

"ஆகாத் தோம்பி யாப்பய னளிக்கும்
கோவலர் வாழ்க்கையோர் கொடும்பாடில்லை"

(சிலம்பு. அடைகலக்காதை: 120,121)

என்ற பாடல்வரிகள் விளக்குகின்றன. இதே கருத்தினை பெரும்பணாற்றுப்படையும் கூறுகிறது.

"நாண்மோர் மாறு நன்மா மேனிச்
சிறுகுழை துயல்வரும் காதிற் பனைஆயத்தோட்
குறுநெறிக் கொண்ட கூந்த லாய்மகள்" (பெரும். 160-162)

என்ற பாடல்வரிகளால் தெளிவுபடுத்துகிறது. ஆயர் குலப்பெண்கள் தங்களின் குடுபம் மேம்பாட்டிற்காகப் பாலினைக் கொண்டு விற்ற பொருளில் பொன், பொருளினை வாங்காமல் ஆநிரைகளை வாங்கியுள்ளது வாயிலாக வியாபாரம் பெருக்கும் நோக்கு வெளிப்படுகிறது.

முல்லை நில மக்கள் புல்லாங்குழலை இசைத்துப் பாடிய முல்லைப் பண்ணை இரசித்ததோடு குமிழ மரத்தின் தண்டில் 'மரல்' எனப்படும் கள்ளிநாரால் யாழ் செய்து குறிஞ்சிப் பண்ணையும் பாடி மகிழ்ந்து இருந்தனர். என்பதனை,

"செந்தீத் தோட் கருத்துளைக் குழலின்
இன்றீம் பாலை முனையிற் குமிழின்
புழக்கோட்டுத் தொடுத்த பரற்புரி நரம்பின்
விலயா ழிசைக்கும் விரலெறி குறிஞ்சி" (பெரும்: 179-182)

என்ற பாடலடிகள் விளக்குகின்றன.

மேற்கண்டவாறு முல்லைநில மக்கள் தங்களின் நிலச்சூழலுக்கு ஏற்றவாறு வாழ்ந்ததோடு, குறிஞ்சி நிலப்பண்ணான குறிஞ்சிப் பண்ணையும் வாசித்து மகிழ்ந்தனர் என்ற செய்தி இசைப்புலமையைக் காட்டுகிறது.

மருதம்:

வயலும் வயல் சார்ந்த பகுதி மருதநிலமாகும். இங்கு வாழும் மக்கள் உழவர்கள் என்றழைக்கப்பட்டனர். இவர்கள் தங்களின் தொழிலாகிய உழவுத்தொழிலினை மிகவும் செம்மையாகச் செய்துள்ளனர். அவ்வாறு உழும்போது வயலினை அகலமாகவும் ஆழமாகவும் உழுதுள்ளனர் என்பதனை,

"குடிநிறை வல்சிச் செஞ்சா லுழவர்
நடைநவில் பெரும்பகடு புதவிற் பூட்டிப்
பிடிவா யன்ன மடிவாய் நாஞ்சில்
உடுப்புமுக முழுக்கொழு மூழ்க வூன்றி" (பெரும்.197-200)

என்ற பாடல் வரிகள் தெளிவுபடுத்துகின்றன. மருதநிலமானது மிகவும் வளப்பம் மிக்க பகுதி என்பதனால் அங்கு வாழும் மக்கள் வசதியான இல்லங்களை அமைத்து வாழ்ந்துள்ளனர். என்பதனை,

"குமரி மூத்த கூடோங்கு நல்லில்" - (பெரும். 247)
"அமளித் துஞ்சும் அழகுடை நல்லில்" - (பெரும்.252)

என்ற பாடல் வரிகள் வாயிலாக வளமுடைய இல்லங்கள் அமைக்கப்பட்ட செய்தியை அறியமுடிகிறது.

நெய்தல்:

கடலும் கடல் சார்ந்த பகுதி நெய்தல் நிலமாகும். இப்பகுதியில் வாழ்ந்த மக்கள் பரதர் எனப்பட்டனர். இவர்கள் தங்கள் நாட்டில் விளைந்தப் பொருட்களை ஏற்றுமதி செய்தும், மற்ற நாட்டுப் பொருட்களை இறக்குமதி செய்தும் வாழ்ந்துள்ளனர். இதற்கு நாவாய்களை அதிக அளவில் பயன்படுத்தி உள்ளனர். இதனை

"..... பாற்கேழ்
வாலுளைப் புரவியோடு வடவளந் தருஉம்
நாவாய் சூழ்ந்த நளிநீர்ப் படப்பை
பரதர் மலிந்த பல்வேறு தெருவில்" (பெரும். 319-321)

என்ற வரிகளில் அறியமுடிகிறது. நாவாய்கள் வந்திறங்கும் நிலப்பரப்பினைச் சுற்றியுள்ள பகுதிகளில் பல பொருட்களை விற்கும் பண்டகசாலைகளும், உயர்ந்த மாடங்களும் அமைக்கப்பட்டிருந்தன. அதனை பட்டினம் என்ற பெயரிட்டு அழைத்துள்ளனர். இதனை,

"மூத்த வார்மணற் பொற்கழங் காடும்
பட்டின மருங்கி னசையின்" (பெரும். 335-336)

என்ற அடிகள் குறிப்பிடுகின்றது. இவ்வாறு நெய்தல் நில மக்கள் கடல் சூழ்ந்த பகுதியிலுள்ள பொருட்களைக் கொண்டு ஏற்றுமதி, இறக்குமதி செய்து வாழ்ந்தது புலப்படுகிறது. நெய்தல் நில வாழ்வியல் வழி துறைமுக நகரங்கள், கடல்வழி போக்குவரத்து என சர்வதேச வணிகமையமாக நெய்தல் நிலம் விளங்கியதை அறியமுடிகிறது.

பெரும்பாணாற்றுப்படையில் சமூக அமைப்பு: தனிமனிதர்கள் பலரை ஒன்றிணைக்கும் ஓர் அமைப்பே சமூகமாகும். ஐந்து வகையான நிலங்களில் மனிதன் வாழத் தொடங்கிய போதே கூட்டம் கூட்டமாக வாழ்ந்துள்ளான். அவ்வாறு வாழும்போது தான் வாழும் நிலத்தின் அமைப்பிற்கு ஏற்றவாறு பல தொழில்கள், உணவுமுறைகள், வீட்டமைப்புகள் போன்றனவற்றை கொண்டிருந்தனர் என்பதை அறியமுடிகிறது. சமூக அமைப்பு என்பது சாதி அடிப்படையாகக் கொண்டதல்ல. அது மனிதர்கள் வாழும் நிலவியலின் அடிப்படையில் அமைவது என்பதை வெளிக்காட்டும் வகையில் இவ்வாய்வுக் கட்டுரை அமைகிறது.

தொழில்:

ஐந்து வகையான நிலங்களில் வாழும் மக்கள் தங்களின் நிலவியலமைப்பிற்கு ஏற்றவாறு தொழில்களினைச் செய்துள்ளனர். உதாரணமாக, வயல் சார்ந்த பகுதியான மருதநில மக்கள் உழவுத் தொழிலினை மேற்கொண்டுள்ளனர். அதனால் அவர்கள் உழவர் என்று வழங்கப்பட்டதனை,

"குடிநிறை வல்சிச் செஞ்சா லுழவர்" (பெரும்-197)

என்ற அடியானது புலப்படுத்துகிறது. இவ்வாறு ஒவ்வொரு நிலத்தின்கண் வாழும் மக்களின் தொழில் முறையானது அமைவது தெளிவுபடுகிறது.

உணவு முறை:

பண்டைக் காலம் முதற்கொண்டே மனிதர்கள் தங்களின் நிலப்பகுதியில் கிடைக்கக் கூடிய உணவுப் பொருட்களை உணவாக உட்கொண்டு வாழ்ந்தனர். முல்லை நிலமக்கள் தங்கள் வாழும் பகுதி காட்டுப்பகுதி என்பதால் அங்கு விளைந்த அவரை விதையின் பருப்போடு சோற்றை உண்டு மகிழ்ந்துள்ளனர். இதனை

"அவரை வான்புழுக் கட்டிப் பயில்வுற்
றின்சுவை மூரற் பெறுகுவிர்" (பெரும்.195-196)

என்ற பாடல்வரிகள் விளக்குகின்றன. அவரவர் நிலத்தில் விளைந்த உணவினை உட்கொண்டாலும் வறுமை நிலையிலிருக்கக் கூடிய பாணர்கள் பரிசில் பெறச் செல்லும்போது தாங்கள் கடந்து செல்லும் நிலங்களில் கிடைக்கக் கூடிய உணவினை உட்கொண்டதனை பெரும்பாணாற்றுப்படையானது தெளிவுபடுத்துகிறது.

வீட்டமைப்பு:

இயற்கைச்சீற்றம், பேரிடர்கள், விலங்கினங்களின் அச்சுறுத்தல் போன்றவற்றிலிருந்து பாதுகாத்துக் கொள்ள துணைபுரிபவை வீடுகளாகும். சங்க கால மனிதன் இயற்கை நிலச்சூழலின் அமைப்பிற்கு ஏற்ற வகையில் வீடுகளை அமைத்துக் கொண்டான். பாலை நிலமானது மிகவும் வறண்ட நிலப்பரப்பு என்பதால் அங்கு அதிகளவில் இருக்கக்கூடிய ஈச்சமர இலையைக் கொண்டு குடிலினை அமைத்திருந்தனர். என்பதனை,

"ஈத்திலை வேய்ந்த எய்ப்புறக் குரம்பை" (பெரும். 88)

என்ற அடி குறிப்பிடுகிறது. மருதநில மக்கள் பல்வேறு வகையான இல்லங்களை அமைத்திருந்தனர். கடலோரத்தில் வாழும் நெய்தல் நில மக்கள் பல அடுக்குகளை உடைய மாடங்களையும், சூறைக்காற்று உட்புகாதவாறு தோப்பு வீடுகளையும் அமைத்திருந்தனர் என்பதை அறியமுடிகிறது.

விருந்தோம்பல்:

வீட்டிற்கு விருந்தினராக வந்தவர்களை இன்முகத்தோடு வரவேற்று உபசரிப்பது தமிழர் மரபு. அவ்வாறு உபசரிக்கும் போது முகந்திரியாமல் உபசரிக்க வேண்டும். இதனை திருவள்ளுவர்,

"மோப்பக் குழையும் அனிச்சம் முகந்திரிந்து
நோக்கக் குழையும் விருந்து" (குறள்: 90)

என்று குறிப்பிடுகிறார். இக்கருத்தினைப் பெரும்பாணாற்றுப்படையில் உற்று நோக்கும் போது வறுமை நிலையிலுள்ள பாணனிடம் பரிசு பெற்ற பாணன் ஐவகை நிலங்களிலும் தான் விருந்தாகப் பெற்ற உணவினை கூறுகிறான். இதனை,

"செவ்வரை நாடன் சென்னியம் எனினே
தேய்வ மடையில் தேக்கிலைக் குவை இறும்
பைதீர் கடும்பொடு பதமிகப் பெறுகுவிர்" (பெரும். 103-105)

என்ற பாடல்வரிகள் விளக்குகின்றன. இவ்வாறு, ஐந்து வகையான நிலங்களில் வாழ்ந்த மக்கள் தொழில், உணவு வீட்டமைப்பு போன்றவற்றிலெல்லாம் மாறுபட்டுக்

காணப்பட்டாலும் விருந்தோம்பல் பண்பில் ஒரே மாதிரியான மனநிலையில் காணப்பட்டது தெளிவுபடுகிறது.

முடிவுரை:

பெரும்பாணன் தான் பரிசு பெற கடந்து சென்ற பாதையானது பாலை, குறிஞ்சி, முல்லை, மருதம், நெய்தல் என்ற ஐவகை நிலவியலமைப்பில் அமைந்திருந்தது. மக்கள் தங்கள் நிலத்தின் சூழலுக்கும், தங்களுடைய பொருளாதார நிலைக்கு ஏற்ற வகையில் இல்லங்களை அமைத்தும், உணவு முறைகளில் மாறுபட்டும் வாழ்ந்துள்ளனர். பெரும்பாணாற்றுப் படையில் சமூக அமைப்பானது நிலவியலமைப்பின் அடிப்படையில் அங்கு வாழும் மக்களின் வீட்டமைப்பு, தொழில், உணவு முறைகள் போன்றவற்றின் வழி அமைவது தெளிவுபடுத்தப்பட்டுள்ளது. இவ்வாறு, நிலவியல் அமைப்பு வழி சமூகமும் வாழ்வியலும் விளங்கியது தெளிவுபடுத்தப்பட்டுள்ளது.

துணைநூற்பட்டியல்:

1) **சங்க இலக்கியம் பத்துப்பாட்டு - நியூசெஞ்சுரி புக்கவுஸ், சென்னை.**
2) **திருக்குறள் - சாரதா பதிப்பகம், சென்னை 600 014**
3) **தொல்காப்பியம் - சைவ சித்தாந்த நூற்பதிப்புக் கழகம், திருநெல்வேலி.**

◆

இராவணின் நிறைகள்

திருமதி. சுகிர்தா
பகுதி நேரமுனைவர் பட்ட ஆய்வாளர்,
நிர்மலா மகளிர் கல்லூரி(தன்னாட்சி), கோவை -18

முன்னுரை

உயிரினங்களிலேயே மனிதர்களுக்கு மட்டுமே வாய்த்த மகத்தான ஒன்று பகுத்தறிவு என்பதாகும். அதனால் தான் 2300 ஆண்டுகளுக்கு முன்பே, மனித நாகரிகத்தின் தொட்டில் என வரலாற்று அறிஞர்களால் கொண்டாடப்படும் கிரேக்க நாட்டில் மனிதன் என்றால் என்ன இலக்கணம்? என்ன வரையறை? என்ற வினா எழுந்த போது, அரிஸ்டாட்டில் மனிதன் என்பவன் பகுத்தறியும் விலங்கு எனச் சுருக்கமாக எல்லாரும் இன்று வரை ஏற்றுக் கொள்ளும்படியான ஒரு வரையறை வழங்கினார். எனவே, மனிதர்களாகிய நமது அடிப்படைக் குணமே, எப்பொழுதும் எந்த ஒன்றைப் பற்றியும் பகுத்துப் பகுத்துப் பல்வேறு கோணத்தில் பல்வேறு முறையில் ஆராய்ந்து கொண்டே இருப்பது தான். எனவே தான் ஆராய்ச்சி இல்லாத இடத்தில், மனிதர்களின் இருப்பும் இல்லாமல் போய் விடுகிறது என அறிஞர்கள் கருதுகின்றனர்.

மேற்கூறிய கருத்துக்களை மனதில் இருத்தி ஈடும் இணையும் இல்லாத ஒரு இறும்பூதும் காவியமாம் கம்பராமாயணத்தின் எதிர்நிலைத்தலைவன் இராவணனின் நிறைகளைப் பகுத்தறியும் நோக்கில் இக்கட்டுரை அமைகிறது.

எதிர்நிலைத்தலைவர்கள்

இலக்கியங்களில் கதைத்தலைவர்கள் மட்டுமின்றி எதிர்நிலைத் தலைவர்களும் நிலைத்த இடம்பெற்று விடுகிறார்கள். பாரதம் என்றவுடன் அருச்சுனன் நினைவுக்கு வருவது போலவே துரியோதனனும் நினைவுக்கு வருகிறான். கந்தபுராணம் என்றவுடன் முருகன் மட்டும் நினைவுக்கு வருவது இல்லை, சூரபன்மனும் நினைவுக்கு வருகிறான். இது தமிழ் இலக்கியத்திற்கு மட்டுமின்றி உலக இலக்கியத்திற்கே பொதுவான ஓர் இயல்பாகும்.

ஷேக்ஸ்பியரின் வெனிஸ் வர்த்தகன் நாடகத்தில் வரும் கதாநாயகன் பசானியோவைப் போலப் பேராசைக்காரனான ஷைலாக்கும் படிப்பவர் மனதில் நிற்கிறான். உலக வாழ்க்கையிலும் இதனைக் காணலாம். அண்ணல் காந்தியை நினைக்கும் போது அவரைக் கொன்ற கோட்சேவை நினைப்பது தவிர்க்க இயலாதது.

அதுபோலவே இராமாயணத்தில் இராமன் எப்படி நிலைத்த பாத்திரமாக இருக்கிறானோ அப்படி இராவணனும் நிலைத்த இடத்தைப் பெற்றுள்ளான். சிறந்த தலைவனைப் போலச் சிறந்த எதிரியும் நிலையான இடத்தைப் பெறுகிறான். அதே சமயத்தில் எதிர்நிலைத்தலைவனின் பெருமையை விளக்குவது காப்பிய ஆசிரியர்கள் மேற்கொள்ளும் நல்ல உத்திகளில் ஒன்றாகும். கம்பரும், வான்மீகியும் இவ்வுத்தியினைக் கையாண்டுள்ளனர். அதனால் இரு காப்பியங்களிலும் இராவணன் பாத்திரப்படைப்பு அழகுற அமைந்துள்ளது எனலாம்.

காப்பிய ஆசிரியர்கள் எல்லாப் பாத்திரங்களையும் ஒரே நிலையில் தான் கருதுவர். அவற்றை அவற்றின் இயல்பு புலப்படும் வகையில் மிகுந்த அக்கறையோடு படைப்பார்கள். காப்பியத்தின் தலைவனைப் படைப்பதில் எவ்வளவு கருத்து செலுத்துவார்களோ அவ்வளவு கருத்தினை எதிர்நிலைத் தலைவனைப் படைப்பதிலும் செலுத்துவர். ஏனெனில், இருவரும் அவர்கள் குழந்தைகளே. கம்பன் இராமன் என்னும் பாத்திரத்தை வனைவதற்கு எடுத்துக் கொண்ட முயற்சிக்கு சற்றும் குறையாத முயற்சியினை இராவணன் என்னும் பாத்திரத்தை வனைவதற்கும் எடுத்துக் கொண்டுள்ளார். கற்பவர் நெஞ்சில் இராமன் தொழத்தக்கவனாக நிற்பதைப்போல இராவணன் இரக்கத்திற்குரியவனாக நிற்கிறான். அத்தகைய இராவணனின் வாழ்க்கையில் நிறைகளும் குறைகளும் கலந்தே இருந்தன. அவன் நிறைகளுள் குறிப்பிடத்தக்கவை அவனுடைய பெருமிதம், பத்திமை, வீரம் ஆகியவனவாகும்.

பெருமிதம்

இராவணன் பெருமித வாழ்வினை அழகுற வாழ்ந்துள்ளான். அவன் எந்தச் சூழலிலும் தன்னைப் பற்றித் தானே தாழ்வாக நினைத்ததில்லை. தன்னைத் தானே கர்வத்தோடு நடத்திக் கொள்வதில் இராவணனுக்கு நிகர் இராவணனே.

எத்துணைப் பெரிய வீரனாயினும் மனைவி ஊடல் கொண்ட சமயத்தில் அவள் ஊடலைத் தணிப்பதற்காக அவளை வணங்குவது உண்டு. அது குற்றமாகக் கருதப்படுவதில்லை உயர்வாகவே போற்றப்படும்.

"மனைவி உயர்வும் கிழவோன் பணிவும்
நினையுங் காலைப் புலவியுள் உரிய"
(தொல். பொருளியல் 33)

என்பது இலக்கணம். திருவள்ளுவர் அத்தோல்வியை வெற்றியாகக் குறிக்கிறார். ஊடலிற் தோற்றவர் வென்றார் என்பது அவர் வாக்கு.

ஆனால், இராவணன் ஊடற்காலத்தில் கூட மகளிரை வணங்காதவனாம். அன்புக்காகக் கூட அவன் யாரையும் அடிபணிந்தவன் அல்லன். புலவிக் காலத்திலும் அழகிய பெண்களை வணங்காத அவன் தலைகளில் மகுடங்கள் ஒளிவீசின.

"புலியின்அதன் உடையானும் பொன்னாடை
புனைந்தானும் பூவி னானும்
நலியும்வலத் தார்அல்லர் தேவரின் இங்கு
யாவர்இனி நாட்டல் ஆவார்?
மெலியுமிடை தடிக்குமுலை வேயிளந்தோள்
சேயரிக்கண் வென்றி மாதர்
வலியநெடும் புலவியினும் வணங்காத
மகுடநிலை வயங்க மன்னோ! (3069)

அவன் தோள்கள் உதயமலைகள் போல் உயர்ந்து நின்றன. அவன் காதுகளில் அணிந்த குண்டலங்கள் தோள்களின் மேலே சுடர்விட்டு ஒளிர்ந்தன. அந்தப் பன்னிரு சுடர்களும் இருபதாக வடிவங் கொண்டிருந்தாற் போலத் தோன்றின. அவன் மார்பில் சன்னவீரம் என்னும் ஆரம் கிடந்தது. அ.ீது அவனால் இலங்கையில் அடைத்து வைக்கப்பட்டிருந்த கோள்கள் எல்லாம் சிறைப்பட்டது போலக் காட்சி தந்தது. அவன் கால்களில் கிடந்த வீரக் கழல்கள் அரக்கர் தலைவர்களும் பிறரும் தங்கள் கிரீடம் பொருந்த வணங்குவதால் தேய்ந்து தேய்ந்து புத்தொளியோடு திகழ்ந்தன.

இப்புனைந்துரையில் இராவணனின் பெருமிதத்தோற்றம் மட்டும் விளங்கவில்லை. அவன் சூரியன், கோள்கள் முதலியவற்றையும் வெற்றி கொண்டவன் என்னும் குறிப்பும் புலப்படுகிறது.

மேலும் இராவணனின் அரண்மனையில் மூவுலகத்தலைவர்களும் ஓயாமல் கொண்டு வந்து தந்த பரிசுகள் மலையாய் குவிந்து கிடந்தன. அவன் எப்பொழுது தங்களைப் பார்ப்பானோ என்பது அறியாமல் எப்பொழுதும் தலைமேல் கைகளைக் குவித்தவாறு வித்தியாதரவேந்தர்கள் காத்திருந்தனர். அவன் பெண்களிடம் ஏதாவது சொன்னாலும் தங்களிடம் தான் சொல்லுகிறான் என்று கருதிச் சித்தர்கள் வணங்கி நின்றனர்.

பத்திமை

இராவணன் வேதங்களைக் கற்றுணர்ந்தவன். அவனை ஆயிரம் மறைப்பொருள் உணர்ந்து அறிவு அமைந்தவன் என்கிறான் கும்பகர்ணன். இராவணன் சமயச்சார்பு பற்றி வான்மீகத்தில் குறிப்பு இல்லை. ஆனால் கம்பநாடர் அவனைச் சிறந்த சிவபக்தனாகப் படைத்துள்ளார்.

கம்பநாடார் அவன் பத்தியைக் காட்டும் வகையில் நெஞ்சை நெகிழ்விக்கும் நிகழ்ச்சியொன்றைச் சித்தரிக்கிறார். இராவணன் பெரும்படைகள் எல்லாம் அழிந்துவிட்டன. அவன் வாழ்வின் இறுதிக்கட்டம் அது. அவன் இலங்கையில் எஞ்சியிருந்த அரக்கர்களைத் திரட்டிக் கொண்டு இறுதிப்போருக்குப் புறப்பட்டான். அதற்கு முன்பு முறைப்படிச் சிவனுக்கு வழிபாடு நிகழ்த்தினான். வேதவிதிப்படி கொடை வழங்கினான். மேலும் விரும்பியவர்களுக்கெல்லாம் அவர்கள் விரும்பியதைத் தந்து போருக்கு ஆயத்தமானான்.

"ஈசனை இமையா முக்கண்
ஒருவனை இருமைக்கு ஏற்ற
பூசனை முறையின் செய்து
திருமறை புகன்ற தானம்
வீசினன் இயற்றி மற்றும்
வேட்டன வேட்டோர்க்கு எல்லாம்
ஆசுஅற நல்கி ஒல்காப்
போர்த் தொழிற்கு அமைவது ஆனான் **(9644)**

வீரம்

இராவணன் வீரம் மிக்கவன். சீதையைக் கவர்ந்து சென்ற பின்னரே இராவணன் தன் நிலையில் தாழ்ந்தான். அதற்கு முன்பும் அவனிடம் காமம் இருந்தது. ஆனால் அ.ீது அளவுபட்டிருந்தது. அது மட்டுமின்றி அதற்கு முன்பு அவன் விரும்பிய பெண்களை எல்லாம் அடைந்து விட்டான். அதனால் வீரத்தை அரித்து அழிக்கும் விரகதாபம் அவனை அண்டவில்லை.

வீரத்தில் இராமனுக்கு அடுத்த நிலையில் எண்ணத்தக்கவனாக இராவணன் திகழ்ந்தான். இதனைக் காப்பிய நிகழ்ச்சிகள் நுட்பமாகக் காட்டுகின்றன.

இராவணனை எதிர்த்துத், தனித்துப்போரிட்ட அனுமன், சுக்கிரீவன், இலக்குவன் ஆகியவர்களால் வீழ்த்த முடியாத மிகப்பெருவீரன் இராவணன்.

இதனை இராவணனிடத்தில் தூது சென்ற அங்கதன் இராவணனைக்கண்ட அப்பொழுதே உணர்ந்தான். அவனை இராமன் ஒருவனால் மட்டுமே வெல்ல முடியும் என்ற முடிவுக்கு வந்தான்.

"கல்லுண்டு மரமும் உண்டு ஏழைக்
கடல் ஒன்றும் கடந்தேம் என்றும்
சொல்லுண்டே இவனை வெல்லத்
தோற்றும் ஓர் கூற்றம் உண்டே?
எல்லுண்ட படைகைக் கொண்டால்
எதிர் உண்டே? இராமன் கையில்
வில் உண்டேல் உண்டு என்று எண்ணி
ஆற்றலை வியந்து நின்றான் "(6989)

என்று அவன் எண்ணத்தைத் தெரிவிக்கின்றார் கம்பநாடார்.

முடிவுரை

இவ்வாறு பெருமித வாழ்வும், பத்திமையும், வீரமும் பெற்றிருந்த இராவணன் அழிவு நம் உள்ளத்தில் வருத்தத்தை உண்டாக்கவில்லை. மாறாக அவனது ஆற்றலும், வீரமும் பிற தகுதிகளும் வீணாகிவிட்டனவே என்பதான இரக்கம் எழும். இராவணன் போன்றவர்களின் வீழ்ச்சி வருத்தத்தை உண்டாக்காமல் இரக்கத்தை மட்டுமே உண்டாக்குகிறது.

தன் உயிர் விற்றுப் புகழைப் பெறுவது புனித மரணம். தன் உயிர் கொடுத்துப் பழியைப் பெறுவது புலைமரணம். அது இராவணன் அடைந்தது. இராவணன் உயிர்கொடுத்துப் பழிகொண்ட பித்தன் எனலாம்.

◆

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EMPOWERMENT OF WOMEN IN THE PLAYS OF EURIPEDAS

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Euripedas (c.480 – 406 B.C.) was the last of the great Greek dramatists. He wrote ninety two plays and of the nineteen that survive the most important are the tragedies like *Alcestis, Medea, Hippolytes, Electra, The Trojan Women, Helen* and *The Bacchae* and the only surviving play satyr play, *Cyclops*. Euripedas is notable for his portrayal of powerful women characters like Medea and Electra. He investigates their mental agony and their depth of character. Euripedas was interested in the psychological analysis of his characters, so his portrayels are rounded, sometimes contradictory and always complicated. Euripedas was more of a romantic who appealed to the newer generation with new theatrical and psychological concepts. In his classic work *Medea* he has dealt in detail with the weakening of marriage bonds, cruelty of men to women. Euripedas chose to present problems of individuals. *Medea* for example, presents a case of emancipation of women, Euripedas was trying to expose the social evils through his plays, thus women is always in a precarious is always assailable and vulnerable. Euripedas has made out of a strong case for regeneration of women. A litterateur, being a spokesperson of his age, has to draw attention of the people to the problems confronting the society.

POPULARITY

Medea is written by the Greek dramatist Euripedas probably in 431 B.C., Even though the play belongs to the classical age, but still it creates interest for its art and theme towards the modern readers. It also inspires several writers like Neophron who also writes the play regarding the same content and title. Roman writer Seneca also writes *Medea* with certain differences. Ovid also tries to write the play, but for some unknown reasons he abandons the plan. Euripedas*Medea* has stands the evidence of time because even now it has been translated and elected into various languages.

EMPOWERMENT OF WOMEN

Medea is the protagonist of the play and the entire story revolves around her. The dramatist gives emphasis on Medea. Even though she belongs to the barbarian place of Colchies, but she is an intellectual person having enigmatic capacities. She shows inequity by selecting her sole partner. She is an emotional lover. She leaves her father's home for her true love of Jason. And also she is ready to cheated the daughters of Pelias in order to murder their father. She remains faithful to her husband Jason and gives birth to two sons for him. But Jason shows falseness and injustice to her, marries another women and orders to her to be exiled along with her sons. But she is not like a submissive women who accept betrayal. She truly loves Jason and remains very loyal to him. By her intelligence, she murders the traitors, but she also murders her children in order to protect them from the injustice and violence of the enemies and also adds injuries on the psyche of Jason. Through her actions she gives an underlying theme to this current world that one must not consider that women are weak, inferior, submissive and ready to tolerate the tyrannies. They have the great admirable qualities of both head and heart.

WOMEN'S PREDICAMENT

Literature is the reflection of society. Women in the age of Euripedas consider as subordinate and inferior to men. Euripedas, however, gives importance to women psyche as a feminist, wants to work for up gradation of women. So that, he announces women's case in front

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of society through the long speech given by Medea. She mentions a women buys husband ruled over her body and also her mind. Then it depends upon her destiny whether the husband is good or bad. If she applies for divorce, she loses her reputation in the society. In addition, the society compel her to adopt with the new rules and customs follow by her husband's family. She also has the skill to be familiar with the taste and desires of a man whose bed she shares. If her husband enjoys his marriage yoke happily, then the wife is blessed with a happy life. But on the other hand if the marriage does not work, wife's life is worse than hell. Her husband finds a mistress to enjoy his life. A women meets greater danger of life during the child birth than men in the war field. She tolerates the labour pain and gives life to her baby. As a literature review shows in 2000 to finds out the memory of pain during child birth that women do not forget the pain during child birth. The researches comes to the conclusion that women are able to feel the pain of child birth perhaps not accurates. The researches also mentions that most women discuss the pain of labour in a positive way, simply mention the happiness of holding her baby for the first time overpowers any pain or negativity from the pain. Euripedas makes a strong effort for the rehabilitation of women. As a feminist, being a spokesperson of his age he gains attention and reputation among people to the problems of the society. Through the long speech given by Medea, he expresses the women's predicament in the society and gives emphasises of women's role.

INJUSTICES FACED BY WOMEN

For the past hundred years, March 8th has been celebrated as the International Women's Day, which primarily aims to acknowledge the role of women and raise awareness of the injustices that still happened to them. This technological era also we find inequities between gender, Millions of women in this present world face injustices, they are denied by an education, forced with an early marriage, made victims of gender based violence. These injustices arrest women from reaching their ambition.

STEPS TO ACHIEVE GENDER EQUALITY

Women's voices are often ignored from domestic and global decision making. A women's voice and her ability to become a leader in her community is fundamental to empowering women. Men and women were created to be different. They were created with different strengths and weakness to complement each other. Instead of missing their strengths to put down or show the superiority over the opposite sex, we must try to create a healthier society which highlights and respects the individual qualities and strengths of each person. The dramatist is an excellent craftsman though he has taken the mythological story but gives the content which apt for the present society. The play deals with the message that marital happiness is not possible unless women gets rightful place in the society.

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War as a theme in the novels of Michael Ondaatje

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Michael Ondaatje in his novels *The English Patient*, *Anil's Ghost a*nd *War light* uses the theme of war in order to clearly signify to the readers how war impacts human life be it civil war, the war between nations or wars for more beneficial or superficial reasons. This paper voices out how lives of people are shaped and remolded by the gruesome effects of war.
Keywords: war, revolution, psychological impacts, family

War as a theme in the novels of Michael Ondaatje

Literature has testified detailed information of life on this planet in the most credible at the same time in the most plethoric way ballooning ideas for study ever since human civilization commenced the art of documenting. It is a fact that humans have evolved and are evolving in various parallels seeking knowledge and insight to innumerable fields and thoughts. In spite of such advancements, human life has succeeded in the battle of dominance. Power which was the most difficult strength to possess has now reached the palms of individuals and mass destruction for any reason is just a thought away.

Canadian literature is one among world literature and has its own reflections of the group that belongs to that space giving it distinguishing characteristics due to various influences. For literature is concerned, it is a fact that human groups have various stories to share and it is possible to achieve the same through technological advancements within the blink of an eye. From the legacies of explorers, colonial writing, writings influenced by the confederation groups, the Canadian school and its influences along with the writers express their ideas in history, poetry, essays, novels, stories, drama and non-fiction writings. Margaret Atwood, Malcolm Gladwell, Kathleen Margaret, Michael Ondaatje, Yann Martel, Alice Munro, Rohinton Mistry and more are Canadian contemporary writers. Their intellectual merit and immense understanding of the natures of everything that facilitates the birth of wondrous stories is reflected in their works. Worldwide acclaim is a prestigious asset to this group of writers.

Michael Ondaatje, is the First Canadian writer to have won the Booker Prize in the year 1992, he was born in Sri Lanka and moved to Canada and is presently based in Toronto along with his spouse Linda Spalding, who is also a literary figure. He is the recipient of various literary awards and is one of Canada's most famous and excelling writers. He excels as a poet, novelist, editor and film maker. The movie adaptations of his books are also greatly praised and many awards were won for the same. He was also made an Officer of the Order of Canada and was the Foreign Honorary Member of the American Academy of Arts and Letters. He is the author of many books including novels, books of poetry and memoirs. His writings are highly mysterious and moving, compelling the readers to travel into the world of war with love, maps and exploration.

The English Patient is a novel written by Michael Ondaatje and was published in the year 1992. Michael Ondaatje won the Booker Prize, the Canada Australia Prize and the Governor General's Award for the same. The novel was adapted as a motion picture, which won the Academy Award for Best Picture and many other awards.

The novel is set in an Italian villa during the Italian Campaign of the Second World War. Four varied characters are brought together by the character the English patient who gets unrecognizably burnt. Hana, a nurse, stays behind in the abandoned villa to tend a patient whom she believes is English. The patient is taunted by his memories of love, passion, exploration and betrayal. The only object of clue that meets the space between the two is the copy of *The Histories* by Herodotus with written notes on a tragic love affair described in a provocative manner and makes Hana curious about the anonymous person.

The other characters like David Caravaggio and Kip (Kirpal Singh) join in the story as it unfolds. Caravaggio suspects the English man and his suspicions are confirmed as the patient reveals his story little by little, we get to know that the patient is Almasy and how his love affair with Geoffrey Clinton's wife Katherine cost his own life. The story shifts to Kip who is an Indian and how he is smart enough to diffuse bombs and missiles with a particular knack and his affinity towards his job as a snapper. Hana has a secret liking towards Kip and feels secure when he is around. Hana celebrates her twenty first birthday and Kip feels uncomfortable as her boyfriend though she is the one who reminds him that humanity exists at a war zone. Very soon Kip is enraged by the news that the white men have dropped a missile in another white mens' land (the United States launching their bombs on Japan), Kip is disturbed by this and leaves the place. Soon the novel winds up with Kip settling down in India as a doctor with his happy life, though he sometimes gets reminded of Hana.

In this novel, Michael Ondaatje expresses through words the gruesome effects of war from the following lines:

"The last vices of war. Completely unsafe... The smell of the dead is the worst. We need a good snowfall to clean up this country. We need ravens." (*The English Patient*, 1992 p.31), through these lines we understand that the situation after war is the most gruesome as the land is filled with the presence of death and decay. The situation seems to be very dark and eerie along with a landscape that needs immediate sanitation.

In the same novel we also read how the land turns out to be a very sensitive ground where either the bombs generally get activated poisoning the fertile land or how the unexploded bombs get buried in the lanes and fields. It shows how a post war scenario is where every step for survival is a blessing as a small trigger or nudge against the casing of the bombs may cause an unexpected damage through deadly explosions.

Anil's Ghost (2000) is a novel set in Sri Lanka tells the story of a young female anthropologist investigating war crimes for an international human rights group. *Anil's Ghost* (2000) returns us to the author's Sri Lankan homeland. Here the backdrop shifts from the European World War to the South Asian civil war and the horrors and traumas of the post-colonial violence. The novel is the story of Anil Tissera, a forensic anthropologist trained in the United States and in England. Anil returns to Sri Lanka to investigate a series of politically motivated murders on the island. Paired up with another anthropologist, Sarath Diyasena, it is the discovery of human remains in the Banderawala caves that drives the quest for the truth and which haunts both the novel and its war-torn landscape.

In this novel through one of the characters we understand that human beings were so used to combat and competition that they did not need a specific reason to wage war especially when people found that power was in their hands, even silly reasons such as personal duels turned out to be the reasons of war between human groups and nations. "The reason for war was war" (Anil's Ghost, 2000 p39.)

Warlight (2018) is the most recently published novel of Ondaatje. It is a thrilling novel of adventures and reflects how war, death and turmoil has changed the lives of people and how it forced people to run on the treadmills of the world with the fear of falling prey to poverty. People had to leave homes to harvest money and trust while children were left under the care of strangers.

In this novel also we find the impact of war as the story is set in London and how families live and survive in a post-war scenario. "At night everyone disappears, and five-hundred-pound bombs and high-explosive–incendiaries whistle down on the sparsely populated houses and streets, so it seems light as day". (Warlight,2018 p.217). The pain of families hiding in silence even when ammunitions are dropped a few feet away from where they sleep and the fate of embracing every second life with hope is what human beings go through during war and post-war.

Through these novels we are enlightened by the fact that sapiens have lost their minds and have turned endless lives into a whirlwind of havoc, and yet none of the human groups have attained complete contentment.

As in the last line of the book- Sapiens by Yuval Noah Harari- "Is there anything more dangerous than dissatisfied and irresponsible gods who don't know what they want?" (Sapiens,2011 p.466), it is true that human beings have become godlike creators and destroyers for their wants and desires yet are unsure of what they really want and have a very little idea on what to do with all the power they possess.

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DISPLACEMENT OF REPRESSED EMOTIONS IN TONI MORRISON'S NOVEL *GOD HELP THE CHILD*

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This study deals with the struggle and focuses on the interpretation of the individual and importance of being loved and valued in the life of an individual its impact, disordered and traumatic behavior resulting from an unsettling and disturbing experience. The work attests to the physical and emotional oppression worked out upon children with special regard on the protagonist Lula Ann Bridewell in Toni Morrison's novel *God Help the Child* and strives to investigate alternative modes of thought and behavior in dealing with children. The individual development of the children with the right kind of attention and love lead to the attainment of selfhood.

KEY WORD: Black female body, pain, rejection, depression.

INTRODUCTION:

Toni Morrison's *God Help the Child* leafs through the consequences of the recurrence of the past terrible experiences in the makeup of the present and the memory of childhood on the individual's psyche. The inter-racism characteristic of America in the times of slavery, represented in the novel through the character of Sweetness; and the second is the contemporary American society where blackness represents beauty, also represented in the text through the black protagonist, Bride. Third is Booker, the love of her life. Everything seemed perfect with him, just like in the fairytale.

The novel carries on a discussion on Morrison's major themes in her well-known works as racial bigotry, black skin colour and centre-periphery relationships. It is also, as the title indicates, about childhood and the way to confront childhood past ghost to better reclaim the present and the future. The story of the novel revolves around Lula Ann Bridewell, Morrison's black protagonist, born to light skin parents, the father Louis and the mother Sweetness.

CHILDHOOD MEMORIES

Morrison's novel starts with the birth of Lula Ann. From the moment she is born, her mother is repelled by her, as she has skin so black that it scares her mother, sweetness explains "Midnight black, Sudanese black" (3). The hostility grows when Lula Ann's father leaves them, because he does not believe that he can be the father of a girl as black as Lula Ann. Lula Ann's mother looks back at how she and her husband had three good years together and how it changed when Lula Ann was born. He blamed her "and treated Lula Ann like she was a stranger – more than that, an enemy" (5).

As a dark baby girl, Lula Ann Bridewell was refused by her father and hated by her mother because of her black epidermal signs. The child's dark skin embarrassed the mother to the extent that she obliges the daughter to call her sweetness instead of mom. She even tried once to kill her by pressing a blanket on her face, and withholds any kind of affection and love for her.

> I hate to say it, but from the very beginning in the maternity ward the baby, Lula Ann, embarrassed me. Her birth skin was pale like all babies', even African ones, but it changed fast. I thought I was going crazy when she turned blue-black right before my eyes. I know I went crazy for a minute because once-just for a few seconds- I held a blanket over her face and pressed. (4,5)

Sweetness, with her ironic name, rears Lula Ann in a patriarchal authoritarian way. Lula Ann grows up bereft of affection and love, which destroys the mother- daughter bond. Patriarchal motherhood prevents Sweetness from developing the necessary emotion and affection ties with her daughter, critical during the first years of a child's life. Lula Ann remembers how her mother loathed touching her dark skin, "distaste was all over her face when I was little and she had to bathe me."(31)

As an infant, Lula Ann misses being close to her mother. She remembers hiding behind the door to hear Sweetness hum some blue song, thinking how nice it would have been if they could have sung together. Sweetness's withdrawal of affection is her daughter's worst memory. Lula Ann is desperately in need of love. That is why she testifies against a teacher, Sofia Huxley, and lies about her pervert abuses of children, "to get some love- from her mama" (156).

Lula Ann remembers how Sweetness was kind of mother like the day she colludes with her classmates to accuse their teacher, a white women named Sofia Huxley, of sexually molesting them. Smiling at her and even holding her hand when they walked down the courthouse steps,

which she had never done before. "I glanced at Sweetness; she was smiling like I've never seen her smile before- with mouth and eyes". (31)The racial self-contempt that Sweetness, who has accepted an inferior definition of the black self, inculcates in her daughter does not allow her to have a sense of belonging or identity.

Sweetness believes that "there was no point in being tough or sassy even when you were right."(41) To help black children cope with racism, their parents teach them special skills, self-reliance, self-defence, dealing with pain and disappointments. However, Sweetness's motherhood only seeks absolute and uncontested obedience. She does not foster a positive racial identity in her daughter so she can resist racist practices, culture norms, values and expectations of the dominant culture.

Lula Ann's upbringing and disciplining are really harsh and even more when she is turning an adolescent. Her rearing was all about following rules, which she obeyed. "I behaved and behaved and behaved" (32). And yet Lula Ann feels that:

> She never knew the right thing to do or say or remember what the rules were. Leave the spoon in the cereal bowl or place it next to the bowl; tie her shoelaces with a bow or a double knot; fold her socks down or pull them straight up to the calf? What were the rules when did they change? (78, 79)

Despite all the suffering, Sweetness' patriarchal motherhood cannot preserve her daughter from the curse that starts with Mr. Leigh's insults when Lula Ann sees him abusing a boy. He calls her nigger and cunt. Lula Ann, who is only six years old, does not need the definitions of the words because she feels the hate and revulsion they are charged with.

Lula Ann learns her mother's lessons and "let the name calling, the bullying travel like poison, like lethal viruses through her veins, with no antibiotic available building up immunity so tough that not being a nigger girl was all she needed to win" (57). Sweetness' patriarchal motherhood does not focus on meeting Lula Ann's cultural and emotional needs. She is more concerned about her daughter living up to the standards, norm-abiding ideas, consensus values and expectation of the white dominated racist society.

BECOMING BRIDE

Bride's memory as an adult is still stuck in her experiences of childhood traumas and refuses to forget her mother's avoidance. She builds a new life for herself, escaping from her mother's and society's definitions. Bride reinvents herself. She becomes the regional manager of a prosperous cosmetic business, Sylvia Inc., and leads a glamorous life. "She had stitched together: personal glamour, control in an exciting even creative profession, sexual freedom and most of all a shield that protected her from any overly intense feeling, be it rage, embarrassment or love"(79).

Being a successful woman she finds vengeance in selling her elegant blackness to her childhood ghost, her tormentors, so they can feel envious of her triumph. And still, her past is with her. Bride tries to make amends for the terrible lie she told as a young girl but, in the process, her boyfriend Booker walks out on her and bride decides to approach her former teacher, who has recently been released on parole, to make recompense for her imprisonment but Huxley greets Bride with a vicious, disfiguring beat down. She learns that making amends does not always go according to plan.

> I reverted to the Lula Ann who never fought back. Ever. I just lay there while she beat the shit out of me…. I didn't make a sound, didn't even raise a hand to

> protect myself when she slapped my face then punched me in the ribs before smashing my jaw with her fist then butting my head with hers.(32)

Bride's relationship with her lover, Booker Starbern, has just run aground. Bride suspects that Booker's leaving has instigated her body's melting away. As she heals from her run-in with Huxley, Bride notices that her body has begun regressing towards some prepubescent stage, her pubic hair suddenly disappears, her ear lobe piercings close, and she stops menstruating.

> I shouldn't have –trusted him, I mean. I spilled my heart to him; he told me nothing about himself. I talked; he listened. Then he split, left without a word. Mocking me, dumping me exactly as Sofia Huxley did….but I really thought I had found my guy. "You not the woman" is the last thing I expected to hear. (62)

Bride decides to track down Booker to find out why he exited their relationship. Bride says, her failures in adult life her breakup with Booker, her boyfriend or being beaten by Sofia Huxley makes her realize that, in spite of her mother's strict lessons, she is helpless in the presence of confounding cruelty. She just obeyed, never fought back. She feels that she is "Too weak, too scared to defy Sweetness, or the landlord, or Sofia Huxley, there was nothing in the world left to do but stand up for herself finally and confront the first man she had bared her soul to, unaware that he was mocking her"(79).

All along the novel, the extent of harm sweetness's patriarchal motherhood has inflicted in Bride is exposed. Her traumatic childhood experiences keep surfacing. Her lost identity is symbolized by physical regression, "back into a scared little black girl" (142), triggered by Booker's rejection.She becomes conscious that "she had counted on her looks for so long-how well beauty worked. She had not known its shallowness or her own cowardice, the vital lesson Sweetness taught and nailed to her spine to curve it" (151).

In rural California, Bride confronts Booker and her confession to him makes her feel newly born. "No longer forced to relive, no, outlive the disdain of her mother and the abandonment of her father" (162). Bride tells him about her pregnancy and he offers her "the hand she had craved all her life, the hand that did not need a lie to deserve it, the hand of trust and caring for" (175).

At the end of the novel, Bride acquires, apparently, the sense of self required to mother her baby and not to reproduce Sweetness. "A child. New life. Immune to evil or illness, protected from kidnap, beatings, rape, racism, insult, hurt, self-loathing, abandonment…so they believe" (175). There is a ray of hope in the ending of this brisk tale.

Morrison is a writer to whom stories come spontaneously. This is shown in *God Help the Child*. She has woven in this one tale of Bride many other stories that are reverberating with too much human life. The characters in Brides life have their own pain, trauma, death, cheat, love, and losses. The action of this novel s made intense by these individual stories.

This is exactly what Judith Herman reflects on child abuse in her book Trauma and Recovery:

> Many abused children cling to the hope that growing up will bring escape and freedom. But the personality formed in an environment of coercive control is not well adapted to adult life. The survivor is left with fundamental problems in basic trust, autonomy, and initiative. She is still a prisoner of her childhood; attempting to create a new life, she reencounters the trauma. (80)

FINDINGS

One among the many themes in the novel is individual psyche. Morrison's novels always make sense of the individual psyche and memory in wider social and political term. As a chronicle of African American experience, Morrison's contribution has been to create, the face of public dissociation of painful past, a space where the traumatic material may find a coherent articulation and a collective dimension. Her novels create a public space for trauma.

Morrison dwells with innumerable problems of individual that are seen in the novel under study, through which she wishes to bring to light the suffering and the hardship through her characters. Themes like ill motherhood, child abuse, victims and witnesses of trauma are deeply embedded in Toni Morrison's novel.

Reminiscent memories are another notable theme in the novel. They have a deep impact on the lives of the individuals and have a great bearing on their future self. Memories can either shape an individual or break them down beyond repair. The influence of childhood memory is plainly seen in the lives of Bride, Booker and sweetness. Though it's destructive in the lives of Booker, Bride and Sweetness, Bride at the edge of crushing down braces herself breaking all clutches of chain that was holding her back and marches towards the unknown to find out the truth.

As a black woman writer, a designation she embraces, Morrison has created many memorable female characters whose stories are informed by the difficulty of growing up in a predominantly white racist society. Bride even since a child faced problems due to her unusual skin colour. Right from her mother to the people she met gave her a repulsive stare. Sweetness confessed "I wish she hadn't been born with that terrible color". (5)

Rejection is another important theme in the novel. Bride goes through the same phase in life where she is fighting her childhood demons. She grows out from those dark and gloomy days yet they reappear when booker deserts her saying "You not the women I want."(8) These words keep resonating in her ears and she feels like she does not belong at all. But Bride from a scarred, unloved girl who is hiding herself changes into a beautiful, popular and successful woman.

Racism plays a prominent theme in the novel. Around which many events of the novel are interconnected. Sweetness said "her color is a cross she will always carry" (7) but Bride turned her colour into a weapon that helped her gain the lost identity and selfhood. "I forgot just how black she really was because she was using it to her advantage in beautiful white clothes." (43) For she wore it well and remade herself. "She's sort of pretty under all that black." (35) She only wore white and looked stunning like a "panther in snow". (34) Bride had met a designer named Jeri for her makeover and all he said was "you should always wear white and all white all the time…because of what it does to your licorice skin….make people think of whipped cream and chocolate soufflé every time they see you." (33)

Bride endured many events in her life which lead up to her delusion state of mind. She constantly battles with the desire to be loved and the desire comes from the lack of love from her mother and the man of her life, Booker. Bride fights all odds and goes on a search to discover why all the people in her life leave her devastated. It is only after tracking down Booker in an unknown land she knows the true feeling of being loved.

The novel closes down with a beautiful note from Sweetness who is now regretting for all the things she did to Bride. "No. I have to push those memories away fast" (177). She wants to believe that she had raised her daughter right to cope with the harsh reality black people had to

face. "I know I did the best for her under the circumstances." (177) yet she passes on an advice to all the Mothers out there "what you do to children matters. And they might never forget."(43) And she ends with a blessing like bidding "Good luck and God help the child." (178) to Bride who is now pregnant with her own child.

CONCLUSION

God Help the Child is filled with various themes that revisit traumatic moments in the black history and culture. Toni Morrison has voiced African American experiences of racism, and has particularly concentrated on the oppression inflected upon children. Indeed, the theme of childhood abuse and trauma has been recurrent in her major works including *Beloved*, *The Bluest Eye*, and *Tar Baby* among the others.. Bride is an example of survival; she firmly battled the nightmares of her past to offer them a happy living in the present.

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MORALITY IN THE NOVELS OF BARBARA KINGSOLVER

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Literature enlightens the mind and life of an individual through philosophy, religion and morality. Moral or Ethnic criticism is one of the oldest approaches to Literature that conveys a message or a lesson in a particular work of literature. This approach of Literature significantly affirms to the values that readers experience in their own lives. The concept of morality in literature began to influence many past and contemporary American writers.

Barbara Kingsolver is an American writer, most prominently known for the moral values, social justice and ecological themes portrayed in her works. Kingsolver believes that a work of art should evoke a thought in the mind of the reader representing a moral and social responsibility. The proposed paper attempts to make a study on the unravelling the moral struggles in an individual's life in the novels of Barbara Kingsolver.

Morality in the novels of Barbara Kingsolver

The writers of the past and present paint the image of literature with the sole concept that it holds the replica of life. Morality, philosophy and spirituality plays a crucial role in the labyrinth of human life and so does literature. Literature from its origin is known to impart moral values and aesthetic pleasures. Moral and Ethnic literature should be different from sermonizing in a way that allows readers to assimilate the ideas and see if these values are morally adequate.

Literature in the perspective of morality aims to create works that would help readers to live better lives for the enhancement of the human race as a whole. Most of the literature in America portray characters who endure moral conflicts in their lives, finding it difficult to choose the right from wrong. Various genres of literature produced works of morality and philosophy. Some of the most prominent writers like Ralph Waldo Emerson, Ernest Hemingway produced morality works in literature that pictured lives of individuals often conflicting moral implications and struggles.

Barbara Kingsolver is an American environmentalist, novelist, poet and journalist. Her works were nominated for the Pulitzer Prize Award and it also won the Orange Prize for Fiction and many other awards. Kingsolver cites the adage, "Literature should inform as well as enlighten". She uses her fiction to bring out social justice and moral values through the experiences of life by which her characters are drawn.

Her most focused themes signify the importance of motherhood, ecological aspects, human relationships, forgiveness, loss, human and non-human connections, religion, political aspects and romance. Kingsolver's novels contain serious and lofty issues that are debatable. It holds racial, sensational, spiritual and ethnic perspectives that support philosophical and moral values.

Kingsolver's works represent symbols that infuse ideas or thoughts into the mind of the reader that would integrate into an appreciated deed in the life of the reader. Her novels explain that actions can be effective. Her characters are consistently empathetic and attain social justice with a special sense of belonging. They are created in such a way that helps them self-reinvent themselves from their pessimistic former ways. Kingsolver's protagonists are moulded in a way that often begins the novel with a cynical or negative character, who, by the end of the novel is morally transformed into a person of moral and ethical value. The resolutions of her novel show her readers that hope is always renewable and is one of the most essential things in life.

John Gardner in his essay, *On Moral Fiction,* strongly affirms that "true art is moral: it seeks to improve life, not debase it". The inherent value of a piece of art is that it should deal with moral struggles and emit moral intelligence to its readers. In the novels of Barbara Kingsolver, most of her characters experience moral struggles that help them make better choices in future. Distinguishing the right from the wrong or choosing the right choice is what matters in everyday life. Kingsolver's novels lead the readers through such circumstances and incidents.

In the novel, *Animal Dreams* Codi comes to Grace, she feels detached and lost but towards the end of the novel, Codi chooses to stay in Grace and help in solving the issues of the town and teach students science rather than going to Tucson and spending her life with her new boyfriend. She lost her mother, her baby, her sister and her father. In the midst of moral challenges and struggles, she chooses to forgive Loyd and reconciled with her father. All she wanted to do was to be a strong and brave person like her sister Hallie and she accomplished it through the moral challenges. By doing this, she also gained what she lost.

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Kingsolver's works always present a self-congratulatory quality. John Leonard gave a tribute to Kingsolver's artistry in *The Nation* as, "our very own Lessing and our very own Gordimer". Her novels speak about insolent people not showcasing them as discourteous but people with a lesser sense of goodness. In the novel, *Pigs in Heaven*, Taylor has Turtle, the Native American child whom she adopted without proper legal documents. She loved Turtle more than herself, "Since she found Turtle in her car and adopted her three years ago, she has had many moments of not believing she's Turtle's mother" (Kingsolver 10). They develop a mother-daughter relationship which made it hard for them to give up on each other.

Towards the end of the novel, Turtle is allowed to stay with Taylor after so many difficulties. The novelist brings about a moral purpose in this novel that transforms the lives characters. Alice, Cash and Taylor were ready to do anything for the happiness of Turtle, a lost and abused child. Kingsolver also gives the reader an insight into morality through Native American morality tales.

In Kingsolver's novel, *The Poisonwood Bible*, it is not the Africans who go through sufferings alone, but the white Americans who suffer moral conflicts, anguish and pain. The house of this white family becomes a prison that is contradictory to the adage of a good home or family. Hope was the only escape for the Price's girls. They always hoped for a better life and they received what they hoped for. Just as how she explains in her novel, *Pigs in Heaven,* "No matter what kind of night you're having, morning always wins." (Kingsolver 6).Kingsolver seems to set into a new moral ground in this influential and emotionally echoing novel. The author conveys that in the local spaces of hope, there is always a predicament and a promise.

Ernest Hemingway in *Hills like White Elephants*, speaks about the choices that an individual makes between the right and the wrong in the midst of a moral dilemma. It portrays a moral sense of truth in spite of the complete senselessness by which the characters are drawn. Kingsolver's novel, *Prodigal Summer*, also takes the reader through a moral dilemma in the novel that is neatly unravelled by the protagonist Lusa. Moral perspectives in literature come in various ways holding one solid solution or moral transformation.

In the novel, *Prodigal Summer,* Kingsolver portrays the moral redemption brought by the protagonist. Lusa reconciles with her husband's family and even adopts her sister-in-law's children as her own. This is the result of a moral conflict in her life. She lost her husband and hates his family. She experiences a lot of pain and false accusations. Out of all these problems, Lusa forgives, loves and reconciles and also seems to live a happier life than before. Kingsolver presents a moral transformation of a character that emerged from moral struggles.

Kingsolver says that she wakes up with a question in her mind that she finds difficult to answer. The only way she finds the solution to her question is by writing a novel that resolves it in the most attractive manner showcasing moral values and social awareness. In Literature, moral art shows a path for a better future. The novel *Flight Behaviour* seems to be a masterpiece of moral fiction of the modern age. The novel began with a propulsive moral rigour and then gradually leads the reader through various moralistic aspects. Dellarobiameets circumstances where she is given the opportunity to choose the right thing in accordance with her moral self.

Married at a very young age, Dellarobia is unhappy with her husband Cub and his family. Being a mother of two kids, she experiences a lot of moral dilemmas and discovers a moral purpose to take the right decision in life. She returns from committing adultery after encountering something that she called the "burning bush" (Kingsolver 16). Another incident of moral conflict in her life was when she begins to fall in love with Ovid and then later realizes her fault. All

through the novel, Dellarobia has moral instincts within her. Towards the end of the novel, Dellarobia transforms into a beautiful monarch butterfly, a "perfect female" (Kingsolver 396).

Emerson also has a moralistic perspective in a work of art. According to him, it should be aesthetic, intellectual and most of all moral. To identify a work of art with a moral approach to literature is to identify a lesson or a message that it brings. Kingsolver graced her novels with morals and ethnic principles. Her characters always made the right choice in times of moral conflict. Her works portray real-life situations where the decision between the virtuous and malevolent serves as the most significant criterion in the life of any individual.

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Importance of Constructing Normalcy – A critical study on the Movie *Ratsasan*

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Literature always sheds light to all corners of the society. Disability Studies is an emerging topic in literature, which helps people to understand the difference between impairment and disability and it helps them to analyze the importance of constructing normalcy in the society. Differences among us make each of us unique, but few people are treated in a different way based on look and behavior. According to the appearance and behavior few people are termed as physically or mentally impaired. Being impaired does not harm the society but sometimes it is hard to digest when an impaired person is next to us. *Ratsasan* is a Tamil psychological thriller movie, which portrays the life of a serial killer, Christopher who suffers from a hormonal disorder similar to Progeria, a genetic condition that makes a child looks old. This movie is one of the best examples to highlight the role of society in the cognitive development of children with disability. This paper explores the importance of constructing normalcy in society to make this society a better place for all people without any difference.

Importance of Constructing Normalcy – A critical study on the Movie *Ratsasan*

Literature always reflects the society. People can find information about anything they want in literature. Nowadays, there are many new emerging trends that help people to understand literature and society. One of the important trends is disability studies. There are many ideas and theories that make people aware of various disabilities. The main objective of disability studies is voicing the difficulties faced by disabled people in society and making the society a better place for them to live peacefully. Normally, when disabled people appear among the crowd they are treated differently and sometimes badly. There is always a pity or fear filter in the way they are seen and treated. In many instances, they are considered weak and ill-treated and this behavior

and attitudes of other people affect their psyche and it either makes them strong or weak. In other words, the way people with impairments are considered disabled by other people affects their cognitive development and psychosocial behavior.

Creating normalcy in the ways that people with impairments are treated in the society will facilitate people in many ways. Government has normalized many rules to create normalcy among people but lack of awareness among people in understanding the difference between impairments and disability create a lot of problems for people with impairments. So framing rules alone will not be enough to change the lives of people. Spreading awareness and making everyone understand that people with impairments are not disabled they are very normal like any other people. The various models of disability play a vital role in analyzing the importance of constructing normalcy in society. The prominent models are medical model of disability and social model of disability.

Social model of disability emphasizes that people with impairments are not socially disabled. UPIAS (1976) draws an important conceptual distinction between the terms 'impairment' and 'disability'. Impairment is defined as 'lacking part of or all of a limb, or having a defective limb, organ or mechanism of the body', while disability is defined as "the disadvantage or restriction of activity caused by a contemporary social organization which takes no or little account of people who have physical impairments and thus excludes them from participation in the mainstream of social activities". (UPIAS 1976:14). Society influences a person's identity. Oliver, a disabled activist and lecturer, who also coined the phrase social model of disability, stresses the need to focus on the social aspects of disability, especially how 'the physical and social environments impose limitations upon certain categories of people'.

There are many physiological disorders such as, cosmetic disfigurement, or anatomical loss affecting one or more of the following body systems: Neurological; musculoskeletal; special sense organs; respiratory, including speech organs; cardiovascular; reproductive; digestive; genitourinary; hemic and lymphatic; skin; and endocrine. There are many genetic disorders like Hunter's Syndrome, Down Syndrome, Angelman Syndrome, Albinism and Progeria. These disorders are visible and they make people with these disorders look different from others. In a lot of situations people who suffer from cosmetic, physical and genetic disorders are treated badly based on their appearance. People with these disorders face problems in the society from their childhood so that affects their cognitive development and psychosocial behavior. Everyone should understand that people with impairments and disorders are not worthless and unproductive. They also have personal and social life like everyone else. This paper aims to explore the ways of constructing normalcy in society with reference to a Tamil psychological thriller movie *Ratsasan*.

The story of the movie *Ratsasan* revolves around the protagonist, Arun. He wants to become a film director and he collects a lot of information about many psycho killers. Unfortunately, he could not find a producer to film his psycho thriller movie so he joins the Tamilnadu police force as a sub inspector. He engages himself in tracking an unknown serial killer, who kills young girls in a very cruel manner. The killer kidnaps young girls and brutally chops them into pieces when they are alive and lets them bleed to die. He leaves a doll with some marks on its face while he kidnaps the girls. Then he leaves some marks which are similar to the marks on the dolls, on the faces of the girls he kills. He targets girls who are fifteen years old and kills them. He even kills Arun's favorite niece Ammu, who studies eleventh standard. Arun was clueless even after this incident. Later he finds a clue from a hearing aid of a dead girl. Arun discovers that the psycho killer is not a man but a woman. She is a magician and uses magic as a tool to interact with the girls who she plans to kill. Arun prevents a girl from getting murdered by the women and reaches her place. There he finds many photos and he checks his collection of

serial killers. He finds the information about Mary Fernandez, who killed a school girl in a very cruel manner. He approaches the police inspector Raja manickkam who investigated the case.

Through him he learns the story of Mary Fernandez and Christoper Fernandez, her son. Fernandez is a magician and his Mary is deaf and dumb. After her husband's death Mary does part-time magic shows in many places. Christoper her son, suffers from a rare genetic disorder, which is similar to Progeria. The disorder makes him look like an old man. During his adolescence age Mary sends him to a new school. Other students in the school refused to talk to him and accept him. One of his classmates Sofia, accepts him as her friend and they spend their time together. Mary is happy to see them. Sofia gifts Christopher a doll on his birthday. Sofia being the one and only companion Christopher develops love towards her. Meanwhile, Mary trains Christopher to become a good magician. Christopher entertains Sofia with his magical tricks and she also encourages him. One day Christopher confesses his love to Sofia. Sofia is shocked by the confession and she starts to avoid him.

Christopher is not able to accept the changes so he keeps on disturbing Sofia. One day he behaves very aggressively to one of his classmates and Sofia. Sofia takes him to the school library and asks him to read the genetic books she has read but Christopher gets emotional and refuses to read them. Without any other option Sofia informs Christopher about his genetic disorder and because of it he is impotent. Sofia asks him to forget about love and marriage and she leaves the library with a heavy heart. On that day, Christopher feels very bad and low and he cries to his mother and narrates the incidents that happened in his school. Mary convinces him that he will become a good magician and she grooms him up.

On the next day, Christopher goes to school very confidently but other students in the school teases him to the core and they laugh at him by calling him impotent. They draw some disturbing pictures and laugh at Christopher. Christopher's confidence gets collapsed and he runs from him school to his house. Mary witnesses the incidents that happened in her son's school. Christopher is frustrated so he hits the doll which is gifted by Sofia and broke it into pieces with a hammer. Mary was very disappointed and on the next day Mary visits Sofia and requests Sofia to be friends with Christopher again. Sofia feels sorry for her action and informs Mary that she was absent the day before because of fever and she is ready to be friends with Christopher again. Mary gives a present to Sofia and Sofia is shocked to find the head of the broken doll. Then she is found dead in Mary's house. Both Mary and Christopher are arrested by Rajamanickkam.

When Arun searches Mary, inspector Rajamanickkam calls him and tells him that the case is very serious and he has a clue. But before Arun reaches the inspector's house he is killed. Arun collects many photographs from the inspector's house and finds that Mary is not the serial killer. It is Christopher who disguises himself as Mary and kills many girls. Christopher is killed in the end because of his psychotic acts that harms many people.

Christopher has a disorder but he is efficient in many ways. His peers refused to accept him so this affects his psychosocial relationship with other students of his age. His one and only companion is Sofia, during adolescence it is very common for both genders to get attracted towards opposite gender. Christopher also has the same feeling like other children of his age. Sofia cares about Christopher so she hesitates to reveal the consequences of his disorder to him but at one point she reveals that to him and rejects his proposal. Sofia has all rights to accept or reject any guy's proposal irrespective to any disorder. Sofia rejects Christopher's proposal and she asks him to learn the truth about him and forget about love and marriage. This will be shocking for any child during adolescence. Even after knowing about his disorder he tries to overcome Sofia's refusal and goes to school the next day. But Christopher was neglected by other

students and they never accepted Christopher as he is and when they learn about his disorder they teased him and bullied him heartlessly. Their actions made Christopher and Mary hate Sofia.

Being a single mother Mary tried her best to raise her son with confidence. But she was upset to see her son suffer. They believed that Sofia is the reason for all the troubles. This incident made them to hate mankind. They started to enjoy death instead of life so they killed Sofia. They felt comfortable and powerful when people were afraid of them. Christopher continued to kill girls in Sofia's age because he thought Sofia rejected him because of his disorder and spread the information about it to other students. But it was not true. The neglecting attitude of people affected Christopher's cognitive development and psychosocial behavior from his childhood.

Mary and Christopher are efficient in their professions and they could have served and played a better social role to the society. Christopher's disorder does not stop him from being a normal child. However, the negative attitude of people has complicated his day-to-day life. People focus only on external appearance and fail to identify the uniqueness in each individual. Here, Christopher's love proposal and Sofia's rejection was an amateur personal expression of love between two teenagers, whereas Christopher's peer school mates have been a trigger for him to turn up into a treacherous serial killer. Also, we should notice that Christopher's mother had influenced his killing for pleasure appetite.

Constructing normalcy in society is a Himalayan task. If society would have acknowledged Christopher's impotencies he might have been a successful person, rather the public mocked at his disorder and allowed him to isolate and aggravated his negative attitude towards the society and made him become a living monster, Ratsasan.

The social model of disability is especially concerned with addressing the 'barriers to participation' experienced by impaired people as a result of various ableist social and environmental factors in society. (O'Connell, Finnerty & Egan 2008:15). From the movie Ratsasan, the viewers can understand how society affected Christopher's psychosocial behavior and stimulated his psychotic behavior. Understanding the social model of disability helps people to construct normalcy. Constructing normalcy in society is an effective way to create a strong society.

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The Destructive Effects of Money on Close Domestic Relations in Sudha Murty's Novel House of Cards

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Sudha Murty a disciplined writer, a technically skilled with the most innovative and skilful mind has been highly reverenced with awards for her philanthropic and literary accession. She is writing in the back ground of Indian English Literature. The works of recent Indian writers like Anita Desai, Ruth Prawer Jahabwala, Mahashweta Devi Shashi Deshpande, Shobhaa De, Jhumpa Lahiri, Arundhati Roy and Sudha Murthy has not only reached a large and international reading public but has also made us to know and understand difficulties of life in a better way. They made the readers to learn about the social taboos in Indian society and the problems faced by voiceless people. Her novels are fascinating; they are understandable, unique and stimulate spiritually the readers to aspire and to calibrate their mental outlook. She has published Dollar Bahu, House of Cards, Mahashweta, The Bird with Golden Wings, Wise and Otherwise: A Salute to life, The Old man and his God, The Day I Stopped Drinking Milk, A Wedding in Russai, The Accolades Galore, Changing India, House of Cards, Sweet Hospitality, Gently falls the Bakula, Fasalcut chiefly through penguin. This article focuses on the destructive effects of money on close domestic relations. The protagonist Mridula didn't spend money because she wanted to build a financially secure and harmonious future. Her husband had exploited her completely due to her love and trust in him by secretly giving lakhs of money to his mother and sister. The breach of trust made her paralysed and she was disappointed and absconded herself. Heartless judiciousness, manipulation and power destroy a marital relationship and the house built insubstantially was dreadfully collapsed.
Keywords: humanitarian, marriage, responsibility, trust, exploitation, relationship, house, respect, collapsed.

INTRODUCTION

Sudha Murty draws one's attention to the contemplation of Indian consciousness that entrust through legendary episodes, characters, and relationships. She descends deep into the heart of the characters and focus on the absurdity going on in them. She focuses on the atmosphere of native elegance in her writings and the readers become well acquainted with the Karnataka places and appreciate the glimpses of villages. The names of the characters are also from Karnataka. Sudha Murthy's art and mind is reflected in the creation of her novels. Sudha Murty in House of cards focuses on the temperament of the people when they have more money. She also describes the pretentiousness, insensibility, greediness of the characters mostly males. The novel House of Cards presents the transformation in the marital life of Mridula and Sanjay. This article focuses on the destructive effects of money on close domestic relations. The protagonist Mridula didn't spend money because she wanted to build a financially secure and harmonious future. Her husband had exploited her completely due to her love and trust in him by secretly giving lakhs of money to his mother and sister. The breach of trust made her paralysed and she was disappointed and absconded herself. In this novel the protagonist Mridula is from Aladahalli a top student, unobjectionable, pure at heart, knowledgeable and possesses attractive large twinkling eyes and also long dark hairs on which she used to put a string of flowers. Her family was full of content, not pretentious or money hungry. She thinks that everybody is like her. She possesses enormous enthusiasm for life and unlimited energy for reading, cooking and sketching. She enjoyed every beautiful moment of life and always excelled in school. She was working as a teacher in Government high School

DISSCUSSION

The protagonist of this novel Sanjay came from a lower middle class Indian family from a semi urban area and became a renowned medical practitioner through incessant hard work. When he worked in a Government medical college in Bangalore as an apprentice, he cared for patients and their relatives without any expectations. He thought of it as the noblest profession in the world. His idea was that "If he continued in the Government hospital, he could teach the next generation and easily keeps himself updated with the latest information about surgery, drugs and other medical innovations. He recollected his father's words: "Sanjay, the foremost duty of a doctor is to take care of his patients. As a doctor, you should understand a patient's sufferings and serve him the same way that you serve the God. God doesn't stay in just T. Narasipura's temple. He also comes inthe form of a patient."[1] He treated his patients in public hospital with a pious sense of devotion, thinking of them as the incarnations of divine souls. He was available to them for twenty four hours of a day, without caring much for his own health. Though he suffered due to the political interferences there, he did not stop from his voluntary selfless services to the poor and needy. He faced all the odds there for the sake of his patients.

He cared for his beloved wife Mridula and discussed each and every point of his personal and professional career with her. His world comprised of his wife and son in the first stage. Mridula reciprocated his simplicity, honesty and integrity by continuously showering her love and affection on him. She had opted to marry him in spite of his deformity because he had not hidden it from her. His frankness had impressed her. Even when she knew that life after marriage was battle, she was ready to fight it out with the help of her Sanjay.

Relationship between Mridula and Sanjay in the initial stage was based on mutual love and trust. They knew each other pretty well. They had woven their destiny in each other's interdependence. This helped them build a palatial house for them and state of the art hospital for the needy patients. But then the things began to go wrong. Affluence spoiled their innocence. Sanjay began to play a game of hide and seek with Mridula for no specific reason. Wealth brought arrogance in him which isolated him from Mridula. He acquired capitalist's philosophy and said, "Nothing is black or white in this world. The cow gives milk for its calf. But we drink that milk. Isn't that wrong? Trees have life. But we cut them and use their wood. Isn't that wrong too? Mosquitoes and bugs are also creatures. Don't we kill them because they trouble us? Big fish always eats the small fish. Is that wrong?" [2] Mridula was dumbstruck by Sanjay's array of arguments which forced to revise her thinking about him.

In spite of all professional hurdles in Sanjay's life, their marital life was carried on smoothly, without any disagreement between the two because they did not have huge property. Lack of money kept them together; needs stuck them to each other. Mridula brought three lakh rupees from her middle class father to build a hospital. She purposefully avoided a debate with her mother in law by giving her undue respect to help Sanjay to keep cool and concentrate on his work. She thought of Sanjay's sister's convenience before her own comforts. Sanjay in return respected Mridula's parents. Everything seemed smooth.

Sanjay's ideals however collapsed in the face of continuous flow of unaccountable money in the hospital. He obtained name and fame within such a comparatively short time that he had no need to think about their miserable past. He could not eat on time and rest for a while. The needy patients, international medicine companies and corrupt doctors paid him white and black money. He deliberately kept it a secret from Mridula. He learned to amass money through all the possible sources. Money blinded him to the realities of personal decency. He started blaming Mridula for being sensitive and emotional and philosophised that if she was less emotional she would have better chances of success in life. He made fun of Mridula's monthly salary forgetting its crucial

role in shaping his life in the past. He mocked at her wise suggestions to be considerate to his patients. He remorselessly conceals his unethical medical practices in the hospital from his wife. First he ignored her; gradually he began to hide things from her. Later on he began to lie with her about the hospital management. In the end arrogance took him over. All these changes resulted into an unbridgeable gap between the two. Mridula had no place in his busy schedule. "He came home and joined his family for dinner. This was the only time he spent with Shishir. He talked to him about everything and advised him on his future. Sanjay thought Mridula did not play an important role anywhere in his life now. Rosemary assisted Sanjay in the hospital, Shankar managed the accounts, Sakamma did the cooking and Shishir entertained him. Sanjay hardly ever took a holiday and when he travelled abroad, it was only for business. Sanjay did not ask Mridula what she did during the day or about her family at Aladhalli. As far as he was concerned, the small talk was a waste of time." [3]

Richness played its diabolic role in breaking them into pieces. Innocent Mridula was deadly hurt by the changes in Sanjay's attitude to her and to his profession. She tried to reason things out with him but it necessarily ended in unexpectedly humiliating response from Sanjay. He mocked at her old fashioned thinking. He ridiculed her ignorance about the changes in global scenario. She realized that he was incurable and there was only one way out to save her from the emerging disaster that was to go away from him at her earliest.

CONCLUSION

Money had purchased his soul. Naturally, he was not expected to track her down after her sudden disappearance. The novel ended with hallucination in which she felt the hand of Sanjay balancing her swing. Wealth had accumulated but men had decayed. The couple was attached to each other as long as their income was proportionate to their daily needs. They fell into pieces immediately after they began to earn in millions.

Mridula's son Shishir did not care much for his mother because he had always seen her as a middle class wage earner. He had seen his father earning lakhs of rupees every month and also knew the purchasing power of money in human market. He purchased clothes, electronic gadgets, and furniture, food items at excessive rates without thinking much about their need in life. When Mridula tried to explain to him the importance of good habits, he made a mockery of her profession. He knew that once one had tremendous wealth, human relations were meaningless. Young generation's thoughts about the place of money in life are vividly expressed in Shishir's ideas about his mother. "Amma was so beautiful when she was young. Had she been taller, she could have entered the Miss India parade. She has wasted her beauty by becoming a teacher and housewife. Had I been in her place, I'd have pursued modeling and probably made more money than dad and taken less time than him. She could have become a lady doctor and joined dad and they could have built many more nursing homes together. Amma would have been also famous. She's spent so much of energy on teaching children in Government schools."[5]This remark showed that Shishir looked at Mridula not as mother but as a contestant in beauty competition.

The title *House of Cards* signified the rickety nature of human relations in the modern world. It is always said in India that houses are not built merely by lifeless bricks, cement and steel. They are built by trust among the members of the house. If members did not possess mutual love, it became a rickety house of cards, likely to collapse at the slightest thump. One is always webbed into some relations in India. Husband, wife, son, daughter, grandparents, grandsons, uncle, aunts are closely weaved in personal relations. Any threat to such relations always causes sleepless nights to the sensitive minds. Mridula and Anita were startled by the money madness of their husbands. They were shocked by the careless attitude of their sons to their mothers.

Sudha Murty, being a woman knew the emotional make of female well. As she has mentioned in her telephonic talk with the researcher, she had taken tremendous efforts to portray these emotions in her works well. She knew that teenager girls in India can be easily beguiled into friendship and then can be emotionally blackmailed and exploited to selfish purposes by men.

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Characteristics of Young Adult fictions in *Harry Potter and the sorcerer's stone* by *J.K. Rowling*

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Young Adult fictions are emerging form of literature where most of the teen readers are interested in it and Young Adult fiction attempts to bridge the gap between children's literature and writing for adults. Though age categories were kept for YA still there are confusions for this Young Adult on who reads it and what titles fill under this particular category.

Harry potter and the sorcerer's stone is the first novel of the entire series where most of the characters are children of age ten and above but their activities and actions were completely of Young Adults. The characteristics associated with YA is prominently seen with the main characters. Psychologically it can be defined as behavioral psychology in which a person's behavior depends on the situation and environment he lives. Internal events such as thinking can be explained through behavioral psychology. The stimulus-response of the characters merges with the psyche there by the person behaves more reserved accordingly. J.K Rowling in the novel made a characters in such a way with Young Adult features to demonstrate the need of development within children to tackle the hurdles. This paper attempts to define the elements of YA in this novel.

Keywords: Young Adult, behavioral psychology, stimulus.

Characteristics of Young Adult fictions in *Harry Potter and the sorcerer's stone* by *J.K. Rowling*

Young Adult literature emerged as a distinct category in the twentieth century, it can be broadly defines as fiction written for Young Adults by Young Adults about Young Adults. On the basis of understanding attempts had been made to define Young Adult fiction, on the other side children's literature is completely different were it is meant for children with the stories full of

rich values, morals. They help in the proper growth of children in the form of their behavior and characteristic towards society and with the people around them.

Literature is a way of defining life, the sensual features in it molds a person to actively participate and face all the encounters in the crucial phase of life. It can be enjoyed as well as experienced in such a way children's literature is meant for children and it guides them and entertain but they are not for adults. The colorful, magical characters in children's novels cannot match to the expectation of adults. There comes Young Adult novels which were meant for teenagers as well as adults irrespective of their acceptance.

In the novel Harry Potter and the Sorcerer's Stone we find the features of the term Young Adult with almost all the children characters. This novel initially categorized as children's literature as the story plot, turning points were made in such a way that it could attract children. The protagonist of the novel is harry a ten year old boy in the start of the novel, so it is clear that this novel and the plot setting is developed for children, but there are places where the elements of Young Adults like actions, eagerness, fearless, challenges, willpower, fight for self-identity etc. they are seen in the characters of the novel. In this manner Harry potter can be seen as a coming of age novel. Harry the protagonist starting the journey as a ten year old boy but his behavior and psychic nature is well set like a Young Adult.

Joanne Rowling is a British novelist, philanthropist, film producer, television producer and screen writer who writes under the pen name J.K Rowling who is known for her well known Harry Potter series. The books have won multiple awards and sold more than 500 million copies becomes the bestselling book series history. Harry Potter and the |Sorcerer's stone was publishes in 1997 which came after numerous hurdles in Rowling's life, but this novel and its series has completely changed the level of literature and it was a next leap in the field of literature and a trend setting master work in English literature. This novel is actually written for children as a lengthy story for them but soon it picked up the place of matching the quickness and the desires of youngsters too. The characters are built and designed with many different characteristics that is each character differs from the other, but ultimately every character possess some massage to lead a life.

This novel have the protagonist Harry Potter an orphan lives in his uncle's place who is very cruel. On his tenth birthday he came to know about his most powerful dead witch and wizard father and mother and about their death. Harry reaches Hogwarts school of magical arts in the right time there he experiences many hurdles and comes to know about his own power which was so far hidden within hi. It actually arouse him to voluntarily act in many situations. He meets his friends Hermione, Ron Wesley and the other important competitor Draco Malfoy who envies and starts to have enmity on Harry and his friends. Harry and his friends finds the Sorcerer's stone after undergoing many struggles and saves it from the hands of evil there by portraying them as the gems of their group Gryffindor.

The story is the first brief experience of Harry potter in the magical school of Hogwarts. Magic is meant for children they enjoy it but wizardry is not an easy job for a ten year old boy he comes under the category of kid. He doesn't know about the world outside, but in their novel Harry Potter learns wizardry and acts in an abnormal way if we compared him to a normal kid of that age, for example his uncle's son Dudley, he is nearly the same age of Harry but spends his time in feeding himself and bully Harry even other people the elders. He has the control over his parents and on the other side his parents that is Harry's uncle and aunt pampers Dudley with all he wishes. He was not a perfect boy with good potentials but he was a normal kid who go behind what he needs in whatever way, but Harry was completely reserved.

In the study of the plot we find that the characters like Harry, Ron, Hermione, and Malfoy with Young Adult characteristics. They behave as if they are adults. It is a shocking reality in the novel as the plot revolves around them. Psychologically the children were possessed with extraordinary characteristics and talents and a desire towards their psyche and needs. Harry potter didn't come to Hogwarts with a motive of becoming the world's famous wizard, his intention was to experience something at least to experience something new away from his uncle's place. Harry meets people fearlessly and interacts without any hesitation, being in uncle's home for years the absence of friendship, love, care so long for ten years didn't affected him in a wrong way. He wholeheartedly enjoys his place in Hogwarts. It is not the nature of a kid who had a terrible life in uncle's place opening up to the outsiders. A normal kid will be afraid and behave shyly in front of new people but Harry's first move was so heroic. He has the desire to find the secrets, he was not afraid of rules and regulation he was waiting for challenges and new experiments in Hogwarts. Harry faces it all alone without any help, he fights with Malfoy at first and as a result he enters Quidditch and he wins there. It didn't made him to behave arrogant rather it molded him to behave much more wisely and actively he researches about the sorcerer's stone and its value silently. The urge of knowing the secret about it was burning vigorously. He breaks the ruled and regulations followed In Hogwarts he goes out with his friends at night they meet Malfoy without knowing the trap and gets punished. Harry was fearless and he goes deep into the forest with his wand alone and encounters new people out there. Normal children never disobeys elders particularly teachers and they are afraid of being caught. Harry was behind his explorations and behaves like a fearless fighter a youngster. He makes himself ready to face the hardships and fights against his professors Snape and Quirell and finally a face to face combat with Voldemort. These are completely matching to the features of Young Adults.

The women character Hermione is a living dictionary an encyclopedia. She is engulfed with full of knowledge and her memory power is unbelievable, no kid can do it in normal life. She saves Harry and Ron, she helps them in all possible way. Being a book worm she answers for most of the problematic questions in a way of giving solutions and ideas. Besides that she has good quality of maintaining unity among the three friends Harry, Ron, Hermione. Normally kids may get jealousy upon other friends and acts possessively on them but here she guides as well as guards them in a perfect way.

The story plot becomes more entertaining as the character Ron enters into the scene. He is comical and try to deal the problems in a cool way. He fears inside but still accompanies his friends than hiding behind like a kid. Ron behaves like a great companion to both of them. Towards the story these characters becomes fond of each other. Ron supports Harry with his entire family this creates a bond between them. He looks childish but behave in a more matured way.

A story cannot be an entertaining one if there is no enemy, Malfoy is one of the characters who bullies the three friends in an irritating way. He goes to the extent of killing the particularly he corners Harry Potter and tries to attack him physically and mentally in a brutal way. Harry, Ron, Hermione moves to the extreme level of giving their lives in the end of the novel for saving the sorcerer's stone. No children takes the risk but these three goes without any fear by breaking the rules and orders and trusting only their willpower and mind, through that they succeed at the end. The challenges were one by one and they face it without any agitation but had with a desire and eagerness.

The psychology of these Young Adults in Hogwarts is completely new to the literature field. They are children but capable enough to fight back against the crime. Children's don't have the mind power to differentiate good and bad, but in the case of Hogwarts all the students were taught magical arts, black magic with wands and guided by their teachers. These three kids were

unbelievable they voluntarily involves themselves in risks there by saving the wealth and name of Hogwarts. The stimulus- response of the characters were based on their environment, the magical school and its secrets pushes them to know about them. Its strikes them psychologically to move along with the riddle life in school at the same time it encourages them to proceed further according to their desire. Behavioral theory when examine d with the characters of Hogwarts they act according to their surrounding and follow their psyche, their inner mind pricks them to involve in actions than being idle. Harry is an orphan, was not guided by his family members though he grew up in such a mess still he was good enough even perfect in interaction with people like |Dumbledore, McGonagall, Hagrid. He respects them and follow the words, help them. He takes care of him and the surroundings like a little guardian but his mind is completely a gentle man.

The Young Adult feature and elements are flooded with the characters of the novel. Though this novel comes under children's literature base still from the point of view of a Young Adult reader it shows the elements of YA in the novel. A child could only see the magical elements and flash of unbelievable flying teapots, people nimbus 2000 alone. Beside that this novel is for both children as well a Young Adult too. Thus it is clear being the first novel of the series though with ten year old characters still the novel possess the qualities of Young Adults it paves a way to understand it when the interpretation is based on the nature of the person.

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MULTICULTURALISM AND IMMIGRANT EXPERIENCES IN JHUMPA LAHIRI'S NOVEL "THE NAMESAKE":

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Jhumpa Lahiri, Pulitzer Prize Winner 2000 was born in 1967 in London, England, and raised in Rhode Island. Jhumpa Lahiri in her novel "THE NAMESAKE" affirms her Bengali culture identity and substantiates it as a reality in multi-cultural America. The Namesake is a novel which tells about a middle-class Bengali family in particular, their traditions, customs, cultural beliefs and social set-up. It also depicts their struggle to acculturate themselves in the American culture. During their process of acculturation they lose their self-identity and also face loss and nostalgia. JhumpaLahiri, a second generation immigrant, explores the immigrants' inner psyche, identity crisis, sense of belongingness, loneliness, alienation, clash of cultures, the conflicts of adjustment and the baffling ties between the first and second generation. When coming to immigrants' experiences it includes displacement, hybridity, quest for identity and gender inequality. The diasporans feel homeless and alienated in the foreign land. Dispersal of root involves pain, alienation, identity crisis and other feelings to the accultured ones.
KEY WORDS: Bengali culture, rituals, ceremony, immigrant identity, multi-culturalism.

MULTICULTURALISM AND IMMIGRANT EXPERIENCE IN JHUMPA LAHIRI'S "THE NAMESAKE":

NilanjanaSudeshana "JhumpaLahiri"(Bengali) wasborn on July 11, 1967. She was born in London, the daughter of Bengali Indian emigrants from the state of West Bengal. Lahiri's mother wanted her children to grow up knowing their Bengali heritage and her family often visited Calcutta. This influence of her mother to her children about the Bengali culture made an impact on her which could be revealed through the character Gogol in the story, Namesake.

'Multiculturalism' suggest the co-existence of a number of different culture. *'TheNamesake* 'explores the theme of transnational identity and trauma of cultural dislocation. The Namesake describes the struggles and hardships of a Bengali couple who immigrates to USA. In *The Namesake* the quest for identity plays a major role. The immigrant experience includes quest for identity, uprooting, re-rooting, no sense of belongingness, no involvement, etc.

The immigrants can neither assimilate with the western culture nor associate with the parent culture. The immigrant children are in a dilemma whether they should follow their native culture or to follow their western culture. This state of mind can be clearly seen through the character Gogol, the son of the Immigrants. This makes him void and loses interest in all the aspects of his life. Even after getting married he is not interested in that life.

The Namesake throws light on the excruciate and painful experience of the immigrants (Here, "The Gangulis").The word "NAMESAKE" itself gives the entire concept dealt in the story. Namesake means something done without any involvement, no sense of belongingness, and loses interest in what one does. Thus the character in the story Gogol does everything in his life for namesake, he did nothing with interest or passion. His whole life was lifeless, devoid and empty.

The immigrants life can be indicated as 'Life without significance'. The different facets of experience of immigrants are,

"Politics without Principle

Education without Values

Prayer without Trust

Service without Love

Identity without Sense of belongingness"

In the fiction *THE NAMESAKE*, Lahiri's experiences of growing up as a child of immigrants resemble that of her protagonist, Gogol Ganguli. As Lahiri belongs to the second generation of Indian diaspora, whose on-going quest for identity never seems to end, it is reflected through the character Gogol. Jhumpa Lahiri tries to focus on the issues of identity, what she has faced in her childhood. The problem of Gogol's name symbolizes the problem of his identity. He wants to be connected to the strange names in the grave yard when the students were taken to the grave yard for the project. NIKHIL replaces Gogol when he enters Yale as a fresh man. As nobody knows his earlier name, he feels relief and confidence. His transformation starts here with new name. This can be seen in the following lines from the novel,

"There is only one complication : he doesn't feel like Nikhil. Not yet. Part of the problem is that the people who now know him as Nikhil have no idea that he used to be Gogol. They know

him only in the present, not all in the past. But after eighteen years of Gogol, two months of Nikhil feel scant, inconsequential. At times he feels as if he's cast himself in a play, acting the part of twins, indistinguishable to the naked eye yet fundamentally different"(105).

He starts doing many activities which he could not do as Gogol. He takes American girls, he shares live-in relationship, his way of life, food, everything changes. But the new dilemma clutches him. Gogol's life in New York, in turn, leads to transformation within Romantic relationships. Lahiri's narrator focuses on Gogol's life with three women: Ruth in college, Maxine in New York, and, finally, Moushimi, his wife. Each women marks a stage in Gogol's development.

The Namesake is about the way various generations look at their native and foreign land. The generation belongs to 1960s. They face trouble to merge with foreign culture. On the contrary, the second generation practices Indian culture to pacify their parents. But they live as Americans in their hearts as Gogol did in the novel.

SUMMATION: Through out the novel the dilemma in culture can be seen. The best example for the immigrant who is in search of self identity and ends up in the novel without getting solution for his quest is Gogol. He could neither fit himself to the Indian tradition and culture nor to the American culture. When he tries to fit himself to the American culture he could see that he is not at all satisfied with anything in his life. Thus, through JhumpaLahiri's novel the dilemma in the minds of the second generation immigrants can be clearly understood.

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AN ECOPSYCHOLOGICAL PERSPECTIVE OF KIRAN DESAI'S HULLABALOO IN THE GUAVA ORCHARD

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The article aims at focusing human –nature relationship in the perspective of Ecopsychology. Ecopsychology is a newly emerging literary approach with nature, human-nature relationship is reflected in current literary works. A critical study is undertaken to seek and discover the protagonist's relationship with the nature in the perspective of Ecopsychology. It discusses how the protagonist immerses himself in the natural elements and how he is healed with the help of nature. Hullabaloo in the Guava Orchard is one of the best novels of Kiran Desai can be seen from the perspective of Ecopsychology, and has a profound ecological thoughts which reflects how the humans' psyche is healed and developed with the nature's encounter. Humans are part of nature. It ends with an exploration of the protagonist's relation with nature and how he becomes one with the nature. Humans should embrace nature in order to heal them. It concludes that nature is important to save the humankind. Humans should embrace the Mother Earth to awake the ecological consciousness, to generate the feelings and emotions as well as to promote an ecological life style that humans live harmonious with nature.

Key Words: Nature, Ecopsychology, and Eco-consciousness.

Humans have a place on the earth, similarly as creatures and plants do. They are also a species of animal and a part of the ecosystem and ward upon it for survival. Nature has given everything abundantly to use for the people, yet humans fail to understand his part in ensuring nature. The ecological turn in literature is incidental, natural and inevitable. Literature has forever evolved through the concerns of the globe both inclusively and exclusively. The disastrous results of industrialisation, modernisation, and urbanisation have taken its toll upon humanity. The contribution of the writers and proponents of 'Green Literature' and ecocriticism in cultivating 'Eco-consciousness' is influential and praiseworthy Ecopsychology offers the treatment with nature for mental illness, which bridges the gap between people and nature. The Earth is our ground, our constant companion. *Environmentalists have made awareness of industrial civilization's often-harmful impacts on the natural world. However, these warnings have only rarely led to any significant. Ecopsychology is a new area of psychological study and its aim is to use established psychological principles to help the humans to understand the tendency to the love environment and to change one's behaviour in ways that allows living more responsibly, harmoniously and sustainably in the world.*

Social historian Theodore Rosak publicly articulates the term 'ecopsychology'. He is credited with coining the term 'Eco psychology' in his book, *The Voice of the Earth* (1992). As a term, it considers the connection between one's self and the nature. It recognises the healing of oneself and the healing of the world are interrelated. It is also known as 'Psycho ecology', 'Eco therapy', 'Green therapy', 'Earth-centred therapy' and ' Re-earthing'. It is an area which is dedicated to an examination of the emotional bonds that exists between humans and the natural world. It seeks to understand the complexity of these bonds and suggests paths to healing the weakened connections embedded in the human-nature relationship

It is the primary relationship in this physical world. The Earth is our life force and life-support system, our mother and our very substance. Kiran Desai's *Hullabaloo in the Guava Orchard* embodies the ecological idea of the bond between humans psyche and nature. Sampath is being bored with the materialistic life and his works at the post office, and hence runs away from his home and take protection in the guava orchard for life and liveliness. Beautiful nature helps in his healing and fills him with spiritual enlightenment. A new life has begun to him. Nature plays an important role in healing our interior and exterior features, which is body and mind.

When Sampath has born, he has a brown birthmark upon one cheek on his face. Sampath's frustration with the life and his duties, that leads him to find freedom. The boundaries and limitations of Sampath force him to escape and climb the guava tree. It seems to be quite abnormal, but it is right for someone who loves nature with genuine and deep love. According to Sampath, working at the post office is another form of imprisonment.

He is tormented at his workplace. He has a nice time with his own devices. Hence, he cannot concentrate his work. He is fed up with his routine way of living. He is disturbed and thus becomes quiet. He examines all the letters and hence he comes to know all the personal details of his people. When his chief's daughter's wedding had arrived, Sampath is giving the job of filling glasses with sherbet. He feels very boring to do the work. Filling and washing hundreds of glasses make him tired. He looks around the house and comes into the room, which is filled with wedding finery. On seeing the fineries, his heart starts to grow light with the fragrance of marigolds, mothballs, rose water and baby powder.

He is in a scented world of sandalwood oil. He examines the jewel box of his cousin-sister, and he wears a nose ring. He behaves differently without any reasons. As the room is dark, he lits a candle to him in the mirror with the fineries. He metamorphoses himself into a glorious

bird, where he feels far away from the lifts to another world. The lines show he longs for another world:

> Distant, tinged with mystery, warm with the romance of it all, he felt
>
> a sudden sharp longing, a carving for an imagined world, for
>
> something he'd never known but felt deep within himself. The candle
>
> attracted his finger like a moth and he drew it back and forth through the
>
> yellow and blue flame (38).

He holds the candle far enough away to lose its heat, yet close enough to keep the light around him. He traces the outline of his face and draws in the fantastic costume. He smiles and bows at his reflection as if he were his honored guest. The lizards on the wall watch him with harsh eyes. He sticks his tongue at them, feels suddenly and unreasonably happy. Encouraged by the atmosphere, he feels floating in some groundless state. He wades into the fountain and jumps in the spray, by splashing the grand women with water so they run squealing in consternation. Therefore, Mr D.P. S orders him not to come for the job. He removes his clothes and runs from the crowd.

The act of removing his clothes suggests that he is not of this world and his sense of meaningless in the world. His resolution to isolate himself from the boring life is a bold step to cope up with the feeling of alienation. Sampath also does not like his work and he hates it. He hates his life too. His life becomes a never-ending flow of misery. He is born in a prison. He feels bitter at heart. He returns to home jobless for his ill behavior. He does not want the job but he needs a free space and to be left alone. He wants peace and contentment in his life.

A beautiful turning point has come into Sampath's life is when her mother Kulfi gives him a guava. First, he does not like to eat that guava and finally he holds it. However, his stomach needs it. His stomach begins to growl and he takes the guava into his hands. He is cross and grumpy. The guava is cool, green, and calm looking. He likes the guava; he forgets his worries, disgrace on seeing the guava. He wishes to get all the coolness, quiet and stillness of the fruit. He forgets himself in the coolness of the guava.

Intentionally, he stares at the guava. Ferociously, with a deep gaze he shakes it. He can feel that the guava is expanding in response, when he speaks to it and rising under his fingers. He says to the guava that he does want a job and does not live like this. This is the first conversation with nature in the novel. He starts to speak with a guava and does not like to speak with any human. The size of the guava then rises even more and explores in an enormous explosion. The guava becomes fleshy, creamy, and cool.

The cool greenness of guava fills his body. His heart swells with a mysterious wild sweetness. He feels awake when the clear juice flows through him, which is quite unlike the human blood. A strange force enters into him, something which is new inside him, is circulating. He smiles at the first time and openly says to his mother ‘I need freedom'. The strength, in which the guava gives, helps Sampath to understand him and his needs. He comes out of his house propelled by a great enthusiasm of feeling; he makes his way down to the bazaar. He catches the first bus he sees. In his escape, he thinks of snakes that leave the withered rags of their old skins, insects that break pods that struggle to form the warm blindness of silk.

His escape is a symbol of a man from the materialistic world to the natural world. This is his real place. Sampath thinks how he is going to leave the world, which makes only endless revolutions towards nothing. Breaking away from the world is not an easy way, but he makes his mind to live only with nature and not with the humans. His heart is full of joy and fear. He feels the thin air and the freshness of greenery. He is now ready to surrender himself to nature in order to cure himself.

In his house, he is ignored and disregarded; though he is loved by his mother he separates himself from her. Unintentionally and accidentally, he sees the guava orchard from the bus. He does not have the idea to stay for his goodness, but only to fulfil the immediate urge to find a quiet place to take rest. However, later he feels that it is good to spend his whole life with the tree. At a very early age, he climbs the tree. Indeed, he is in need of isolation and alienation. Nature fulfils his desires. He understands his 'Self'.

He feels the marvellous emotion that has overtaken him begin to droop. The bus goes to the slope of the hill. He leaps from the window of the stalling bus. He runs into the wilderness towards the guava orchard. With a feeling of urgency, he runs into it. The emotion is high. Through the bushes and weeds, he runs to the orchard. He sees an old tree, which is silent, holds between the branches like prayer. Excitedly, without ceasing he climbs the tree. It seems like baby who goes fast to its mother for its refuge. Now he is in the lap of the Mother Earth. No one is daring enough to disgrace or scold him. He becomes one with nature. His deep emotional bond with nature is clearly shown when he climbs the guava tree. The tree is big than any other he had ever seen in his life.

Among the branches, he feels a wave of peace and contentment over takes him. He is amazed at the beauty of nature. The orchard is matched to what Sampath has imagined in his life. It has filled his whole mind and he wonders if he gets enough of it. He touches the leaves that are delicate and smooth. When he sees a flock of parrots, which are chattering in the sky, his mind is full of joy and he realises that this is the way of riches and this is the life of a king. He wants to become a part of nature. He has to learn many things in the orchard. His love for nature is revealed in an exotic way:

> He thought. . . and he ached to swallow it whole, in one glorious mouthful
>
> that could become part of him forever. Oh, if he could exchange his life for this
>
> luxury of stillness, to be able to stay with his face held towards the afternoon
>
> like a sunflower and to learn all there was to know in the orchard; each small
>
> insect that is crawling by; the smell of the earth thick beneath the grass: the bristling
>
> of leaves; his way easy through the foliage; his tongue around every name (51).

At last, he is in the right place. He falls asleep in the guava tree, whereas he never sleeps in his house. He refuses to come down when his family members called him. He is now attached completely to the tree. He is happy without his family and asks them not to disturb him. He adopts a new and simple way of life. He has no relatives now. However, he does not want to hurt anyone's feelings. Being one with nature, he does not like to hurt anyone. All the creatures become his relatives and now he is a beast that the air can play with his fur (hair).

It is true that nature is the powerful therapeutic resource. It seeks to help people to explore the connection and restore the bond where it may have broken. Sampath has a deep love

for nature and thus it restores its bond with him. A number of studies suggested that if a person spends his time with nature, his level of stress is decreased.

The orchard in the novel connects back with nature and he starts associating his existence with its beauty. He can feel himself as an inseparable part of nature and he realizes that he would be able to regain his lost identity in the lap of nature. He has become a part of the cosmos and the secret of its creation .The protagonist finally becomes one with nature. After his experience of being at a purely natural state, he is free to go anywhere. His inner strength guides him and let him fall apart. His spiritual association with the forest symbolizes his sense of harmony with nature. He gains knowledge of the forest as the source of energy and productivity. His ecological insight helps him in discovering his identity as a man. He can feel tranquility and inner peace in the forest and that helps her in gaining real insight of her identity. He can associate with the well-being of the forest and the monkeys.

The psychological approach with environmental activism results in greater effectiveness. Thus, Kiran Desai calls her readers to relate with nature in the perspective of psychology. To become one among the nature is noteworthy and it gives peace to one's heart and mind. Nature, by its nature, is therapeutic. Nature heals humans in the times of troubles and distress. The special value of Kiran Desai in the novel lies in the relationship between nature and humans in the technological society. Ecopsychology is relevant for sustainability because the reconnecting of humans and non-human nature is viewed by the ecopsychologists not merely an end in itself, but as a step towards healing the planet.

Let our eco-consciousness and eco-sensitivity lead to firm and sincere eco-commitment and integrated spirituality of love and compassion that embrace nature.

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Constructive Influence: A Psychological study of Frances Hodgson Burnett's novel *The Secret Garden*

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Literature is a legacy of the past to the present and the future. A literature is a record of human experience, and people have always been impelled to write down their impressions of life. The children's literature embraces the whole content of the child's imaginative world and that of his daily environment, as well as certain ideas and sentiments characteristic of it. *The Secret Garden* by Frances Hodgson Burnett is the story of how Mary Lennox and her friends find independence as they tend their garden.

Frances Eliza Hodgson Burnett born on November 24, 1849, in Manchester, England, had a long and productive writing career. She was a novelist and a playwright. She is famous for her children's books such as *Little Lord Fauntleroy, A Little Princess* and *The Secret Garden. The Secret Garden* is a novel about change, friendship and nature. It portrays that when people are introduced to an atmosphere of nurture and comfort they can change. The positive changes in the environment lead to the changes in the character.
Key Words – Environment, conditioning, behaviour, psychology.

Constructive Influence: A Psychological study of Frances Hodgson Burnett's novel *The Secret Garden*

Behaviourism is a theory of human development that studies observable behaviours. Behavioural Theories focus on the observable behaviours of a person. These theories state that the forces in the environment have a primary influence on a person's behaviour than the person's unconscious. It is concerned with the environmental factors which affect the behaviour. Behaviourism was formally established with the publication of a paper *Psychology as the Behaviourist Views It* (1913) by John Broadus Watson, the Father of Behaviourism. The two founding theorists of the behavioural movement were John Watson and Ivan Pavlov.

John Watson in his book *Psychological Care of Infant and Child* (1928) explained that behaviourists were starting to believe psychological care and analysis was required for infants and children. He explains that love is conditioned. The emotional disabilities were a result of personal treatment, not inherited. He holds the view that nothing is instinctual, rather everything is built into a child through the interaction with their environment. Parents therefore hold complete responsibility for choosing the environment which plays a very prominent role in the development of the personality of their children. Behaviourism is also known as behavioural psychology. It is a theory of learning based on the idea that all behaviours are acquired through conditioning. Conditioning occurs through interaction with the environment.

The novel *The Secret Garden* is the story of Mary Lennox, a selfish and disagreeable ten year old girl, who is living in India with her wealthy British family. She is spoiled by her servants and neglected by her unloving parents. When a cholera epidemic kills her parents and the servants, Mary is orphaned. She is sent to live with her uncle Archibald Craven, at his huge Yorkshire estate, Misselthwaite Manor. She finds the key to 'the secret garden' of Mrs. Craven which remained locked for ten years after her death. Mary continues to tend the garden with the help of Dickon Sowerby, and her interaction with the environment results in a transformation of her behaviour from foul tempered to kind and considerate. She also helps her sick cousin, Colin Craven to regain his health mentally and physically. The three children tend the garden together

and bring it back to life. Mary's and Colin's interaction with nature help them to grow healthier and happier.

The Secret Garden is a story which is an exaltation of the beauty of nature and the beneficial effects of nature on the human spirit, the need for human companionship, and the importance of allowing children the time to be children. Being emotionally neglected, becoming orphaned, being separated from her culture, and beginning anew in a different country are all environmental risk factors which is frequently manifested in temper problems and poor peer relations of Mary Lennox. Despite these emotional and behavioural issues, the magical healing quality of the Secret Garden aided the blossoming of friendships cultivated within Misselthwaite Manor, friendships that demonstrate to readers, young and old alike, that empathy towards others and a focus outside of oneself can help to heal even the oldest of wounds.

Mary Lennox is the only daughter of Captain Lennox and Mrs. Lennox who never cared about her. Mary was deprived of the affection that she should have got from her parents. She grows into a spoilt and lonely child. She was never given the love she deserved from her parents, who always leave her under the care of her Ayah. Mrs. Lennox was never pleased to see her daughter Mary. She grew up as a fretful girl who was not loved by anyone.

In the first chapter of the novel *The Secret Garden*, Mary Lennox is introduced as 'the most disagreeable-looking child' disliked by her own mother. She was a tyrannical, selfish and spoilt child. She was a mistreated young girl who lacks care given to her by her mother, who never wanted Mary to be born:

> She had not wanted a little girl at all, and when Mary was born she handed her over to the care of an Ayah, who was made to understand that if she wished to please the Memsahib she must keep the child out of sight as much as possible. So when she was a sickly, fretful, ugly little baby she was kept out of the way, and when she became a sickly, fretful, toddling thing she was kept out of the way also. (1)

The physical needs of Mary were met, but she was emotionally neglected. The native servants served to her whims and fancies, yet no one cared to give her the affection she lacked from her parents. The environmental condition in which a child grew up influences its behaviour and character. Mary was not given the affection she deserved when she was a child. It is reflected in her character as she never cares about anyone other than herself. She is disagreeable and never cares about other people around her.

Mary thought that her life in the new place would teach her a number of things quite new to her. This change was brought in her first by Martha Sowerby, who always talks to Mary and tells her good positive things. Though she comes from a poor family, she is a good hearted person. It was hard for Mary to make new friends in the beginning. But as days passed in the new place, she started to like people, "There was something comforting and really friendly in her queer Yorkshire speech and sturdy way which had a good effect on Mary" (23).

Behaviourism emphasizes the role of environmental factors in influencing behaviour. Behavioural theories provide a basis for understanding how people can learn new things from the environment. A new behaviour is learned from the environment. The environment of the garden brought a change in Mary. She was beginning to take care of something around her with all her heart: "She had began to like the garden just as she had begun to like the robin and Dickon and Martha's mother. She was beginning to like Martha, too. That seemed a good many people to like. . ." (54).

Colin Craven is introduced in the novel *The Secret Garden* as a boy with 'a sharp, delicate face, the colour of ivory'. He is a weak, sickly and hysterical child who throws tantrums often. He was also deprived of parental affection like Mary. In his case, his mother died shortly after his birth and his father didn't like to see him because he has his mother's eyes. He was bedridden since his birth and everyone believed that he will die before he reaches adulthood. Mary questions him why he won't let people near him, "Because I am like this always, ill and having to lie down. My father won't let people talk me over, either. The servants are not allowed to speak about me. If I live I may be a hunchback, but I shan't live. My father hates to think I may be like him." (105).

The impact of the 'secret garden' on the characters Mary and Colin as displayed in the novel *The Secret Garden* shows that love and care can change people. Mary transformed from a hateful girl to a friendly child when she is introduced to an atmosphere of care and comfort. The atmosphere of the Misselthwaite Manor and the caring people she had met in the Manor helped her for good. She helps her cousin Colin to recover with her positive words. The 'secret garden' helps them both acquire happiness in their lives:

> 'The boy is a new creature.'
>
> 'So is the girl,' said Mrs. Medlock. 'She's begun to be down-right pretty since she's filled out and lost her ugly little sour look. Her hair's grown thick and healthy looking and she's got a bright colour.'(212)

Environment helps people to change as it influences human behaviour. The change in the environment leads to a change in behaviour. This change is seen in the character, Mary, as her secret garden helps her to heal. The experiences she gets in the new place shape her character. The love she gets from the people around her brings out the goodness in her. The secret garden and the venture to bring the garden back to life transformed not only the garden but also the lives of Mary and Colin. Their friendship with Dickens brings a new experience in their lives and it helps them a lot to get healed.

Behavioural theories help to understand the human behaviour which is shaped by the environment. They have helped to see that troubling behaviour occurs not because of something that is wrong with the child but because of the environmental conditions in which the child is grown. Mary Lennox is grown in an atmosphere where nobody has cared about her. When she is given the care she never got from her parents, she changed.

Burnett portrayed that the lack of love has a negative impact on children and the same love can help them to come back from sorrows and bring them happiness. Lack of love and affection made Mary and Colin 'contrary' and 'spoilt'. The power of love helped Mary and Colin to be better people. The spoilt children, Mary and Colin, transformed into healthy and understanding children with the help of others and the environment.

The Secret Garden renders an influential message to its readers. It shows to its readers how a person can change when they are introduced to a better environment. Their transformation is the result of the environment to which they are exposed. The new atmosphere has a positive impact on them. The secret garden, which Mary discovered, is the place for Mary and Colin to recover and to experience love that they have been missing for a long time. Mary and Colin gradually show some welcome changes in their character as the result of the influence of environment on them.

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SENSE OF LETHALITY IN THE NOVEL *THE FAULT IN OUR STARS* BY JOHN GREEN

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Literature depicts the life of the people in various aspects. Death plays a major role in the lives of the people. Though people are aware that one day everyone is going to die, to accept the death is a very difficult task to the humans. In the novel *The Fault in Our Stars* John Green picturises the life of the young adult American citizen who are suffering from cancer. They know that their life is too short compared to the normal youngsters. Somehow they accept the fate and living the happiest life is the heart breaking plot of the novel. Death robs dreams, aspiration and ambition of juveniles like Augustus, Hazel, Issac etc... Hazel and Augustus are star crossed lovers that are born with an anomaly into this world. Since both are on the threshold of death, it becomes important to know how the writer deals with the theme of death.

Here, author portrays how the power of death changes the brave person, Augustus into coward. He dies a painful and pathetic death, but his life is not failure. It gives a full circle to Hazel because of his love on him, she is transformed into a stronger character that death is nothing to be feared of. This paper discusses how the theme of death enterprises the structure of the fiction. To cover and examine this significant theme, Green uses the similar symbols, images and character.

SENSE OF LETHALITY IN THE NOVEL "*THE FAULT IN OUR STARS*" BY JOHN GREEN

Death, be not proud, though some have called thee

Mighty and dreadful, for thou are not so

-John Donne

Literature is the collection of best use of language which is a means of human communication. Literature has developed language to grow. It acts as a mirror of life. It plays an important role for many reasons, including its ability to provide pleasure, to help readers for

building experience, empathizing with others and to develop thinking skills. It visualizes the various aspects of human being.

Young adult literature is described for the readers from the age of twelve to eighteen. During the last half of twentieth century, young adult literature has developed as a distinct unit of publishing. There is a market for stories especially written for youth. There is also doom and gloom talk of people no longer reading like they used to, that there are too many other interest including the media and the internet, that take away from reading activities. There is a wide variety of literature for young adults. The late sixties saw distinct changes in publishing for youth adults with the publication of *The Pigman*, by Paul Zindel in 1968, and The Outsiders, by S.E. Hinton in1967.

John Green is the author of popular novels for teens and young adults, including 2012's *The Fault in Our Stars.* He's also one half of the brother duo whose YouTube channel is known as VlogBrothers. He grew up in Florida and is a 2000 graduate of Kenyon College, where he studied English and Religion. He was a publishing assistant in Chicago and a book reviewer in NewYork, and in 2005 published his first novel, *Looking For Alaska*. The book was well-received and sold well, and Green went on to publish the novel *An Abundance of Katherines (*2006) and *Paper Towns* (2008), which won the Edgar Award for best young adult novel. By that time, Green and his brother, Hank, were gaining popularity on YouTube for a series of back-and-forth exchanges that came to be known as Vlog Brothers and Brothers2. They advocated social activism and their fans became known as "Nerd fighters." The Green brothers went on to make a series of educational videos for teens, and they founded The Foundation to Decrease World Suck, a grassroots charitable organization. Green has also collaborated on a number of young adult novels, and the best-selling *The Fault in Our Stars* was made into a 2014 movie starring Shailene Woodley and Ansel Elgort.

The Fault in Our Stars is a tragic love story that deals with the sufferings and death of cancer patients. John Green borrows the title from Shakespeare's Julius Caesar, wherein Cassius says, "the fault dear Brutus is not in ourselves that we are underlings." But on divergent to what cassius says, this story establishes the puzzle that people are helpless in front of fate. This paper discusses the real lives of the young adults suffering from cancer and setting, characters, symbols used by green to examine the feel of mortality.

The Fault in Our Stars by Green is not only a work of fiction, but it is also remarkable for being realistic picture of the world of diseased people. Green has portrayed the true picture of tragic lovers through his personal experience with the cancer patients. Working as a student chaplain he came across a nerd fighter, "Esther Earl", who served a great inspiration for his novel. Esther died of cancer in 2010 and he dedicated it to her pure soul. Although the protagonist of the novel is Hazel Grace, the readers can find the echos of Esther's suffering in the novel. Green follows the first person narration by making Hazel as a central character and vividly compacts the conflict of life and death. The novel has the universal notion as it depicts the picture of cancer patients all over the world.

Green's art of characterization is unique. His characters are young and imaginary which leave credible thoughts on the heart of the readers. Hazel and Augustus are hero and heroine of the novel. They both are suffering from cancer and their friends are also cancer patients. Their tentancy to accept the death and living a care free life is the highlight of the novel which provokes pity and touched the heart of the readers. Hazel, the narrator and the protagonist, is a sixteen year-old girl, suffering from a terminal form of thyroid cancer for last three years. Cancer has spread to her lungs and she is confined to breathe through the four walls of an oxygen cylinder. Green makes use of a powerful image by showing how she has to drag the oxygen cylinder round the

neck. "These tubes give me oxygen and help me breath."(4). her life depends on the cylinder which contains her life to a great extend. The image of carrying the cylinder describes the forthcoming death, which can burst like a balloon in any moment.

Hazel is a conscientious girl, far mature for her tender she is aware other impending death and this is the reason she has confined herself to her parents and her home. She knows the pain the death of a beloved to the parents and other concerned ones. She is determined not to scar the lives of others by her death, and keeps herself aloof and alienated from others. Green makes use of another visual image to show how the persistently gnawing sense of mortality has got the better of Hazel. She considers herself a"Grenade" which is going to explode very soon, annihilating all rounds in its train "I'm a grenade and at some point I'm going to blow up and I would like to minimize the casualties, okay?"(6) Since is aware of her mortality, she does not want others to cry for her when is dead. It can be realized from her words," I can't be realized from her words; I can't be a regular teen, because I'm grenade" (7) how her mortality is weighing on her vitality.

In order to while away her time and engross herself with things other than the mortality of a cancer patient, she reads a fictional novel, "An Imperial Affliction" written by Van Hounten. The novel has captivated her as it deals with the mortality of a young girl, Anna, who is also a cancer patient. Although the character of Anna is only a sub plot, it further pokes into the theme of mortality, wherein the reader can draw a parallel between the characters of Hazel and Anna. Hazel is enthralled as well as deluded by the novel, since the novel ends mid sentences. Hazel is bent upon discovering the fate of Anna's parents at the end; a fact that she will assimilate into her own parents. If Anna's parents can brave with her death, the Lancaster's may as well do with hers.

Hazel's melancholy has made her love her parents passionately, and it is for the sake of their happiness that she joins a support group, despite her severe bouts of depression. It is here at the support center that her stars take hold of hers, and she initiates a journey into the unknown, she is accosted by an eighteen-year-old lively. Handsome and enthusiastic boy, Augustus Waters. He suffers from osteosarcoma, and as a result of it, wears prosthesis. He is a romantic boy who falls in love with Hazel at first sight. He weaves his gossamer of a heroic life, and wants to do something, which will be remembered by humanity forever. He fears oblivion, and is desperate to do something that will make him a hero. During a video game, "the price of drawn", he sacrifices himself by jumping on a grenade in order to save the innocent children. He takes pride in declaring, "may be that's the minute that buys them an hour, which is the hour that buys them a year. No one's gonna buy them forever, Hazel Grace, but my life bought them a minute. And that's not nothing." (8). A happy basketball player, Augustus, is now a handicapped individual, and this serves a guiding force in the life of Hazel. He fills enthusiasm and magnetism into her life, through his romantic gestures and theatrical grandiosity, quite ignorant of the fact that cancer is eating into his body but he is dying. He is determined to make the life of Hazel meaningful through his love, sincerity and exuberance. Green uses another visual image of Augustus holding a cigarette between his lips, an image that makes him aware of his vulnerability and mortality. His main contribution in the life of Hazal starts when he gives a concrete shape to her most cherished desire of meeting the author of "An Imperial affliction". Through the character of Peter Van Houten, Green makes Hazel's reason get the better of her emotions. She realizes that Van Houten is not a "veritable god" or a magical person. His character plays a significant role in restoring Hazel back from the dream world to the real world. Like her, Houten is also a victim of the stars. His character Anna is not a fictitious one, but takes after his daughter Anna, who died of cancer at eight. Through the imaginative character of Anna John Green depicts the grief of death.

The Fault in Our Stars is completely packed up with the sense of death with the usage of images, characters and symbols. It finds answer within the novel for the death. The power of death can be seen when Hazel is weak, stirred upon herself and betray to face the society, Augustus is transformed from the brave into coward, from the escapist into the realist and from lively into the death. Through him, the life of Hazel come a complete circle and she is transformed into a stronger character that death is nothing to be feared of and that life goes on. She is thankful to Augustus, and will cherish his memories still her end and the same will go with her parents, who will be sad but proud of being her parents.

Life is like a bed of roses, so enjoy every moment. Destiny is deserved in hand of God. As every sentences has a full stop, all living and non livings has an end in life that is death. Past is like waste paper, present is like Newspaper and Future is a Question Paper. Don't go in search of the Question paper where the answer is with God, unable to get it from him. God will give everything at a right time. Death is nothing to be feared of and that life must move on.

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Le sentiment de la nature dans les œuvres de Charles Ferdinand Ramuz et de S. Corinna Bille : Une analyse.

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Résumé :

La nature était toujours un thème important de la littérature, même si elle est perçue différemment à travers le temps, chez les écrivains différents. Dans les œuvres *Cantique de la jeune fille* de S. Corinna Bille et *C'est une fille avec un garçon* de Ramuz, on voit que la manifestation de la nature est remarquable. L'objectif de cette analyse est de mettre en évidence le thème de la nature comme noyau de l'œuvre de Charles Ferdinand Ramuz et de S. Corinna Bille : le rôle de la nature présenté et comment ils perçoivent la nature. En premier lieu, on examine le rôle de la nature dans les deux œuvres et en deuxième lieu, on aborde le portrait de la nature favorable et en troisième lieu, on discute de la représentation de la nature destructive.
Mots clés : *la nature, le rôle joué, la nature favorable et destructive, la complice de l'amour.*

Charles Ferdinand Ramuz et S. Corinna Bille sont des écrivains suisses renommés du vingtième siècle et la place qu'ils occupent dans la littérature francophone est considérable. Vaud est la région d'origine de Ramuz et souvent ses écritures tournent autour des thèmes qui sont vaudois : les montagnes, les paysans, la vie rurale, la nature, les paysages, etc. tandis que la nature, la mort, la passion, l'amour et le désir sont les principaux thèmes des œuvres de S. Corinna Bille. A travers l'analyse de la nouvelle *Cantique de la jeune fille* de S. Corinna Bille et du morceau *C'est une fille avec un garçon,* nous allons examiner le rôle de la nature présenté et comment ils perçoivent la nature.

La nature était toujours un thème important de la littérature, même si elle est perçue différemment à travers le temps, chez les écrivains différents. Souvent elle constitue un décor ou une ambiance; parfois elle est dépeinte comme un personnage; fréquemment, elle forme des symboles, des métaphores et des images etc. de la littérature. La nature a été une source d'inspiration sans égal pour de nombreux poètes.

Dans les œuvres *Cantique de la jeune fille* de S. Corinna Bille et *C'est une fille avec un garçon* de Ramuz, on voit que la manifestation de la nature est remarquable. En premier lieu, je vais discuter le rôle de la nature dans les deux œuvres et en deuxième lieu, je vais aborder le portrait de la 'nature favorable' et en troisième lieu, je parlerai de la représentation de la nature destructive.

Le rôle de la nature

Dans *Cantique de la jeune fille* par Corinna Bille et *C'est une fille avec un garçon* par Ramuz, la présence de la nature est impressionnante. Dans le morceau de Ramuz, la nature est présentée comme un des trois personnages ; elle est personnifiée. Par exemple, au début, le ruisseau représente la nature :

« Et la voix qui venait maintenant (…) était celle du ruisseau épelant et lisant difficilement une phrase (…). »[1]

On voit que le garçon n'ose pas dire « j'aime bien Louise »[2] mais le ruisseau ose l'épeler, i.e., la nature ose. Dès le début jusqu'à la fin, le narrateur présente la nature comme jouant un rôle important dans l'amour du garçon et de la fille. Elle est représentée à travers des images différentes. Par exemple, la bord d'un buisson de ronces, le bruit des abeilles, les bourdons, les

1 RAMUZ, C F. Salutation paysanne, Œuvres complètes, C'est une fille avec un garçon, Editions Rencontre, Lousanne. (p. 84)
2 Ibid (p. 84)

mouches, la voix de ruisseau le tunnel que faisaient les branches, la chaleur, le bois, l'orage, une garniture d'anémones, et des couleurs (la grande nature peinte en blanc, nuages couleur de pierre, espèces de vert, la couleur des feuilles de hêtres, un tronc gris et blanc avec des couleurs blanches, etc.).

Dans *Cantique de la jeune fille* Corinna Bille présente la nature comme ayant des visages différents. « Les prairies »[3] représente la nature avec ses cotés variés. « (…) de graines et d'épis tranchants, elles parfument et brûlent, elles guérissent, elle donne la mort ».[4] De plus important, à la fois, la narratrice la perçoit comme guérissante et destructive. « (…) elles guérissent, elles donnent la mort»[5]. La narratrice ressent ces manifestations différentes qui lui amènent à prendre des positions différentes quant à la nature; D'une part elle s'identifie avec la nature adoucissante et d'autre part, elle se distancie de la nature destructive.

Elle commence la nouvelle en présentant la nature favorable. Elle s'amuse bien avec son amant dans la nature. « Nous traversons à la nage les fleuves, nous galopons sur les chevaux sauvages»[6]. Pour elle, la nature est guérissante, adoucissante et favorable. C'est la nature qui lui donne l'amour et la joie. C'est elle qui remplit ses jours des milles couleurs. Le bonheur est son cadeau. En fait, dans ces deux œuvres, ce visage favorable de la nature est reconnu.

La nature favorable

La nature est tellement favorable et adoucissante que la narratrice de *Cantique de la jeune fille,* cherche à s'éloigner de ce qui est possiblement artificielle et humain et à se reconnaît dans la nature, comme sa partie.

C'est aussi intéressant de noter que quand elle se reconnaît dans la nature, elle se distancie des autres hommes. Cette idée est démontrée dans la ligne, « Nous traversons à la nage les fleuves, nous galopons sur les chevaux sauvages.» car les chevaux ne sont pas apprivoisés par l'homme mais restent sauvages :

> Nous ne nous épouserons jamais selon la loi des hommes. Nous resterons nus et absents,. Mais l'amour fou sera notre bien, l'espace notre demeure. Pas de toit, ni de maison (…)[7].

Elle ne veut pas vivre selon la loi des hommes et elle ne veut posséder que l'amour comme leur bien et l'espace comme leur demeure. C'est comme 'vivre dans la nature' avec la nature suivant ses lois et dénonçant la loi de l'homme.

Une telle perception de la nature est comparable à la perception de la nature chez les écrivains romantiques. C'est au dix-huitième siècle que Rousseau a développé cette idée de la nature sauvage offrant aux âmes sensibles un refuge contre la cruauté et la bêtise de la société. Il dit, «La nature a fait l'homme heureux et bon, mais la société le déprave et le rend misérable»[8]. Les écrivains romantiques cherchent à prendre du recul de la civilisation humaine et la nature pour eux, est un lieu de repos et de recueillement. De la même façon, dans *C'est une fille avec un garçon,* Ramuz dépeint une nature favorable en présentant la nature comme une complice de l'amour du garçon et de la fille.

Même l''amour est perçu comme un phénomène très naturel et c'est la nature qui leur conduit. La phrase, « Il disait rien, elle ne disait rien ; il ne pensait pas à vouloir, il pensait plutôt à ne pas vouloir, (...) »[9] indique que le garçon n'est pas conscient de ce qu'il fait mais qu'il est

3 BILLE, CORINNA. Cantique de la jeune fille (p.91)
4 Ibid (p.91)
5 Ibid (p.91)
6 ibid (p.91)
7 ibid (p. 93)
8 Rousseau, Jean-Jacques, Rousseau juge de Jean-Jacques, 1795 ; Paris, France.
9 RAMUZ, C F. Salutation paysanne, Œuvres complètes, C'est une fille avec un garçon, Editions Rencontre, Lausanne. (p. 84)

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automatique et naturel. La nature permet assez d'espace pour les deux amoureux. C'est comme la nature les aide à être ensemble. Les phrases comme celles-ci le démontrent.

> (…) comme si le sentier eut été fait sur mesure pour eux. Mais c'était une indication de plus et c'est un encouragement quand même(...)[10].
>
> Cet endroit semblait avoir été fait exprès pour eux[11].

C'était comme tout est préparé purement pour les deux amoureux. Ils ne se distancient pas de la nature mais ils trouvent leur bonheur dans elle.

De ce point de vue, on voit que la nature joue presque le même rôle dans les deux œuvres ; la source de bonheur. Cependant, dans *Cantique de la jeune fille,* le visage destructif de la nature est également dépeint côte à côte avec l'image d'une nature favorable.

La nature comme destructrice

La nature est perçue aussi comme une destructrice dans la nouvelle de Corinna Bille ; « elle donne la mort.»[12] À travers la nouvelle, l'idée que 'la nature est destructive et effrayante', apparaît. Souvent on a le sentiment que la narratrice se distancie de la nature et elle pense que la nature détruit et dévore ce qui n'est pas naturelle, ce qui est fabriqué. C'est démontré par des images comme, « le lierre rongeait les statues des parcs, Parfois, les feux les avaient détruits, les genévriers griffaient, la neige nous a recouverts, les racines ébranlaient »[13], etc.

Son amour est comparable à des choses fabriquées par des hommes. Pour elle, l'amour n'est pas naturel comme pour Ramuz et elle croit que la nature essaie de dévorer son amour par la mort de son amant et ainsi son absence. À la fin, elle veut peut-être prendre du recul de la nature qui lui a offert des souffrances par la mort de son amant. Elle veut s'en distancier :

> (…) nous nous élèverons dans les airs. (…) au-dessus des villes et des tours, au-dessus des brouillards, des rivières et des lacs, au-dessus du plus haut sommet des montagnes brunes.[14]

Dans l'œuvre de Ramuz, la nature est la complice de l'amour et le narrateur dépeint la collaboration de la nature à créer une rencontre agréable entre les deux amoureux. Même dans la nouvelle de Corinna Bille, elle présente une nature adoucissante et favorable au début mais elle finit par reconnaître le 'visage destructeur' de la nature. Pour elle, la nature est à la fois la source de bonheur et son destructrice ; l'amour n'est pas naturel comme pour Ramuz et la nature le détruit et le dévore. Les deux auteurs présentent deux visages opposés de la nature ; la nature qui cherche à détruire l'amour et la nature qui est une complice de l'amour.

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10 ibid
11 ibid (p. 85)
12 BILLE, CORINNA. Cantique de la jeune fille (p.91)
13 ibid (p.92)
14 ibid (p. 93)

शोध सारांश

श्रीमती. सुधा शर्मा
विभागाध्यक्षा, हिंदी विभाग
निर्मला कॉलेज फॉर वीमेन
कोयम्बत्तूर-४.

सभ्यता के विकास के साथ–साथ मनुष्य अपने जीवन के अर्थ की खोज में लग गया। इसी क्रम में वह हताश और निराश हुआ किंतु खुद संभल कर उसने अपना रास्ता बनाया। हर मनुष्य अपने भाग्य का निर्माता स्वयं है। वस्तुतः ' अस्तित्त्ववाद' का यही सार है। हिंदी साहित्य के साहित्यकारों ने अपनी रचनाओं के जरिए मानव मात्र को अपना अस्तित्त्व तलाश करने की प्रेरणा दी है। उषा प्रियंवदा जी के उपन्यासों में अस्तित्त्ववाद की स्पष्ट झलक दिखलाई पड़ती है। अपने सशक्त नारी पात्रों के माध्यम से उषा जी समाज की नारियों को आकाश की ऊँचाईयों को छू लेने का साहस प्रदान करती हैं।

उषा प्रियंवदा के उपन्यासों में अस्तित्त्ववाद

1940 और 1950 के दशक में अस्तित्त्ववाद पूरे यूरोप में एक विचारसंक्रांति के रूप में उभरा। 1950 के आसपास मनोवैज्ञानिकों ने मनोविज्ञान के व्यावहारिक पक्ष पर भी विचार करना शुरु कर दिया। जिसके फलस्वरूप मनोविश्लेषण तथा अस्तित्त्ववादी मनोविज्ञान ये दोनों उन्हें अधिक उपयुक्त प्रतीत होने लगे।

"जिस विश्व में व्यक्ति का अस्तित्त्व है, जिसमें वह रह रहा है, उसके साथ व्यक्ति के एकीकरण को ही अस्तित्त्ववादी मनोविज्ञान की संज्ञा दी जा सकती है।"

अस्तित्त्ववादी, विचार या प्रत्यय की अपेक्षा व्यक्ति के अस्तित्त्व को अधिक महत्त्व देते हैं। वास्तव में, अस्तित्त्ववादी मनोविज्ञान का लक्ष्य है घटनाओं का वर्णन करना, न कि उनके कारणों की व्याख्या करना। अस्तित्त्ववाद, मानव–अस्तित्त्व में कारण–प्रभाव संबंध को नहीं मानता, वह तो कारणों के स्थान पर अनुप्रेरणा तथा समझ–बूझ के आधार पर व्यक्ति के व्यवहार की व्याख्या करता है। अस्तित्त्ववाद के अनुसार सारे विचार या सिद्धांत व्यक्ति की चिंतना के ही परिणाम हैं।

अस्तित्त्ववादियों ने मनुष्य को एक अस्तित्त्व के रूप में माना है और स्पष्ट किया है कि मानव जीवन को समझने के लिए व्यक्तियों की अनुभूतियों को समझना अनिवार्य है। अस्तित्त्ववादी मनोविज्ञान मानव स्वभाव के प्रति अधिक सकारात्मक दृष्टिकोण अपनाता है। उसकी मान्यता यह है कि मनुष्य में अपने को विकसित करने तथा आत्मधारणा एवं आत्मबोध की अपूर्व क्षमता होती है।

आधुनिक मानव प्रकृति से दूर होता जा रहा है। फलस्वरूप वह दिनोंदिन अपने को अकेला और लोगों से दूर महसूस करने लगा है। आज मानसिक रूप से विकृत अधिकांश लोगों को अपेक्षाकृत अस्तित्त्वात्मक स्नायु–विकृति की अधिक शिकायत रहती है तथा स्नायु–विकृति के विशिष्ट लक्षणों की कम।

"अस्तित्त्वात्मक स्नायु विकृति से तात्पर्य है, सार्थक जीवन के अभाव में अकेलेपन एवं असंतोष की अनुभूति।" अस्तित्त्ववाद की दृष्टि से आज के अधिकांश लोग प्रायः शून्य में ही रहते हैं। प्रसिद्ध मनोचिकित्सक विक्टर फ्रैंक्ल के अनुसार **"यह एक तरह का अवसाद है जिसमें व्यक्ति अपने जीवन में संतोष की कमी को महसूस करता है, साथ ही अपने जीवन के अकेलेपन का भी उसे अहसास होता है।"**

फ्रैंक्ल ने अस्तित्त्ववादी शून्यता को दूर कर जीवन की सार्थकता के लिए संतोष प्रदान करने वाले जीवन मूल्यों की अनिवार्यता पर जोर दिया है। इस संदर्भ में उन्होंने तीन प्रकार के जीवन मूल्यों को प्रधान माना है। वे तीन जीवन मूल्य हैं –

1. रचनात्मक मूल्य–जिनका संबंध व्यक्ति की उपलब्धियों से है।
2. अनुभवजन्य मूल्य–जिनका संबंध दूसरे व्यक्तियों को समझने और प्यार देने से है।
3. मनोवृत्त्यात्मक मूल्य–जिनका संबंध साहस तथा बिना झिझक के दुःख सहने की क्षमता से है।

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1. मनोविज्ञान का इतिहास, डॉ. रामप्रसाद पाण्डेय, पृ.सं. 424
2. मनोविज्ञान का इतिहास, डॉ. रामप्रसाद पाण्डेय, पृ.सं. 424
3. Man's search for Meaning – Frankl, Victor E., Pg. 141

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इन मूल्यों के कारण ही मानव जीवन सार्थक प्रतीत होता है। वस्तुतः प्रत्येक व्यक्ति अपने आप में विशिष्ट होता है। अतः वह अपने अनुकूल जीवन मूल्यों को अपनाकर जीवन को सार्थक बना लेता है। **''अस्तित्त्ववाद अन्य लोगों के प्रति व्यक्ति के कर्त्तव्य पर भी जोर देता है क्योंकि अस्तित्त्ववाद के अनुसार यह कर्त्तव्य बोध ही उसके 'स्व' को सार्थक बनाता है।''**

सभ्यता के विकास के साथ–साथ, मनुष्य जीवन के अर्थ की खोज में भी लग गया। इसी क्रम में वह हताश और निराश भी हुआ लेकिन फिर खुद ही संभल कर उसने अपना रास्ता बनाया। हर मनुष्य अपने भाग्य का निर्माता स्वयं है। 'अस्तित्त्ववाद' का यही सार है। हिंदी साहित्य के कई साहित्यकारों ने अपनी रचनाओं के जरिये मनुष्य को अपना अस्तित्त्व तलाशने की प्रेरणा दी है। उषा प्रियंवदा उन साहित्यकारों में एक हैं।

उषा प्रियंवदा के सभी उपन्यासों में 'अस्तित्त्ववाद' की झलक मिलती है। उषाजी के उपन्यास नारी प्रधान हैं। 1961 ई. में प्रकाशित 'पचपन खंभे लाल दीवारें' की नायिका सुषमा दिल्ली के एक प्रतिष्ठित कॉलेज में लेक्चरर है। उसके ऊपर अपने बीमार पिता, माता और छोटे–छोटे भाई–बहनों का दायित्त्व है। सुषमा के भी सपने हैं। किंतु वह अपना घर बसाकर अपने परिवार को बेसहारा नहीं छोड़ सकती। नीरस जिंदगी जीते–जीते सुषमा कुंठित हो जाती है। 'फ्रैंक्ल' ने अपनी पुस्तक, 'मैन्स सर्च फॉर मीनिंग' में इसे 'अस्तित्त्व कुंठा का नाम दिया है। फ्रैंक्ल के अनुसार, **''मनुष्य के अर्थ की खोज की धारा में हताशा या निराशा ही अस्तित्त्व कुंठा' कहलाती है।''**

'फ्रैंक्ल' के अनुसार आधुनिक युग में मनुष्य को जीवन अर्थहीन लगने लगा है जिसकी वजह से उसमें जिंदगी को जीने की उत्सुकता ही नहीं रही। मनुष्य के जीवन में खोखलापन आ गया है क्योंकि वह आंतरिक अकेलेपन से गुजरता है।

सुषमा की भी यही स्थिति है। सुषमा को लगता है कि उसके माता–पिता इतने स्वार्थी हो गए हैं कि उन्हें सुषमा की खुशी का कोई ख्याल नहीं है। हर वक्त, छोटी बहन नीरू की शादी के लिए चिंतित अपनी माँ से सुषमा को नफ़रत सी होने लगती है। एक दिन सुषमा की अम्माँ जब सुषमा की दोनों छोटी बहनों के बारे में सुषमा से कहती हैं – ''तुम्हारे पास तो सब कुछ है। ये दोनों भी अपने घर जाएँ, सुख से रहें, अपने मन का खाएँ, यही चाहती हूँ।''

यह सुनते ही सुषमा बिफर उठती है – ''अभी कौन दुःख है। भूखी रहती हैं या तन ढँकने को–कपड़े नहीं हैं? मैं कुँवारी रह गई तो कौन सा आसमान फट पड़ा? इन दोनों की भी शादी न हो सकी तो क्या हो जाएगा?''

सुषमा की जिंदगी में नील के आने से बहार आ जाती है। उसके सपने इंद्रधनुषी हो जाते हैं। लेकिन वह चाहकर भी खुले आसमान में उड़ान नहीं भर सकती। उसके पैरों में उत्तरदायित्त्व की बेड़ियाँ हैं।

अपने परिवार के प्रति कर्तव्यबोध सुषमा के 'स्व' को सार्थक बनाता है। अपने कर्म में लिप्त होकर सुषमा अपने जीवन का हल ढूँढ़ लेती है और नील के साथ हॉलैंड जाना अस्वीकार कर देती है। त्याग और समर्पण के साथ–साथ सुषमा का 'अस्वित्त्ववादी दृष्टिकोण' उसे आदर्श बनाता है।

उषा जी का उपन्यास 'शेषयात्रा' 1984 ई. में प्रकाशित हुआ। 'शेषयात्रा' की कथा भारत के एक शहर के अनजान मोहल्ले से निकलकर अमेरिका में जा बसी 'अनुका' उर्फ अनु के इर्द–गिर्द बुनी गई है। बचपन से अनाथ, पराश्रिता अनु को अमेरिका का ठाट–बाट स्वप्न की तरह लगता है। लेकिन शीघ्र ही उसका यह स्वप्न चूर–चूर हो जाता है जब उसका पति दूसरी स्त्री के मोहपाश में बँधकर अनु को अकेला छोड़कर चला जाता है। अनु को लगता है – **''जिसकी पूर्णता, जिसका पत्नीत्त्व, सब कुछ नकार दिया गया है, जिसकी पूरी आइडेंटिटी, पूरा अनु-पन एकदम झकझोर दिया गया है। लहरों ने उसे कूड़े की तरह रेत पर लाकर पटक दिया है और जैसे अनेक आवाजें उसे चिढ़ा चिढ़ाकर कहती रहती हैं–तुम कुछ नहीं हो, तुम कुछ नहीं हो।''**

असहाय, अकेली अनु विक्षिप्त सी हो उठती है। वह 'अस्वित्त्ववादी शून्यता' की स्थिति में चली जाती है। उसे जिंदगी अर्थहीन लगने लगती है। लेकिन अपनी सहेली दिव्या के कहने पर अपने टूटे–बिखरे अस्वित्त्व को जोड़कर, कठिन परिस्थितियों में जीने का रास्ता खोजती है। अटूट आत्मविश्वास के साथ पढ़ाई करने में लग जाती है और एक अस्पताल में जूनियर पैथोलॉजिस्ट हो जाती है। तब अनु को लगता है – **''मैं हूँ अनु, अपने में तुष्ट, अपने स्वत्त्व बोध में सुखी, अपने सुख-दुःख में अकेली, अपने में स्वाधीन। उसे यह अनुभूति प्रिय लगती है। उसने अपने व्यक्तित्व और अस्तित्व का लक्ष्य पा लिया है।''**

वक्त करवट लेता है और उसे मंझधार में अकेला छोड़कर चल देने वाला उसका पति प्रणव, उसी के अस्पताल में हृदय–रोग का इलाज कराने आता है। अनु को देखकर वह हैरान रह जाता है। प्रणव पूछता है –

''मगर अनु, पैसा कहाँ से?''
अनु बताती है –

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1. मनोविज्ञान का इतिहास, डॉ. रामप्रसाद पाण्डेय, पृ.सं. 424
2. Man's search for Meaning – Frankl, Victor E., Pg. 141-142
3. शेषयात्रा, उषा प्रियंवदा, पृ.सं. 9

"कुछ था, कुछ नौकरियाँ की, कुछ कर्ज लिए-एक बार शुरुआत करके फिर छोड़ने का सवाल ही नहीं उठा। किसी-न-किसी तरह से, पेट के बल रेंगते हुए मैंने यह पुल पार कर ही लिया।"

फैंक्ल के अनुसार मनुष्य जब जीवन में हताश हो जाता है, तभी उसे अपने अस्तित्त्व का अहसास होता है। अपने पति द्वारा ठगी गई अनु के सामने दो विकल्प थे–जीवन में हार मान लेना या जिंदगी की विषम परिस्थितियों का डटकर मुकाबला करना। अनु ने दूसरा विकल्प चुना। 'अस्तित्त्ववाद' के अनुसार सारे विचार या सिद्धांत व्यक्ति की चिंतना के ही परिणाम हैं। अनु ने निश्चय कर लिया।

"शुरुआत तो करो, देखो कि तुम भी प्रणव कुमार बन सकती हो कि नहीं? इत्तफाफ से मेडिकल कॉलेज में एडमिशन मिल गया, माँ की भी इच्छा थी कि मैं डॉक्टर बनती, एंड हियर आइ ऐम-नोबल प्राइज़ विजेता की रिसर्च टीम में ...."

मानव जीवन सुख–दुःख से भरा है। दुःख के क्षणों में उदास होना स्वाभाविक है। लेकिन मनुष्य के लिए अनिवार्य है कि वह परिस्थितियों को अपने ऊपर हावी न होने दे। नदी के थपेड़ों से घबराए नहीं अपितु सतत तैरता हुआ किनारे की तलाश करे। 'अस्तित्त्ववाद' का यही सार है। मनुष्य स्वयं अपने भाग्य का निर्माता है। जीवन में अपने अस्तित्त्व को बनाए रखना ही मानव मात्र का लक्ष्य होना चाहिए।

'पचपन खंभ लाल दीवारें' की नायिका सुषमा और 'शेषयात्रा' की अनु दोनों ही नारियाँ जीवन की आँधियों से घबरा जाती हैं लेकिन हिम्मत नहीं हारतीं। अपने अस्तित्त्व की तलाश कर ऐसे मुकाम पर जा पहुँचती हैं, जहाँ उन्हें खुद अपने आप पर गर्व होता है। सुषमा भले ही जीवन में अकेली रह जाती है लेकिन उसका निःस्वार्थ त्याग उसे सम्मान का पात्र बनाता है। अनु' विदेशी भूमि पर अदम्य साहस का परिचय देती हुई अपने निष्ठुर पति प्रणव के समकक्ष जा खड़ी होती है। सचमुच उषा जी की ये दोनों नायिकाएँ 'अस्तित्त्ववाद' की आदर्श उदाहरण हैं और समाज की नारियों के लिए अनुकरणीय हैं। ये 'गुप्त जी' की अबला नारियाँ नहीं अपितु 'महादेवी जी' की तर्ज पर तोड़ दूँ क्षितिज, देख लूँ उस ओर क्या है का हुँकार भरने वाली नारियाँ हैं।

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