



Face Edge Sum Divisor Cordial Graphs

G. Vijayalakshmi^{1*} and M. Mohamed Sheriff²

¹Research Scholar, School of Mathematics, Madurai Kamaraj University, Madurai 625021, Tamil Nadu, India

²Head and Associate Professor, P.G. and Research Department of Mathematics, Hajee Karutha Rowther Howdia College, Uthamapalayam - 625533, Affiliated to Madurai Kamaraj University, Tamil Nadu, India.

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*Address for Correspondence

G. Vijayalakshmi

Research Scholar,
School of Mathematics,
Madurai Kamaraj University,
Madurai 625021, Tamil Nadu, India
E.Mail: gviji365@gmail.com



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ABSTRACT

In this paper, we introduce a face edge sum divisor cordial labeling of graph and investigate the face edge sum divisor cordial labeling of a triangular snake graph, middle graph of path, total graph of path and friendship graph.

Keywords : Edge sum divisor cordial labeling, Edge sum divisor graph, face edge sum divisor cordial labeling, face edge sum divisor graph, Triangular snake.

INTRODUCTION

We begin with simple, finite, planar, undirected graph. A (p,q) planar graph G means a graph $G = (V,E)$, where V is the set of vertices with $|V| = p$, E is the set of edges with $|E| = q$ and F is the set of interior faces of G with $|F| =$ number of interior faces of G . For standard terminology and notations related to graph theory we refer to Harary [3]. For graph labeling we refer to Gallian [2]. In [1], Cahit introduced the concept of cordial labeling of graph. In [9], Yilmaz et al introduced the concept of E-cordial labeling of graph. Varatharajan et al.[7] introduced the concept of divisor cordial labeling of graphs. The concept of sum divisor cordial labeling was introduced by Lourdasamy et al.[5]. Lawrence et al introduced the concept of face edge product cordial labeling of graph in [4]. In [8], Vijayalakshmi et al. introduced the concept of edge sum divisor cordial labeling of graph. Mohamed Sheriff et al. introduced the concept of face sum divisor cordial labeling of graph in [6]. The present work is focused on some new families of face edge sum divisor cordial labeling of a triangular snake graph, middle graph of path, total graph of path and friendship graph.





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Definition 1.1 Let a and b be two integers. If a divides b means that there is a positive integer k such that $b = ka$. It is denoted by $a|b$. If a does not divide b , then we denote $a \nmid b$.

Definition 1.2 Let $G = (V(G), E(G))$ with p vertices and q edges and $f : E(G) \rightarrow \{0,1\}$. Define f^* on $V(G)$ by $f^*(v) = \sum\{f(uv)/uv \in E(G)\} \pmod{2}$. The function f is called an E -cordial labeling of G if the number of vertices labeled 0 and the number of vertices labeled 1 differs by at most 1 and the number of edges labeled 0 and the number of edges labeled 1 differs by at most 1. A graph that admits E -cordial labeling is called E -cordial.

Definition 1.3 Let $G = (V(G), E(G))$ be a simple graph and $f : V(G) \rightarrow \{1,2,\dots, |V(G)|\}$ be a bijection. For each edge uv , assign the label 1 if $f(u)|f(v)$ or $f(v)|f(u)$ and the label 0 otherwise. The function f is called a divisor cordial labeling if $|e_r(0) - e_r(1)| \leq 1$. A graph with a divisor cordial labeling is called a divisor cordial graph.

Definition 1.4 Let $G = (V(G), E(G))$ be a simple graph and $f : V(G) \rightarrow \{1,2,\dots, |V(G)|\}$ be a bijection. For each edge uv , assign the label 1 if $2|(f(u)+f(v))$ and the label 0 otherwise. The function f is called a sum divisor cordial labeling if $|e_r(0) - e_r(1)| \leq 1$. A graph which admits a sum divisor cordial labeling is called a sum divisor cordial graph.

Definition 1.5 Let $G = (V(G), E(G))$ be a simple graph and $f : E(G) \rightarrow \{1,2,\dots, |E(G)|\}$ be a bijection. For each vertex v , assign the label 1 if $2 | f(a_1)+f(a_2)+\dots+f(a_s)$ and the label 0 otherwise where a_1, a_2, \dots, a_s are edges incident with the vertex v . The function f is called a edge sum divisor cordial labeling if the number of vertices labeled with 0 and the number of vertices labeled with 1 differ by at most 1. A graph which admits an edge sum divisor cordial labeling is called an edge sum divisor cordial graph.

Definition 1.6 A face sum divisor cordial labeling of a graph G with vertex set V is a bijection f from $V(G)$ to $\{1,2,\dots, |V(G)|\}$ such that an edge uv is assigned the label 1 if 2 divides $f(u)+f(v)$ and 0 otherwise and for face f is assigned the label 1 if 2 divides $f(u_1)+f(u_2)+\dots+f(u_k)$ and 0 otherwise, where u_1, u_2, \dots, u_k are vertices corresponding to the face. Also the number of edges labeled with 0 and the number of edges labeled with 1 differ by at most 1 and the number of faces labeled with 0 and the number of faces labeled with 1 differ by at most 1. A graph which admits a face sum divisor cordial labeling is called a face sum divisor cordial graph.

Definition 1.7 A face edge sum divisor cordial labeling of a graph G with edge set E is a bijection f from $E(G)$ to $\{1,2,\dots, |E(G)|\}$ such that a vertex v is assigned the label 1 if 2 divides $f(a_1)+f(a_2)+\dots+f(a_s)$ and 0 otherwise where a_1, a_2, \dots, a_s are edges incident with the vertex v and for face f is assigned the label 1 if 2 divides $f(b_1)+f(b_2)+\dots+f(b_t)$ and 0 otherwise, where b_1, b_2, \dots, b_t are edges corresponding to the face f . Also the number of vertices labeled with 0 and the number of vertices labeled with 1 differ by at most 1 and the number of faces labeled with 0 and the number of faces labeled with 1 differ by at most 1. A graph which admits a face edge sum divisor cordial labeling is called a face edge sum divisor cordial graph.

MAIN RESULTS

Theorem 1.1 Triangular snake T_n is face edge sum divisor graph for $n \geq 2$.

Proof. Let $v_1, v_2, \dots, v_n, v_{n+1}, v_{n+2}, \dots, v_{2n-1}$ be vertices, $e_1, e_2, \dots, e_{3n-3}$ be edges and f_1, f_2, \dots, f_{n-1} interior faces of T_n , where $e_{2i-1} = v_i v_{n+i}$, $e_{2i} = v_{n+i} v_{i+1}$ and $e_{2n-2+i} = v_i v_{i+1}$ for $i = 1, 2, \dots, n-1$ and $f_i = v_i v_{n+i} v_{i+1} v_i$ for $i = 1, 2, \dots, n-1$.

Let G be the graph T_n . Then $|V(G)| = 2n-1$, $|E(G)| = 3n-3$ and $|F(G)| = n-1$.

Define $f : E(G) \rightarrow \{1,2,\dots, |E(G)|\}$ as follows.

$$f(e_{n-1+i}) = i, \text{ for } 1 \leq i \leq 2n-2$$

$$f(e_i) = 2n-2+i, \text{ for } 1 \leq i \leq n-1$$

Then induced vertex labels are

When n is odd, then

$$f^*(v_i) = 1, \text{ for } 1 \leq i \leq n$$





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$$f^*(v_i) = 0, \text{ for } n+1 \leq i \leq 2n - 2$$

When n is even, then

$$f^*(v_i) = 1, \text{ for } 1 \leq i \leq n-1$$

$$f^*(v_i) = 0, \text{ for } n \leq i \leq 2n - 2$$

Also the induced face labels are

$$f^{**}(f_i) = 1, \text{ if } i \text{ is odd.}$$

$$f^{**}(f_i) = 0, \text{ if } i \text{ is even.}$$

In view of the above defined labeling pattern we have

$$v_r(1) = v_r(0)+1 = n \text{ and } f_g(1) = f_g(0) = \frac{n-1}{2}, \text{ when } n \text{ is odd}$$

$$v_r(0) = v_r(1)+1 = n \text{ and } f_g(1) = f_g(0)+1 = \frac{n}{2}, \text{ when } n \text{ is even.}$$

Then $|v_g(0) - v_g(1)| \leq 1$ and $|f_g(0) - f_g(1)| \leq 1$.

Thus T_n is face edge sum divisor graph for any n.

Illustration 1.1 T_5 and its face edge sum divisor labeling is shown in figure 1.

Theorem 1.2 $M(P_n)$ is face edge sum divisor graph for $n \geq 2$.

Proof. Let v_1, v_2, \dots, v_n be the vertices and e_1, e_2, \dots, e_{n-1} be the edges of path P_n . Let $M(P_n)$ be the middle graph of path P_n with $V(M(P_n)) = V(P_n) \cup E(P_n)$ and $E(M(P_n)) = \{v_i e_i, 1 \leq i \leq n-1; v_i e_{i-1}, 2 \leq i \leq n; e_i e_{i+1}, 1 \leq i \leq n-2\}$. Let f_1, f_2, \dots, f_{n-2} interior faces of $M(P_n)$, where $f_i = v_i e_{i-1} v_i, 2 \leq i \leq n-1$. Let G be the graph $M(P_n)$. Then $|V(G)| = 2n-1, |E(G)| = 3n-4$ and $|F(G)| = n-2$.

Define $f: E(M(P_n)) \rightarrow \{1, 2, \dots, |E(G)|\}$ as follows.

$$f(v_1 e_1) = 3n-5$$

$$f(v_n e_{n-1}) = 3n-4$$

$$f(v_i e_i) = 2i-2, \text{ for } 2 \leq i \leq n-1$$

$$f(v_i e_{i-1}) = 2i-3, \text{ for } 2 \leq i \leq n-1$$

$$f(e_i e_{i+1}) = 2n-4+i, \text{ for } 1 \leq i \leq n-2$$

Then induced vertex labels are

When n is odd, then

$$f^*(v_1) = 1$$

$$f^*(v_i) = 0, \text{ for } 2 \leq i \leq n$$

$$f^*(e_i) = 1, \text{ for } 1 \leq i \leq n-1$$

When n is even, then

$$f^*(v_i) = 0, \text{ for } 1 \leq i \leq n-1$$

$$f^*(v_n) = 1$$

$$f^*(e_i) = 0$$

$$f^*(e_i) = 1, \text{ for } 2 \leq i \leq n-1$$

Also the induced face labels are

$$f^{**}(f_i) = 1, \text{ if } i \text{ is odd.}$$

$$f^{**}(f_i) = 0, \text{ if } i \text{ is even.}$$

In view of the above defined labeling pattern we have

$$v_r(1) = v_r(0)+1 = n \text{ and } f_g(1) = f_g(0)+1 = \frac{n-2}{2}, \text{ when } n \text{ is odd}$$

$$v_r(0) = v_r(1)+1 = n \text{ and } f_g(0) = f_g(1) = \frac{n-2}{2}, \text{ when } n \text{ is even.}$$





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Then $|v_g(0) - v_g(1)|$ and $|f_g(0) - f_g(1)| \leq 1$.
 Thus $M(P_n)$ is face edge sum divisor graph for any n .

Illustration 1.2 $M(P_5)$ and its face edge sum divisor labeling is shown in figure 2.

Theorem 1.3 $T(P_n)$ is face edge sum divisor graph for $n \geq 2$.

Proof. Let v_1, v_2, \dots, v_n be the vertices and e_1, e_2, \dots, e_{n-1} be the edges of path P_n . Let $T(P_n)$ be the total graph of path P_n with $V(T(P_n)) = V(G) \cup E(G)$ and $E(T(P_n)) = \{v_i v_{i+1}, 1 \leq i \leq n-1; v_i e_i, 1 \leq i \leq n-1; e_i e_{i+1}, 1 \leq i \leq n-2; v_i e_{i-1}, 2 \leq i \leq n\}$. Let $f_1, f_2, \dots, f_{2n-3}$ interior faces of $T(P_n)$, where $f_{2i} = v_{i+1} e_i e_{i+1} v_{i+1}, 1 \leq i \leq n-2$ and $f_{2i-1} = v_i e_{i-1} v_i, 1 \leq i \leq n-1$. Let G be the graph $T(P_n)$. Then $|V(G)| = 2n-1, |E(G)| = 4n-5$ and $|F(G)| = 2n-3$.

Define $f : E(T(P_n)) \rightarrow \{1, 2, \dots, |E(G)|\}$ as follows.

Case 1 : For n is even

$$f(v_{2i-1} e_{2i-1}) = 4i-3, \text{ for } 1 \leq i \leq \frac{n}{2}$$

$$f(v_{2i} e_{2i}) = 4i-2, \text{ for } 1 \leq i \leq \frac{n-2}{2}$$

$$f(v_{2i} e_{2i-1}) = 4i-1, \text{ for } 1 \leq i \leq \frac{n-2}{2}$$

$$f(v_{2i+1} e_{2i}) = 4i, \text{ for } 1 \leq i \leq \frac{n-2}{2}$$

$$f(v_n e_{n-1}) = 2n-2$$

$$f(v_i v_{i+1}) = 2n-2+i, \text{ for } 1 \leq i \leq n-1$$

$$f(e_i e_{i+1}) = 4n-4-i, \text{ for } 1 \leq i \leq n-2$$

Then induced vertex labels are

$$f^*(v_i) = 1, \text{ for } 1 \leq i \leq n$$

$$f^*(e_i) = 0, \text{ for } 1 \leq i \leq n-1$$

Also the induced face labels are

$$f^{**}(f_{4i-3}) = 0, \text{ for } 1 \leq i \leq \frac{2n-4}{4}$$

$$f^{**}(f_{4i-2}) = 1, \text{ for } 1 \leq i \leq \frac{2n-4}{4}$$

$$f^{**}(f_{4i-1}) = 1, \text{ for } 1 \leq i \leq \frac{2n-4}{4}$$

$$f^{**}(f_{4i}) = 0, \text{ for } 1 \leq i \leq \frac{2n-4}{4}$$

$$f^{**}(f_{2n-3}) = 1.$$

In view of the above defined labeling pattern we have

$$v_f(1) = v_f(0)+1 = n \text{ and } f_g(1) = f_g(0)+1 = n-1$$

Then $|e_g(0) - e_g(1)| \leq 1$ and $|f_g(0) - f_g(1)| \leq 1$.

Case 2 : For n is odd

$$f(v_{2i-1} e_{2i-1}) = 4i-3, \text{ for } 1 \leq i \leq \frac{n-1}{2}$$

$$f(v_{2i} e_{2i}) = 4i-2, \text{ for } 1 \leq i \leq \frac{n-1}{2}$$





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$$f(v_{2ie_{2i-1}}) = 4i-1, \text{ for } 1 \leq i \leq \frac{n-1}{2}$$

$$f(v_{2i+1e_{2i}}) = 4i, \text{ for } 1 \leq i \leq \frac{n-1}{2}$$

$$f(v_{iv_{i+1}}) = 2n-2+i, \text{ for } 1 \leq i \leq n-1$$

$$f(e_{ie_{i+1}}) = 3n-3+i, \text{ for } 1 \leq i \leq n-2$$

Then induced vertex labels are

$$f^*(v_i) = 1, \text{ for } 1 \leq i \leq n$$

$$f^*(e_i) = 0, \text{ for } 1 \leq i \leq n-1$$

Also the induced face labels are

$$f^{**}(f_{4i-3}) = 0, \text{ for } 1 \leq i \leq \frac{2n-6}{4}$$

$$f^{**}(f_{4i-2}) = 1, \text{ for } 1 \leq i \leq \frac{2n-6}{4}$$

$$f^{**}(f_{4i-1}) = 1, \text{ for } 1 \leq i \leq \frac{2n-6}{4}$$

$$f^{**}(f_{4i}) = 0, \text{ for } 1 \leq i \leq \frac{2n-6}{4}$$

$$f^{**}(f_{2n-5}) = 0$$

$$f^{**}(f_{2n-4}) = 1$$

$$f^{**}(f_{2n-3}) = 1$$

In view of the above defined labeling pattern we have

$$v_r(1) = v_r(0)+1 = n \text{ and } f_g(1) = f_g(0)+1 = n-1$$

$$\text{Then } |v_g(0) - v_g(1)| \leq 1 \text{ and } |f_g(0) - f_g(1)| \leq 1.$$

Thus $T(P_n)$ is face edge sum divisor graph for any n .

Illustration 1.3 $T(P_5)$ and its face edge sum divisor labeling is shown in figure 3.

Theorem 1.4 The friendship graph F_n is face edge sum divisor graph for $n \geq 2$.

Proof. Let $v_1, v_2, \dots, v_{2n}, e_1, e_2, \dots, e_{3n}, f_1, f_2, \dots, f_n$ be the vertices, edges and an interior faces of F_n , where $e_{3i-2} = v_{2i-1}v_{2i}, e_{3i-1} = v_{2i}v_{2i+1}, e_{3i} = v_{2i-1}v_{2i+1}$ and $f_i = v_{2i-1}v_{2i}v_{2i+1}$, for $1 \leq i \leq n$. Let G be the friendship graph F_n . Then $|V(G)| = 2n+1, |E(G)| = 3n$ and $|F(G)| = n$.

Define $f : E(G) \rightarrow \{1, 2, \dots, |E(G)|\}$ as follows.

$$f(e_i) = i, \text{ for } 1 \leq i \leq 3n$$

Then induced vertex labels are

$$f^*(v_i) = 1, \text{ if } n \text{ is odd}$$

$$f^*(v_i) = 0, \text{ if } n \text{ is even}$$

$$f(v) = 0, \text{ if } n \text{ is odd}$$

$$f(v) = 1, \text{ if } n \text{ is even}$$

Also the induced face labels are

$$f^{**}(f_i) = 1, \text{ if } i \text{ is odd.}$$

$$f^{**}(f_i) = 0, \text{ if } i \text{ is even.}$$

In view of the above defined labeling pattern we have

$$v_r(1) = v_r(0)+1 = n+1 \text{ and } f_g(1) = f_g(0)+1 = \frac{n+1}{2}, \text{ when } n \text{ is odd}$$





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$v_f(0) = v_f(1)+1 = n+1$ and $f_g(1) = f_g(0) = \frac{n}{2}$, when n is even.

Then $|v_g(0) - v_g(1)| \leq 1$ and $|f_g(0) - f_g(1)| \leq 1$.

Thus F_n is face edge sum divisor graph for $n \geq 2$.

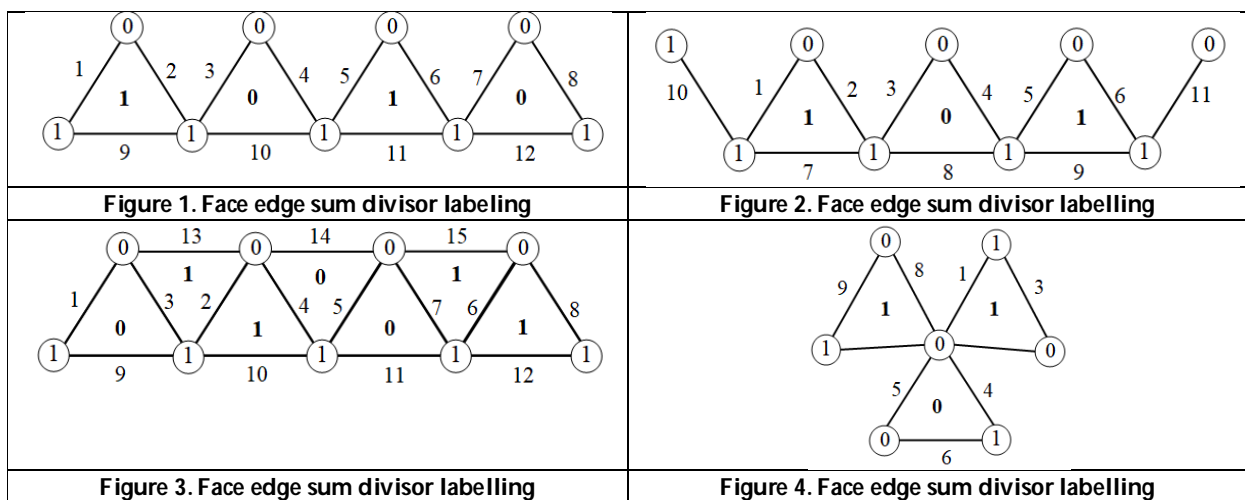
Illustration 1.4 F_3 and its face edge sum divisor labeling is shown in figure 4.

CONCLUSION

In this paper, we introduced a new type of face edge sum divisor cordial labeling of graph and investigated the face edge sum divisor cordial labeling of a triangular snake graph, middle graph of path, total graph of path and friendship graph.

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Synthesis and Characterization of Cavansite and its Environmental Remedial Property

Abhijit M^{1*} and Suresh Kumar B V²

¹Research Scholar, Department of Studies in Earth Science, University of Mysore, Mysuru, Karnataka, India

²Professor, Department of Studies in Earth Science, University of Mysore, Mysuru, Karnataka, India

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*Address for Correspondence

Abhijit M

Research Scholar,
Department of Studies in Earth Science,
University of Mysore, Mysuru,
Karnataka, India.
E.Mail: abhijit.geology@gmail.com



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ABSTRACT

Cavansite is a framework of zeolites that were produced hydrothermally to comprehend the properties of the nanoparticles. This study describes the behavior of two groups of raw materials subjected to different temperatures and isobaric conditions. XRD, SEM, EDAX, BET, PL spectroscopy, and UV-Vis's spectroscopy analyses were used to characterize the synthesized sample. Nanoparticles were synthesized at two different temperatures at 180°C and 220°C of CA-1 and CA-2 respectively with an isobaric condition of 1.01325 bar. The presence of vanadium during the synthesis was discovered to have an impact on the morphology and size. The EDX confirmed the production of cavansite from calcium vanadium silica nanoparticles. For methylene blue, the photodegradation effectiveness of cavansite nanoparticles was evaluated for CA-1 and CA-2. The largest level of degradation by absorption under dark and photocatalytic activity compared with the two synthesized samples 86.4% and 91.5% occurred after 140 minutes of CA-1 and CA-2 respectively.

Keywords: Cavansite, Photocatalyst, Hydrothermal Synthesis, Methylene Blue

INTRODUCTION

Compounds known as dyes are frequently used in the textile, cosmetic, pigment, paper, and plastics industries [1]. The wastewater produced by textile companies has a very low biodegradability, high surfactant content, high COD, toxicity, high temperature and pH fluctuation, and vivid color [2,3]. The ecosystem is seriously harmed by these

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textile effluents, and even their degradation products may be harmful, harming both human health and aquatic life [4]. Methylene blue (MB), also known as 3,7-Bis(dimethylamino)-phenothiazin-5-ium chloride, is a widely used dye in the textile industry. Additionally, it is used in the food, printing, cosmetics, leather, and pharmaceutical industries. Its removal is complicated because of the aromatic rings included in its structure [5-7]. Being exposed to MB dye can cause increasing nausea, heart rates, diarrhea, shock, vomiting, stomach cramp, and human tissue necrosis [8]. Zeolite has excellent ionic exchange properties with a high surface area, which makes it ideal for the degradation/adsorption of organic impurities. In addition, zeolite is biocompatible, abundant, and inexpensive. Various types of zeolites-supported photocatalysts have been investigated in the past few years. Mostafa and Ehab prepared zeolite nanostructures by the hydrothermal treatments of Si and various Al sources for the adsorption and photocatalytic degradation of MB molecules from aqueous media. Hosting photoactive visitors like adding metal ions and metal oxides can both stimulate the zeolites' photocatalytic activity [9].

Cavansite: $\text{Ca}(\text{VO})\text{Si}_4\text{O}_{10} \cdot 4\text{H}_2\text{O}$ It is a hydrous calcium vanadium silicate with an open framework structure similar to Zeolite. Cavansite minerals are associated with calcite, heulandites, analcime, thomsonite, apophyllite, and stilbite minerals. They have radiating habits and are greenish-blue in color. Cavansite (ca'-van-site) and Pentagonite (Pen-ta'-gon-ite) are diatomorphs, with the main difference being the absence of twinning in pentagonite and the presence of twinning in cavansite. Evans in 1973 described the mineral cavansite general atomic arrangement. Cavansite is made up of chains of four-fold and eight-fold rings that are joined laterally into sheets. The VO^{2+} group was bridged between the tetrahedral chains. The Ca and H_2O molecules are mostly configured into rings and are held in the layer's cavities. The eight-membered rings in Pentagonite are nearly circular, whereas those in cavansites are elliptical. [10,11]. One water molecule per Ca ion at 220°C occurs in the structure, and at 400°C lost water molecule and became completely dehydrated [12]. This mineral was found in tholeiitic basalt cavities as well as tuffaceous andesite pores and altered basalt breccias. Cavansite associated with zeolites is found in some parts of Western India's Deccan trap, which covers nearly 5,00,000 square kilometers. [13]. Cavansite is present in India, Poona region Wagholi quarry. Latitude of $18^\circ 34' \text{N}$ and Longitude $73^\circ 58' \text{E}$ lies about 1 km from Wagholi village and east of the city about 25km from Pune [14].

Natural cavansite was studied for its porous framework potential, with pyramids of vanadyl-type connecting sheets of silicate tetrahedral structure [15]. Cavities and geodes in andesites can be found in the Lonavala area of Maharashtra, India. Vanadium was remobilized as a result of hydrothermal activity. Vanadium mineralized solution may have migrated upward through more porous rock units, especially along highly fractured, brecciated areas [16]. Because of the special catalyst properties of vanadium, large novel mineral pores were synthesized by introducing this into silicate structures for various applications [17,18]. The open framework vanadosilicate structures synthesized exhibit absorption, thermal stability, and ion-exchange properties. Vanadium is well-known in oxidation chemistry due to its multiple oxidation states and Zeolitic properties [19]. Under UV light, the nanoparticles' ability to photodegrade methylene blue (MB) was evaluated. This study on cavansite and its use in photo degradation is possibly the first of its type. The benefits of using cavansite nanoparticles to provide better shape, more surface area, and increased photodegradation are discussed. Additionally, a schematic illustration is given to describe how produced nanoparticles have a consistent and regulated morphology.

MATERIALS AND METHODS

Synthesis

Preliminary preparation of Cavansite precursor.

The basic preparation was done by magnetic stirrer with three chemicals Calcium Hydroxide (M.W-74.09 g/mol) + Vanadium Pentoxide (M.W- 181.88 g/mol) + Silicon Hydroxide Colloidal Hydrate (M.W-60.08 g/mol) of appropriate stoichiometry placed in beaker mixed with the 200ml distilled water. The beaker was heated at a temperature of 45°C and stirred in a magnetic stirrer for 3 days aging to mix well and to prepare the precursor. The compound solution was split into two solutions to synthesize under two hydrothermal conditions.





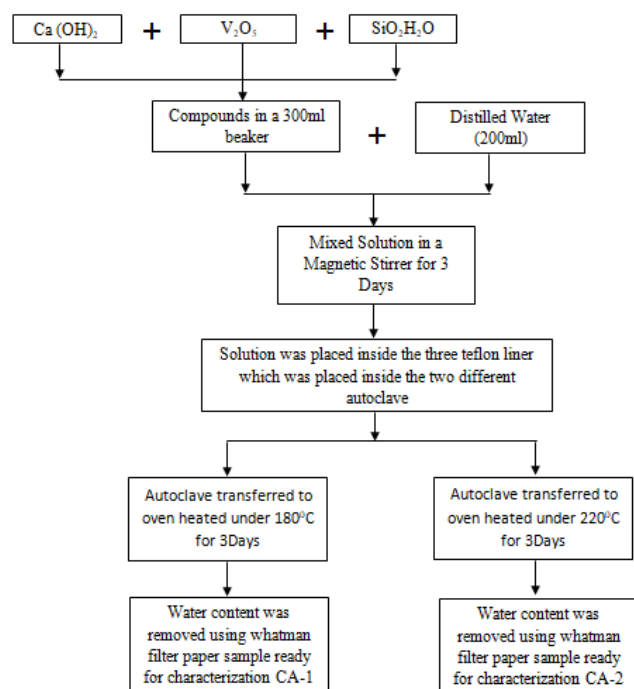
Hydrothermal Synthesis

The chemicals used for the syntheses are commercial reagent grade used for the modification of a pure commercial variety of cavansite rather than natural blue-colored crystals. The experiment was carried out with suitable stoichiometry of chemicals in two different temperatures (180°C and 220°C) in an isobaric condition of 1.01325 baratmospheric pressure. The compounds were placed in Teflon-lined autoclaves to treat under hydrothermal conditions at two different temperatures. After aging for reaction time the compound which was placed inside the oven was cooled down by quenching with water to arrest the reaction and removed from the autoclaves. The resultant product was dried at 45°C before it was filtered by whatman filter paper to remove the water content in the samples. The products were washed with double distilled water and dried at room temperature. (Explained the full techniques in flow chart 1)

Characterization

Scanning electron microscopes were used to examine the morphology of heated materials (SEM). Employing a Rigaku Smart Lab II (Cu K radiation, = 1.5414 Å) X-ray diffract meter (XRD) and EDS measurement. A Sorptomatic 1990 instrument's surface area was measured using the BET method. At liquid nitrogen temperature, measurements of desorption and adsorption were made using pure nitrogen gas. While BET surface area and pore volume were calculated using conventional software, pore size distribution and volume were examined using the Barrett-Joyner-Halenda (BJH) approach, the diffuse-reflectance spectra (DRS) of nanoparticles were measured in the UV-visible range, and photoluminescence spectrophotometer (F-2700).

Flow Chart of Synthesis



Photocatalytic degradation experiments

To analyze the cavansite photocatalytic activity, Methylene blue (MB) dye was employed. This procedure involved mixing 200 ml of MB aqueous solution (20 mg/L) with a produced solution was then added with 30 mg of cavansite as a photocatalyst, treated under darkness for 20,40, and 60 minutes and continuously stirred to observe absorption.





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By employing a UV-Visible Spectrophotometer, the photocatalytic property of cavansite was lastly examined during various times, such as 20, 40, 60, and 80 minutes under sunlight.

RESULT AND DISCUSSION

XRD

The powder diffraction XRD patterns of CA-1 and CA-2 obtained at two different temperatures for the samples, for a sample heated at 180°C and 220°C with reference to the matching to the match software entry number 96-900-0308 reveals that the sample as cavansite. The mineral shows an orthorhombic crystal system ($\alpha=\beta=\gamma=90^\circ$), the plane of cleavage oriented along (0 1 0), cell parameters are $a=9.6329 \text{ \AA}$, $b=13.6606 \text{ \AA}$, $c=9.7949 \text{ \AA}$, Volume of Unit cell= 1288.923 \AA^3 . Both samples showed a high degree of crystallinity. Figure 1 shows the peaks of cavansite samples in the XRD. CA-1 matches the all mentioned patterns but in the case of CA-2, the Pattern (321) plane doesn't locate.

SEM:

A morphology study is the main aim of this paper was conducted through SEM. The CA-1 and CA-2 samples are 3-20 μm crystallites in a prismatic shape. In figure 2 samples showed crystals are thin plates with a size of <4 μm thickness bladed plates. To understand the size and shape of the powdered samples SEM provides topological information[20]. The CA-2 mineral synthesized under 220°C showed good crystallized bladed structures when compared with CA-1 at 180°C.

EDS: - The graph of the CA-1 and CA-2 sample of cavansite analysis provides bulk composition. The percentage of weight for Ca, V, Si & O was tabulated. The elemental concentration of stoichiometry composition was used in the experiment and proved by the analysis after the formation of the crystal. In figure 3 we can observe the element identified as most abundant in the samples is oxygen, which has the highest weight percent of 48.5 in CA-1 and the lowest weight percent of 45.6 in CA-2. With a maximum value of 44.2 weight percent in sample CA-1 and a value of 32.8 in sample CA-2, silicon is the second most prevalent element. following silicon Ca is the least abundant element in sample CA-1, which has a value of 2.7 weight percent, which is lower than sample CA-2's value of 6.7. Vanadium, an important semiconductor, is present in greater amounts in CA-2 (15.0 weight percent) than in CA-1 (4.6 weight percent).

BET Surface area analysis

N_2 adsorption isotherm analysis was used to determine BET surface area. CA-1 and CA-2 had excellent BET surface area. The decorating of tiny metal oxide particles on the zeolite framework, which provides greater areas, is the likely cause of the loaded cavansite's higher surface areas [21,22]. Figure 5 shows the N_2 sorption-desorption isotherms of the cavansite exhibit type IV isotherms, which are characteristic of mesoporous materials according to IUPAC classification, according BET measurements. Although the average pore size and pore volume were calculated by the BJH method. The pore size is quite close to the mesoporous size; thus it can be regarded as microporous. Data is tabulated in table :1

UV-Vis Studies

Photocatalytic activity is greatly influenced by a photocatalyst's optical quality and energy band structure[23,24]. The Tauc plot for calculating the optical bandgap energies of CA-1 and CA-2 is shown in Fig 5 a). In the UV and visible areas, the spectra of all the materials exhibit considerable absorption. While CA-1 and CA-2 had a similar absorbance profile with maximum absorption.

$$(\alpha\lambda\nu) = A(h\nu - E_g)^{1/2} \quad (1)$$

where α is the absorption coefficient, λ is the wavelength, ν is frequency, h is the Planck constant, A is constant, and E_g is the bandgap energy. Extrapolation of the Tauc plot of $(\alpha\lambda\nu)^2$ against $h\nu$ gives the value of optical bandgap



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energy. The band gap as shown in figure 5b) values were found to be 3.12 eV and 3.00 eV for CA-1 and CA-2 respectively.

Photocatalytic degradation of MB

Cavansite particles further lowered the content of methylene blue under sunlight before it was treated under darkness [25,26]. To create an equilibrium between the dye and the photocatalyst, the reaction solution was agitated in the dark for 60 minutes. The suspension was then continuously stirred while being exposed to sunshine [27]. Using a UV-Visible spectrophotometer, the concentrations of MB were determined at different time intervals and calculated the percentage by equation (2). CA-1 and CA-2 were utilized to maintain absorption-desorption equilibrium showing 36.5% and 40% dye degradation by absorption. The cavansite was a photocatalyst for 80 minutes, CA-1 and CA-2 show the concentration of methylene blue was reduced by 86.4% and 91.5% respectively as plotted in figure 5 c).

$$v = (1 - C/Co) * 100 \quad (2)$$

Where Co and C represent the solution's concentrations before and following irradiation for t min, respectively. Co and C are the concentrations of the solution before and following irradiation for the duration t in minutes, and k is the kinetic rate constant. Both samples R^2 values for the linear plot of $\ln(C/Co)$ with time are greater than 0.9, showing that the data are comparable with the pseudo-first-order kinetic model (Figure 5d).

Material Reusability and pH observation

The study was conducted for CA-1 and CA-2 as these nanoparticles have shown good photocatalytic activities under UV light. For the reusability investigation, after each cycle [28], nanoparticles were separated by centrifugation, dried at 60°C for an hour, and then used for the following cycle. In figure 5f) at the end of the second and third cycles, CA-1 showed MB degradation of 85.4% and 84.2%, respectively, in 80min. For the second and third cycles, CA-2 revealed MB degradation of 90.7% and 89.8% in 80min. At the end of the fourth and fifth cycles, CA-1 showed MB degradation of 82.4% and 81.7%, respectively, in 80min. For the fourth and fifth cycles, CA-2 revealed MB degradation of 87.7% and 86.4% in 80min. Vanadium packing in the SiO_2 structure, which facilitates effective electron transfer during photosynthesis due to V_2O_5 's various oxidation states (+3 to +5), increased efficiency for cavansite. Even after five cycles of use, cavansite nanoparticles maintain good stability and efficiency, virtually matching the performance of photocatalysts studied here. The pH observed here shows maximum degradation occurs at pH 8 further increasing pH reduces the degradation capacity shown in figure 5 e).

CONCLUSION

Using a simple and fast precipitation approach of the hydrothermal method at 180°C and 220°C, we effectively synthesized cavansite, it demonstrated 86.4% and 91.5% removal efficiency CA-1 and CA-2 respectively. The low recombination rate of photo induced electron-hole pairs and the mesoporous nature of cavansite absorbed nearly half of the dye before exposing to sunlight. The cycle investigations further support the high stability and reusability of cavansite for MB degradation. As a result, the synthesized CA-2 has the potential to act as a photocatalyst for the effective removal of organic dyes during the processing of industrial waste than the CA-1.

Conflict of interest

No conflict of interest exists.

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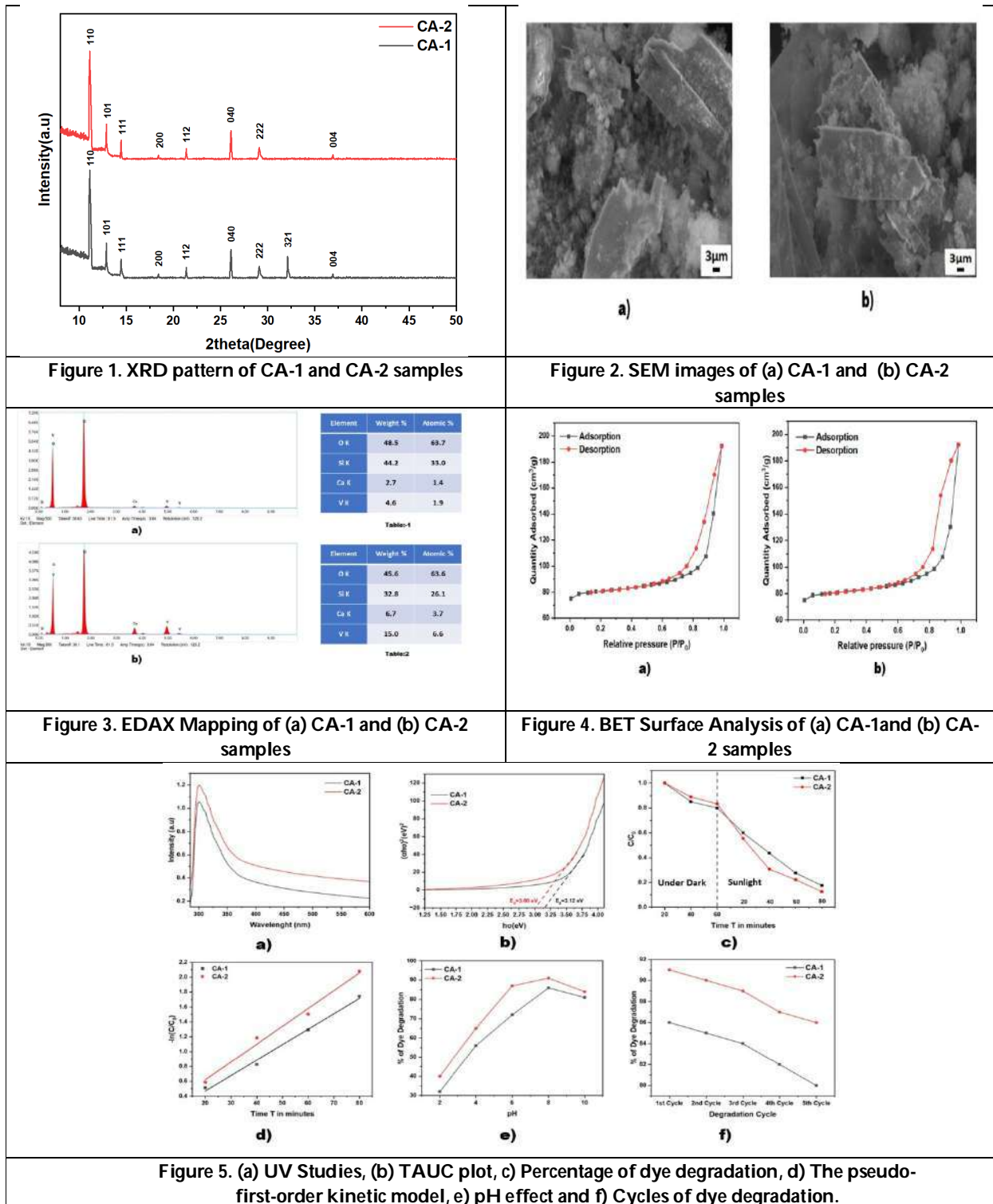
Table.1. BET Surface area analysis

Sample Name	Mineral Surface Area in m ² /g	Pore Volume in cm ³ /g	Pore Diameter in nm
CA-1	225.8	0.164	14
CA-2	265.4	0.192	18





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Design, Characterization and Evaluation PF Polymer Nanoparticle of Colon Targeted Drug Delivery System

Tirumala Devi Kolli^{1*}, B.S.Venkateswarlu² and R. Margret Chandira²

¹Research Scholar, Vinayaka Mission's College of Pharmacy, Vinayaka Mission's Research Foundation (DU), Yercard Adivaram, Salem, Tamil Nadu, India.

²Professor, Vinayaka Mission's College of Pharmacy, Vinayaka Mission's Research Foundation (DU), Yercard Adivaram, Salem, Tamil Nadu, India.

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*Address for Correspondence

Tirumala Devi Kolli

Research Scholar,
Vinayaka Mission's College of Pharmacy,
Vinayaka Mission's Research Foundation (DU),
Yercard Adivaram, Salem, Tamil Nadu, India.



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ABSTRACT

Colon targeted drug delivery system (CDDS) is a promising tool for treatment of inflammatory bowel diseases (IBD) such as ulcerative colitis, crohn's disease, colon cancer, amoebiasis etc. The development of safe drug delivery systems for a therapeutic agent with less side effects and more bioavailability to the targeted site is very vital in drugs formulation. Nanoparticles (NPs) for CDDS are known for their specific accumulation in the inflamed tissue and may therefore allow a selective delivery to the site of action. The objective of this study was to formulate and characterize NPs of selected drugs (metronidazole, satranidazole, tinidazole and ornidazole) to achieve site- specific and instant drug release in colon for effective treatment of IBD. In-vitro drugrelease, muco penetration and In-vivo mucoadhesive studies. Our results demonstrate that, 1:1ratio of chitosan and HPMCP formulation of all NPs provides better spatial interaction between them and drugs with spherical porous and the particles size was diverging between 202 - 236 nm. In vitro release of all drugs followed Higuchi and first order equations better than zero order equation. The drug release results of NPs formulations indicate that the NPs have potential as CDDS, compared to uncoated NPs and coated NPs have comparatively less mucoadhesive detachment force. In conclusion, the study was an evidence to use NPs in colon targeted drug delivery systems for better bioavailability of drugs at targeted site and the biodistribution properties of drugs using NPs will be depend on their composition, particle size and their adhesive abilities.

Keywords: Colon targeted drug delivery system, Nanoparticle, chitosan, HPMCP, EudragitS100.





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INTRODUCTION

Oral route for drug delivery system

The several developed drug administration methods, oral route has found its way to prove potential convenience to offer the greatest potential for more effective therapeutics, but they do not facilitate drug that easily cross mucosal surfaces and biological membranes; they are easily denatured or degraded, prone to rapid clearance in the liver and other body tissues and require precise dosing. Despite the barriers for successful drug delivery that exist in the gastrointestinal tract (such as acid-induced hydrolysis in the stomach, enzymatic degradation throughout the gastrointestinal tract by several proteolytic enzymes, bacterial fermentation in the colons), which supplies continuously the amount of drug needed to maintain constant plasma levels once the steady state is reached [1]. Taking into account gastric emptying and small and large intestine transit time, it would seem that a reasonable duration in the GI tract is approximately 24 hours. The absorption, distribution and elimination of drugs are normally simplified by considering them all to be simple first-order processes. Given the average 24-hour residence time and high individual variability in the GI tract, only drugs with relatively short elimination half-lives should be considered for membrane-controlled reservoir systems [2].

Targeted drug delivery system

Targeted drug delivery is an advanced method of delivering drugs to the patients in such a targeted sequences that increases the concentration of delivered drug to the targeted body part of interest only (organs/tissues/ cells) which in turn improves efficacy of treatment by reducing side effects of drug administration. Basically, targeted drug delivery is to assist the drug molecule to reach preferably to the desired site to direct the drug loaded system to the site of interest. The first being pharmaceutical reason conventional drugs have low solubility and more drug instability in comparison to targeted drug delivery systems. Secondly conventional drugs also have poor absorption, shorter half-life and require large volume of distribution. These constitute its pharmacokinetic properties. The third reason constitutes the pharmacodynamic properties of drugs. The targeted or site- specific delivery of drugs is indeed a very attractive goal because this provides one of the most potential ways to improve the therapeutic index of the drugs. These systems remain in close contact with the absorption tissue, the mucous membrane, releasing the drug at the action site leading to a bioavailability increase and both local and systemic effects The oral route of drug administration constitutes the most convenient and preferred means of drug delivery to systemic circulation [3].

Colon specific Drug delivery approaches

The pH is about 6.5 in the proximal small intestine and about 7.5 in the distal small intestine. From the ileum to colon, pH declines significantly. It is about 6.4 in the caecum. However, pH values as low as 5.7 have been measured in the ascending colon in healthy volunteers. The pH in the transverse colon is 6.6, in the descending colon 7.0. Use of pH dependent polymers is based on these differences in pH levels. Colonic delivery refers to targeted delivery of drugs into the lower gastrointestinal tract, which occurs primarily in the large intestine (i.e. colon). The site specific delivery of drugs to lower parts of the gastro intestinal tract is advantageous for localized treatment of several colonic diseases, mainly inflammatory bowel disease (Crohn's disease and ulcerative colitis), irritable bowel syndrome, and colon cancer.⁵¹ The luminal pH of the distal intestine in patients with inflammatory bowel disease (IBD) or ulcerative colitis can be lower than that seen in healthy volunteers as found in previous study involving six patients with ulcerative colitis, the colonic pH of three patients varied from 5.0 to 7.0, whereas in case of other three subjects very low pH of 2.3, 2.9 and 3.4 were observed. Lower surface area and relative 'tightness' of the junctions in the colon can also restrict drug transport across the mucosa and into the systemic circulation. Eudragit L coatings have been used in single unit tablets to target 5-ASA on the colon in patients with ulcerative colitis or Crohn's disease [4].





METHODOLOGY

Materials & Instruments (Table.1)

The Chemicals, reagents and materials used in the research work were of either Analytical grade or Pharma grades from standard manufacturer/supplier and used for the studies without any further purification or investigation [5].

List of Instruments Used (Table.2)

Preparation of nanoparticles by modified ionic gelation process (table:3)

The nanoparticles were formulated by using modified ionic gelation method with magnetic stirring at room temp. In brief, different conc. of chitosan (0.1 - 0.2 % w/v) was prepared in acetic acid (1 % v/v) at pH 5. HPMCP (0.1 - 0.2 % w/v) solution was prepared in sodium hydroxide (0.1 M). This solution was added slowly to chitosan solution containing MNZ, SNZ, TNZ and ONZ (0.05 - 0.1 % w/v) under magnetic stirring for 30 min at 100 rpm while maintaining the pH of final dispersion was kept at 5.5. for 30 min at a speed of 20,000 rpm (42,000 g) at 4°C. Supernatant was used to measure free MNZ, SNZ, TNZ and ONZ. Collected nanoparticles were washed using double distilled water, freeze dried in a lyophilizer (Martin Christ model Alpha 1-2 LD plus) using D (+) 0.5 % w/v of trehalose dihydrate as a cryoprotectant at -55° C at a pressure of 0.01 mm of Hg [6].

In vitro drug release studies from NPs (MNZ, SNZ, TNZ and ONZ)

The equivalent weight of lyophilized MNZ, SNZ, TNZ and ONZ loaded NPs capsules and 10 ml phosphate buffer (pH 7.4) was placed into a dialysis bag that immersed into 100 ml phosphate buffer solution and maintained at 37°C at 100 rpm in a reciprocal shaking bath [9]. Aliquots of 1 ml of the sample were withdrawn at time intervals of 0, 0.5, 1, 1.5, 2, 3, 4, 8, 12, 18, 24, 30 & 36 hrs, They were analyzed by UV Spectroscopy using UV-Visible Spectrophotometer (fig 21-24)

Bioavailability Studies [10-11] Test substances

1. Optimized Drug Loaded nanoparticle formulations (MNZ F5, SNZ F5, TNZ F5 & ORD (Table.5)

Principle of the Experiments [12-16]

In vivo bioavailability behavior of the formulated and optimized MNZ F5, SNZ F5, TNZ F5 & ORD F5 in comparison to the marketed tablet formulations was performed.

Study design: Albino Wistar rats weighing about 210 ±30 gm were selected and divided into 2 different study groups after keeping them in overnight fasting condition. Optimized Drug Loaded formulation MNZ F5 NPs was supplied to rats in study group I, and the rats in study group II got a dosage equal to 10 mg/kg of drug from MNZ F5 NPs and similar procedures were carried out by group III to VIII, NPs and commercialised tablet. The retro-orbital venous plexus puncture of anaesthetized rats at specified time intervals of 0, 0.5, 1, 2, 3, 4, 6, 8, 12, 18, 24, and 36 hours following the drug administration, respectively.

Stability studies [17-18] Introductions

The stability of the active component must be a major consideration in selecting whether or not to accept or reject dosage forms for drugs in any design or evaluation. A three-month stability study was conducted for the optimized formulations at Room temperature (25°C±2°C/60%RH±5%RH) and Refrigerated temperature (4°C±2°C/60%RH±5%RH) in this study (table:4)

RESULTS AND DISCUSSION

Solubility studies

Solubility studies were performed by shaking flask method with excess amount of (MNZ), (SNZ), (TNZ), (ONZ) powder (approximately 100mg) drug added to distilled water, ethanol, 0.1N HCL and tween-20 in water (1% (v/v) in separately. The solubility level was determined using UV spectrophotometric.



**Tirumala Devi Kolli et al.,****Discussion**

The drug MNZ was soluble in 0.1N HCL, SNZ was soluble in tween-20 in water (1% (v/v)), TNZ was soluble in 0.1N HCL and ONZ was soluble in 0.1N HCL, All samples are very slightly soluble in water .

UV-Visible Spectrophotometer

The stock solution of concentration 100 µg/mL was shows in the range of 200-400nm for λ_{max} using double beam UV Spectrophotometer. The absorption peak obtained is shown in Fig.No:1,2, 3,4, 5, 6, 7 and Fig.No:8. And Table:12-15 Respectively

Discussion

From scanning of drug in 0.1 N HCl and phosphate buffer pH 6.8 dissolution media, it was also concluded that the drug had maximum wavelength of (MNZ) 277 nm, (SNZ) 284nm, (TNZ) 277nm, (ONZ) 277nm. It was observed that the drug obeys BeerLamberts law in concentration range of (MNZ),(SNZ),(TNZ) i.e. 0, 5, 10, 15, 20, 25 & 30 µg/ml., (ONZ) i.e. 0, 3, 6, 9, 12, 15 & 18 µg/ml.

FTIR study of (MNZ, SNZ, TNZ and ONZ)**Discussion**

The FTIR spectrum of pure (MNZ ,SNZ ,TNZ ,ONZ), physical mixture of (MNZ , SNZ ,TNZ ,ONZ), with HPMCP Polymer, physical mixture of (MNZ,SNZ,TNZ, ONZ), with Chitosan Polymer, and optimized NPs formulations . There is no the physicochemical interactions between drug and polymers of NPs are shown in **Figures: (9 – 12)**.

Dissolution rate analysis of nanoparticles loaded MNZ, SNZ, TNZ and ONZ formulations**Discussion**

The formulations targeted to the colon release the drug in the colon after enzymatic degradation by colonic bacteria. Hence in vitro drug release studies were carried out in SCF (pH 7.4 phosphate buffer containing 4%w/v of rat caecal contents [Anande et al, 2008]. at the end of the 36 hrs of testing that percentage drug released from the MNZ F5, SNZ F5, TNZ F5 and ONZ at 36 hours and for compared with marketed tablet it was 98.21% within 12 hours of satranidazole, TNZ F5 was found to be 95.85±0.24%, at 36 hours and for compared with marketed tablet it was 97.36% within 12hours of tindazole and ONZ F5 was found to be 97.79±0.14%, at 36 hours and for compared with marketed tablet it was 98.24% within 12 hours of ornidazole. However after careful comparison within the test batches ,drug release rate was more efficiently controlled as found in the batch F5 showing more uniform rate of drug release that was maintained uninterruptedly up to 36 hours as a continuous pattern showing This eventually demonstrated the nanoparticles to possess enormous potential to release drug in a predetermined, controlled and reproducible way [Khamanga et al., 2012

Discussion

It was also observed that maximum batches of microspheres followed release pattern that were very close to zero order model and more distinctly the batch MNZ F5, SNZ F5, TNZ F5 and ONZ F5 that followed Higuchi model with highest correlation co-efficient that predicted uniform release through spherical matrix following diffusion method [Higuchi, 1963]. All the formulations exhibited fickian and non- fickian diffusion mechanism and followed zero order kinetics. Based on the found data of in vitro drug release and kinetic data modeling, formulation MNZ F5, SNZ F5, TNZ F5 and ONZ F5 was selected for the animals studies and stability studies.

In vivo studies (Fig:25-32)

The pharmacokinetic parameters of All the samples in individual rats for marketed formulations and lyophilized optimized formulations F5 were calculated. The pharmacokinetic parameters C_{max} , AUC_{tot} , T_{max} , MRT and $t_{1/2}$ were calculated. The bioavailability of optimized NPs was found to be increased 2.13% times for all drugs than that of tablet powder marketed formulation.





Stability studies

Stability studies were conducted for finally optimized formulation F5 at room temperature and refrigerated temperature for three months. Mild variations were noticed in size, PDI and zeta potential values, which indicated the resistance for stability problems during storage at room temperature and 4° C & 25°C of SLMs.

SUMMARY AND CONCLUSION

The present research work was carried out with an aim to formulate and evaluate lyophilized nanoparticles of Metronidazole, Satranidazole, Tinidazole and Ornidazole to achieve improved bioavailability, site specificity drug release in sustained drug delivery system and better patients compliance. The UV spectrophotometric analysis used to determine the maximum absorbance of drug . FTIR Analysis and FTIR Spectrum shows that all the drugs are compatible with polymers. This indicates that there is no interaction between the drugs and polymers used in the study. The pure drug of MNZ, SNZ, TNZ and ONZ was subjected to preformulation study like bulk density, tapped density, hausner ratio, percentage compressibility index and angle of repose. The research revealed that the F5 formulations of all the drugs showed sustained release when compared with the marketed tablets. It was also observed that maximum batches of Nanoparticles followed release pattern that were very close to zero order model and the kinetic modeling studies revealed that all the formulations exhibited Fickian and Non-Fickian diffusion mechanism and followed zero order kinetics in releasing the drug with sustained manner. The in-vivo studies carried out by using pharmacokinetics parameters, The research found that there is no markable deviations were noticed after 3 months of stability study period in the parameters of particle size, PDI and Zeta potential it showed that there is no preferable variation observed are as in particle size.

CONCLUSION

The present study aimed on the Development and Evaluation of lyophilized lipid soluble Nanoparticles formulation of Metronidazole, Satranidazole, Tinidazole and Ornidazole , as an novel delivery system for site specific drug delivery. Based on the evaluational parameters colonic targeted drug delivery system ensuring effective treatment with minimal systemic side effects. The developed formulation is a better alternative mode of administration compared to oral administration .The drugs were shown effective Antiprotozoal activity. The in-vitro and in-vivo evaluation parameters of model drugs in polymeric nanoparticle formulation compared with the marketed formulations.

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Table:1. List of Chemicals, Reagents and Materials used

Materials	Suppliers
Metronidazole	M/S Albert David Ltd. Ghaziabad
Satranidazole	M/S Albert David Ltd. Ghaziabad
Tinidazole	M/S Albert David Ltd. Ghaziabad
Ornidazole	M/S Albert David Ltd. Ghaziabad
Chitosan	Yarrow Chem Products, Mumbai
HPMCP	Amrutha organics, Hyderabad.
Eudragit s 100	Amrutha, Hyderabad, India
Methanol	Merck, Hyderabad, India
Hydrochloric acid	Merck, Hyderabad, India
Acetone	Amrutha organics, Hyderabad
TrehaloseDehydrate	Amrutha organics, Hyderabad
Phosphate buffer, tween 20 &80	Merck, Hyderabad, India
Tween 20 &80	Merck, Hyderabad, India

Table: 2.List of Instruments used

Name of the Instrument	Manufacturer /Supplier
Digital Balance	Shimadzu, Japan.
Digital Stirrer	Remi motors, Chennai.
Magnetic stirrer	Remilab, India.
Optical Microscope	Olympus, Japan.
Dissolution apparatus USP XXIII	Lab India, Mumbai.
UV Spectrophotometer	ELICO SL-159 and Shimadzu 1601
pH meter (Digital)	Eutech Instruments, Japan.
Scanning Electron Microscope	Joel model JSM 6400, Japan.
DSC	Mettler Star SW 8.10
FTIR	shimadzu FT-IR 8300
rotary flash evaporator	rotor F-35-6-30.
Stabilizer	Rimek Industries, Ahmadabad.
Homogenizer	Heidolph, Germany
Probe soincator	Vibracell, Sonics, USA





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Table : 03 Formulation Development of MNZ,SNZ,TNZ,ONZ

Formulation	Code	MNZ (%w/v)	SNZ (%w/v)	Chitosan (%w/v)	HPMCP (%w/v)
SNZ	F8	---	0.1	0.2	0.2
SNZ	F7	---	0.1	0.1	0.2
SNZ	F6	---	0.1	0.2	0.1
SNZ	F5	---	0.1	0.1	0.1
SNZ	F4	---	0.05	0.2	0.2
SNZ	F3	---	0.05	0.1	0.2
SNZ	F2	---	0.05	0.2	0.1
SNZ	F1	---	0.05	0.1	0.1
MNZ	F8	0.1	---	0.2	0.2
MNZ	F7	0.1	---	0.1	0.2
MNZ	F6	0.1	---	0.2	0.1
MNZ	F5	0.1	---	0.1	0.1
MNZ	F4	0.05	---	0.2	0.2
MNZ	F3	0.05	---	0.1	0.2
MNZ	F2	0.05	---	0.2	0.1
MNZ	F1	0.05	---	0.1	0.1

Formulation	code	TNZ (%w/v)	ONZ (%w/v)	Chitosan(%w/v)	HPMCP (%w/v)
ONZ	F8	---	0.1	0.2	0.2
ONZ	F7	---	0.1	0.1	0.2
ONZ	F6	---	0.1	0.2	0.1
ONZ	F5	---	0.1	0.1	0.1
ONZ	F4	---	0.05	0.2	0.2
ONZ	F3	---	0.05	0.1	0.2
ONZ	F2	---	0.05	0.2	0.1
ONZ	F1	---	0.05	0.1	0.1
TNZ	F8	0.1	---	0.2	0.2
TNZ	F7	0.1	---	0.1	0.2
TNZ	F6	0.1	---	0.2	0.1
TNZ	F5	0.1	---	0.1	0.1
TNZ	F4	0.05	---	0.2	0.2
TNZ	F3	0.05	---	0.1	0.2
TNZ	F2	0.05	---	0.2	0.1
TNZ	F1	0.05	---	0.1	0.1





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Table:4 stzbility studies and solubility

Study	Storage condition	Time period
Long term	25°C±2°C/60%RH±5%RH or 30°C±2°C/65%RH±5%RH	12 month
Intermediate	30°C±2°C/75%RH±5%RH	6 month
Accelerated / Refrigerated	40°C±2°C/75%RH±5%RH or 4°C±2°C/65%RH±5%RH	3 month

Table:11 Particle Size, ZP, PDI, EE and TDC of MNZ, SNZ, TNZ, ONZ of various formulations

Formulation code	Particle size (nm)	Zeta potential (mV)	PDI	Entrapment efficiency (%w/v)	Total drug content (%)
MNZ F5	150.73±4.47	-29.1±2.16	0.201±0.097	88.88±2.48	97.6±0.06
SNZ F5	149.53±3.25	-28.9±2.60	0.202±0.077	89.78±2.48	96.9±0.07
TNZ F5	150.31±3.41	-29.1±2.16	0.202±0.088	91.56±0.30	96.5±0.04





Quantification of Azodicarbonamide in Selected Food Samples by Validated RP-UPLC method and *In silico* Docking Study of Azodicarbonamide as a Potential Immunomodulator

P.G.Sunitha^{1*}, Deattu N², S.Banu Priya³, G.Kalaiselvi³ and Anish Mahadevan⁴

¹Assistant Professor, Department of Pharmaceutical Chemistry, College of Pharmacy, Madras Medical College, Chennai-600 003, Tamil Nadu, India.

²Assistant Professor, Department of Pharmaceutics, College of Pharmacy, Madras Medical College, Chennai-600 003, Tamil Nadu, India.

³Research Student at College of Pharmacy, Madras Medical College, Chennai-600 003, Tamil Nadu, India.

⁴Research Student, PSG Institute of Medical Sciences and Research, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

P.G.Sunitha

Assistant Professor,
Department of Pharmaceutical Chemistry,
College of Pharmacy, Madras Medical College,
Chennai-600 003, Tamil Nadu, India.
E.Mail: sunitha.srm@gmail.com



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ABSTRACT

Major shifts in dietary patterns are continually occurring especially towards consumption of industrially processed food products. Instant noodles and ready to cook pasta have become the only choice of breakfast during busy mornings and wheat flour alone comes to the rescue of diabetic patients. Azodicarbonamide (ADA) is often added as flour maturing agent in the preparation of the above-mentioned food products. It is mandatory that this additive is within permissible limit to be safe for consumption by humans. This study aims to develop a novel UPLC method for the estimation of azodicarbonamide in selected food samples. The study also aims to assess the immunomodulatory effects of azodicarbonamide. UPLC method was performed on AccQ Tag Ultra C₁₈ column using the mobile phase pH 3.0 phosphate buffer and Acetonitrile (60:40) with a flow rate 0.15 mL/min with run time of 5 minutes. ADA as well as its degradation products were docked against five immunomodulatory receptors. Sample PS II was found to contain ADA more than the permissible limit. The presence of ADA in sample PS II was justified by recording mass spectrum. The immunomodulatory role of ADA and its degradation products has been highlighted by docking studies.

Keywords: Azodicarbonamide, UPLC, Validation, Docking, Immunomodulation.



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INTRODUCTION

Food additives play an important role in the food industry. There is a need to ensure the stability of processed food at the time of consumption by the consumer. Throughout this journey, right from the factories and industries to the needs of the consumers various preservatives and additives are added to keep the food appealing and palatable. There is always a growing demand by the consumers' for certain food and food substances throughout the year. Hence there is a need for additives and preservatives to meet the needs of the consumers. Additives and preservatives can be of plant, animal, or synthetic origin. Irrespective of the origin of these additives, it is mandatory that they are within the permissible limit which is safe for consumption by humans and animals [1].

Azodicarbonamide (ADA) is one such additive that is used as a flour treating or flour bleaching agent. It is commonly referred to as "yoga mat chemical" that is predominantly used in the rubber and polymer industry. ADA in food, acts by, accepting hydrogen of thiol groups from amino acids and is reduced to biurea [2]. Semicarbazide is also formed as a degraded product from azodicarbonamide that is used for lining PVC caps of food containers [3]. Nitrofurazone was banned in 1991 for its mutagenic and carcinogenic nature. In some cases, estimation of semicarbazide is used to identify the illegal use of Nitrofurazone [4]. There exist other sources of semicarbazide formation and contamination in food excluding the use of nitrofurazone [5]. Semicarbazide in food explains the use of azodicarbonamide as a chemical blowing agent for caps [6]. However, there are also other sources of semicarbazide occurrence in aquatic species [7]. ADA is still in use as a whitening agent in cereal flour and as a dough conditioner in bread making in the USA, Canada and in few countries. Semicarbazide a degraded product of ADA is a known carcinogen [8]. Also, ADA has been classified as a respiratory stimulant and given a health hazard GHS08 [9]. ADA is also used in bread making. ¹⁰ADA has been analysed in bread samples and noodles using HPLC, Electrophoresis¹¹and Near IR [12] methods. The reported methods required tedious sample pre-treatment procedures. Hence in this study an attempt has been made to develop and validate a precise and accurate RP-UPLC method for the quantification of ADA. Further, to explore the immunomodulatory potential of ADA and its degradation products, *in silico* docking studies have been carried out.

MATERIALS AND METHODS

Chemicals and Reagents

All the chemicals and reagents were purchased from Rankem. The API Azodicarbonamide was obtained as a gift sample from Fontec Polymers Ltd. All the food samples were purchased from local market at Chennai.

Method development

Method development was carried out using Ultra Performance Liquid Chromatography (UPLC). The instrument used was Waters Acquity UPLC with Binary solvent manager, Sample Manager, Column manager and Photo Diode Array (PDA) detector. The data were recorded and processed using Empower 3 software. Characterization was performed using UPLC-MS in positive ion mode using formic acid. UPLC is a rapid, time saving technique compared to HPLC. The high pressure and small particle size enable a good resolution. RP-UPLC was performed on AccQ Tag Ultra C₁₈ (2.1 x 100mm, 1.7µm) column using the mobile phase pH 3.0 Phosphate Buffer and Acetonitrile (60:40) with a flow rate 0.15mL/min. The column was maintained at a temperature at 30°C. The injection volume was set at 1µL for a run time of 5 minutes. Maximum absorbance was recorded at 242nm. The standard drug of concentration 2.5ppm was injected into the RP-UPLC system and the chromatogram was recorded.

Sample Preparation

Various food samples were collected and ground to fine powder. The samples were subjected to sonication with diluent for 15minutes. Further, the samples were centrifuged at 2500 RPM for 10 minutes and the supernatant solution was filtered through 0.22µm Nylon 66 syringe filter. The samples were then analysed by the developed method.



**Sunitha et al.,****Method Validation**

In order to check the reliability of the developed method, validation was carried out as per ICH guidelines and the validation parameters were determined.

Docking Studies

To assess the immunomodulatory potential of ADA and its degradation products, *in silico* docking studies were carried out. The ligands azodicarbonamide, semicarbazide and biurea were docked against immunomodulatory receptors like 6GVF - crystal structure of PI3K alpha (Phosphoinositide 3-kinase alpha) in complex with ligand, 2P6B - crystal structure of human calcineurin in complex with PVIVIT Peptide, 1CDJ - structure of T-cell surface glycoprotein CD4, 1M49 - crystal structure of human Interleukin-2 complexed with SP-1985, 5TTS - Jak3 (Janus kinase 3) with covalent inhibitor 4. Inhibition of PI3K alpha will result in down regulation of immunity [13]. Calcium-dependent serine-threonine phosphatase commonly known as calcineurin activates the T-cells and is responsible for the expression of immunity [14]. CD4 gene encodes the protein CD4, which is present on the cell surface of T-cells [15]. Cytokines are well known targets for autoimmune diseases. IL2 is a much-focussed target to suppress immunity [16]. Janus kinase 3 regulates immunity via the JAK/STAT pathway. Inhibitors of this receptors serves as an immunomodulatory agent as well [17]. The ligands were drawn using ACD Chemskech freeware and converted to suitable format. The proteins were downloaded from RCSB PDB [18], further prepared using Molegro Molecular Viewer software. Autodock version 1.5.6 was used to perform the docking studies.

RESULTS AND DISCUSSION**RP-UPLC Method Development**

Retention time of ADA was found to be 1.555 under the developed chromatographic conditions. Peak shape was found to be symmetrical and all the system suitability parameters were within the acceptance criteria. The chromatogram is shown in Figure 1.

Method Validation

The method was specific as there was no interference from the blank. Six working standards were injected and the mean % RSD was found to be 0.5 with a standard deviation of 217.07. System precision and method precision performed using 6 replicates possessed % RSD of 0.2. Detection limit of the Azodicarbonamide in this method was found to be 0.02µg/mL equivalent to 0.4 mg/kg. Quantification limit of the Azodicarbonamide in this method was found to be 0.05µg/mL equivalent to 1 mg/kg. Linearity was performed from LOQ to 300%. Accuracy observed for 50%, 100% and 150% using 3 replicates for each had a % mean recovery of 100.88%, 100.69% and 100.62% respectively. Robustness is the ability of the method to remain unchanged by small deliberate changes. Changes made include increase and decrease of flow rate, increase and decrease of organic mobile phase concentration and at high and low temperature. The developed method was found to be robust. All the validation parameter results are furnished in Table 1.

Sample analysis

All the samples were analysed using the developed method. The amount of ADA present in the samples are given in Table 2. The presence of ADA in the samples was confirmed by mass spectral studies as shown in Figure 2. In positive ion mode the peak at 117.0569 confirms to m+1 peak of ADA.

Docking Results

Observation of docking results shows that all the three ligands exhibited optimum interaction with the receptor sites of Calcineurin (2P6B), PI3K alpha (6GVF), and IL-2(1M49). A binding energy of -7 to -10 is favourable. The binding energy and the interaction of the ligands with the amino acids of the receptor sites are given in Table 3.





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CONCLUSION

Azodicarbonamide is an additive used as a dough conditioner in preparations of bread, noodles and pasta. The degradation products of azodicarbonamide are biurea and semicarbazide. Semicarbazide is a well-known mutagen and carcinogen. A suitable rapid RP-UPLC method has been developed to detect azodicarbonamide in food samples. The developed method was found to be accurate, specific and robust. ADA when present in an amount of >45mg/kg causes asthma and is a potential carcinogen. Hence, there arises a need to limit its amount in food products. The developed method was validated as per ICH guidelines. The docking studies showed effective interaction with the immunomodulatory receptors. Optimum binding energy of the ligands with the proteins Calcineurin (2P6B), PI3K alpha (6GVF), and IL-2(1M49) were observed.

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Table 1. Validation Parameters

Parameters	Obtained value	LIMIT
Linearity: Range ($\mu\text{g/ml}$)	0.05 – 7.5 $\mu\text{g/ml}$	R < 1
Regression coefficient	0.999	
Regression equation (Y = mx + c)	y = 15218x + 4242.5	
Specificity	Specific	No interference of any peak
System precision %RSD	0.2	NMT 2.0%
Method precision %RSD	0.2	NMT 2.0%
Accuracy %recovery	100.73%	98-102%
LOD	0.4 mg/kg	NMT 3
LOQ	1 mg/kg	NMT 10
Robustness	0.81	NMT 2.0 %

Table 2. Quantification of ADA in food samples

S.No.	Samples	Code	Amount of ADA (mg/Kg)	Safe Acceptance Limit (US FDA)
1.	Wheat flour Brand A	AS-I	29.3	Not More than 45 mg/kg
2.	Wheat flour Brand B	FS-I	18.1	
3.	Wheat flour Brand B	RS-I	BDL	
4.	Pasta Brand A	PS-I	76.9	
5.	Pasta Brand B	PS-II	315.3	
6.	Noodles Brand A	SN-I	BDL	
7.	Noodles Brand B	RN-I	BDL	





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Table 3. Binding energy with Interactions

PROTEIN (PDB ID)	LIGANDS	BINDING ENERGY (kcal/mol)	INTERACTIONS
6GVF	ADA	-5.54	Asp933, Tyr836, Lys802
	SEM	-6.93	Asp933, Ser774
	BIUREA	-5.68	Asp933, Tyr836, Ser774
5TTS	ADA	-5.24	Asp967, Asn954, Leu828
	SEM	-4.24	Asp967, Gly831
	BIUREA	-5.52	Asp967, Arg953
2P6B	ADA	-6.87	Ile331, Asn330, Met329
	SEM	-6.31	Ile331, Asn330, Met329
	BIUREA	-5.68	Ile331, Asn330, Met329
1CDJ	ADA	-4.74	Asp78, Glu77, Asp80, Asn30
	SEM	-3.4	Glu77, Asp80
	BIUREA	-4.64	Asp80, Asn30
1M49	ADA	-6.55	Arg38
	SEM	-5.55	Lys43, Glu62
	BIUREA	-5.52	Lys43





An Exploratory Study on Awareness and usage of She-Box among Public and Private Sector Employees with Special Reference to Bengaluru City, India.

Aishwarya K^{1*} and Ritty Francis²

¹Assistant Professor, Mount Carmel College, Autonomous, Bangalore, India

²Associate Professor, St. Joseph's College of Commerce, Bangalore, India

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*Address for Correspondence

Aishwarya K

Assistant Professor,

Mount Carmel College(Autonomous),

Bangalore, India

E. Mail: aishwaryakrishnamurthy97@gmail.com



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ABSTRACT

Sexual harassment at workplace continues to be plaguing the society. While legal and organizational mechanisms exist to curb sexual harassment at workplace, the taboo associated with it continues to be observed. With advancement in technology, online complaint mechanisms have been developed and implemented in various areas. The Government of India launched an online complaint management system called Sexual Harassment Electronic Box (SHe-Box) to provide a unified platform for women across all workplaces to register sexual harassment complaint. While it is a commendable initiative, reach, usage and accessibility are yet to be explored. While laws and practices aim at preventing crimes and punishing the guilty. Reporting is essential to condemn and punish those who indulge in malfeasance and transgression. The presence of a platform will lack usage if victims aren't registering complaints. Exploring the awareness and usage of the platform by people is pertinent to understand the effectiveness of the platform. The study attempts to explore the awareness and usage by understanding the reporting behavior of individuals on using the platform based on its credibility. The outcomes of the study are expected to facilitate in building awareness and further aid in identifying scope for future studies. The study would also gauge the understanding of the platform through comparison between public and private sector employees.

Keywords: Sexual Harassment, Online Complaint Management System, Awareness, Usage, Reporting behavior

INTRODUCTION

Sexual Harassment at workplace is a form of gender discrimination as it violates the individual rights of women. (Supreme Court Case Analysis: Vishaka and Ors v. State of Rajasthan and Ors By: Kavisha Gupta, 2018) The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013 is the first law that was brought into force to solely address the issue of harassment at workplace. The act defined behaviors that would





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constitute sexual harassment. The act explicitly states that nonphysical cues can also constitute sexual harassment. The act made it mandatory for organizations to set up a complaints committee to handle grievances that arise due to sexual harassment and conduct investigation to provide justice to the aggrieved woman. (Veena Gopalakrishnan, A. S. 2013)A woman is not supposed to experience sexual harassment at any place of employment. According to the law, sexual harassment may occur when there is an implicit or unequivocal assurance of preferable treatment in the workplace, a threat of unfavourable treatment, a threat regarding current or future employment, interruption with work, the creation of a threatening, offensive, or unsupportive work environment, or humiliating treatment that could endanger the health or safety of a female employee.(Poonja, 2018) The act introduced employer's liability in relation to non-compliance and failure to adherence. While the act made it pertinent for organizations to formulate policies and set up committees, reporting sexual harassment has been problematic due to sensitivity and negative consequences faced by victims.

(Jaggi, 2018) The world saw a revolutionary movement when women started speaking up about incidents of sexual harassment in the year 2018. The #metoo movement aimed at empowering woman all over the globe to stand up and fight against sexual harassment. Women from different walks of life shared harassment experiences through social media platforms. Women working in various industries, from film industry to government offices spoke up. The movement also gained popularity in India. The number of women who spoke up about sexual harassment at workplace was observed in huge numbers. (Folberg, 2020)The #metoo movement brought to light several cases that were unreported due to fear of job loss and lack of a confidential system to report the grievance. It is important to fill the gap with regards to the actual number of cases and those being reported.

An online complaint management system called the Sexual Harassment Electronic Box (SHe-Box) was launched in 2017. It is a government effort that seeks to provide women with a forum to report sexual harassment. Through SHe-Box, women now have a single point of contact to report sexual harassment, regardless of whether they work in the corporate, government, or unorganised sectors. When a complaint is submitted using the "SHe-Box," it is instantly forwarded to the relevant jurisdiction's authorities, who then takes appropriate action. SHe Box is a proactive move to the #MeToo movement, which has encouraged women to share their stories of abuse and sexual harassment at the workplace. The online complaint system for sexual harassment of women at work, launched by the Woman and Child Development Ministry in 2017, has only received 1349 complaints as of July 27, 2022, according to a written response by Union Minister Smriti Irani in the Lok Sabha. (1349 Complaints Received via She Box: Smriti Irani, 2022)

Objectives of the Study

1. To study the awareness level regarding SHe-Box among public and private sector employees.
2. To analyze the usage of SHe-Box among public and private sector employees.
3. To provide suggestions to the government authorities and organizations, that would result in increased awareness about SHe-Box.

LITERATURE REVIEW

Sexual harassment has come to light as a significant social issue with substantial ramifications for both individuals and organisations, there has been an upsurge in research efforts to understand how victims react to this distressing and potentially horrific ordeal.(Fitzgerald 1995) Since its identification as a socio-legal issue in the 1970s, research on workplace sexual harassment has exploded during the past three decades. (Zippel 2006) The research on SH offers strong support for comprehending more general ideas about the causes, signs, and advancement of gender equality in the workplace. Workplace SH is problematic in a special and damaging way since it destroys an individual's sense of self, lowers the standard of working life, and puts up obstacles to full and equal participation in the workplace. (McDonald 2012) Qualitative research that takes into account more complex features of the SH phenomenon, such as geographical and historical characteristics, professional experience, organizational cultures, and individual and



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group coping mechanisms, should be conducted in addition to surveys to gain better perspective to address Sexual Harassment.

(Ellen 1998) Numerous cases of sexual harassment have been covered by the media. It appears that many organisations take a long time to address internal sexual harassment allegations, which forces victims to seek remedy outside the organisation through the legal system. This "deaf ear" syndrome, or the failure to respond to concerns, is unexpected given the well-publicized consequences to human resources and employer reputation. (Sampath 2018) One of the main causes of the incredibly low reporting rate has been identified as the normalisation of sexual harassment at work. Social workers who specialize in gender inclusion say it's important to address the issue of lack of knowledge about reporting procedures.(Bergman 2002)The victim may experience increased psychological distress and decreased job satisfaction as a result of reporting. Such findings imply that the victim's fair course of action, at least in some workplace settings, is to refrain from reporting. Hence to promote reporting of sexual harassment while minimising its negative effects, making reporting a justifiable action the culture of the company around sexual harassment holds the key to the solution.

(Lorenz, K., & O'Callaghan, E. 2020)Studies have reported that workplace disclosure of Sexual Harassment is prompted when an individual has no alternative but to report or risk losing their job. Positive and negative social reactions that survivors experienced had an impact on their recovery and employment situation which also impacts reporting and disclosing. (2017, July 24)The Women and Child Development Ministry of India decided to offer an online platform for reporting of sexual harassment cases when the Union Minister Maneka Gandhi was receiving several complaints from female employees of various ministries. Ms. Gandhi told that the people who would report using SHE BOX are the female employees who work in committee-free environments, committees that exist only for their own sake, or committees made up entirely of unfavorable individuals.

L. (2019, July 5) Telangana Government introduced a mobile app for women to report sexual harassment. The application is known as T-SHE BOX. Using only a phone number, a complaint can be put in place. After creating an account, the issue can be reported through a form being filled out and submitted. Depending on the complainant's entity, the complaint would subsequently be referred to the ICC / LCC. T-SHe BOX is the first tool to count the number of complaints filed, handled, and dismissed. (Nasr, O., & Alkhider, E. 2015)By eliminating corruption and saving time, the online complaint management system offers a method for the public to deal with their issues. The goal of the complaints management system is to make it simpler to organize, supervise, track, and address problems. It also gives the companies a useful tool to pinpoint problem areas, track the effectiveness of how complaints are handled, and improve operations. It is a strategic approach for evaluating, analyzing, and responding to complaints. (Bhat, R. A., & Deshpande, A. 2017).Over the past ten years, there has been a continuous rise in sexual harassment cases. Despite the efforts to remove it, research shows that sexual harassment is still common in India's workplaces. According to the study, the urgent requirement is to carefully examine the problem and offer preventive measures. There is a need to create zero tolerance and intense redressal.

(Adams-Roy, J., & Barling, J.1998)Self-confidence foreshadowed the choice to face the harasser. Reporting of sexual harassment was linked to perceived procedural justice and accountability. In contrast to expectations, women who had reported instances of sexual harassment through official channels displayed lower feelings of obtaining justice.

(Bailey, E. 2020)The elements like ease of reporting, knowledge of policy, positive perception towards effectiveness were looked at to see if they could aid in the disclosure and reporting of sexual harassment. It was discovered that peoples choices and intentions to report sexual harassment they witnessed or experienced were predicted by their favourable awareness of and views toward the effectiveness of harassment related rules and policies.

Statement of Problem

The current legal mechanism has created a pathway and provided a roadmap to address sexual harassment at workplace. But the measures and benefits of the act can only be implemented if women are reporting the cases. With underreporting or no reporting, the offenders tend to get away. This has made it difficult to comprehend the actual





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number of incidents. The gap that exists between the actual number of cases of sexual harassment at workplace and cases that are not reported was very evident during the #metoo movement. This indicates absence of convenient and comfortable set up for women to put forth the issues to seek redressal. (Two Years of SHe-Box, Women Still Oblivious – the Softcopy, 2020) While the government launched SHe BOX women seem to still be oblivious to reporting online.

Scope of the Study

The scope of this research study is to be of help to the government authorities and private and public organizations and help them understand the awareness level of the SHe-Box platform. The findings of the study will help the decision making bodies in improving the platform and making it more user friendly. Also, this piece of research will definitely inspire the future researchers to explore and identify new dimensions in this particular area of research.

RESEARCH METHODOLOGY

The research is exploratory in nature based on a qualitative design. The study mainly uses primary data and it is further supported using secondary data. Primary data was collected by preparing an interview schedule specially designed to fulfill the purpose of the study. The semi structured interview schedule was validated by peers, an area expert and a subject expert. The study consisted of 22 participants after which the researchers faced saturation. The data collected was analyzed and interpreted in detail by the researchers. The research is exploratory in nature and follows the convenience sampling technique. The data was analyzed using thematic analysis. The interview ranges from 30 to 45 minutes with each participant. The participant's informed consent was taken to be part of the study. The participants of the study were employees of various private and public sector organizations across Bangalore city. During the interview the participants were given a brief about SHe Box to understand their perspective towards the online complaint management system.

RESULTS AND DISCUSSION

Data analysis consisted of comparisons and identifying commonalities among the interview responses. This was done particularly to understand the awareness of participants regarding SHe Box. The themes identified by analyzing the data are discussed further.

Understanding Sexual Harassment

According to the participants, sexual harassment is considered as a form of violation through verbal or non verbal means. Harassment was associated with abuse and actions causing discomfort. Most participants associated sexual harassment to women. Sexual Harassment includes gawking, jokes and inappropriate comments. It is not bound by physical touch only. Public and private sector employees understand Sexual Harassment.

Awareness of SHe BOX

Participants were unaware of the existence of a platform started by the Ministry of Women and Child Development. The lack of awareness was associated with the absence of government efforts to reach out to people to understand and use the platform in times of need. While the Sexual Harassment Act, 2013 is also not known by many of the participants from Private and Public Sector, the participants feel that the government needs to create more promotional activities to spread awareness about SHe Box and the law. Most participants are aware of the inhouse anti - harassment committees in their respective workplaces called as POSH - Prevention of Sexual Harassment, Anti Sexual Harassment - ASH, CASH- Committee Against Sexual Harassment at their workplaces in the Private Sector. The Public Sector and in some cases even the Private Sector either didn't have an inhouse committee or were directed towards the HR for any grievance of such nature.



**Aishwarya and Ritty Francis****Opportunities****Usage and Convenience**

SHe box is considered an extremely progressive move by the participants of the study. It is an initiative that would help in avoiding challenges with reporting in the terms of privacy, accessibility, bias and delays. It also provides an extremely convenient platform to report easily by navigating through two tabs only. The platform is extremely user friendly.

Lack of accessibility and digital illiteracy

SHe box is definitely suitable for the digitally literate and accessible to the literate class. But to those who aren't tech savvy, it isn't beneficial. The platform provides a complaint view status to receive updates on the progress of the enquiry and investigation. The features of the platform are perceived as a mechanism that can be used mostly by the Urban population only.

In house platform - Public Sector employees do not have any inhouse online platform to report Sexual Harassment at workplace. A few of the Private Sector employees did mention the in house availability. It is ideally part of the employee portal where complaints could be registered.

Incapacity

In case of physical or mental incapacity anyone can file a complaint on behalf of the aggrieved woman.

Lesser Apprehensions

Participants felt that they could forego judgemental and biased behavior during the process of reporting the incident. It is observed that while reporting the incident women do undergo situations where they are mis-judged. Women also feel threatened and anxious about the consequences. All of the above mentioned could be easily avoided while using SHe Box.

Challenges

Uncertainty- The participants of the study showed signs of dilemma in reporting using the platform. Since the government hasn't promoted the platform consistently there could be lower reliability and trust to report using a less popular platform.

Drafting the Complaint - While SHe box offers a user friendly interface for reporting Sexual Harassment the difficulty in describing the incident in words is a challenge.

Credibility - The results of reporting on SHe box are not known to people. The effectiveness of using the platform isn't explored. While the number of cases reported are very less. Reports of complaints being resolved aren't published to the public.

Limitations

Only a particular section of both the sectors could be interviewed. Existence of stigma among prospective participants was a challenge. Sensitive nature of the topic restricted data collection.

Future Prospects

- Interview others groups in organizations, different class of people could be interviewed,
- Exclusive study taking into consideration participants those who have used the platform.
- The geographical scope of the study could be widened to accommodate different opinions across culture throughout the country. Differences of opinion based on gender could be explored.





Suggestions

- Sex education and ways to deal with situations involving sexual harassment should be inculcated at school level.
- Government intervention should increase in conducting awareness programs.
- Resolved cases should be published anonymously on SHe box to increase reliability of the platform.
- Organizations should orient the employees regarding SHe box and its usage along with the inhouse mechanisms.

CONCLUSION

Stigma is still present with respect to Sexual Harassment. Progress can be observed in the Urban population. Sensitivity towards the issue is increasing. Although awareness is low, there is scope to educate and enhance people about the relevance of reporting to reduce sexual harassment. SHe Box is a commendable initiative taken by the government. With the right approach and increased promotion, education and awareness the benefits of SHe box can be realized to the maximum.

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Study of Aquatic Entomofauna and their Biodiversity at Vaigai Reservoir in Theni District, Tamilnadu, India

A. Anitha Marry^{1*} and M. R. Delphine Rose²

¹Assistant Professor, Department of Zoology, Jayaraj Annapackiam College for Women's (Autonomous), Periyakulam, Theni District, Tamil Nadu, India.

²Associate Professor, Department of Zoology, Jayaraj Annapackiam College for Women's (Autonomous), Periyakulam, Theni District, Tamil Nadu, India.

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*Address for Correspondence

A. Anitha Marry

Assistant Professor,
Department of Zoology,
Jayaraj Annapackiam College for Women's (Autonomous),
Periyakulam, Theni District, Tamil Nadu, India.



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ABSTRACT

Insects play a significant role in the biodiversity of ecosystem. The majority of bug species known as aquatic insects live in freshwater habitats like swamps, ponds, lakes, springs, streams and rivers. Over 8600 insect species, belonging to 12 orders and 150 families have been found to live in different freshwater habitats. They maintain the health of freshwater environments by playing important ecological roles. Vaigai reservoir aquatic insect biodiversity was gathered and studied between October 2021 and September 2022. There were two sample locations, each 5 km from the Vaigai reservoir. 4626 insect individuals were found in the study, classified into 29 families and 9 orders. Using accepted techniques, the environmental factors affecting water were estimated. Due to their high abundance, rapid colonization of freshwater habitat, enormous biomass, and high birth rate with short generation times, aquatic insects are regarded as model species in studies of the structure and function of the freshwater ecosystem.

Keywords: Aquatic insect, water quality, Bio-indicator, Vaigai reservoir

INTRODUCTION

A very common and diversified group that lives in various watery environments, aquatic insects are an important part of aquatic ecosystems. (Zborowski P *et al.*, 1995) They serve as bioindicators and are important to the operation of ecosystems (New TR 1984, Yen A, Butcher R, 1997). The ecological role of aquatic species, the physical attributes of their habitat, and the availability of food combine to determine where they are found (Merritt R.W.

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and Cummin K.W 1996). Consequently, the community structure of aquatic insects depends on a variety of elements, including oxygen content, water quality, substrate type, sediment particle size, water velocity and environmental conditions near the water source (Buss D.F and *etal.*,2004, Woodcock T.S., Huryn A 2007 and Hynes H.B.N, 1970). Aquatic insects are frequently employed as markers of the effects of human activities on water systems because they reflect environmental changes and provide details on habitat and water quality (Wiggins G.B 1996). In general, aquatic insects are largely ignored in the current estimation of Indian biodiversity, which is why the present study examines the diversity of aquatic insects in Vaigai reservoir, Theni District, Tamilnadu, India. The use of aquatic insects as bio indicators provides data to estimate the degree of environmental impact and its potential effects on other living organisms.

MATERIALS AND METHODS**Study Area**

Vaigaidam reservoir is located to the West of Periyakulam town at the Latitude, 77- 28'4" and Longitude of 10 o 7'45" on the foot of Western Ghats of Palani hill range. It is 9k.m. away from Periyakulam and 10 km away from Jayaraj Annapackiam College for women, Periyakulam and supplies water to Periyakulam throughout the year. Irrigation under Vaigai reservoir system is about 2,865 acres. The capacity of maximum water level is 100 meter squarefeet. Area of water spread on maximum water level is 48.64 meters squarefeet.

Sampling of Aquatic insects

Aquatic insects were sampled using aquatic D-hand net with a dimension of 30× 30cm frame, 250 µm mesh, 50 cm length, a large hand net (mesh size 1 mm) was used throughout the sampling (R. W. Merrit and L. w Cummins 1988). The collected specimens were preserved and identified with the help of standard keys (D. Dudgeon 1999, K. A. Subramanian and K. G. Sivaramakrishnan 2007).

Aquatic insects were sampled using

RESULTS AND DISCUSSIONS**Aquatic insects orders**

Ephemeroptera: Mayflies are some of the best-known aquatic insects. Mayflies live in both lentic (lakes) and lotic (rivers) systems. Their breathing mechanisms heavily silted and polluted streams and lakes are usually void of mayflies.

Odonata: One of the most distinctive water insects is the damselfly. They are frequently found in wetlands, the backwaters of streams, and lakes, and are typically connected to vegetation. They consume smaller fish as well as other insects. They can be recognized by a distinctive mouthpiece that extends from their bodies to catch food at a distance. The adults are advantageous because they consume a lot of insects.

Plecoptera: Stoneflies are found primarily in streams. They require a larger supply of oxygen to survive than other aquatic insects. Stoneflies can often be seen doing "pushups" after capture by humans in order to stimulate water movement along their bodies to increase oxygen flow. These insects are nearly absent from degraded and polluted streams.

Hemiptera: They are usually visible on the water surface skating fast about and many people may be familiar with them as water striders. Due to their high levels of predation on other insects, these pests can severely harm some species, including mosquito larvae and other dipteran species. The back swimmers and huge water bugs are two other species in this group in addition to water striders.



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Megaloptera: Smallmouth fisherman may be familiar with this order which includes hellgrammites, a ferocious looking insect that can reach 3 or more inches with giant pincher mouthparts. These are common in riffles of streams and rivers. Other alderflies are common to backwaters and areas with heavy organic matter in the water.

Trichoptera: caddisflies are an intriguing order of insects because they construct casing to conceal themselves. Some even utilise webs to catch food. They put these under and on rocks and use adhesive webbing to keep them together. These casings are unique to each family and many of them may be recognised by their casing alone due to their construction shape or material type.

Diptera: From the water left in an abandoned tire to the purest mountain stream, from the bottom of a lake to the riffles of a stream, from brackish to fresh water, the real flies can be found in every aquatic habitat imaginable. Although mosquito larvae are the most well-known fly larvae, midge larvae are among the most significant ecologically. Many people might feed their fish blood worms. Yellow perch, trout, darters, and many other fish species use blood worms as food (Voshell,2002).

Aquatic insects and their habitats

Aquatic insects may survive in both standing water and moving water. Similar habitats are also commonly found around lakeshores, where they are known as erosional habitats. In a similar vein, flood plain pools and backwaters frequently host a variety of depositional habitat species. The habitats for aquatic insects can be seen in relation to several geographical and temporal scales. It varies in size on a spatial scale from microscopic particles to the entire drainage basin, which covers squares of kilometres. Temporally, the changes in the habitats can be visualized from days to thousands of years. The permanence of the physical structures of the habitats varies with the spatial scale. The drainage network can take thousands of years, whereas individual grains and microhabitats can take only a few days. The wetlands' insect communities react to these temporal and geographical variations as well. Aquatic insects maintain their location within a certain habitat by adhering to surfaces, swimming, skating or burrowing into the ecosystem (Hershey *et al.*,2010).

Aquatic insect distribution is influenced by the complex interactions between substrate, flow, turbulence, and food supply. The frequency of movement within the habitat is determined by the habit of a particular species. Substrate is a crucial physical component of the habitat and is quite complicated. The substrate's physical characteristics are influenced by the water stream and the type of parental material that is accessible.

The organic debris complicates the substrate and has a significant impact on how the organism reacts to it. It is known that the faunal composition varies with the substrate across all continents and biomes. Whereas lake basins, river flood plain pools, and stream/river backwaters offer depositional circumstances, Lake Shoreline waves and stream/river currents both produce erosional habitats. Quantity and diversity of species that have adapted to erosion (Subramanian and Sivaramakrishnan, 2007). In comparison, diversity is high in silty sand, whereas diversity may be low and biomass high on muddy substrata (Collins,2012).

The present study recorded the diversity of aquatic insect fauna at Vaigai reservoir, a total of 4626 of individuals representing to classified under 29 families and 9 orders from October, 2021 to September, 2022. Identified order Hemiptera was highest represented by seven families Belostomatidae, Gerridae, Helotrephidae, Pleidae, Naucoridae, Nepidae and Notonectidae. Order Coleoptera represented by three families Dytiscidae, Elmidae and Hydrophilidae. Order Odonata represented by three families Coenagionidae, Libellulidae and Gomphidae. The similar observations were Bijita and Gupta (2015) stated that 21 species of aquatic insects belonging to 14 families and 7 orders in Bakuamaristream. Abhijna *et al.*, (2013) reported to 60 species classified under 37 families and 8 orders were identified at Vellayani Lake. Anjana Choudhary and Janakahi(2015) explained an aquatic insects belonging to 4 orders, 10 families were collected from the Sagarlake.





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Order Ephemeroptera represent by three families Baetidae, Ephemerellidae and Leptophlebiidae. Order Diptera represented by two families Chironomidae and Sciomyzidae. Order Megaloptera represented by one family Corylladidae. Order Trichoptera represented by one family Leptoceridae, Order Plecoptera represented by one family Perlidae and Orthoptera represented by one family Tetrigidae (Table-1), (Figure1,2). A total of 4626 individuals of aquatic insects representing 29 families and 9 orders were collected from the upstream and downstream of Vaigai reservoir from October, 2021 to September, 2022. Total number of insects recorded totally in upstream and downstream was 2956 and 1670 respectively during October, 2021 to September, 2022. Ephemeroptera and Hemiptera was the dominant group with highest number of insects followed by Diptera, Coleoptera, Odonata, Megaloptera and Leptoceridae population in upstream and downstream at Vaigai reservoir. Conservation of natural resources and biodiversity has become urgent issues in recent years for attaining an environmentally sustainable future. Growing number of studies on the habitats and distributional pattern of certain aquatic insects is making their use increasingly suitable. Aquatic insects are used for monitoring the health of aquatic environments because of their differential responses to stimuli in their aquatic habitat and determining the quality of that environment. The improvement and development of existing and new biomonitoring tools using aquatic insects are a major effort among aquatic entomologists.

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Table – 1 Families of aquatic insects recorded in Vaigai reservoir from October, 2021 to September, 2022

Order	Family
Coleoptera	Gyrinidae
	Hydrophilidae
	Psephenidae
Diptera	Tipulidae
	Simuliidae
Ephemeroptera	Ephemereltidae
	Heptageniidae
	Leptophelebiidae
	Baetidae
Hemiptera	Hydrometridae
	Gerridae
	Belastomatidae
	Ranatridae
	Notonectidae





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	Nepidae
	corixidae
Megaloptera	Coridalidae
Odonata	Libellulidae
	Gomphidae
	Euphaeidae
	Aeshnidae
Plecoptera	Perlidae
Trichoptera	Hydropsychidae
	Lepidostomatidae
	Helicopsychidae
	Calamoceratidae
	Philopotamidae
Orthoptera	Tetrigidae

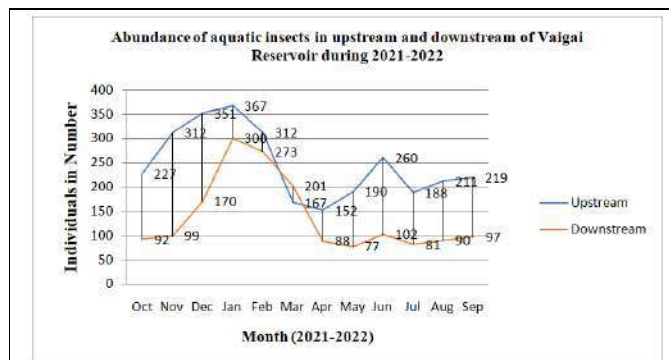


Figure – 1 Abundance of aquatic insects in upstream and downstream of Vaigai Reservoir during 2021-2022

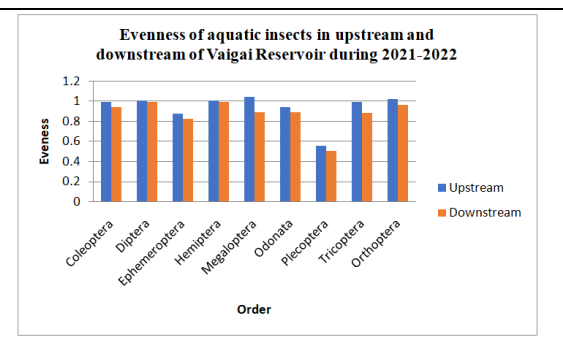


Figure – 2 Evenness of aquatic insects in upstream and downstream of Vaigai Reservoir during 2021-2022





Psychological Predictors of Relationship Satisfaction: A Study on Married Couples

Vandana Kabra¹ and Meenakshi Joshi^{2*}

¹Research Scholar, Department of Psychology, Manipal University Jaipur, Jaipur, India.

²Assistant Professor, Department of Psychology, Manipal University Jaipur, Jaipur, India.

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*Address for Correspondence

Meenakshi Joshi,

Assistant Professor,

Department of Psychology,

Manipal University Jaipur,

Jaipur, India.

E.Mail: meenakshi1768@gmail.com



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ABSTRACT

The purpose of this study is to examine the predictors of relationship satisfaction in married couples. Satisfaction is a subjective feeling in a relationship, it is dependent on psychological factors. In our study we have incorporated relationship autonomy, perceived partner responsiveness and commitment to understand the satisfaction among partners. Married couples were taken as sample for the research. Questionnaire related to satisfaction in relation to commitment, relationship autonomy and perceived partner responsiveness was shared online as google form to collect the data. It is seen that satisfaction is higher in the couples who are being devoted to each other in their marriage, committed partners avoid giving up. Relationship autonomy helps partners to empower their individuality and at the same time tune in with their partners, if this is maintained it enhances relationship satisfaction. Having idea about the feelings and thoughts of one's partner decides the strength of the relationships. Perceived partner responsiveness is thinking what his partner is feeling about another one. Satisfaction is seen in the couples who have determine devotion in their relationships.

Keywords: Satisfaction, Commitment, relationship autonomy and perceived partner responsiveness.

INTRODUCTION

Relationship satisfaction aids in anticipating marital stability. How much is one satisfied in a relationship impacts the quality of relationship. (Janina Larrissa Buehler, 2021) [1] Satisfaction is a subjective feeling, as a couple both may differ, it is dependent on the experience one has that gives satisfaction. Falling and sustaining in a relationship is vital for wellbeing, survival, and fulfilment of personal goals, couples should benefit in a relationship to choose in maintaining relationships that help partners meet these needs (R.F Baumeister, M.R Leary, 1995) [2]. Howbeit, not all

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close relationships are equal, there are distrust, selfishness and aggression in some, and these factors are overall harmful for an individual (Hellmuth & McNulty, 2008; McNulty & Russell, 2010) [3], and poor relationships affect both physical and mental health (Trombello, & McGinn, 2014) [4]. Thus, to optimize personal well-being it is required to be decisive about the need to end the relationship. Though, all relationships encounter problems but, every couple looks for satisfaction in their bond (Khalatbari *et.al.*) [5], Marriage is a long-term investment where partner share mutual responsibilities to make it last through. Satisfaction is an attitude individual has for his or her marital relationship. In comparison to other relations, marriages are more fragile and needs lots of emotional investment to keep its functioning better.

Satisfaction in marriages is subjective to partners opinions. (Spanier & Cole, 1974) [6] stated that satisfaction in marriage is a dependent on the couple, it's very personal on how they deal with their better half, marriage, and their relationship. (Hawkins,1968) [7] marital satisfaction is how one senses happiness, satisfaction, and joy experienced by their mates, keeping in consideration all aspects of marriage. Locus of control, self- esteem and intimacy were seen in interaction among each other to see how it influences marital satisfaction, it was found intimacy is directly related with marital satisfaction (Udofia *et.al.*) [8]. Marital satisfaction influence life satisfaction, like success in work, social communication, and physical and mental health of couples, for most partners it is a protective factor (Hatami H *et.al.*) [9]. Marital satisfaction affects individual's health; thus, its affecting factors needs to be reviewed (Darden Cindy A, Ginter Earl J) [10]. (Lee and Lee ,2012) [11] men associate marital satisfaction with self-esteem depending on gender based spousal roles. (Kim and Park 2013) [12] In metropolitan areas married couples, marital satisfaction is influenced not only by self-esteem but also by partner support, how they match with each other, recovery attempts and alternatives to marriage. This indicated that marital satisfaction in husbands was noticeably higher compared to their wives.

From past 60 years marital satisfaction is being studied and is still in continuation. Multiple factors were identified which directly indicated marital satisfaction, including unique personal features, mental maturity, thinking, perception of oneself and other, assumptions of life, communication and problem-solving skills, mythological belief system, affection, intimacy, loyalty, economical factors, cognitive and emotional factors, health and physical factors, partner behaviour towards each other, social support, ways in parenting, connections with relatives and friends, how leisure time is spent, recreational activity marital conflict, stress, and lot more things at the individual and social level (Udofia, 2014) [13]. The current research work is focused on understanding the impact of certain psychological concomitants on relationship satisfaction in couples. Satisfaction is a byproduct of the experience one has in a relation and how commitment, autonomy and perceived partner responsiveness impacts couples is being studied.

Theoretical Background**Commitment and satisfaction**

(Bradely Vanover, 2016) [14] Communication, time spent together, and external support enhances commitment. These cumulatively are key factors for marital success and satisfaction. (HonghongXu,2017) [15] Marital satisfaction is highly influenced by coping styles, couple commitment, internal locus of control and the ways of solving interpersonal problems. (Kochhar & Sharma, 2015) [16] Every couple is different in presenting their love styles and these are directly related to the factors like commitment, intimacy and more. Gender differences in couples doesn't affect relationship satisfaction. (Vajda, Mako, 2014) [17] With a review and summarization of the questionnaire techniques relationship satisfaction was studied. It was found that relationship satisfaction is a complex process as it is dependent on many factors, commitment, interpersonal dependence, and few more being crucial. (Baker *et.al* in 2017) [18] Forming and maintaining close relationship is important for couples. It was proposed that relationship satisfaction was based on the experience of the commitment in long term. (Alcia Bucher *et.al*, 2019) [19] In a longitudinal study it is found that satisfaction is fully linked with need fulfilment and commitment. The amount of effort put by the partner to make other feel related and competent affects the level of satisfaction.





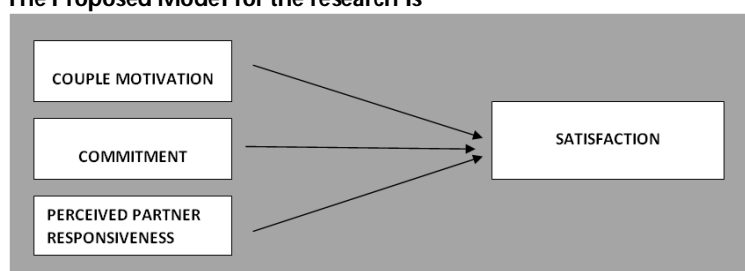
Relationship Autonomy and Satisfaction

(Timothy Lee Williams, 2015) [20] Autonomy predicts intimacy, partner understanding influences the bond among partners, hence enhancing satisfaction. Autonomy is reflective when the personality of both the partners is managed by them. As per the response of the partners it was seen that intimacy and equity as well as dependency and autonomy are predictors of relationship satisfaction. (Kluwer, 2020) [21] fulfillment of basic psychological requirements ensures the bonding of the close relationship. Autonomy along with relatedness ensures satisfactory relationship. (Deci & Ryan, 2014) [22] Relationship autonomy enhances integration in one's relationship and reflects a genuine desire to stay with the partner. Feelings of autonomy are enhanced when individuals are given choice and can govern their own behaviour, and when their partner understands their feelings. The motivation to stay in a relationship is proposed in relationship motivational theory. It states that when both partners offer self-initiation and self-regulation of their own behaviour in their relations, it affects the level of satisfaction among them. Couples want to be close and at the same time wish for independence in relationship. Intimacy and autonomy (Catherine Goodman) [23] help partners shape expressions in relationships. When partners experience higher autonomy and support for each other they can be seen satisfied in relationship. Making decisions and feeling independent when one is having a committed relationship is autonomy. [L A Rankin-Esquer](#), [C K Burnett](#), [D H Baucom](#), [N Epstein](#) [24] satisfaction in marriage is connected to autonomy and relatedness. It is considered that these two factors exist together and influence satisfaction in marriage. With time the feelings and engagement in close relationship has reformed. Equity among couples, expectations and gender roles has changed. Marriages are one of the complicated connections where mutual understanding is must to sustain.

Perceived Partner Responsiveness and Satisfaction

Gable & Reis, 2006, [25] Partner Responsiveness in a relationship induce understanding, care and validation in partners. Being warm, sensitive and considered about the feelings of their partner make them feel comfortable, valued, heard, and understood. (Reis, 2012; Selcuk, Karagobek, & Gunaydin, in press; 2018) [26] One important relational process that influence adult health and well-being is perceived partner responsiveness, the range of understanding for one another; being cared and appreciated by the spouse majorly contribute in the stability and satisfaction among them. (Reis, 2013) [27] Perceived partner responsiveness is pivotal in affecting the range of romance in close relationship. It concludes the extent of satisfaction and intimacy in partners. The space of self-discloser widens for each other in a relationship only when there is mutual appreciation, care and other related feelings.

The Proposed Model for the research is



METHODOLOGY

Quantitative research was conducted to measure the dependence of relationship satisfaction in context with commitment, couple autonomy and perceived partner responsiveness.

Sample and Procedure

The required sample for the study were the married couples who have completed 3 years of marriage and have at least one child. Prior to the collection of data consent was taken and only those who agreed were given the





questionnaire. The questionnaires were shared online as Google forms as well as in hard copy to collect the responses. The potential responses were selected and scored as per the instruction. The number of data used in the research is 170.

Measuring Scales

Three scales were used along with brief demographic details. The questionnaire was divided into two parts, first was the demographic details (spouse detail, age, sex, years of marriage, education etc.). the second part included 3 questionnaires to be answered as per the direction given for each.

- **The Marital Investment Scale** - Developed by Caryl E. Rusbult, John M. Martz and Christopher R. Agnewb in 1998. The scale is divided into 4 parts Satisfaction level, investment size, quality of alternatives and commitment) containing 6 questions in first 3 parts and 7 in last part. Part 1 and 3 is to be scored on 4-point scale and part 2 and 4 to be scored on 8-point scale.
- **Perceived Partner Responsiveness Scale** - Designed by Harry T. Reis, Dev Crasta, Ronald D. Rogge in 2006, to measure the degree of responsiveness in a relationship. It is an 18- items scale which must be scored on 9-point scale.
- **Couples Motivation Questionnaire** - Designed by Blais in 1990, using the scale, an individual can indicate the degree of autonomy one feels in relationship. It has 18 items which must be rated on 7-point scale

Data Analysis

Data were analyzed using SPSS 22.0. Linear regression was carried out to investigate the impact of independent variables on the dependent variable.

RESULTS AND DISCUSSION

A total of 170 married couples voluntarily completed the research questionnaires. Out of the 170 filled questionnaires 20 were rejected due to poor data quality. The remaining 150 filled questionnaires were considered for further analysis. Sample characteristics are shown in table 1. Internal consistency of all the scales was measured using Cronbach's alpha. The alpha value for all the scales was greater than 0.7, indicating good internal consistency.

Regression Model

To test the model regressed onto the satisfaction and commitment, perceived partner responsiveness and relationship autonomy. Table 3 shows linear regression analysis of satisfaction to in married couples. Sex, age and education were entered into the first block. CMQ, IMSC and PPRS were entered into the first block.

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Table1: Sample Characteristics

	Characteristic	n	%
Age	30 – 45years	170	-
Sex	Male	73	42.9
	Female	97	57.1
Highest Educational Qualification	Graduate	97	57.1
	Post- Graduate	67	39.4
	Doctorate	06	03.5

Descriptive statistics for the scales and internal consistency of the scales are shown in table 2.

Table2: Scale Characteristics

Construct	Code	No. of Items	Mean(SD)	Cronbach's Alpha
Satisfaction	IMSS	6	59.76 ± 15.52	0.94
Relationship Autonomy	RA	18	11.22	0.75
Perceived Partner Responsiveness	PPRS	18	5.89 - 6.11	0.94
Commitment	IMSC	7	8.46 ± 4.15	0.91

Internal consistency of all the scales was measured using Cronbach's alpha. The alpha value for all the scales was greater than 0.7, indicating good internal consistency.

Table3:Regression Analysis

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	.921 ^a	.848	.845	5.47735	.848	281.836	3

Co efficients^a

Model		Un standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-9.216	1.621		-5.686	.000
	CMQ	.183	.043	.304	4.240	.000
	IMSC	.194	.078	.154	2.481	.014
	PPRS	.199	.030	.504	6.710	.000

According to the model summary was significant (F (281.836) and the variables accounted for 84%.





A Few Kinds of Operators in Kasaj Topological Spaces

P.Sathishmohan^{1*}, M. Sindhu², K. Lavanya² and K. Rajalakhmi³

¹Assistant Professor, Department of Mathematics, Kongunadu Arts and Science College, Coimbatore, Tamil Nadu, India.

²Research Scholar, Department of Mathematics, Kongunadu Arts and Science College, Coimbatore, Tamil Nadu, India.

³Assistant Professor, Department of Science and Humanities, Sri Krishna College of Engineering and Technology, Coimbatore-641 042, Tamil Nadu, India.

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*Address for Correspondence

P.Sathishmohan,

Assistant Professor,

Department of Mathematics,

Kongunadu Arts and Science College,

Coimbatore, Tamil Nadu, India.

Email: sathishmohan@kongunaducollege.ac.in



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ABSTRACT

The purpose of this paper is to introduce a new type of Kasaj generalized-pre-[Kasaj generalized-semi pre]-neighbourhood of a sets, Kasaj generalized-pre-[Kasaj generalized-semi pre]-interior of a sets, Kasaj generalized-pre-[Kasaj generalized-semi pre]-closure of a sets, Kasaj generalized-pre-[generalized-semi pre]-exterior of a sets, Kasaj generalized-pre-[Kasaj generalized-semi pre]-frontier of a sets, Kasaj generalized-pre-[Kasaj generalized-semi pre]-border of a sets are called $KS_{gp}[KS_{gsp}]$ -neighbourhood, $KS_{gp}[KS_{gsp}]$ -interior, $KS_{gp}[KS_{gsp}]$ -closure, $KS_{gp}[KS_{gsp}]$ -exterior, $KS_{gp}[KS_{gsp}]$ -frontier, $KS_{gp}[KS_{gsp}]$ -border of a sets in Kasaj topological spaces and investigates the relation between this set with other sets in Kasaj topological spaces. Characterizations of $KS_{gp}[KS_{gsp}]$ -neighbourhood, $KS_{gp}[KS_{gsp}]$ -interior, $KS_{gp}[KS_{gsp}]$ -closure, $KS_{gp}[KS_{gsp}]$ -exterior, $KS_{gp}[KS_{gsp}]$ -frontier, $KS_{gp}[KS_{gsp}]$ -border of a sets are given.

AMS Subject Classifications: 54A05, 54B05, 54A99.

Keywords: $KS_{gp}[KS_{gsp}]$ -neighbourhood of a sets, $KS_{gp}[KS_{gsp}]$ -interior of a sets, $KS_{gp}[KS_{gsp}]$ -closure of a sets, $KS_{gp}[KS_{gsp}]$ -exterior of a sets, $KS_{gp}[KS_{gsp}]$ -frontier of a sets, $KS_{gp}[KS_{gsp}]$ -border of a sets.





INTRODUCTION

In year 1970, Levine [1] introduced the concept of generalized closed sets in topological spaces. This was introduced as generalization of closed sets in topological space and new results were proved. M.L. Thivagar et.al [2] introduced Nano topological spaces with respect to a subset X of a universal set U which is defined in terms of lower and upper approximation of X. A. Chandrashekar [3] introduced a new topology namely, Micro topology which is extension of nano topological space and we introduced partial extension of Micro topological space namely Kashyap G.Rachch and Sajeed topological spaces. Kashyap G.Rachchh and Sajeed [6] introduce partial extension of Micro topological space namely Kashyap G.Rachchh and Sajeed topological spaces. Kashyap G.Rachchh and Sajeed [7] introduce the concept of Kasaj generalized closed sets in Kasaj topological spaces. P. Sathishmohan[4] et al introduced the new type of closed sets known as $KS_{gp}(KS_{gsp})$ -closed sets in Kasaj topological spaces. [5] E. Prakash et.al introduced the concept of an Operators of a sets in Kasaj topological spaces. In this paper we shall define Kasaj generalized pre neighbourhood of a sets, Kasaj generalized pre interior of a sets, Kasaj generalized pre closure of a sets, Kasaj generalized pre exterior of a sets, Kasaj generalized pre frontier of a sets, Kasaj generalized pre border of a sets and Kasaj generalized semi pre neighbourhood of a sets, Kasaj generalized semi pre interior of a sets, Kasaj generalized semi pre closure of a sets, Kasaj generalized semi pre exterior of a sets, Kasaj generalized semi pre frontier of a sets, Kasaj generalized semi pre border of a sets in Kasaj topological spaces.

Notations

In this paper, We use the following symbols:

Kasaj Closed $\rightarrow \mathcal{KS}-\mathcal{C}$

Kasaj Generalized Closed $\rightarrow \mathcal{KS}_g-\mathcal{C}$

Kasaj Generalized Pre Closed $\rightarrow \mathcal{KS}_{gp}-\mathcal{C}$

Kasaj Generalized Semi Pre Closed $\rightarrow \mathcal{KS}_{gsp}-\mathcal{C}$

Kasaj Closure $\rightarrow \mathfrak{K}\mathfrak{C}-\mathfrak{C}$

Kasaj Generalized Closure $\rightarrow \mathfrak{K}\mathfrak{C}_g-\mathfrak{C}$

Kasaj Generalized Pre Closure $\rightarrow \mathfrak{K}\mathfrak{C}_{gp}-\mathfrak{C}$

Kasaj Generalized Semi Pre Closure $\rightarrow \mathfrak{K}\mathfrak{C}_{gsp}-\mathfrak{C}$

Kasaj Interior $\rightarrow \mathfrak{K}\mathfrak{I}-\mathfrak{I}$

Kasaj Generalized Interior $\rightarrow \mathfrak{K}\mathfrak{I}_g-\mathfrak{I}$

Kasaj Generalized Pre Interior $\rightarrow \mathfrak{K}\mathfrak{I}_{gp}-\mathfrak{I}$

Kasaj Generalized Semi Pre Interior $\rightarrow \mathfrak{K}\mathfrak{I}_{gsp}-\mathfrak{I}$

Kasaj Open $\rightarrow \mathcal{KS}-\mathfrak{O}$

Kasaj Generalized Open $\rightarrow \mathcal{KS}_g-\mathfrak{O}$

Kasaj Generalized Pre Open $\rightarrow \mathcal{KS}_{gp}-\mathfrak{O}$

Kasaj Generalized Semi Pre Open $\rightarrow \mathcal{KS}_{gsp}-\mathfrak{O}$

Kasaj Exterior $\rightarrow \mathcal{KS}-\mathcal{EX}$

Kasaj Generalized Exterior $\rightarrow \mathcal{KS}_g-\mathcal{EX}$

Kasaj Generalized Pre Exterior $\rightarrow \mathcal{KS}_{gp}-\mathcal{EX}$

Kasaj Generalized Semi Pre Exterior $\rightarrow \mathcal{KS}_{gsp}-\mathcal{EX}$

Kasaj Frontier $\rightarrow \mathcal{KS}-\mathcal{FR}$

Kasaj Generalized Frontier $\rightarrow \mathcal{KS}_g-\mathcal{FR}$

Kasaj Generalized Pre Frontier $\rightarrow \mathcal{KS}_{gp}-\mathcal{FR}$

Kasaj Generalized Semi Pre Frontier $\rightarrow \mathcal{KS}_{gsp}-\mathcal{FR}$

Kasaj Border $\rightarrow \mathcal{KS}-\mathcal{BD}$

Kasaj Generalized Border $\rightarrow \mathcal{KS}_g-\mathcal{BD}$

Kasaj Generalized Pre Border $\rightarrow \mathcal{KS}_{gp}-\mathcal{BD}$

Kasaj Generalized Semi Pre Border $\rightarrow \mathcal{KS}_{gsp}-\mathcal{BD}$





Kasaj Neighbourhood $\rightarrow \mathcal{KS}\text{-}\mathcal{NBD}$
 Kasaj Generalized Neighbourhood $\rightarrow \mathcal{KS}_g\text{-}\mathcal{NBD}$
 Kasaj Generalized Pre Neighbourhood $\rightarrow \mathcal{KS}_{gp}\text{-}\mathcal{NBD}$
 Kasaj Generalized Semi Pre Neighbourhood $\rightarrow \mathcal{KS}_{gsp}\text{-}\mathcal{NBD}$
 Kasaj Topological Spaces $\rightarrow \mathfrak{K}\mathfrak{T}\mathfrak{S}$.

Definition 1.1.[7]

- The $\mathfrak{K}\mathfrak{C}\text{-}\mathfrak{C}$ and the $\mathfrak{K}\mathfrak{C}\text{-}\mathfrak{I}$ of a \mathfrak{P} is denoted by $\mathfrak{K}\mathfrak{C}\text{-}\mathfrak{C}(\mathfrak{P})$ and $\mathfrak{K}\mathfrak{C}\text{-}\mathfrak{I}(\mathfrak{P})$ respectively. It is defined by $\mathfrak{K}\mathfrak{C}\text{-}\mathfrak{C}(\mathfrak{P}) = \cap\{\mathcal{Q} : \mathfrak{P} \subseteq \mathcal{Q}, \mathcal{Q} \text{ is } \mathcal{KS}\text{-}\mathfrak{C}\}$ and $\mathfrak{K}\mathfrak{C}\text{-}\mathfrak{I}(\mathfrak{P}) = \cup\{\mathcal{Q} : \mathcal{Q} \subseteq \mathfrak{P}, \mathcal{Q} \text{ is } \mathcal{KS}\text{-}\mathfrak{O}\}$.
- A Kasaj-generalized closure of \mathfrak{P} is defined as the intersection of all $\mathfrak{K}\mathfrak{C}_g\text{-}\mathfrak{C}$ sets containing \mathfrak{P} . It is denoted by $\mathfrak{K}\mathfrak{C}_g\text{-}\mathfrak{C}(\mathfrak{P})$ and A Kasaj-generalized interior of \mathfrak{P} is defined as the union of all $\mathfrak{K}\mathfrak{C}_g\text{-}\mathfrak{O}$ sets contained in \mathfrak{P} . It is denoted by $\mathfrak{K}\mathfrak{C}_g\text{-}\mathfrak{I}(\mathfrak{P})$.

Definition 1.2.[4]

- If $\mathfrak{P} \subseteq \mathfrak{U}$ in $(\mathfrak{U}, \tau_R(\mathfrak{X}), \mathcal{KS}_R(\mathfrak{X}))$ is said to be $\mathcal{KS}_{gp}\text{-}\mathfrak{C}$ set if $\mathcal{KS}_{pcl}(\mathfrak{P}) \subseteq \mathfrak{P}$ whenever $\mathfrak{P} \subseteq \mathfrak{B}$ and \mathfrak{B} is $\mathcal{KS}\text{-}\mathfrak{O}$ set in \mathfrak{U} . The complement of $\mathcal{KS}_{gp}\text{-}\mathfrak{C}$ set is $\mathcal{KS}_{gp}\text{-}\mathfrak{O}$ set in \mathfrak{U} .
- A Kasaj-generalized pre interior of \mathfrak{P} is defined as the union of all $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{O}$ sets contained in \mathfrak{P} . It is denoted by $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$.
- A subset $\mathfrak{P} \subseteq \mathfrak{U}$ in $(\mathfrak{U}, \tau_R(\mathfrak{X}), \mathcal{KS}_R(\mathfrak{X}))$ is said to be $\mathcal{KS}_{gsp}\text{-}\mathfrak{C}$ if $\mathcal{KS}_{spcl}(\mathfrak{P}) \subseteq \mathfrak{P}$ whenever $\mathfrak{P} \subseteq \mathfrak{B}$ and \mathfrak{B} is $\mathcal{KS}\text{-}\mathfrak{O}$ set in \mathfrak{U} . The complement of $\mathcal{KS}_{gsp}\text{-}\mathfrak{C}$ set is $\mathcal{KS}_{gsp}\text{-}\mathfrak{O}$ set in \mathfrak{U} .
- A Kasaj-generalized semi pre interior of \mathfrak{P} is defined as the union of all $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{O}$ sets contained in \mathfrak{P} . It is denoted by $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P})$.

Definition 1.3.[7] If $(\mathfrak{U}, \tau_R(\mathfrak{X}), \mathcal{KS}_R(\mathfrak{X}))$ is a $\mathfrak{K}\mathfrak{T}\mathfrak{S}$. Then \mathfrak{P} is said to be $\mathcal{KS}_g\text{-}\mathcal{NBD}$ of a point u of \mathfrak{P} if there would be $\mathcal{KS}_g\text{-}\mathfrak{O}$ set N containing u consequently $u \in N \subseteq \mathfrak{P}$.

Definition 1.4.

- If $(\mathfrak{U}, \tau_R(\mathfrak{X}), \mathcal{KS}_R(\mathfrak{X}))$ is a $\mathfrak{K}\mathfrak{T}\mathfrak{S}$. Then \mathfrak{P} is said to be $\mathcal{KS}\text{-}\mathcal{NBD}$ of a point u of \mathfrak{P} if there would be $\mathcal{KS}\text{-}\mathfrak{O}$ set N containing u consequently $u \in N \subseteq \mathfrak{P}$.
- If $(\mathfrak{U}, \tau_R(\mathfrak{X}), \mathcal{KS}_R(\mathfrak{X}))$ is a $\mathfrak{K}\mathfrak{T}\mathfrak{S}$. A point $u \in \mathfrak{U}$ is said to be an $\mathcal{KS}\text{-}\mathcal{EX}$ point of \mathfrak{P} iff it is an $\mathcal{KS}\text{-}\mathfrak{I}$ point of the complement \mathfrak{P}' of \mathfrak{P} . That is iff there would be an $\mathcal{KS}\text{-}\mathfrak{O}$ set \mathfrak{G} consequently $u \in \mathfrak{G} \subseteq \mathfrak{P}'$ and $u \in \mathfrak{G}$ and $\mathfrak{G} \cap \mathfrak{P} = \phi$. The set of all $\mathcal{KS}\text{-}\mathcal{EX}$ points of \mathfrak{U} is said to be $\mathcal{KS}\text{-}\mathcal{EX}$ of \mathfrak{P} and is stands for by $\mathcal{KS}\text{-}\mathcal{EX}(\mathfrak{U})$.
- If $(\mathfrak{U}, \tau_R(\mathfrak{X}), \mathcal{KS}_R(\mathfrak{X}))$ is a $\mathfrak{K}\mathfrak{T}\mathfrak{S}$. A point $u \in \mathfrak{U}$ is said to be an $\mathcal{KS}_g\text{-}\mathcal{EX}$ point of \mathfrak{P} iff it is an $\mathcal{KS}_g\text{-}\mathfrak{I}$ point of the complement \mathfrak{P}' of \mathfrak{P} . That is iff there would be an $\mathcal{KS}_g\text{-}\mathfrak{O}$ set \mathfrak{G} consequently $u \in \mathfrak{G} \subseteq \mathfrak{P}'$ and $u \in \mathfrak{G}$ and $\mathfrak{G} \cap \mathfrak{P} = \phi$. The set of all $\mathcal{KS}_g\text{-}\mathcal{EX}$ points of \mathfrak{P} is said to be $\mathcal{KS}_g\text{-}\mathcal{EX}$ of \mathfrak{P} and is stands for by $\mathcal{KS}_g\text{-}\mathcal{EX}(\mathfrak{P})$.
- For any subset \mathfrak{P} of \mathfrak{U} . Then
 $\ast\mathcal{KS}\text{-}\mathcal{FR}$ of \mathfrak{P} is defined by $\mathcal{KS}\text{-}\mathcal{FR}(\mathfrak{P}) = \mathcal{KS}\text{-}\mathfrak{C}(\mathfrak{P})\text{-}\mathcal{KS}\text{-}\mathfrak{I}(\mathfrak{P})$.
 $\ast\mathcal{KS}_g\text{-}\mathcal{FR}$ of \mathfrak{P} is defined by $\mathcal{KS}_g\text{-}\mathcal{FR}(\mathfrak{P}) = \mathcal{KS}_g\text{-}\mathfrak{C}(\mathfrak{P})\text{-}\mathcal{KS}_g\text{-}\mathfrak{I}(\mathfrak{P})$.
 $\ast\mathcal{KS}\text{-}\mathcal{BD}$ of \mathfrak{P} is defined by $\mathcal{KS}\text{-}\mathcal{BD}(\mathfrak{P}) = \mathfrak{P}\text{-}\mathcal{KS}\text{-}\mathfrak{I}(\mathfrak{P})$.
 $\ast\mathcal{KS}_g\text{-}\mathcal{BD}$ of \mathfrak{P} is defined by $\mathcal{KS}_g\text{-}\mathcal{BD}(\mathfrak{P}) = \mathfrak{P}\text{-}\mathcal{KS}_g\text{-}\mathfrak{I}(\mathfrak{P})$.

$\mathcal{KS}_{gp}[\mathcal{KS}_{gsp}]\text{-NEIGHBOURHOOD OF A SETS}$

In this effort, the \mathcal{KS}_{gp} and $\mathcal{KS}_{gsp}\text{-}\mathcal{NBD}$ of a set in $\mathfrak{K}\mathfrak{T}\mathfrak{S}$ are introduced and investigated.

Definition 2.1

.If $\mathfrak{P} \subseteq \mathfrak{U}$ is said to be a $\mathcal{KS}_{gp}\text{-}\mathcal{NBD}[\mathcal{KS}_{gsp}\text{-}\mathcal{NBD}]$ of a point u of \mathfrak{U} , iff there would be $\mathcal{KS}_{gp}\text{-}\mathfrak{O}[\mathcal{KS}_{gsp}\text{-}\mathfrak{O}]$ set N containing u consequently $u \in N \subseteq \mathfrak{P}$.





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Theorem 2.2.

Let $(U, \tau_R(X), K S_R(X))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Let $\mathfrak{P} \subseteq U$. Then $\mathfrak{P} \in \mathcal{K S}_{gp}\text{-}\mathbb{O}$ iff it is a $\mathcal{K S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of each of its points.

Proof:

Assume $\mathfrak{P} \in \mathcal{K S}_{gp}\text{-}\mathbb{O}$ set and $u \in \mathfrak{P}$, then $u \in N \subseteq \mathfrak{P}$. Hence \mathfrak{P} is $\mathcal{K S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of each of its points. Conversely, assume that \mathfrak{P} is $\mathcal{K S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of each of its points. Then \mathfrak{P} is $\mathcal{K S}_{gp}\text{-}\mathbb{O}$ set containing each of its points. So, \mathfrak{P} is $\mathcal{K S}_{gp}\text{-}\mathbb{O}$ set.

Theorem 2.3.

Let $(U, \tau_R(X), K S_R(X))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. If \mathfrak{P} is a $\mathcal{K S}_{gp}\text{-}\mathcal{C}$ subset of U and $u \in U\text{-}\mathfrak{P}$, then there would be a $\mathcal{K S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ N of u consequently $N \cap \mathfrak{P} = \phi$.

Proof:

Since \mathfrak{P} is $\mathcal{K S}_{gp}\text{-}\mathcal{C}$, then $U\text{-}\mathfrak{P}$ is $\mathcal{K S}_{gp}\text{-}\mathbb{O}$ set in U . By thm 2.2, $U\text{-}\mathfrak{P}$ contains a $\mathcal{K S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of each of its points. Hence there would be a $\mathcal{K S}_{gp}\text{-}\mathcal{C}\mathfrak{P}$ of u consequently $N \subseteq U$. i.e., no point of N belongs to \mathfrak{P} and accordingly $N \cap \mathfrak{P} = \phi$.

Theorem 2.4. Let $(U, \tau_R(X), K S_R(X))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Let $\mathfrak{P} \subseteq U$. Then $u \in \mathcal{K S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$ iff for any $\mathcal{K S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ N of u in U , $\mathfrak{P} \cap N \neq \phi$.

Proof: Consider $u \in \mathcal{K S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$. Consider that there is a $\mathcal{K S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ N of u in U consequently $N \cap \mathfrak{P} = \phi$. Since N is $\mathcal{K S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u in U , by defn of $\mathcal{K S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ there would be an $\mathcal{K S}_{gp}\text{-}\mathbb{O}$ set G of u consequently $u \in G \subseteq N$. Therefore we have $G \cap \mathfrak{P} = \phi$ and so $\mathfrak{P} \subseteq G^c$. Since $U\text{-}G$ is an $\mathcal{K S}_{gp}\text{-}\mathcal{C}$ set containing \mathfrak{P} . We have by defn of $\mathcal{K S}_{gp}\text{-}\mathcal{C}$, $\mathcal{K S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \subseteq U\text{-}G$ and therefore $u \notin \mathcal{K S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$, which is a contradiction to hypothesis $u \in \mathcal{K S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$. Therefore $\mathfrak{P} \cap N \neq \phi$. Conversely, suppose for each $\mathcal{K S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ N of u in U , $\mathfrak{P} \cap N \neq \phi$. Suppose that $u \in \mathcal{K S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$ then by defn of $\mathcal{K S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$ there would be a $\mathcal{K S}_{gp}\text{-}\mathcal{C}$ set G of U consequently $\mathfrak{P} \subseteq G$ and $u \notin G$. Thus $u \in U\text{-}G$ and $U\text{-}G$ is $\mathcal{K S}_{gp}\text{-}\mathbb{O}$ set in U and accordingly $U\text{-}G$ is a $\mathcal{K S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ N of u in U . But $\mathfrak{P} \cap (U\text{-}G) = \phi$. Accordingly $u \in \mathcal{K S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$.

Theorem 2.5.

Let $(U, \tau_R(X), K S_R(X))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Let $\mathfrak{P} \subseteq U$. Then $\mathfrak{P} \in \mathcal{K S}_{gsp}\text{-}\mathbb{O}$ iff it is a $\mathcal{K S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of each of its points.

Proof:

Consider $\mathfrak{P} \in \mathcal{K S}_{gsp}\text{-}\mathbb{O}$ set and $u \in \mathfrak{P}$, then $u \in N \subseteq \mathfrak{P}$. Accordingly \mathfrak{P} is $\mathcal{K S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of each of its points. Conversely, assume that \mathfrak{P} is $\mathcal{K S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of each of its points. Then \mathfrak{P} is $\mathcal{K S}_{gsp}\text{-}\mathbb{O}$ set containing each of its points. So, \mathfrak{P} is $\mathcal{K S}_{gsp}\text{-}\mathbb{O}$ set.

Theorem 2.6.

Let $(U, \tau_R(X), K S_R(X))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. If \mathfrak{P} is a $\mathcal{K S}_{gsp}\text{-}\mathcal{C}$ subset of U and $u \in U\text{-}\mathfrak{P}$, then there would be a $\mathcal{K S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ N of u consequently $N \cap \mathfrak{P} = \phi$.

Proof:

Since \mathfrak{P} is $\mathcal{K S}_{gsp}\text{-}\mathcal{C}$, then $U\text{-}\mathfrak{P}$ is $\mathcal{K S}_{gsp}\text{-}\mathbb{O}$ set in U . By thm 2.5, $U\text{-}\mathfrak{P}$ contains a $\mathcal{K S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of each of its points. Accordingly there would be a $\mathcal{K S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$ of u consequently $N \subseteq U\text{-}\mathfrak{P}$. As it were no point of N belongs to \mathfrak{P} and hence $N \cap \mathfrak{P} = \phi$.

Theorem 2.7.

Let $(U, \tau_R(X), K S_R(X))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Let $\mathfrak{P} \subseteq U$. Then $u \in \mathcal{K S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$ iff for any $\mathcal{K S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ N of u in U , $\mathfrak{P} \cap N \neq \phi$.

Proof:

Suppose $u \in \mathcal{K S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$. Consider that there is a $\mathcal{K S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ N of u in U consequently $N \cap \mathfrak{P} = \phi$. Since N is $\mathcal{K S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u in U , by defn of $\mathcal{K S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ there would be an $\mathcal{K S}_{gsp}\text{-}\mathbb{O}$ set G of u consequently $u \in G \subseteq N$. Therefore we have $G \cap \mathfrak{P} = \phi$ and so $\mathfrak{P} \subseteq G^c$. Since $U\text{-}G$ is an $\mathcal{K S}_{gsp}\text{-}\mathcal{C}$ set containing \mathfrak{P} . We have by defn of $\mathcal{K S}_{gsp}\text{-}\mathcal{C}$, $\mathcal{K S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \subseteq U\text{-}G$ and therefore $u \notin \mathcal{K S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$, which is a contradiction to hypothesis $u \in \mathcal{K S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$. Therefore $\mathfrak{P} \cap N \neq \phi$. Conversely, suppose for each $\mathcal{K S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ N of u in U , $\mathfrak{P} \cap N \neq \phi$. Suppose that $u \in \mathcal{K S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$ then by defn of $\mathcal{K S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$ there would be a $\mathcal{K S}_{gsp}\text{-}\mathcal{C}$ set G of U consequently $\mathfrak{P} \subseteq G$ and $u \notin G$. Thus $u \in U\text{-}G$ and $U\text{-}G$ is $\mathcal{K S}_{gsp}\text{-}\mathbb{O}$ set in U and accordingly $U\text{-}G$ is a $\mathcal{K S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ N of u in U . But $\mathfrak{P} \cap (U\text{-}G) = \phi$. Accordingly $u \in \mathcal{K S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$.





$KS_{gp}[KS_{gsp}]$ -INTERIOR OF A SETS

In this section, the $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}$ and $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{I}$ of a set in $\mathfrak{K}\mathfrak{I}\mathfrak{S}$ are established and explored.

Definition 3.1.

Let $(\mathfrak{U}, \tau_R(\mathfrak{X}), KS_R(\mathfrak{X}))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Let $\mathfrak{P} \subseteq \mathfrak{U}$. A point $u \in \mathfrak{P}$ is said to be an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}$ of \mathfrak{P} , iff \mathfrak{P} is a $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{NBD}$ of u , that is iff there would be an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$ set \mathfrak{G} consequently $u \in \mathfrak{G} \subseteq \mathfrak{P}$. The set of all $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}$ points of \mathfrak{P} is said to be $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ and is stands for by KS_{gp}^o or $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$.

Theorem 3.2.

Let $(\mathfrak{U}, \tau_R(\mathfrak{X}), KS_R(\mathfrak{X}))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Let $\mathfrak{P} \subseteq \mathfrak{U}$. Then

1. $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) = \cup\{\mathfrak{G}: \mathfrak{G} \text{ is } \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}, \mathfrak{G} \subseteq \mathfrak{P}\}$.
2. $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ is an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$ set.
3. $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ is the largest $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$ set contained in \mathfrak{P} .
4. \mathfrak{P} is $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$ iff $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) = \mathfrak{P}$.

Proof:

i) $u \in \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$.

$\Leftrightarrow \mathfrak{P}$ is a $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{NBD}$ of u .

\Leftrightarrow would be an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$ set \mathfrak{G} consequently $u \in \mathfrak{G} \subseteq \mathfrak{P}$.

$\Leftrightarrow u \in \cup\{\mathfrak{G}: \mathfrak{G} \text{ is } \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}, \mathfrak{G} \subseteq \mathfrak{P}\}$.

Hence $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) = \cup\{\mathfrak{G}: \mathfrak{G} \text{ is } \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}, \mathfrak{G} \subseteq \mathfrak{P}\}$.

ii) Let u be an arbitrary point of $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$. Then u is an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}$ point of \mathfrak{P} . Accordingly by defn, \mathfrak{P} is a $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{NBD}$ of u . Then there would be an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$ set \mathfrak{G} consequently $u \in \mathfrak{G} \subseteq \mathfrak{P}$. Since \mathfrak{G} is an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$, it is $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{NBD}$ of each of its points and so \mathfrak{P} is also a $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{NBD}$ of each point of \mathfrak{G} . It follows that every point of \mathfrak{G} is an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}$ point of \mathfrak{P} so that $\mathfrak{G} \subseteq \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$. Thus it is shown that to each $u \in \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ there would be an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$ set \mathfrak{G} consequently $u \in \mathfrak{G} \subseteq \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$. Accordingly $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ is a $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{NBD}$ of each of its points and consequently $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ is $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$ set.

iii) Let $\mathfrak{P} \subseteq \mathfrak{P}$ and let $u \in \mathfrak{G}$ so that $u \in \mathfrak{G} \subseteq \mathfrak{P}$. Since \mathfrak{P} is $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$, \mathfrak{P} is a $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{NBD}$ of u and consequently is an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}$ point of \mathfrak{P} . Accordingly $u \in \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$. Thus we have shown that $u \in \mathfrak{G}$ this implies that $u \in \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ and so $\mathfrak{G} \subseteq \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{P}$. Accordingly $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ contains every $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O} \subseteq \mathfrak{P}$ and it is therefore the largest $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$ subset of \mathfrak{P} .

iv) Let $\mathfrak{P} = \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$, by (i) $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ is $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$ set and therefore \mathfrak{P} is also $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$. Conversely \mathfrak{P} be $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$, then \mathfrak{P} is surely identical with the largest $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$ set of \mathfrak{P} . But by (ii), $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ is the largest $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O} \subseteq \mathfrak{P}$. Accordingly $\mathfrak{P} = \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$.

Theorem 3.3.

Let $(\mathfrak{U}, \tau_R(\mathfrak{X}), KS_R(\mathfrak{X}))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Let $\mathfrak{P}, \mathfrak{Q} \subseteq \mathfrak{U}$. Then

1. $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{U}) = \mathfrak{U}, \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\phi) = \phi$.
2. $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{P}$.
3. $\mathfrak{P} \subseteq \mathfrak{Q} \Rightarrow \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{Q})$.
4. $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P} \cap \mathfrak{Q}) = \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cap \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{Q})$.
5. $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P} \cup \mathfrak{Q})$.

Proof:

i) Since \mathfrak{U} and ϕ are $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{O}$ sets, we have by (iv) of theorem(3.2), $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{U}) = \mathfrak{U}, \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\phi) = \phi$.

ii) $u \in \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$.

$\Leftrightarrow u$ is an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}$ point of \mathfrak{P} .

$\Leftrightarrow \mathfrak{P}$ is a $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathcal{NBD}$ of u .

$\Leftrightarrow u \in \mathfrak{P}$.

Hence $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{P}$.





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iii) Let $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$. Then u is an $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ point of \mathcal{P} and so \mathcal{P} is a $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of u , since $\mathcal{P} \subseteq \mathcal{Q}$, \mathcal{Q} is also a $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of u . This implies that $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{Q})$. Thus we have shown that $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$ this implies that $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{Q})$. Therefore $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{Q})$.

iv) Since $\mathcal{P} \cap \mathcal{Q} \subseteq \mathcal{P}$ and $\mathcal{P} \cap \mathcal{Q} \subseteq \mathcal{Q}$. We have by (iii), $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P} \cap \mathcal{Q}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$ and $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P} \cap \mathcal{Q}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{Q})$. This implies that $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P} \cap \mathcal{Q}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{Q})$ ——(1). Again let $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{Q})$. Then $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$ and $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{Q})$. Accordingly u is an $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ point of each of the set \mathcal{P} and \mathcal{Q} . It follows that \mathcal{P} and \mathcal{Q} are $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of u so that their intersection $\mathcal{P} \cap \mathcal{Q}$ is also a $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of u . Hence $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P} \cap \mathcal{Q})$. Thus $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{Q})$ this implies that $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P} \cap \mathcal{Q})$. Therefore $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{Q}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P} \cap \mathcal{Q})$ ——(2). From (1) & (2) we get, $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P} \cap \mathcal{Q}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{Q})$.

v) By (iii), $\mathcal{P} \subseteq \mathcal{P} \cup \mathcal{Q}$ this implies that $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P} \cup \mathcal{Q})$ and $\mathcal{Q} \subseteq \mathcal{P} \cup \mathcal{Q}$ this implies that $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{Q}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P} \cup \mathcal{Q})$. Accordingly $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{Q}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P} \cup \mathcal{Q})$.

Definition 3.4.

Let $(\mathcal{U}, \tau_R(\mathcal{X}), \mathcal{K}\mathcal{S}_R(\mathcal{X}))$ be a $\mathcal{K}\mathcal{I}\mathcal{S}$. Let $\mathcal{P} \subseteq \mathcal{U}$. A point $u \in \mathcal{P}$ is said to be an $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of \mathcal{P} , iff \mathcal{P} is a $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of u , that is iff there would be an $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$ set \mathcal{G} consequently $u \in \mathcal{G} \subseteq \mathcal{P}$. The set of all $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ points of \mathcal{P} is said to be $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of \mathcal{P} and is stands for by $\mathcal{K}\mathcal{S}_{gsp}^o$ or $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$.

Theorem 3.5.

Let $(\mathcal{U}, \tau_R(\mathcal{X}), \mathcal{K}\mathcal{S}_R(\mathcal{X}))$ be a $\mathcal{K}\mathcal{I}\mathcal{S}$. Let $\mathcal{P} \subseteq \mathcal{U}$. Then

1. $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) = \cup\{\mathcal{G} : \mathcal{G} \text{ is } \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}, \mathcal{G} \subseteq \mathcal{P}\}$.
2. $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$ is an $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$ set.
3. $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$ is the largest $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$ set contained in \mathcal{P} .
4. \mathcal{P} is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$ iff $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) = \mathcal{P}$.

Proof:

i) $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$.

$\Leftrightarrow \mathcal{P}$ is a $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of u .

\Leftrightarrow would be an $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$ set \mathcal{G} consequently $u \in \mathcal{G} \subseteq \mathcal{P}$.

$\Leftrightarrow u \in \cup\{\mathcal{G} : \mathcal{G} \text{ is } \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}, \mathcal{G} \subseteq \mathcal{P}\}$.

Hence $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) = \cup\{\mathcal{G} : \mathcal{G} \text{ is } \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}, \mathcal{G} \subseteq \mathcal{P}\}$.

ii) Let u be an arbitrary point of $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$. Then u is an $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ point of \mathcal{P} . Accordingly by defn, \mathcal{P} is a $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of u . Then there would be an $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$ set \mathcal{G} consequently $u \in \mathcal{G} \subseteq \mathcal{P}$. Since \mathcal{G} is an $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$, it is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of each of its points and so \mathcal{P} is also a $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of each point of \mathcal{G} . It follows that every point of \mathcal{G} is an $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ point of \mathcal{P} so that $\mathcal{G} \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$. Thus it is shown that to each $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$ there would be an $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$ set \mathcal{G} consequently $u \in \mathcal{G} \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$. Accordingly $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$ is a $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of each of its points and consequently $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$ is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$ set.

iii) Let $\mathcal{P} \subseteq \mathcal{P}$ and let $u \in \mathcal{G}$ so that $u \in \mathcal{G} \subseteq \mathcal{P}$. Since \mathcal{P} is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$, \mathcal{P} is a $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ of u and consequently is an $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD$ point of \mathcal{P} . Accordingly $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$. Thus we have shown that $u \in \mathcal{G}$ this implies that $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$ and so $\mathcal{G} \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) \subseteq \mathcal{P}$. Hence $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$ contains every $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O} \subseteq \mathcal{P}$ and it is therefore the largest $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O} \subseteq \mathcal{P}$.

iv) Let $\mathcal{P} = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$, by (i) $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$ is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$ set and therefore \mathcal{P} is also $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$. Conversely \mathcal{P} be $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$, then \mathcal{P} is surely identical with the largest $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$ set of \mathcal{P} . But by (ii), $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$ is the largest $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O} \subseteq \mathcal{P}$. Accordingly $\mathcal{P} = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P})$.

Theorem 3.6.

Let $(\mathcal{U}, \tau_R(\mathcal{X}), \mathcal{K}\mathcal{S}_R(\mathcal{X}))$ be a $\mathcal{K}\mathcal{I}\mathcal{S}$. Let $\mathcal{P}, \mathcal{Q} \subseteq \mathcal{U}$. Then

1. $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{U}) = \mathcal{U}, \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\emptyset) = \emptyset$.
2. $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}BD(\mathcal{P}) \subseteq \mathcal{P}$.





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3. $\mathfrak{P} \subseteq \mathfrak{Q} \Rightarrow \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q})$.
4. $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P} \cap \mathfrak{Q}) = \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \cap \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q})$.
5. $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P} \cup \mathfrak{Q})$.

Proof:

i) Since \mathfrak{U} and ϕ are $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{O}$ sets, we have by (iv) of theorem(3.2), $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{U}) = \mathfrak{U}$, $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\phi) = \phi$.

ii) $u \in \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P})$.

$\Leftrightarrow u$ is an $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}$ point of \mathfrak{P} .

$\Leftrightarrow \mathfrak{P}$ is a $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{NBD}$ of u .

$\Leftrightarrow u \in \mathfrak{P}$.

Hence $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{P}$.

iii) Let $u \in \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P})$. Then u is an $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}$ point of \mathfrak{P} and so \mathfrak{P} is a $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{NBD}$ of u , since $\mathfrak{P} \subseteq \mathfrak{Q}$, \mathfrak{Q} is also a $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{NBD}$ of u . This implies that $u \in \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q})$. Thus we have shown that $u \in \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P})$ this implies that $u \in \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q})$. Therefore $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q})$.

iv) Since $\mathfrak{P} \cap \mathfrak{Q} \subseteq \mathfrak{P}$ and $\mathfrak{P} \cap \mathfrak{Q} \subseteq \mathfrak{Q}$. We have by (iii), $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P} \cap \mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P})$ and $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P} \cap \mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q})$. This implies that $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P} \cap \mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \cap \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q})$ ——(1). Again let $u \in \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \cap \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q})$. Then $u \in \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P})$ and $u \in \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q})$. Hence u is an $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}$ point of each of the set \mathfrak{P} and \mathfrak{Q} . It follows that \mathfrak{P} and \mathfrak{Q} are $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{NBD}$ of u so that their intersection $\mathfrak{P} \cap \mathfrak{Q}$ is also a $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{NBD}$ of u . Hence $u \in \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P} \cap \mathfrak{Q})$. Thus $u \in \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \cap \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q})$ this implies that $u \in \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P} \cap \mathfrak{Q})$. Therefore $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \cap \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P} \cap \mathfrak{Q})$ ——(2). From (1) & (2) we get, $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P} \cap \mathfrak{Q}) = \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \cap \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q})$.

v) By (iii), $\mathfrak{P} \subseteq \mathfrak{P} \cup \mathfrak{Q}$ this implies that $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P} \cup \mathfrak{Q})$ and $\mathfrak{Q} \subseteq \mathfrak{P} \cup \mathfrak{Q}$ this implies that $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P} \cup \mathfrak{Q})$. Hence $\mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{C}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P} \cup \mathfrak{Q})$.

$\mathfrak{K}\mathfrak{S}_{gp}[\mathfrak{K}\mathfrak{S}_{gp}]\text{-CLOSURE OF A SETS}$

Throughout this section, the $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}$ and $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{C}$ of a set in $\mathfrak{K}\mathfrak{I}\mathfrak{S}$ are proposed and studied.

Definition 4.1.

The $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}$ of \mathfrak{P} of a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$ is the intersection of all $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}$ sets containing \mathfrak{P} . It stands for by $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P})$. Thus $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P}) = \cap \{\mathfrak{X} : \mathfrak{X} \text{ is } \mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C} \text{ and } \mathfrak{P} \subseteq \mathfrak{X}\}$.

Theorem 4.2.

Let \mathfrak{P} be a subset of a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Then

1. $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P})$ is the smallest $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}$ set containing \mathfrak{P} .
2. \mathfrak{P} is $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}$ iff $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P}) = \mathfrak{P}$.

Proof: i) This follows from definition(4.1).

ii) If \mathfrak{P} is $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}$, then \mathfrak{P} itself is the smallest $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}$ set containing \mathfrak{P} and hence $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P}) = \mathfrak{P}$. Conversely let By (i), $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P}) = \mathfrak{P}$, $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P})$ is $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}$ and so \mathfrak{P} is also $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}$.

Theorem 4.3. Let $(\mathfrak{U}, \tau_R(\mathfrak{X}), \mathfrak{K}\mathfrak{S}_R(\mathfrak{X}))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$ and let $\mathfrak{P}, \mathfrak{Q} \subseteq \mathfrak{U}$. Then

1. $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{U}) = \mathfrak{U}$, $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\phi) = \phi$.
2. $\mathfrak{P} \subseteq \mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P})$.
3. $\mathfrak{P} \subseteq \mathfrak{Q} \Rightarrow \mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P}) \subseteq \mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{Q})$.
4. $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P} \cup \mathfrak{Q}) = \mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P}) \cup \mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{Q})$.
5. $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P} \cap \mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P}) \cap \mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{Q})$.
6. $\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P})) = \mathfrak{K}\mathfrak{C}_{gp}\text{-}\mathfrak{C}(\mathfrak{P})$.





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Proof:

- i) Since \mathcal{U} and ϕ are \mathcal{R}_{gsp} - \mathcal{C} sets, we have $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{U}) = \mathcal{U}$, $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\phi) = \phi$.
- ii) By theorem(4.2) of (i), $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$ is the smallest \mathcal{R}_{gsp} - \mathcal{C} set containing \mathcal{P} and so $\mathcal{P} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$.
- iii) By(ii), $\mathcal{Q} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$. Since $\mathcal{P} \subseteq \mathcal{Q}$, we have $\mathcal{P} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$. But $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ is \mathcal{R}_{gsp} - \mathcal{C} set. Thus $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ is a \mathcal{R}_{gsp} - \mathcal{C} set containing \mathcal{P} . Since $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$ is the smallest \mathcal{R}_{gsp} - \mathcal{C} set containing \mathcal{P} , we have $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$. Hence $\mathcal{P} \subseteq \mathcal{Q} \Rightarrow \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$.
- iv) Since $\mathcal{P} \subseteq \mathcal{P} \cup \mathcal{Q}$ and $\mathcal{Q} \subseteq \mathcal{P} \cup \mathcal{Q}$, we have $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q})$ and $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q})$ by (iii). Hence $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q})$ ——(1). Since $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$, $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ are \mathcal{R}_{gsp} - \mathcal{C} sets, $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ is \mathcal{R}_{gsp} - \mathcal{C} . Also $\mathcal{P} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$ and $\mathcal{Q} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ implies that $\mathcal{P} \cup \mathcal{Q} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$. Thus $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ is a \mathcal{R}_{gsp} - \mathcal{C} set containing $\mathcal{P} \cup \mathcal{Q}$. Since $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q})$ is the smallest \mathcal{R}_{gsp} - \mathcal{C} set containing $\mathcal{P} \cup \mathcal{Q}$, we have $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ ——(2). From (1) and (2) we have, $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q}) = \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$.
- v) $\mathcal{P} \cap \mathcal{Q} \subseteq \mathcal{P}$ this implies that $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cap \mathcal{Q}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$ and $\mathcal{P} \cap \mathcal{Q} \subseteq \mathcal{Q}$ this implies that $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cap \mathcal{Q}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$. Hence $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cap \mathcal{Q}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cap \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$.
- vi) Since $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$ is a \mathcal{R}_{gsp} - \mathcal{C} set, we have by (ii) of theorem(4.2), $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})) = \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$.

Definition 4.4.

The $\mathcal{R}_{gsp}\text{-}\mathcal{C} \subseteq \mathcal{P}$ of a $\mathcal{R}\mathcal{I}\mathcal{S}$ is the intersection of all \mathcal{R}_{gsp} - \mathcal{C} sets containing \mathcal{P} . It stands for by $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$. Thus $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) = \cap \{ \mathcal{X} : \mathcal{X} \text{ is } \mathcal{R}_{gsp}\text{-}\mathcal{C} \text{ and } \mathcal{X} \supseteq \mathcal{P} \}$.

Theorem 4.5. Let \mathcal{P} be a subset of a $\mathcal{R}\mathcal{I}\mathcal{S}$. Then

- 1. $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$ is the smallest \mathcal{R}_{gsp} - \mathcal{C} set containing \mathcal{P} .
- 2. \mathcal{P} is \mathcal{R}_{gsp} - \mathcal{C} iff $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) = \mathcal{P}$.

Proof: i) This follows from definition(4.1).

ii) If \mathcal{P} is \mathcal{R}_{gsp} - \mathcal{C} , then \mathcal{P} itself is the smallest \mathcal{R}_{gsp} - \mathcal{C} set containing \mathcal{P} and accordingly $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) = \mathcal{P}$. Conversely let By(i), $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) = \mathcal{P}$, $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$ is \mathcal{R}_{gsp} - \mathcal{C} and so \mathcal{P} is also \mathcal{R}_{gsp} - \mathcal{C} .

Theorem 4.6.

Let $(\mathcal{U}, \tau_R(\mathcal{X}), KS_R(\mathcal{X}))$ be a $\mathcal{R}\mathcal{I}\mathcal{S}$ and let $\mathcal{P}, \mathcal{Q} \subseteq \mathcal{U}$. Then

- 1. $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{U}) = \mathcal{U}$, $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\phi) = \phi$.
- 2. $\mathcal{P} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$.
- 3. $\mathcal{P} \subseteq \mathcal{Q} \Rightarrow \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$.
- 4. $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q}) = \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$.
- 5. $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cap \mathcal{Q}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cap \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$.
- 6. $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})) = \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$.

Proof:

- i) Since \mathcal{U} and ϕ are \mathcal{R}_{gsp} - \mathcal{C} sets, we have $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{U}) = \mathcal{U}$, $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\phi) = \phi$.
- ii) By theorem(4.2) of (i), $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$ is the smallest \mathcal{R}_{gsp} - \mathcal{C} set containing \mathcal{P} and so $\mathcal{P} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$.
- iii) By(ii), $\mathcal{Q} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$. Since $\mathcal{P} \subseteq \mathcal{Q}$, we have $\mathcal{P} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$. But $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ is \mathcal{R}_{gsp} - \mathcal{C} set. Thus $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ is a \mathcal{R}_{gsp} - \mathcal{C} set containing \mathcal{P} . Since $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$ is the smallest \mathcal{R}_{gsp} - \mathcal{C} set containing \mathcal{P} , we have $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$. Hence $\mathcal{P} \subseteq \mathcal{Q} \Rightarrow \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$.
- iv) Since $\mathcal{P} \subseteq \mathcal{P} \cup \mathcal{Q}$ and $\mathcal{Q} \subseteq \mathcal{P} \cup \mathcal{Q}$, we have $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q})$ and $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q})$ by (iii). Accordingly $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q})$ ——(1). Since $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$, $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ are \mathcal{R}_{gsp} - \mathcal{C} sets, $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ is \mathcal{R}_{gsp} - \mathcal{C} . Also $\mathcal{P} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P})$ and $\mathcal{Q} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ implies that $\mathcal{P} \cup \mathcal{Q} \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$. Thus $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ is a \mathcal{R}_{gsp} - \mathcal{C} set containing $\mathcal{P} \cup \mathcal{Q}$. Since $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q})$ is the smallest \mathcal{R}_{gsp} - \mathcal{C} set containing $\mathcal{P} \cup \mathcal{Q}$, we have $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q}) \subseteq \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$ ——(2). From (1) and (2) we have, $\mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P} \cup \mathcal{Q}) = \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{P}) \cup \mathcal{R}_{gsp}\text{-}\mathcal{C}(\mathcal{Q})$.





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v) $\mathfrak{P} \cap \mathfrak{Q} \subseteq \mathfrak{P}$ this implies that $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{P} \cap \mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{P})$ and $\mathfrak{P} \cap \mathfrak{Q} \subseteq \mathfrak{Q}$ this implies that $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{P} \cup \mathfrak{Q}) \cap \mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{Q})$. Hence $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{P} \cap \mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{P}) \cap \mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{Q})$.
 vi) Since $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{P})$ is a $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{C}$ set, we have by (ii) of theorem(4.2), $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{P})) = \mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{P})$.

$\mathfrak{K}\mathfrak{S}_{gp}[\mathfrak{K}\mathfrak{S}_{gsp}]$ -EXTERIOR OF A SETS

This section presents and develops a set's $\mathfrak{K}\mathfrak{S}_{gp}$ and $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}$ in $\mathfrak{K}\mathfrak{I}\mathfrak{S}$.

Definition 5.1.

Let $\mathfrak{P} \subseteq \mathfrak{U}$. A point $u \in \mathfrak{U}$ is said to be an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}$ point of \mathfrak{P} iff it is an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}$ point of the complement \mathfrak{P}' of \mathfrak{P} . That is iff there would be an $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{O}$ set \mathfrak{G} consequently $u \in \mathfrak{G} \subseteq \mathfrak{P}'$ and $u \in \mathfrak{G}$ and $\mathfrak{G} \cap \mathfrak{P} = \phi$. The set of all $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}$ points of \mathfrak{P} is said to be $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}$ of \mathfrak{P} and is stands for by $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P})$.

Theorem 5.2.

Let $(\mathfrak{U}, \tau_R(\mathfrak{X}), \mathfrak{K}\mathfrak{S}_R(\mathfrak{X}))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Let $\mathfrak{P}, \mathfrak{Q} \subseteq \mathfrak{U}$. Then

1. $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{U}) = \phi, \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\phi) = \mathfrak{U}$.
2. $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P}) \subseteq \mathfrak{P}'$.
3. $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P}) = \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}[\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P})']$.
4. $\mathfrak{P} \subseteq \mathfrak{Q} \Rightarrow \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P})$.
5. $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P} \subseteq \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}[\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P})])$.

Proof:

i) $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{U}) = \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{U}')$
 $= \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\phi)$
 $= \phi$.

$\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\phi) = \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\phi')$
 $= \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{U})$
 $= \mathfrak{U}$.

ii) $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P}) = \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{U}') \subseteq \mathfrak{P}'$. Since by thm(3.3) of(ii) $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}) \subseteq \mathfrak{P}$.

iii) Let $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}[\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P})'] = \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}[\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}')]$.
 $= \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}[\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}')]$.
 $= \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}')$ [since $S'' = S$ and $S^{oo} = S^o$ for any set S].
 $= \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P})$.

iv) $\mathfrak{P} \subseteq \mathfrak{Q} \Rightarrow \mathfrak{Q}' \subseteq \mathfrak{P}' \Rightarrow \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{Q}') \subseteq \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}')$
 $\Rightarrow \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P})$.

v) $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P}) \subseteq \mathfrak{P}'$ by(ii). By (iv) gives $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P}') \subseteq \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}[\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P})]$. But $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}) = \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P}')$. Hence $\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}) \subseteq \mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}[\mathfrak{K}\mathfrak{S}_{gp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P})]$.

Definition 5.3.

Let $\mathfrak{P} \subseteq \mathfrak{U}$. A point $u \in \mathfrak{U}$ is said to be an $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}$ point of \mathfrak{P} iff it is an $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{S}$ point of the complement \mathfrak{P}' of \mathfrak{P} . That is iff there would be an $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{O}$ set \mathfrak{G} consequently $u \in \mathfrak{G} \subseteq \mathfrak{P}'$ and $u \in \mathfrak{G}$ and $\mathfrak{G} \cap \mathfrak{P} = \phi$. The set of all $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}$ points of \mathfrak{P} is said to be $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}$ of \mathfrak{P} and is stands for by $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P})$.

Theorem 5.4.

Let $(\mathfrak{U}, \tau_R(\mathfrak{X}), \mathfrak{K}\mathfrak{S}_R(\mathfrak{X}))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Let $\mathfrak{P}, \mathfrak{Q} \subseteq \mathfrak{U}$. Then

1. $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{U}) = \phi, \mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}(\phi) = \mathfrak{U}$.
2. $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P}) \subseteq \mathfrak{P}'$.
3. $\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P}) = \mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}[\mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P})']$.
4. $\mathfrak{P} \subseteq \mathfrak{Q} \Rightarrow \mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{Q}) \subseteq \mathfrak{K}\mathfrak{S}_{gsp}\text{-}\mathfrak{E}\mathfrak{X}(\mathfrak{P})$.





5. $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I} \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}[\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})]$.

Proof:

i) $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{U}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{U}')$.

= $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\phi)$.

= ϕ .

$\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\phi) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\phi')$.

= $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{U})$.

= \mathfrak{U} .

ii) $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{U}') \subseteq \mathfrak{P}'$. Since by thm(3.3) of(ii) $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{P}$.

iii) Let $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}[\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})'] = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}[\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}')]$.

= $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}[\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}')]$.

= $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}')$ [since $S'' = S$ and $S^{oo} = S^o$ for any set S].

= $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})$.

iv) $\mathfrak{P} \subseteq \mathfrak{Q} \Rightarrow \mathfrak{Q}' \subseteq \mathfrak{P}' \Rightarrow \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{Q}') \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}')$.

$\Rightarrow \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{Q}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})$.

v) $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) \subseteq \mathfrak{P}'$ by(ii). By (iv) gives $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}') \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}[\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})]$. But $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}')$. Hence $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}[\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})]$.

$\mathcal{K}\mathcal{S}_{gp}[\mathcal{K}\mathcal{S}_{gp}]$ -FRONTIER OF A SETS

Under this work, the $\mathcal{K}\mathcal{S}_{gp}$ and $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}$ of a set in $\mathfrak{K}\mathfrak{I}\mathfrak{S}$ is introduced, and its investigation is conducted.

Definition 6.1.

For any subset $\mathfrak{P} \subseteq \mathfrak{U}$. The $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}$ of \mathfrak{P} is defined by $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$.

Theorem 6.2.

Let \mathfrak{P} be any subset of a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Then $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$, $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})$, $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$ are disjoint and $\mathfrak{U} = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$. Further $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$ is $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}$ set.

Proof:

By definition(5.1), $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}')$. Also $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{P}$ and $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}') \subseteq \mathfrak{P}'$. Since $\mathfrak{P} \cap \mathfrak{P}' = \phi$, it follows that $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}') = \phi$. Again by definition of $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}$, we have , $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.

$\Leftrightarrow u \notin \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ and $u \notin \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})$.

$\Leftrightarrow u \notin \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})$

$\Leftrightarrow u \in [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}')]$.

Accordingly $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}')] \text{---(1)}$.

It follows that $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) = \phi$ and $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) = \phi$ and $\mathfrak{U} = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$. Since $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ and $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})$ are $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}$ sets, we see from (1) that $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$ is a $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}$ set.

Theorem 6.3.

Let \mathfrak{U} be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Then a point $u \in \mathfrak{U}$ is a $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}$ point of \mathfrak{P} iff every $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u intersects both \mathfrak{P} and \mathfrak{P}' .

Proof:

If $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.

$\Leftrightarrow u \notin \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$ and $u \notin \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}')$.

\Leftrightarrow neither \mathfrak{P} nor \mathfrak{P}' is a $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u .

\Leftrightarrow no $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u can be contained in \mathfrak{P} (or) in \mathfrak{P}' .

\Leftrightarrow every $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u intersects both \mathfrak{P} and \mathfrak{P}' .





Theorem 6.4.

$$\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}')$$

Proof:

If $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.

\Leftrightarrow every $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u intersects both \mathfrak{P} and \mathfrak{P}' .

\Leftrightarrow every $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u intersects both (\mathfrak{P}'') and \mathfrak{P}' .

$\Leftrightarrow u \in \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}')$

Remark 6.5.

$$\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) = \mathfrak{P} \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}).$$

Proof:

Since $\mathfrak{P} \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$ and $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$, We have $\mathfrak{P} \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$ —(1). Also $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}')] = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cap [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}')]$. Again since $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{P}$ and $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$, it follows that $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \subseteq \mathfrak{P} \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$ —(2). From (1) and (2), we get $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) = \mathfrak{P} \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.

Theorem 6.6.

Let $(\mathcal{U}, \tau_R(\mathfrak{X}), \mathcal{K}\mathcal{S}_R(\mathfrak{X}))$ be a $\mathfrak{K}\mathfrak{A}\mathfrak{I}\mathfrak{S}$. Let $\mathfrak{P}, \mathfrak{Q} \subseteq \mathcal{U}$. Then

1. $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}(\mathfrak{P}')\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$.
2. $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) = \mathfrak{P}\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.
3. $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}') = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}')$.
4. $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})) \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.
5. $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P} \cup \mathfrak{Q}) \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{Q})$.
6. $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P} \cap \mathfrak{Q}) \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{Q})$.

Proof:

i) We have $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}')] = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}') \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}')$ [Since De-Morgan's law].
 $= \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}''') \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}'')$ by rem(6.5).
 $= \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}') \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$ [Since $S'' = S$ for any set S].

Now $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}') = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}')$ [Since $S\text{-}T = S \cap T'$ for any set S and T].
 $= \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$, by rem(6.5). Accordingly $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathfrak{P}' = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$.

ii) $\mathfrak{P}\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathfrak{P}\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$.
 $= \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$, by (i) [Since $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{P}$].

iii) We have, $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}') = [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}'')] = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}') \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}')$ [Since De-Morgan's law].

By rem(6.5), $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}') = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$.

Then $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}') = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}'') = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}''') = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}')$ [Since $\mathfrak{P}'' = \mathfrak{P}$].

Therefore $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}') \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$.

iv) $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}))$ by (i).
 $= \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}'''))$, [Since $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}') = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})$].
 $= \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})) \cap (\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}'))$, [Since $S'' = S$ for any set S].
 $\subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}')$, [Since $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P}) \subseteq \mathfrak{P} \Rightarrow \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})) \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$].
 $= \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$ by (i).

Thus $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P})) \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.

v) $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P} \cap \mathfrak{Q}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P} \cup \mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{P} \cap \mathfrak{Q})'$, by (i).





$$\begin{aligned}
 &= \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{Q}) \cap (\mathfrak{P}' \cap \mathfrak{Q}'), [\text{Since Demorgan's law}]. \\
 &\subseteq (\mathfrak{P} \cup \mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}') \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{Q}'). \\
 &= [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap (\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}') \cap (\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{Q}')))] \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{Q}) \cap [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}') \cap (\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{Q}'))], [\text{by distributive law}]. \\
 &= [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}') \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{Q}')] \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{Q}') \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}') = [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{Q}')] \cup [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{Q}) \cap \mathfrak{P}'], \text{ by (i)}. \\
 &\subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{Q}), [\text{Since } \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{Q}') \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})]. \\
 \text{vi) } &\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P} \cap \mathfrak{Q}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P} \cap \mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P} \cap \mathfrak{Q}') \text{ by (i)}. \\
 &\subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}' \cap \mathfrak{Q}'). \\
 &= (\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{Q})) \cap (\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}') \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{Q}')). \\
 &= (\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{Q}) \cup (\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}') \cup [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{Q}')]), [\text{by distributive law}]. \\
 &= [(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}')) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{Q}) \cup [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap (\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}'))]. \\
 &\subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{Q}).
 \end{aligned}$$

Theorem 6.7.

Let \mathfrak{U} be a $\mathfrak{K}\mathfrak{T}\mathfrak{S}$ and let $\mathfrak{P} \subseteq \mathfrak{U}$. Then

1. If \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{O}$, then $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathfrak{P}$.
2. \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{O}$ iff $\mathfrak{P} \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \phi$. i.e., iff $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \subseteq \mathfrak{P}'$.
3. \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}$ iff $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \subseteq \mathfrak{P}$.

Proof:

i) By (i) of theorem(6.6), we have $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P})$. Since \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{O}$, $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}) = \mathfrak{P}$. Accordingly $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathfrak{P}$.

ii) By (i) of above theorem, $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}') \text{---(1)}$. Let \mathfrak{P} be $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{O}$. Then \mathfrak{P}' is $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}$. Accordingly $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}') = \mathfrak{P}' \text{---(2)}$. Now $\mathfrak{P} \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathfrak{P} \cap [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}')] \text{ by (1)}$.
 $= \mathfrak{P} \cap [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathfrak{P}'] \text{ by (2)}$.
 $= [\mathfrak{P} \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathfrak{P}']$ [Since $\mathfrak{P} \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$].
 $= \phi$.

Conversely, let $\mathfrak{P} \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \phi$. Then by(1), $\mathfrak{P} \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \phi$.

- $\Rightarrow \mathfrak{P} \cap [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}')] = \phi$.
- $\Rightarrow \mathfrak{P} \cap [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})] \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}') = \phi$.
- $\Rightarrow \mathfrak{P} \cap [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}')] = \phi$. [Since $\mathfrak{P} \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$]
- $\Rightarrow \mathfrak{P} \subseteq [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}'')]$.

$\Rightarrow \mathfrak{P} \subseteq [\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}')]$. [since $[\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}'')] = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}')$]. But $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}') \subseteq \mathfrak{P}$. Hence $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}') = \mathfrak{P}$. It follows that \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{O}$.

iii) Let \mathfrak{P} be $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}$. Then $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) = \mathfrak{P} \text{---(3)}$. Accordingly $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}')$ by(1).
 $= \mathfrak{P} \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{S}(\mathfrak{P}')$ by(3) $\subseteq \mathfrak{P}$. Conversely, let $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \subseteq \mathfrak{P}$. Then $\mathfrak{P} \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathfrak{P}$. But $\mathfrak{P} \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathfrak{P} \cup \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$ by rem(6.5), it follows that $\mathfrak{P} = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}(\mathfrak{P})$. Accordingly \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathcal{C}$.

Definition 6.8.

For any subset \mathfrak{P} of \mathfrak{U} . The $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}$ of \mathfrak{P} is defined by $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})$.

Theorem 6.9.

Let $\mathfrak{P} \subseteq \mathfrak{U}$. Then $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})$, $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})$, $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$ are disjoint and $\mathfrak{U} = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}(\mathfrak{P})$. Further $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$ is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}$ set.

Proof:

By definition(5.1), $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')$. Also $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \subseteq \mathfrak{P}$ and $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') \subseteq \mathfrak{P}'$. Since $\mathfrak{P} \cap \mathfrak{P}' = \phi$, it follows that $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') = \phi$. Again by definition of $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}$, we have, $u \in \mathcal{K}\mathcal{S}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.

$$\Leftrightarrow u \notin \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \text{ and } u \notin \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}).$$





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$\Leftrightarrow u \notin \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})$
 $\Leftrightarrow u \in [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})]'$.
 Accordingly $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})]$ ——(1). It follows that $(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) = \phi$ and $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) = \phi$ and $\mathfrak{U} = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}$. Since $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})$ and $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P})$ are $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$ sets, we see from (1) that $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$ is a $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}$ set.

Theorem 6.10.

Let \mathfrak{U} be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Then a point $u \in \mathfrak{U}$ is a $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}$ point of \mathfrak{P} iff every $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u intersects both \mathfrak{P} and \mathfrak{P}' .

Proof:

If $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$
 $\Leftrightarrow u \notin \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})$ and $u \notin \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')$.
 \Leftrightarrow neither \mathfrak{P} nor \mathfrak{P}' is a $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u .
 \Leftrightarrow no $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u can be contained in \mathfrak{P} (or) in \mathfrak{P}' .
 \Leftrightarrow every $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u intersects both \mathfrak{P} and \mathfrak{P}' .

Theorem 6.11.

$\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}')$.

Proof:

If $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.
 \Leftrightarrow every $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u intersects both \mathfrak{P} and \mathfrak{P}' .
 \Leftrightarrow every $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{N}\mathcal{B}\mathcal{D}$ of u intersects both (\mathfrak{P}'') and \mathfrak{P}' .
 $\Leftrightarrow u \in \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}')$

Remark 6.12.

$\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) = \mathfrak{P} \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.

Proof:

Since $\mathfrak{P} \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$ and $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$, We have $\mathfrak{P} \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}')] = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cap [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}')]$. Again since $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \subseteq \mathfrak{P}$ and $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$, it follows that $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \subseteq \mathfrak{P} \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$ ——(2). From (1) and (2), we get $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) = \mathfrak{P} \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.

Theorem 6.13.

Let $(\mathfrak{U}, \tau_R(\mathfrak{X}), \mathcal{K}\mathcal{S}_R(\mathfrak{X}))$ be a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$. Let $\mathfrak{P}, \mathfrak{Q} \subseteq \mathfrak{U}$. Then

1. $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}(\mathfrak{P}')\text{-}\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})$.
2. $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) = \mathfrak{P}\text{-}\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.
3. $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}') = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')$.
4. $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.
5. $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P} \cup \mathfrak{Q}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{Q})$.
6. $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P} \cap \mathfrak{Q}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{Q})$.

Proof:

i) We have $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}')]$.
 $= \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{E}\mathcal{X}(\mathfrak{P}')$ [Since De-Morgan's law].
 $= \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}''') \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}'')$ by rem(6.5).
 $= \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$ [Since $S''' = S$ for any set S].

Now $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')$ [Since $S\text{-}T = S \cap T'$ for any set S and T].
 $= \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})$, by rem(6.5). Hence $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathfrak{P}' = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})$.

ii) $\mathfrak{P}\text{-}\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathfrak{P}\text{-}[\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})] = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})$, by (i) [Since $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \subseteq \mathfrak{P}$].





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iii) We have, $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}') = [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}'')] \text{ by (i).}$
 $= \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}') \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')$ [Since De-Morgan's law].

By rem(6.5), $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})$.

Then $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}''') = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}')$
 [Since $\mathfrak{P}'' = \mathfrak{P}$].

Therefore $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}') = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})$.
 $= \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')$.

iv) $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})) \text{ by (i).}$

$= \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}'))$, [Since $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})$].

$= \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')$, [Since $S'' = S$ for any set S].

$\subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')$, [Since $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) \subseteq \mathfrak{P} \Rightarrow \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$].

$\subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')$.

$= \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \text{ by (i).}$

Thus $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$.

v) $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P} \cap \mathfrak{Q}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P} \cup \mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}[(\mathfrak{P} \cap \mathfrak{Q})']$, by (i).

$= \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{Q}) \cap (\mathfrak{P}' \cap \mathfrak{Q}')$, [Since Demorgan's law].

$\subseteq (\mathfrak{P} \cup \mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{Q}')$.

$= [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap (\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{Q}'))] \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{Q}) \cap [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{Q}')] \text{, [by distributive law].}$

$= [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{Q}')] \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{Q}') \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') = [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{Q}')] \cup [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{Q}) \cap \mathfrak{P}'] \text{, by (i).}$

$\subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{Q})$, [Since $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{Q}') \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P})$].

vi) $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P} \cap \mathfrak{Q}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P} \cap \mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P} \cap \mathfrak{Q})'$ by (i).

$\subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}' \cap \mathfrak{Q}')$.

$= (\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{Q}) \cap (\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{Q}'))$.

$= (\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{Q}) \cup (\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') \cup (\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{Q}')) \text{, [by distributive law].}$

$= (\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{Q}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{Q}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')$.

$\subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{Q})$.

Theorem 6.14.

Let \mathcal{U} be a $\mathfrak{K}\mathfrak{T}\mathfrak{S}$ and let $\mathfrak{P} \subseteq \mathcal{U}$. Then

1. If \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$, then $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathfrak{P}$.
2. \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$ iff $\mathfrak{P} \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \phi$. i.e., iff $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \subseteq \mathfrak{P}'$.
3. \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}$ iff $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) \subseteq \mathfrak{P}$.

Proof:

i) By (i) of theorem(6.6), we have $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P})$. Since \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$, $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}) = \mathfrak{P}$. Accordingly $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})\text{-}\mathfrak{P}$.

ii) By (i) of above theorem, $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')$ ———(1). Let \mathfrak{P} be $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{O}$. Then \mathfrak{P}' is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}$. Hence $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}') = \mathfrak{P}'$ ———(2).

Now $\mathfrak{P} \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \mathfrak{P} \cap [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')] \text{ by (1).}$

$= \mathfrak{P} \cap [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathfrak{P}'] \text{ by (2).}$

$= \mathfrak{P} \cap [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathfrak{P}']$ [Since $\mathfrak{P} \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$].

$= \phi$. Conversely, let $\mathfrak{P} \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \phi$. Then by(1), $\mathfrak{P} \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{F}\mathcal{R}(\mathfrak{P}) = \phi$.

$\Rightarrow \mathfrak{P} \cap [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')] = \phi$.

$\Rightarrow \mathfrak{P} \cap [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})] \cap [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')] = \phi$.

$\Rightarrow \mathfrak{P} \cap [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}')] = \phi$. [Since $\mathfrak{P} \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathcal{C}(\mathfrak{P})$]

$\Rightarrow \mathfrak{P} \subseteq [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{S}(\mathfrak{P}'')]$.





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$\Rightarrow \mathfrak{B} \subseteq [\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{B})]$. [since $[\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{B}'')] = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{B})$]. But $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{B}) \subseteq \mathfrak{B}$. Accordingly $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{B}) = \mathfrak{B}$. It follows that \mathfrak{B} is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{O}$.

iii) Let \mathfrak{B} be $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{C}$. Then $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{B}) = \mathfrak{B}$ ———(3). Accordingly $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{FR}(\mathfrak{B}) = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{B}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{B}')$ by(1). = $\mathfrak{B} \cap \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{I}(\mathfrak{B}')$ by(3) $\subseteq \mathfrak{B}$ Conversely, let $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{FR}(\mathfrak{B}) \subseteq \mathfrak{B}$. Then $\mathfrak{B} \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{FR}(\mathfrak{B}) = \mathfrak{B}$. But $\mathfrak{B} \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{FR}(\mathfrak{B}) = \cup \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{B})$ by rem(6.5), it follows that $\mathfrak{B} = \mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{C}(\mathfrak{B})$. Accordingly \mathfrak{B} is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\mathfrak{C}$.

$\mathcal{K}\mathcal{S}_{gp}[\mathcal{K}\mathcal{S}_{gsp}\text{-}BD]$ -BORDER OF A SETS

In this section, the $\mathcal{K}\mathcal{S}_{gp}$ and $\mathcal{K}\mathcal{S}_{gsp}\text{-}BD$ of a set in $\mathfrak{R}\mathfrak{I}\mathfrak{S}$ are created and explored.

Definition 7.1.

For any subset \mathfrak{B} of \mathfrak{U} . The $\mathcal{K}\mathcal{S}_{gp}\text{-}BD$ of \mathfrak{B} is defined by $\mathcal{K}\mathcal{S}_{gp}(\mathfrak{B}) = \mathfrak{B}\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$.

Theorem 7.2.

In a $\mathfrak{R}\mathfrak{I}\mathfrak{S}$ for any subset \mathfrak{B} of \mathfrak{U} , the following statement holds

1. $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\phi) = \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{U}) = \phi$.
2. $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) \subseteq \mathfrak{B}$.
3. $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) = \mathfrak{B}\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$.
4. $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) = \mathfrak{B} \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{C}(\mathfrak{U}\text{-}\mathfrak{B})$.
5. $\mathfrak{B} = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$.
6. $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) = \phi$.
7. \mathfrak{B} is $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{O}$ iff $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) = \phi$.
8. $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})) = \phi$.
9. $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})) = \phi$.
10. $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})) = \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$.

Proof:

(i),(ii),(iii) follows from the definition(7.1).

To prove(iv), $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) = \mathfrak{B}\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \cap (\mathfrak{B}\text{-}\mathfrak{B}\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})) = \mathfrak{B} \cap \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{C}(\mathfrak{U}\text{-}\mathfrak{B})$. $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{C}(\mathfrak{U}\text{-}\mathfrak{B}) = \mathfrak{U}\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$. Accordingly (iv) is proved.

(v) Let $u \in \mathfrak{U}$. If $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$, then $\mathfrak{B} \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$. If $u \notin \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$, then by definition of $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$, $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$. Hence $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$ and so $\mathfrak{B} \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$. On the other hand, since $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \subseteq \mathfrak{B}$ and $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) \subseteq \mathfrak{B}$, $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) \subseteq \mathfrak{B}$. Therefore $\mathfrak{B} = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \cup \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$.

(vi) Suppose $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) \neq \phi$. Let $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$. Then $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$ and $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$. Since $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) = \mathfrak{B}\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$, $u \in \mathfrak{B}$ and $u \notin \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$. But $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$, $u \notin \mathfrak{B}$. This is a contradiction. Accordingly $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) = \phi$.

(vii) Necessity: Suppose \mathfrak{B} is $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{O}$. Since $\mathfrak{B} \subseteq \mathfrak{U}$, then \mathfrak{B} is $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{O}$ in \mathfrak{U} iff $\mathfrak{B} = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$. Now, $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) = \mathfrak{B}\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) = \mathfrak{B}\text{-}\mathfrak{B} = \phi$.

Sufficiency: Suppose $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) = \phi$. This implies, $\mathfrak{B}\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) = \phi$. Therefore $\mathfrak{B} = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$ and hence \mathfrak{B} is $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{O}$.

(viii) By the definition of $\mathcal{K}\mathcal{S}_{gp}\text{-}BD$ of a set, $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}))$. Since $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$. Therefore $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})) = \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$. Therefore $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})) = \phi$.

(ix) Let $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}))$. Since $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}) \subseteq \mathfrak{B}$ and $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \subseteq \mathfrak{B}$, $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})) \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$. Accordingly $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B})$. Since $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})) \subseteq \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$, then $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$. Therefore $u \in \mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathfrak{B}) \cap \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$. By part(vi), $u = \phi$. It follows that $\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})) = \phi$.

(x) By the definition of $\mathcal{K}\mathcal{S}_{gp}\text{-}BD$ of a set $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})) = \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})\text{-}\mathcal{K}\mathcal{S}_{gp}\text{-}\mathfrak{I}(\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B}))$. By part(ix), $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})) = \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})\text{-}\phi$. Accordingly $\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})) = \mathcal{K}\mathcal{S}_{gp}\text{-}BD(\mathfrak{B})$.





Definition 7.3.

For any subset \mathfrak{P} of \mathfrak{U} . The $\mathcal{K}\mathcal{S}_{gsp}$ -BD of \mathfrak{P} is defined by $\mathcal{K}\mathcal{S}_{gsp}(\mathfrak{P}) = \mathfrak{P}-\mathcal{K}\mathcal{S}_{gsp}-\mathfrak{I}(\mathfrak{P})$.

Theorem 7.4.

In a $\mathfrak{K}\mathfrak{I}\mathfrak{S}$ for any $\mathfrak{P} \subseteq \mathfrak{U}$, the following statement holds

1. $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\phi) = \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{U}) = \phi$.
2. $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) \subseteq \mathfrak{P}$.
3. $\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) = \mathfrak{P}-\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$.
4. $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) = \mathfrak{P} \cap \mathcal{K}\mathcal{S}_{gsp}\text{-C}(\mathfrak{U}-\mathfrak{P})$.
5. $\mathfrak{P} = \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$.
6. $\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) = \phi$.
7. \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\emptyset$ iff $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) = \phi$.
8. $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})) = \phi$.
9. $\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})) = \phi$.
10. $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})) = \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$.

Proof:

(i),(ii),(iii) follows from the definition(7.1).

To prove(iv), $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) = \mathfrak{P}-\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \cap (\mathfrak{P}-\mathfrak{P}-\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})) = \mathfrak{P} \cap \mathcal{K}\mathcal{S}_{gsp}\text{-C}(\mathfrak{U}-\mathfrak{P})$. $\mathcal{K}\mathcal{S}_{gsp}\text{-C}(\mathfrak{U}-\mathfrak{P}) = \mathfrak{U}-\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$. Accordingly (iv) is proved.

(v)Let $u \in \mathfrak{U}$. If $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$, then $\mathfrak{P} \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$. If $u \notin \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$, then by definition of $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$, $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$. Hence $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$ and so $\mathfrak{P} \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$. On the other hand, since $\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \subseteq \mathfrak{P}$ and $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) \subseteq \mathfrak{P}$, $\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) \subseteq \mathfrak{P}$. Therefore $\mathfrak{P} = \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \cup \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$.

(vi)Suppose $\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) \neq \phi$. Let $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$. Then $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$ and $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$. Since $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) = \mathfrak{P}-\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$, $u \in \mathfrak{P}$ and $u \notin \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$. But $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$, $u \notin \mathfrak{P}$. This is a contradiction. Hence $\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) = \phi$.

(vii)Necessity: Suppose \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\emptyset$. Since $\mathfrak{P} \subseteq \mathfrak{U}$, then \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\emptyset$. in \mathfrak{U} iff $\mathfrak{P} = \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$. Now, $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) = \mathfrak{P}-\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) = \mathfrak{P}-\mathfrak{P} = \phi$.

Sufficiency: Suppose $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) = \phi$. This implies, $\mathfrak{P}-\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) = \phi$. Therefore $\mathfrak{P} = \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$ and accordingly \mathfrak{P} is $\mathcal{K}\mathcal{S}_{gsp}\text{-}\emptyset$.

(viii)By the definition of $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}$ of a set, $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})) = \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})-\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}))$. Since $\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})) = \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$. Therefore $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})) = \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})-\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$. Therefore $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})) = \phi$.

(ix)Let $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}))$. Since $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}) \subseteq \mathfrak{P}$ and $\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \subseteq \mathfrak{P}$, $\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$. Hence $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P})$. Since $\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})) \subseteq \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$, then $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$. Therefore $u \in \mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathfrak{P}) \cap \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$. By part(vi), $u = \phi$. It follows that $\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})) = \phi$.

(x)By the definition of $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}$ of a set $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})) = \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})-\mathcal{K}\mathcal{S}_{gsp}\text{-I}(\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P}))$. By part(ix), $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})) = \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})-\phi$. Accordingly $\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})) = \mathcal{K}\mathcal{S}_{gsp}\text{-BD}(\mathfrak{P})$.





CONCLUSION

In the existing paper, we had introduced and studied the concept of $KS_{gp}[KS_{gsp}]$ -neighbourhood of sets, $KS_{gp}[KS_{gsp}]$ -interior of sets, $KS_{gp}[KS_{gsp}]$ -closure of sets, $KS_{gp}[KS_{gsp}]$ -exterior of sets, $KS_{gp}[KS_{gsp}]$ -frontier of sets, $KS_{gp}[KS_{gsp}]$ -border of sets in kasaj topological spaces. This shall be extended in the future research with some applications.

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On $\hat{g}\pi$ Homeomorphic Functions in Topological Spaces

R.Vijayalakshmi^{1*} and V.Thiripurasundari²

¹Research Scholar, PG and Research Department of Mathematics, Sri S.Ramasamy Naidu Memorial College (Autonomous), Sattur, (Affiliated to Madurai Kamaraj University), Madurai, Tamil Nadu, India.

²Assistant Professor, PG and Research Department of Mathematics, Sri S.Ramasamy Naidu Memorial College (Autonomous), Sattur, (Affiliated to Madurai Kamaraj University), Madurai, Tamil Nadu, India.

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*Address for Correspondence

R.Vijayalakshmi

Research Scholar,

PG and Research Department of Mathematics,

Sri S.Ramasamy Naidu Memorial College (Autonomous), Sattur,

(Affiliated to Madurai Kamaraj University),

Madurai, Tamil Nadu, India.



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ABSTRACT

Firstly, We introduced $\hat{g}\pi$ -closed function in topological spaces. Also we introduced $\hat{g}\pi$ -homeomorphism. We also studied a new class of mapping, namely $\hat{g}\pi$ -homeomorphism which forms a subclass of $\hat{g}\pi$ -homeomorphisms and also discussed their properties.

Keywords: $\hat{g}\pi$ -closed set, $\hat{g}\pi$ -open set, $\hat{g}\pi$ -continuous, $\hat{g}\pi$ -closed function, $\hat{g}\pi$ -irresolute function

INTRODUCTION

In this paper we introduce a new class of function called $\hat{g}\pi$ -homeomorphic function and study some properties of $\hat{g}\pi$ -homeomorphic function.

Preliminaries

Throughout this paper, X, Y and Z denote the topological spaces (X, τ) , (Y, σ) and (Z, γ) respectively and have no separation axioms are assumed. For a subset A of a space X , $cl(A)$ and $int(A)$ denote the closure of A and the interior of A respectively. We recall the following definitions and some results, which are used in the sequel.

Definition 2.1. A subset A of a topological space X is called

- (1) a pre-open set [5] if $A \subseteq int(cl(A))$.
- (2) a semi-open set [7] if $A \subseteq cl(int(A))$.
- (3) a semi-pre open set [6] if $A \subseteq cl(int(cl(A)))$.
- (4) a regular-open set [10] if $A = int(cl(A))$.





Definition 2.2. [10] For any subset A of (X, τ) , $\pi cl(A) = \cap \{B : B \supseteq A, B \text{ is a } \pi\text{-closed subset of } X.$

Definition 2.3. A subset A of a topological space X is called

- (1) a generalized closed set (briefly g -closed) [3] if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is open in X .
- (2) a generalized semi-closed set (briefly gs -closed) [1] if $scl(A) \subseteq U$ whenever $A \subseteq U$ and U is open in X .
- (3) a generalized α -closed set (briefly $g\alpha$ -closed) [3] if $\alpha cl(A) \subseteq U$ whenever $A \subseteq U$ and U is α -open in X .
- (4) a generalized pre-closed set (briefly gp -closed) [5] if $pcl(A) \subseteq U$ whenever $A \subseteq U$ and U is open in X .
- (5) a generalized a π closed set (briefly $g^*\pi$ -closed) [6] if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is g -open in X .
- (6) a generalized cap closed set (briefly \hat{g} -closed)[4] if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is semi open in X .
- (6) a generalized cap π closed set (briefly $\hat{g}\pi$ -closed)[11] if $\pi cl(A) \subseteq U$ whenever $A \subseteq U$ and U is g -semi open in X .
- (7) a π generalized closed set (briefly πg -closed)[3] if $cl(A) \subseteq U$ whenever $A \subseteq U$ and U is open in X .

Definition 2.4. A function $f : X \rightarrow Y$ is called

- (1) Continuous [1] if $f^{-1}(V)$ is closed in X for every closed subset V of Y .
- (2) g -Continuous[8] if $f^{-1}(V)$ is g -closed in X for every closed subset V of Y .
- (3) \hat{g} -Continuous[12] if $f^{-1}(V)$ is \hat{g} -closed in X for every closed subset V of Y .
- (4) $\hat{g}\pi$ -Continuous[11] if $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X for every closed subset V of Y .
- (5) $\hat{g}\pi$ -irresolute[11] if $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X for every $\hat{g}\pi$ -closed subset V of Y .
- (6) $g^*\pi$ -continuous [6] if $f^{-1}(V)$ is $g^*\pi$ -closed in X for every closed subset V of Y .

Definition 2.5. A bijective function $f : X \rightarrow Y$ is called

- (1) generalized homeomorphism[2] (briefly g -homeomorphism) if f is both g -continuous and g -open.
- (2) \hat{g} homeomorphism [13] if f is both \hat{g} -continuous and \hat{g} -open.
- (3) gc -homeomorphism[13] if both f and f^{-1} are gc -irresolute maps.

3 $\hat{g}\pi$ -Closed Function

Definition 3.1. A function $f : X \rightarrow Y$ is called $\hat{g}\pi$ -closed function if the image of every closed set in X is $\hat{g}\pi$ -closed set in Y .

Proposition 3.2. (a) Every $\hat{g}\pi$ -closed function is g -closed.

(b) Every $\hat{g}\pi$ -closed function is \hat{g} -closed.

(c) Every $\hat{g}\pi$ -closed function is πg -closed.

(d) Every $\hat{g}\pi$ -closed function is gs -closed.

(e) Every $\hat{g}\pi$ -closed function is $g^*\pi$ -closed.

Proof. Follows from the fact that every $\hat{g}\pi$ -closed set is g -closed, \hat{g} -closed, πg -closed, gs -closed and $g^*\pi$ -closed.

Theorem 3.3. A function $f : X \rightarrow Y$ is $\hat{g}\pi$ -closed if and only if for each subset S of Y and for each open set U containing $f^{-1}(S)$ there is a $\hat{g}\pi$ -open set V of Y such that $S \subseteq V$ and $f^{-1}(V) \subseteq U$.

Proof. Suppose f is $\hat{g}\pi$ -closed function. Let S be a subset of Y and U be an open set of X such that $f^{-1}(S) \subseteq U$. Then $V = Y - f(X - U)$ is $\hat{g}\pi$ -open set containing S such that $f^{-1}(V) \subseteq U$.





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Conversely, suppose that F is a closed set in X . Then $f^{-1}(Y - f(F)) = X - F$ is open. By hypothesis, there is a $\hat{g}\pi$ -open set V of Y such that $Y - f(F) \subseteq V$ and $f^{-1}(V) \subseteq X - F$. Therefore $F \subseteq X - f^{-1}(V)$. Hence $Y - V \subseteq f(F) \subseteq f(X - f^{-1}(V)) \subseteq Y - V$, which implies, $(F) = Y - V$. Thus f is $\hat{g}\pi$ -closed function.

Remark 3.4. The composition of two $\hat{g}\pi$ -closed functions need not be a $\hat{g}\pi$ -closed function as seen from the following example.

Example 3.5. Let $X = Y = Z = \{a, b, c\}$, $\tau = \{\varphi, \{a\}, \{a, c\}, X\}$, $\sigma = \{\varphi, \{a\}, Y\}$ and $\omega = \{\varphi, \{a, b\}, Z\}$. Let $f : X \rightarrow Y$ and $g : Y \rightarrow Z$ be identity functions. Then f and g are both $\hat{g}\pi$ -closed functions, but their composition $g \circ f : X \rightarrow Z$ is not a $\hat{g}\pi$ -closed function, since for the closed set $\{b\}$ in X , $(g \circ f)(\{b\}) = \{b\}$ is not $\hat{g}\pi$ -closed in Z .

Theorem 3.6. If $f : X \rightarrow Y$ is closed and $g : Y \rightarrow Z$ is $\hat{g}\pi$ -closed, then $g \circ f : X \rightarrow Z$ is $\hat{g}\pi$ -closed function.
 Proof. Let V be any closed set in Z . Since f is closed, $f(V)$ is closed in Y . Again since g is $\hat{g}\pi$ -closed function, $g(f(V))$ is $\hat{g}\pi$ -closed set in Z . But $g(f(V)) = (g \circ f)(V)$ is $\hat{g}\pi$ -closed in Z . Therefore $g \circ f : X \rightarrow Z$ is $\hat{g}\pi$ -closed function.

Theorem 3.7. Let $f : X \rightarrow Y$ and $g : Y \rightarrow Z$ be any two functions such that $g \circ f : X \rightarrow Z$ be a $\hat{g}\pi$ closed function. If f is continuous then g is a $\hat{g}\pi$ -closed function.
 Proof. Let V be a closed set in Z . Since f is continuous, $f^{-1}(V)$ is closed in X . Since $g \circ f$ is $\hat{g}\pi$ -closed, $(g \circ f)(f^{-1}(V))$ is $\hat{g}\pi$ -closed in Z . Therefore $g(V)$ is $\hat{g}\pi$ -closed in Z . Hence g is a $\hat{g}\pi$ -closed function.

Theorem 3.8. A bijection function $f : X \rightarrow Y$ is a $\hat{g}\pi$ -closed if and only if $f(U)$ is a $\hat{g}\pi$ -open set in Y for every open set U in X .
 Proof. Let $f : X \rightarrow Y$ be a $\hat{g}\pi$ -closed function and U be any open set in X . Then U^c is a closed set in X . Therefore by the hypothesis, $f(U^c)$ is $\hat{g}\pi$ -closed in Y . Since f is bijective, $f(U^c) = [f(U)]^c$ is $\hat{g}\pi$ -closed in Y . Hence $f(U)$ is $\hat{g}\pi$ -open in Y . Conversely, let U be a closed subset of X . Then U^c is an open set in X . By the hypothesis, $f(U^c)$ is $\hat{g}\pi$ -open in Y . Since f is bijective, $f(U^c) = [f(U)]^c$. Thus $f(U)$ is $\hat{g}\pi$ -closed in Y . Hence f is a $\hat{g}\pi$ -closed map.

Remark 3.9. Bijection condition on f is necessary in the above theorem which can be seen in the following example.

Example 3.10. Let $X = Y = \{a, b, c\}$ with $\tau = \{\varphi, X, \{a\}\}$, $\sigma = \{\varphi, Y, \{a\}, \{a, b\}\}$. Let $f : X \rightarrow Y$ be a function such that $f(a) = b, f(b) = a, f(c) = a$. Then for the only open set $\{a\}$ in X , $f(\{a\})$ is $\hat{g}\pi$ -open but not $\hat{g}\pi$ -closed as for the closed set $\{b, c\}$ in X , $f(\{b, c\}) = \{a\}$ is not $\hat{g}\pi$ -closed in Y .

Theorem 3.11. If $f : X \rightarrow Y$ is a $\hat{g}\pi$ -closed function and A is a closed subset of X then $f|_A : A \rightarrow Y$ is $\hat{g}\pi$ -closed.
 Proof : Let $B \subseteq A$ be closed in A . Since A is closed in X , B is closed in X . Since f is a closed function, $f(B) = (f|_A)(B)$ is $\hat{g}\pi$ -closed in Y . Hence $f|_A$ is $\hat{g}\pi$ -closed.

4 $\hat{g}\pi$ - Homeomorphism

Definition 4.1. A function $f : X \rightarrow Y$ is said to be $\hat{g}\pi$ -open if the image of every open set in X is $\hat{g}\pi$ -open in Y .

Definition 4.2. A bijection function $f : X \rightarrow Y$ is called a $\hat{g}\pi$ -homeomorphism if f is both $\hat{g}\pi$ -continuous and $\hat{g}\pi$ -open map.

Theorem 4.3. Every $\hat{g}\pi$ -homeomorphism is πg -homeomorphism.
Proof. Let $f : X \rightarrow Y$ be a homeomorphism. Then f is a bijective $\hat{g}\pi$ -continuous and $\hat{g}\pi$ -open map. Let V be closed in Y , then $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X . Every $\hat{g}\pi$ -closed set is πg -closed set and hence $f^{-1}(V)$ is πg -closed in X . This implies that f is πg -continuous. Let U be $\hat{g}\pi$ -open set in X . Then $f(U)$ is πg -open in Y . This implies that the function f is an πg -open. Hence f is an πg -homeomorphism.





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Remark 4.4. The converse of above theorem need not be true as seen from the following example

Example 4.5. Let $X = Y = \{a, b, c\}$, $\tau = \{\varphi, X, \{b\}, \{a, b\}\}$ and $\sigma = \{\varphi, Y, \{a\}, \{a, b\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is πg -homeomorphism. However, f is not a $\hat{g}\pi$ -homeomorphism.

Theorem 4.6. Every $\hat{g}\pi$ -homeomorphism is g -semi homeomorphism.

Proof. Let $f : X \rightarrow Y$ be a homeomorphism. Then f is a bijective $\hat{g}\pi$ -continuous and $\hat{g}\pi$ -open function. Let V be closed in Y , then $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X . Every $\hat{g}\pi$ -closed set is g -semi closed set and hence $f^{-1}(V)$ is g -semi closed in X . This implies that f is g -semi continuous. Let U be $\hat{g}\pi$ -open set in X . Then $f(U)$ is g -semi open in Y . This implies that the function f is an g -semi open. Hence f is an g -semi homeomorphism.

Remark 4.7. The converse of above theorem need not be true as seen from the following example.

Example 4.8. Let $X = Y = \{a, b, c\}$, $\tau = \{\varphi, X, \{a\}, \{b\}, \{a, b\}\}$ and $\sigma = \{\varphi, Y, \{a\}, \{b, c\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is g -semi homeomorphism. However, f is not a $\hat{g}\pi$ -homeomorphism.

Theorem 4.9. Every $\hat{g}\pi$ -homeomorphism is πgb -homeomorphism.

Proof. Let $f : X \rightarrow Y$ be a homeomorphism. Then f is a bijective $\hat{g}\pi$ -continuous and $\hat{g}\pi$ -open function. Let V be closed in Y , then $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X . Every $\hat{g}\pi$ -closed set is πgb -closed set and hence $f^{-1}(V)$ is πgb -closed in X . This implies that f is πgb -continuous. Let U be $\hat{g}\pi$ -open set in X . Then $f(U)$ is πgb -open in Y . This implies that the function f is an πgb -open. Hence f is an πgb -homeomorphism.

Remark 4.10. The converse of above theorem need not be true as seen from the following example

Example 4.11. Let $X = Y = \{a, b, c\}$, $\tau = \{\varphi, X, \{a\}, \{a, b\}, \{a, c\}\}$ and $\sigma = \{\varphi, Y, \{a\}, \{c\}, \{a, c\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is πgb -homeomorphism. However, f is not a $\hat{g}\pi$ -homeomorphism.

Theorem 4.12. Every $\hat{g}\pi$ -homeomorphism is πgr -homeomorphism.

Proof. Let $f : X \rightarrow Y$ be a homeomorphism. Then f is a bijective $\hat{g}\pi$ -continuous and $\hat{g}\pi$ -open function. Let V be closed in Y , then $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X . Every $\hat{g}\pi$ -closed set is πgr -closed set and hence $f^{-1}(V)$ is πgr -closed in X . This implies that f is πgr -continuous. Let U be $\hat{g}\pi$ -open set in X . Then $f(U)$ is πgr -open in Y . This implies that the function f is an πgr -open. Hence f is an πgr -homeomorphism.

Remark 4.13. The converse of above theorem need not be true as seen from the following example

Example 4.14. Let $X = Y = \{a, b, c\}$, $\tau = \{\varphi, X, \{a\}, \{a, b\}\}$ and $\sigma = \{\varphi, Y, \{a\}, \{a, b\}, \{a, c\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is πgr -homeomorphism. However, f is not a $\hat{g}\pi$ -homeomorphism.

Theorem 4.15. Every $\hat{g}\pi$ -homeomorphism is πgs -homeomorphism.

Proof. Let $f : X \rightarrow Y$ be a homeomorphism. Then f is a bijective $\hat{g}\pi$ -continuous and $\hat{g}\pi$ -open function. Let V be closed in Y , then $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X . Every $\hat{g}\pi$ -closed set is πgs -closed set and hence $f^{-1}(V)$ is πgs -closed in X . This implies that f is πgs -continuous. Let U be $\hat{g}\pi$ -open set in X . Then $f(U)$ is πgs -open in Y . This implies that the function f is an πgs -open. Hence f is an πgs -homeomorphism.

Remark 4.16. The converse of above theorem need not be true as seen from the following example.

Example 4.17. Let $X = Y = \{a, b, c\}$, $\tau = \{\varphi, X, \{b\}, \{a, c\}\}$ and $\sigma = \{\varphi, Y, \{b, c\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is πgs -homeomorphism. However, f is not a $\hat{g}\pi$ -homeomorphism.





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Theorem 4.18. Every $\hat{g}\pi$ -homeomorphism is g -homeomorphism.

Proof. Let $f : X \rightarrow Y$ be a homeomorphism. Then f is a bijective $\hat{g}\pi$ -continuous and $\hat{g}\pi$ -open function. Let V be closed in Y , then $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X . Every $\hat{g}\pi$ -closed set is g -closed set and hence $f^{-1}(V)$ is g -closed in X . This implies that f is g -continuous. Let U be $\hat{g}\pi$ -open set in X . Then $f(U)$ is g -open in Y . This implies that the function f is an g -open. Hence f is an g -homeomorphism.

Remark 4.19. The converse of above theorem need not be true as seen from the following example

Example 4.20. Let $X = Y = \{a, b, c\}$, $\tau = \{\varphi, X, \{c\}, \{a, b\}\}$ and $\sigma = \{\varphi, Y, \{a\}, \{b\}, \{a, b\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is g -homeomorphism. However, f is not a $\hat{g}\pi$ -homeomorphism.

Theorem 4.21. Every $\hat{g}\pi$ -homeomorphism is rg -homeomorphism.

Proof. Let $f : X \rightarrow Y$ be a homeomorphism. Then f is a bijective $\hat{g}\pi$ -continuous and $\hat{g}\pi$ -open function. Let V be closed in Y , then $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X . Every $\hat{g}\pi$ -closed set is rg -closed set and hence $f^{-1}(V)$ is rg -closed in X . This implies that f is rg -continuous. Let U be $\hat{g}\pi$ -open set in X . Then $f(U)$ is rg -open in Y . This implies that the function f is an rg -open. Hence f is an rg -homeomorphism.

Remark 4.22. The converse of above theorem need not be true as seen from the following example

Example 4.23. Let $X = Y = \{a, b, c\}$, $\tau = \{\varphi, X, \{b\}, \{a, c\}\}$ and $\sigma = \{\varphi, Y, \{a\}, \{c\}, \{a, c\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is rg -homeomorphism. However, f is not a $\hat{g}\pi$ -homeomorphism.

Theorem 4.24. Every $\hat{g}\pi$ -homeomorphism is \hat{g} -homeomorphism

Proof. Let $f : X \rightarrow Y$ be a homeomorphism. Then f is a bijective $\hat{g}\pi$ -continuous and $\hat{g}\pi$ -open function. Let V be closed in Y , then $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X . Every $\hat{g}\pi$ -closed set is \hat{g} -closed set and hence $f^{-1}(V)$ is \hat{g} -closed in X . This implies that f is \hat{g} -continuous. Let U be $\hat{g}\pi$ -open set in X . Then $f(U)$ is \hat{g} -open in Y . This implies that the function f is an \hat{g} -open. Hence f is an \hat{g} -homeomorphism.

Remark 4.25. The converse of above theorem need not be true as seen from the following example

Example 4.26. Let $X = Y = \{a, b, c\}$, $\tau = \{\varphi, X, \{c\}, \{a, b\}\}$ and $\sigma = \{\varphi, Y, \{a\}, \{b\}, \{a, b\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is \hat{g} -homeomorphism. However, f is not a $\hat{g}\pi$ -homeomorphism.

Theorem 4.27. Every $\hat{g}\pi$ -homeomorphism is gp -homeomorphism

Proof. Let $f : X \rightarrow Y$ be a homeomorphism. Then f is a bijective $\hat{g}\pi$ -continuous and $\hat{g}\pi$ -open function. Let V be closed in Y , then $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X . Every $\hat{g}\pi$ -closed set is gp -closed set and hence $f^{-1}(V)$ is gp -closed in X . This implies that f is gp -continuous. Let U be $\hat{g}\pi$ -open set in X . Then $f(U)$ is gp -open in Y . This implies that the function f is an gp -open. Hence f is an gp -homeomorphism.

Remark 4.28. The converse of above theorem need not be true as seen from the following example

Example 4.29. Let $X = Y = \{a, b, c\}$, $\tau = \{\varphi, X, \{a\}, \{a, b\}\}$ and $\sigma = \{\varphi, Y, \{a\}, \{a, b\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is gp -homeomorphism. However, f is not a $\hat{g}\pi$ -homeomorphism.

Theorem 4.30. Every $\hat{g}\pi$ -homeomorphism is $g\alpha$ -homeomorphism.





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Proof. Let $f : X \rightarrow Y$ be a homeomorphism. Then f is a bijective $\hat{g}\pi$ -continuous and $\hat{g}\pi$ -open function. Let V be closed in Y , then $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X . Every $\hat{g}\pi$ -closed set is $g\alpha$ -closed set and hence $f^{-1}(V)$ is $g\alpha$ -closed in X . This implies that f is $g\alpha$ -continuous. Let U be $\hat{g}\pi$ -open set in X . Then $f(U)$ is $g\alpha$ -open in Y . This implies that the function f is an $g\alpha$ -open. Hence f is an $g\alpha$ -homeomorphism.

Remark 4.31. The converse of above theorem need not be true as seen from the following example

Example 4.32. Let $X = Y = \{a, b, c\}$, $\tau = \{\varphi, X, \{b\}, \{a, b\}\}$ and $\sigma = \{\varphi, Y, \{a, b\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is $g\alpha$ -homeomorphism. However, f is not a $\hat{g}\pi$ -homeomorphism.

Theorem 4.33. Every $\hat{g}\pi$ -homeomorphism is αg -homeomorphism

Proof. Let $f : X \rightarrow Y$ be a homeomorphism. Then f is a bijective $\hat{g}\pi$ -continuous and $\hat{g}\pi$ -open function. Let V be closed in Y , then $f^{-1}(V)$ is $\hat{g}\pi$ -closed in X . Every $\hat{g}\pi$ -closed set is αg -closed set and hence $f^{-1}(V)$ is αg -closed in X . This implies that f is αg -continuous. Let U be $\hat{g}\pi$ -open set in X . Then $f(U)$ is αg -open in Y . This implies that the function f is an αg -open. Hence f is an αg -homeomorphism.

Remark 4.34. The converse of above theorem need not be true as seen from the following example

Example 4.35. Let $X = Y = \{a, b, c\}$, $\tau = \{\varphi, X, \{b\}, \{a, b\}\}$ and $\sigma = \{\varphi, Y, \{b\}, \{a, c\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is $g\alpha$ -homeomorphism. However, f is not a $\hat{g}\pi$ -homeomorphism.

Theorem 4.36. For any bijection $f : X \rightarrow Y$, the following statements are equivalent:

- (i) $f^{-1} : Y \rightarrow X$ is $\hat{g}\pi$ -continuous,
- (ii) f is a $\hat{g}\pi$ -open,
- (iii) f is a $\hat{g}\pi$ -closed.

Proof. (i) \Rightarrow (ii): Let U be an open set of X . By assumption $(f^{-1})^{-1}(U) = f(U)$ is $\hat{g}\pi$ -open in Y and so f is $\hat{g}\pi$ -open.

(ii) \Rightarrow (iii): Let V be a closed set of X . Then V^c is open in X . By assumption, $f(V^c)$ is $\hat{g}\pi$ -open in Y . **That is,** $f(V^c) = (f(V))^c$ is $\hat{g}\pi$ -open in Y and therefore $f(V)$ is $\hat{g}\pi$ -closed in Y . Hence f is $\hat{g}\pi$ -closed.

(iii) \Rightarrow (i): Let V be a closed set in X . By assumption $f(V)$ is $\hat{g}\pi$ -closed in Y . But $f(V) = (f^{-1})^{-1}(V)$ and therefore f^{-1} is $\hat{g}\pi$ -continuous on Y .

Remark 4.37. The composition of $\hat{g}\pi$ -homeomorphism map need not be $\hat{g}\pi$ -homeomorphism.

Example 4.38. Let $X = Y = Z = \{a, b, c\}$, $\tau = \{X, \varphi, \{a\}, \{c\}, \{a, c\}\}$, $\sigma = \{Y, \varphi, \{a, b\}\}$ and $\rho = \{Z, \varphi, \{a\}, \{b\}, \{a, b\}\}$. Let $f : X \rightarrow Y$, and $g : Y \rightarrow Z$ be identity function. Then both f and g are $\hat{g}\pi$ -homeomorphisms. but their composition $g \circ f : X \rightarrow Z$ is not a $\hat{g}\pi$ -homeomorphism. since for closed set $\{a, c\}$ in Z , $(g \circ f)^{-1}(\{a, c\}) = \{a, c\}$ is not $\hat{g}\pi$ -closed set in X .

Definition 4.39. A bijective function $f : X \rightarrow Y$ is called a $\hat{g}\pi^*$ -homeomorphism if both f and f^{-1} are $\hat{g}\pi$ -irresolute.

Remark 4.40. $\hat{g}\pi$ -homeomorphism and $\hat{g}\pi^*$ -homeomorphisms are independent as shown in the following example.

Example 4.41. Let $X = \{a, b, c\} = Y$ with topologies $\tau = \{\varphi, X, \{a\}, \{b\}, \{a, b\}\}$ and $\sigma = \{\varphi, Y, \{b\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is a $\hat{g}\pi^*$ -homeomorphism since $\hat{g}\pi^*(\tau) = \hat{g}\pi^*(\sigma) = \{\varphi, X, \{a, c\}\}$. But it is not a $\hat{g}\pi$ -homeomorphism since $f^{-1}(\{a, c\}) = \{a, c\}$ not $\hat{g}\pi$ -closed set in X .

Example 4.42. Let $X = \{a, b, c\} = Y$ with topologies $\tau = \{\varphi, X, \{a\}, \{a, b\}\}$ and $\sigma = \{\varphi, Y, \{a\}\}$. Let $f : X \rightarrow Y$ be the identity function. Then f is a $\hat{g}\pi$ -homeomorphism since $\hat{g}\pi(\tau) = \hat{g}\pi(\sigma) = \{\varphi, X, \{b, c\}\}$. But it is not a $\hat{g}\pi^*$ -homeomorphism since $f^{-1}(\{b, c\}) = \{b, c\}$ not $\hat{g}\pi^*$ -closed set in X .





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Theorem 4.43. The composition of two $\hat{g}\pi^*$ -homeomorphisms is a $\hat{g}\pi^*$ -homeomorphism.

Proof. Let $f : X \rightarrow Y$ and $g : Y \rightarrow Z$ be $\hat{g}\pi^*$ -homeomorphisms. Let F be a $\hat{g}\pi$ -closed set in Z . Since g is a $\hat{g}\pi$ -irresolute map, $g^{-1}(F)$ is $\hat{g}\pi$ -closed in Y . Since f is a $\hat{g}\pi$ -irresolute, $f^{-1}(g^{-1}(F))$ is $\hat{g}\pi$ -closed in X . **That is $(g \circ f)^{-1}(F)$ is $\hat{g}\pi$ -closed in X .** This implies that $g \circ f$ is $\hat{g}\pi$ -irresolute. Let G be a $\hat{g}\pi$ -closed in X . Since f^{-1} is a $\hat{g}\pi$ -irresolute, $(f^{-1})^{-1}(G)$ is $\hat{g}\pi$ -closed in X . That is $f(G)$ is $\hat{g}\pi$ -closed in Y . Since g^{-1} is a $\hat{g}\pi$ -irresolute, $(g^{-1})^{-1}(f(G))$ is $\hat{g}\pi$ -closed in Z . **That is $g(f(G))$ is $\hat{g}\pi$ -closed in Z .** Therefore $(g \circ f)(G)$ is $\hat{g}\pi$ -closed in Z . **This implies that $((g \circ f)^{-1})^{-1}(G)$ is a $\hat{g}\pi$ -closed in Z . Thus $(g \circ f)^{-1} : Y \rightarrow Z$ is a $\hat{g}\pi$ -irresolute. Hence $g \circ f$ is a $\hat{g}\pi^*$ -homeomorphism.**

CONCLUSION

In this paper, a new class of function called $\hat{g}\pi$ -homeomorphism has been introduced and the relationship between $\hat{g}\pi$ -homeomorphism with already existing homeomorphisms are analysed. Also some of their properties have been studied.

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Pectinolytic Activity of *Aspergillus* sp Grown on Apple Peel under Solid State Fermentation

M Kannahi^{1*} and R Mathumitha²

¹Assistant Professor, PG and Research Department of Microbiology, STET Women's College (Autonomous), Sundarakottai, Thiruvarur, Tamil Nadu, India.

²M.Phil Scholar, Department of Microbiology, STET Women's College (Autonomous), Sundarakottai, Thiruvarur, Tamil Nadu, India.

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*Address for Correspondence

M Kannahi,

Assistant Professor,

PG and Research Department of Microbiology,

STET Women's College (Autonomous),

Sundarakottai, Thiruvarur, Tamil Nadu, India.

Email: kannahiamf@gmail.com



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ABSTRACT

The present study was aimed at studying pectinolytic activity of resident fungi isolated from decomposing apple peels under solid state fermentation. Apple fruit peel was subjected to natural fermentation and the fermenting fungi were isolated, characterized and identified using standard microbiology methods. The isolated fungi were in turn used for fermentation to determine their pectinolytic activity through solid state fermentation technique. Culture parameters such as incubation period, temperature, moisture content and addition of salts supplements were optimized during the research for five days. The identified fungi were *Aspergillus niger* and *Aspergillus flavus*. The peak of pectinolytic activity was at day 6 of fermentation when the highest pectinase activity of 22.66 $\mu\text{mol}/\text{mg}/\text{min}$ was recorded for *Aspergillus niger* and 14.22 $\mu\text{mol}/\text{mg}/\text{min}$ for *Aspergillus flavus*. The isolated fungi could be promising organisms for pectinolytic enzyme production on apple peel as substrate.

Keywords: Apple peel, pectinolytic activity, Fungi, Solid state fermentation.

INTRODUCTION

Enzymes are being used as natural biocatalyst for both traditional and industrial purpose. Enzymes are highly substrate specific and are used in different metabolic pathways by all living organisms. Although enzymes are formed only in living cells many can be isolated without loss of catalytic function in vitro. This unique ability of

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enzymes to perform their specific chemical transformation from isolation has led to an ever-increasing use of enzyme in industrial processes, collectively termed as "Enzyme Technology". Pectins are the soluble polymeric materials containing pectinic acids as the major component. They can form insoluble protopectins with other structural polysaccharides and proteins located in the cell wall. Pectin substance consists of pectin and pectic acid. Demethylated pectin is known as pectic acid or polygalacturonic acid. Pectic substances are commonly amorphous with a degree of polymerization. Compared with young actively growing tissues, lignified tissues have a low content of pectic substances. The content of the pectic substances is very low in higher plants. They are mainly found in fruits and vegetables, constitute a large part of some algal biomass (up to 30%) and occur in low concentration in forestry or agricultural residue (Morris *et al.*, 2010). Solid-state fermentation is traditionally defined as those process in which microbial growth and products and formation occur on the surfaces of solid substrates in the near absence of free water. Due to this low amount of water available in solid state bio processing, the class of microorganism that are most commonly used is fungi. Several agro-industrial waste and by products such as orange bagasse, sugar cane bagasse wheat bran and other food processing waste are effective substrates for de polymerizing enzyme production by solid state fermentation (Martins *et al.*, 2002).

Agricultural waste with pectic substance is generated annually and constitute nuisance, disposal of which is capital intensive. The use of agro wastes as the main carbon source in solid substrate fermentation for production of enzymes and organic acids is an effective solution in solving detrimental problem arising due to the waste disposal management. Various substrates have been exploited for enzyme production previously. Apple fruit is an annual fruit produced globally. Several tons of peel are generated yearly all over the world. citrus fruit peels skins, essentially apple peel is very rich in pectic substances. The peels are mostly left to rotten in public markets and dumping sites constituting environmental pollution. Environmental management is usually complex and capital consuming. Such waste could be exploited for enzyme production through microbial metabolism. Literature abound on the use of orange peel as a substrate for enzyme production but seems to be scarce on the use of apple peel. Pectinase is an enzyme applicable to many areas of life significant to the survival of human race though, production is not yet localized and indigenous industries import this enzyme with huge amount of money. There is the need to exploit this waste for local enzyme production, hence this study is aimed at using apple peel as indigenous substrate for the production of pectinase through the activity of resident fungi.

MATERIALS AND METHODS

Sample collection

Apple fruits were collected from fruits markets. Collected apple washed with running water to remove dirt as well as soluble pigments. The fruits were then peeled and the peel were dried in oven (TT 9053) at 60°C for 4 days. This dried material was then milled using a warring blender and stored in tight container as the substrate for the productions of pectinase enzymes. After serial dilution, successive dilution (10^{-3} to 10^{-5}) of the different samples were inoculated into Pectinase Screening Agar Medium (PSAM) and the plates were incubated at room temperature (25-30°C) for about 3 to 5 days. The plates were observed for the growth of fungal colonies after incubation period and pure fungal colonies were isolated by pure culture technique.

Identification of fungal isolates

The isolated fungal colonies were identified based on the microscopic observations (colonial morphology, colour, texture, shape, diameter, and appearance of colony) and microscopic characteristics (septation in mycelium, presence of specific reproductive structures, shape and structure of conidia and presence of sterile mycelium). The microscopic examination was done by tease mount technique or LPCB (Lacto Phenol Cotton Blue).

Screening and production of pectinase enzyme

The isolates were screened for pectinase activity. This was done by inoculating the organisms on the Pectinase Screening Broth (PSB), the initial pH of medium was adjusted to 4.5 and incubated at 30 °C for seven days. After



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incubation, the fungal biomass was separated by centrifugation at 10000 rpm for 15 mins at 4°C. The supernatant was used to evaluate the pectinase enzyme activity by spectrophotometry method. (Stiles *et al.*, 1926).

Inoculum preparation

3ml of sterilized distilled water was added to a seven days old Pectinase Screening Broth (PSB) slant culture that has fully sporulated. An inoculating needle was used to dislodge the spore clusters under aseptic conditions and then it was shaken thoroughly to prepare homogenized spore suspension. From the resulting suspension, it was used as inoculum (Dillon *et al.*, 2004).

Solid state fermentation

Ten grams (10g) of the substrate was added to 20 ml of distilled water to moisten the substrate and sterilized in an autoclave at 121 °C for 15 minutes. This was followed by cooling at room temperature. Inoculation was done aseptically with 1ml of each of the fungal spore suspension respectively and the flasks were incubated at 28 °C for 5 days (Kayode *et al.*, 2008).

Assay of pectinase activity

Pectin lyase (PL enzyme) was assayed Spectrophotometrically by determining the optical density (absorption spectrum) at 235 nm wavelength with a Spectrophotometer model (Bausch LomeSpectronic 2000 colorimeter). A wavelength that which unsaturated uronide product of pectin degradation absorb test. One unit of pectin lyase activity was defined as, that amount of enzyme causing an increase in absorbance of 0.01 in 30 minutes.

Optimization study for pectinase enzyme production

The optimization study was performed in Erlenmeyer flasks to determine the effect of different factors such as pH, temperature, incubation period and nutrient source on microbial production of pectinase enzyme. The eight days old fungal spores of *Aspergillus niger* and *Aspergillus flavus* were inoculated into 100ml of pectinase screening broth medium.

i) Effect of pH

Fungal culture inoculated medium containing pectin activity incubated at pH of 3.0, 6.0 and 9.0. The pH of the solution was adjusted using 0.1 N HCL and 0.1 N NaOH solutions. After incubation period, pectinase activity was calculated.

ii) Effect of temperature

Aspergillus niger and *Aspergillus flavus* sp. was carried out at different temperature ranging from 25, 35 and 45 °C for one week. After incubation, the culture medium was filtered and analyzed for percentage of pectinase activity.

iii) Effect of incubation period

The optimum incubation period required by *Aspergillus niger* and *Aspergillus flavus* sp to accumulate heavy metals was determined for the period of 3, 6 and 9 days at room temperature. After each end point of 3, 6 and 9 days, the culture medium was filtered and analyzed for percentage are calculated.

iv) Effect of nutrient source

Different types of nutrient source (carbon and nitrogen) were carried out to optimization studies. carbon source (mannitol) and Nitrogen source (peptone) was optimized in normal PS broth and inoculated in potential fungal species and incubated for one week. After incubation period, the percentage of pectin activity was calculated.

Determination of primary metabolites**Determination of total soluble carbohydrate (Dubois *et al.*, 1956)**

The total soluble carbohydrate content was determined according to the method. 1.0 ml of sample was mixed with 1.0 ml phenol solution and added 5.0 ml of 96% sulphuric acid to each tube and shaken well. Incubated in boiling water



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bath for 20 minutes, after which the absorbance was read at 490nm against a reagent blank. The analysis was performed in triplicates and the results were expressed as ug/ml of sample.

Determination of proteins(Lowry *et al.*, 1951)

Protein content was determined according to the method. 1ml of sample was mixed with 0.5 ml of 0.1 N NaOH and 5 ml of alkaline copper reagent, incubated the mixture in room temperature for 30 minutes. Added 0.5 ml of Folin - Ciocalteu reagent and incubated again for 10 minutes at room temperature. Absorbance was read at 660nm against a reagent blank. The analysis was performed in triplicates and the results were expressed as ug/ml of sample.

Determination of total free amino acid (Moore *et al.*, 1948)

Total free amino acids (ninhydrin method) were determined according to the procedure. 1 ml of the sample was mixed with 1 ml of ninhydrin in a test tube, tubes were kept in boiling water bath for 20 minutes and then added 5 ml of diluent (equal volume of water and n-propanol) incubated at room temperature for 15 minutes and absorbance was read at 570 nm against a reagent blank. The analysis was performed in triplicates and the results were expressed as ug/ml of sample.

Determination of secondary metabolites**Determination of alkaloid(Harborne *et al.*, 1973)**

Estimation of alkaloids in the extract was done by the procedure. 10 mg of sample was homogenized in a mortar and pestle. Added around 20 ml of methanol: ammonia (68:2). Decanted the ammoniacal solution and after 24 hrs. added fresh methanolic ammonia. Repeated the procedure thrice and pooled the extracts. The extracts were evaporated using a flash evaporator. Treated the residue with 1 N HCL and kept it overnight. Extracted the acidic solution with 20 ml of chloroform thrice, pooled the organic layers and evaporated to dryness, basic fraction. Basified the acidic layer with concentrated sodium hydroxide to pH 12 and extracted with chloroform (20 ml) thrice, pooled the chloroform layers, dry over absorbent cotton and evaporated to dryness. The fraction that contains alkaloids was weighed and expressed as ug/ml.

Determination of Tannins (Bray *et al.*, 1954)

Tannins in potential fungi were done by the procedure given by standard method. 1ml of the sample was mixed with 5 ml of vanillin hydrochloride reagent and incubated at room temperature for 20 minutes. Absorbance was read at 500 nm against a reagent blank. The analysis was performed in triplicates and the results were expressed as catechin equivalents.

Estimation of saponins(Trease *et al.*, 1978)

1 ml of test samples were mixed with 80% methanol in 2ml, then 2ml of 72% sulphuric acid solution was added, mixed well and heated on a water bath at 60 °C for 10 minutes, absorbance was measured at 544 nm against reagent blank. Diosgenin is used as a standard material and compared the assay with diosgenin (concentration 20ug) equivalents.

RESULT AND DISCUSSION

Abundant amount of waste materials are produced by agricultural and processing industries, which pose consider disposal and ultimately leads to pollution vast varieties of microorganisms. Decomposing apple fruits collected from market.

Isolation, screening and identification of fungi from apple peel

Apple peel sample recorded higher fungal population 15, 12 and 10 colony forming unit with respective dilution of 10^{-3} , 10^{-4} and 10^{-5} respectively. Maximum number of *Aspergillus* isolated from sample collection. Two species from *Aspergillus* species were recorded. Identification of fungi was done by using standard manual with colour, structure,



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morphology, conidia and conidiophores with special medium was analyzed. According to the black colour with conidial shape was spherical, 3-5 μ and rougher with maturity of colonies were observed by using LPCB observation was as *Aspergillus niger*. The green colour colony with conidia round, smooth slightly rough and form long chains were confirmed as *Aspergillus flavus*. The identified fungal isolates were *Aspergillus niger* and *Aspergillus flavus* from decomposing apple peel waste, was selected as the best producer of pectinase (table 1). This research showed that apple peel was more potential source of pectinolytic than the rotten banana peels. Apple peels are a rich source of pectin since it contains the most microbes such as bacteria and fungi. Apple peel have been contained pectin and is utilized for commercial extraction of pectin (Silva *et al.*, 2002).

Optimization studies**Optimization of process parameters for pectinase production**

Several experiments were carried out for pectinase production by isolated mixed culture of *Aspergillus niger* and *Aspergillus flavus* under solid state fermentation using decomposed apple peel as substrate. To determine the optimal values different process conditions were optimized, the range within which the parameters have been studied were incubation period, pH, temperature and nutrients source (Patil *et al.*, 2010).

i) The effect of pH

The optimum pH was studied by using varied pH condition in different flasks, ranging from pH 3, 6, 9 for the production of pectinase by *Aspergillus niger* and *Aspergillus flavus*. The enzyme activity of *Aspergillus niger* and *Aspergillus flavus* at pH 3 and slightly increased at pH 6. *Aspergillus niger* produced maximum of pectinase 22.66 μ g/ml and *Aspergillus flavus* produced minimum amount of pectinase 6.88 μ g/ml (fig 1). The pH conditions needed for enzyme production and high concentration of pH affect the pectinase production (Kumar *et al.*, 2011).

ii) The effect of temperature

The experiments were run at various temperature between 25 °C and 45 °C. 25 °C temperatures most suitable temperature for growth and production of pectinase activity (Table 2). Any increases in temperature above 40 °C affect metabolic activities of the microorganisms which result in reduced growth and enzyme production (Pedrolliet *al.*, 2009).

iii) The effect of nutrients source

The source of carbon and nitrogen in growth medium has great significant in fungal growth and enzyme production (Table 3). The present study showed the optimal carbon and nitrogen source for the highest production of pectinase and high concentration of nutrient source may inhibit the process of enzyme synthesis (Koser *et al.*, 2014).

iv) The effect of incubation period

The experiments were done at different time duration (from 24 to 144 h) at an interval of 24h for pectinase production under solid state fermentation. *Aspergillus niger* produced maximum amount of pectinase 4.0 μ g/ml and *Aspergillus flavus* produced minimum amount of pectinase 3.4 μ g/ml respectively. The production of enzymes decreased gradually may be due to depletion of nutrients (Adeleke *et al.*, 2012).

Estimation of primary metabolites

Primary metabolite is a very important factor for microbial growth as well as microbial product formation. *Aspergillus niger* produced maximum amount of protein, aminoacids and minimum amount carbohydrate. *Aspergillus flavus* produced maximum amount of carbohydrate. The production of primary metabolites by microorganisms are highly influenced by their growth, which is determined by the availability of the nutrients in the substrate.

Estimation of secondary metabolites

Aspergillus niger produced maximum number of alkaloids 14.05 μ g/ml, tannins 1.33 μ g/ml and minimum amount of saponins. *Aspergillus flavus* produced maximum amount of saponins 0.20 μ g/ml, minimum amount of tannins. Studies have shown that the production of secondary metabolites is under tight regulatory control. As mentioned



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above, secondary metabolites are produced typically toward the end of the exponential growth phase (Yu and Kelier 2005).

SUMMARY AND CONCLUSIONS

Apple peels, which is a waste product and was used as substrate for production of pectinase from *Aspergillus* sp in the present study, may be an efficient carbon source and has good potential as a substrate for pectinase production as they are cost effective, renewable and available in large quantities. Thus, the study concluded that *Aspergillus* was dominant from the study area *Aspergillus niger*, *Aspergillus flavus* sp. were screened for pectinase enzymes production. *Aspergillus niger* produced maximum amount of pectinase and *Aspergillus flavus* produced minimum amount of pectinase. The following growth parameters are required for maximum amount of pectinase production by *Aspergillus niger*. They are pH 6, 25 °C of temperature, six hours of incubation period. Mannitol as carbon source, peptone as nitrogen source. All two species produced carbohydrate, protein and amino acids as a primary metabolites and alkaloids, tannins and saponins as a secondary metabolites. Utilization of worthless waste materials to generate a commercial valuable product, for this purpose above study will helpful for the society.

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Table.1: Screening and production of pectinase enzyme from fungi

S. No	Name of the Fungi	Pectinase (µg/ml)
1	<i>Aspergillus niger</i>	26.66
2	<i>Aspergillus flavus</i>	11.11

Table.2: The effect of temperature

Temperature(°C)	Pectinase (µq/ml)	
	<i>Aspergillus niger</i>	<i>Aspergillus flavus</i>
25 °C	14.22	9.11
35 °C	10.0	3.33
45 °C	2.66	-

Table.3: The effect of nutrients source

Nutrient sources	Pectinase (µg/ml)	
	<i>Aspergillus niger</i>	<i>Aspergillus flavus</i>
Carbon source(mannitol)	45.33	23.33
Nitrogen source (peptone)	3.33	18.66

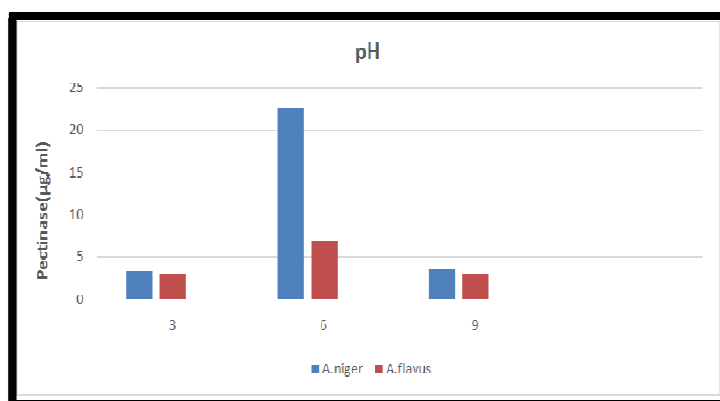


Fig.1: Optimization of pH for pectinase enzyme production





The Novel Approachments on Pharmacoeconomic for Indian Pharmacy Quarter

Durga Prasad Kondeti^{1*}, Sivakumar Vijaya Raghavulu², A.Sujana³ and R. Saravanan⁴

¹Ph.D Scholar, Department of Pharmaceutical Chemistry, SRM College of Pharmacy, SRMIST, Chengalpattu, Tamil Nadu, India

²Associate Professor, Department of Life Science (Zoology), Manipur University, Imphal, Manipur, India

³Lecturer, Department of Pharmaceutical Analysis, Sun Institute of Pharmaceutical Education and Research, Nellore, Andhra Pradesh, India

⁴Professor, Department of Biotechnology, Faculty of Pharmacy, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India

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*Address for Correspondence

Durga Prasad Kondeti

Ph.D Scholar,

Department of Pharmaceutical Chemistry,

SRM College of Pharmacy, SRMIST,

Chengalpattu, Tamil Nadu, India

E.Mail: durgaprasad.kondeti@gmail.com



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ABSTRACT

Pharmacoeconomics is a novel word; it serves as the best alternative term for financial motivations for drugs and various methods of addressing health issues. A pharmacoeconomic study compares the costs of various treatment options and drug regimens with the benefits they provide in order to help policymakers and payers make informed choices about what medications to employ and which ones to foot the bill for. The Pharmacoeconomic study outlook will be used by health care decision-makers to undertake the analysis. A variety of methodologies, including cost reduction, cost effectiveness, cost utility, and cost-benefit analysis, may be employed in these comparison analyses as well. A drug's price reflects the total amount of resources it need to make it. The price is the sum paid to that vendor. Drug efficacy, side effects, and the development of resistance are all factors in both positive and bad results.

Keywords: Pharmacoeconomics, cost-minimization analysis, cost-effectiveness analysis, cost-utility analysis, and cost-benefit analysis



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INTRODUCTION

Pharmacoeconomics is a novel word; it serves as the best alternative word for economic interest in drugs and other treatments of health problems. The judgment during the drug therapy depends on the treatment available within a healthcare system [1]. Pharmacoeconomics is a study that assesses or analyzes the behavior of the individuals and market relevant to the usage of the pharmaceutical product such as drugs. There are various sorts of Pharmacoeconomic technologies such as cost benefits, cost-effectiveness, cost-minimization, cost-of-illness, and cost-utility. Pharmacists can increase the efficacy of the treatment during the therapy by using the Pharmacoeconomic study data. Pharmacoeconomics is the characterization and analysis of the cost of drug therapy to the healthcare system and society [2]. Pharmacoeconomic information is a key for the healthcare decision-makers such as doctors for deciding the drug therapy along with the price relevant to managed care. Pharmacoeconomic research in the managed health care system is boosting. Pharmacoeconomics plays a vital role in various locations such as formulary decisions, designing disease managing programs, and measuring the cost-effectiveness of interventions and programs in managed care [3].

PHARMACOECONOMICS

Pharmacoeconomics is a novel word; it serves as the best alternative term for economic interest in drugs and other treatments of health problems [4]. Pharmacoeconomics is a sub-discipline of health economics. is defined as "the field of study that estimates the study of peoples, businesses, and markets applicable to the pharmaceutical products like drugs, services, and agendas which often concentrate on the cost (input) and results(outcomes) of the use "[5].

HISTORY:[6, 7]

Early the term Pharmacoeconomics was used in a public conference in 1986, at a gathering of druggists in Toronto, Canada. Ray Townsend from the Upjohn Company utilized the word in presentation; By using the phrase Pharmacoeconomics Ray and a few others conducted studies within the pharmaceutical companies since the early 80s. Today pharmaceutical industry is a booming industry with many skilled specialists, broad research, and application plan; then this popularity resulted in a periodical of the same name in 1992. This discipline has been a part of health science in pharmaceutical industries, academia, and practitioners worldwide.

It wasn't until the mid-to-late '80s that the techniques of health economics began to diverge from those of other economists, such as supply and demand, because most health economists had economic training and were simply interested in the market forces influencing the healthcare system. Reimbursement for medical services and pharmaceuticals was one of many policy areas for which economic analyses were consulted in those days. Such research were employed by governments and, to a lesser extent, health care associations. Certain parties recruited health economists directly, while others commissioned them to work on their behalf from private consultants and academics. Finally, a new "evidence-based" movement in medicine began to develop [9]. Starting in the mid-1980s, but gaining in popularity throughout the last decade, this movement was based on the principle of medicine being no different from any other science, and that any medical treatment or therapy should be justifiable using standard scientific rules of "evidence" and statistical validity. As a result of this shift, medicines and other treatments must now "prove themselves" in terms of both clinical efficacy and economic viability. For the government to consider placing a drug on the formulary for payment, pharmaceutical companies in Australia have had to submit an economic study since 1993 [12]. Within a few years, Ontario followed suit, establishing a rule that is now followed across the country. Now, the Netherlands has adopted the same policy. There has been an increase in interest in "Pharmacoeconomic," a field that studies drug use and effectiveness using an economic framework. Several new researchers entered the field, and many of them came from the clinical and pharmaceutical fields because of the clinical nature of the research. With this shift came new concepts and methodologies from the fields of epidemiology, clinical medicine, and psychology into the field [14].



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Pharmacoeconomics is a sub-discipline of health economics and results from the discipline arriving of age through consolidation to diversification. Health Economics is a unit of economics itself relatively young. Pharmacoeconomics is needful in various sectors;

- In industry, Pharmacoeconomics plays a vital role in determining specific research and evolution alternatives.
- In government, it plays a crucial role in determining program benefits and the price paid by the patient.
- In companies, it will be Designing insurance benefit coverage.[16]
- Today, health economics has two distinct aspects. First, there's the "macroeconomic" approach, which focuses on government programmes and market structure, and has been referred to as such by physicians. Traditional health economists are nearly always employed by governments, universities, and some professional organisations, such as medical societies, to work in this field. There hasn't been a lot of growth in this area. [17]
- The second face is that of health economic evaluation, which is substantially larger in terms of activity.
- This field has become increasingly diverse in recent years. In addition to physicians and pharmacists, the subject has drawn in professionals from a wide range of biological specialties. It is not uncommon for these persons to have some health economics coursework, but it is usually less than what is required for a Ph.D. degree in basic economics. A framework adopted from basic economics has been used to integrate ideas from psychology, epidemiology, accounting, and economics into the field of health economic evaluation in order to measure quality of life, outcomes, and costs.
- To the extent that the evidence-based movement develops and is adopted by policy-making bodies and professional associations, this new discipline of health economic evaluation will become even more widely used.
- Pharmaceutical companies will hire health economists (in the broader definition) to support and evaluate their studies relating to the justification of new drugs. Formulary-making bodies will require health economic expertise to evaluate the submissions and to conduct their own studies.
- In addition, governments are beginning to examine nondrug therapies in terms of their economic implications; the field of "health technology assessment" is one that absorbs a number of different disciplines in the evaluation of a wider group of therapies, and the cornerstone of this field is health economic evaluation.

COMPONENTS OF PHARMACOECONOMICS

They are diverse components in economic evaluation that mainly focus on the financial analysis of pharmaceutical products such as drugs.

A. Cost of drug

The value of the resources used in a particular medication therapy is what is known as the cost. It is the sum that the patient pays to the service providers. Results, outputs or outcomes of a pharmacological therapy programme are referred to as consequences. Health care resources and services are included in this category. Medical staff pay, medication expenses, drug administration consumables, time spent preparing and administering medications, and laboratory costs connected with monitoring efficacy and adverse drug responses are all included. There are direct non-medical costs, such as the price of a patient's lodging, dietary restrictions, and transportation, as well as missed work time (essential to employers), such as the time lost by parents of children with acute otitis media to attend to their child's therapy.

Costs borne by the sufferer, family, friends, and society all fall under this category: Even if they're hard to quantify, many of these issues affect us all. Unpaid caregivers; missed pay; illness-related expenses borne by patients, families, friends, employers, and the government; and lost leisure time are all included in this category. A patient's pain and suffering, his or her family's anxiety and psychological difficulties, the influence on the patient's quality of life and their judgments of their own health are all examples of intangible costs. Due to adverse responses of the pharmacological treatment, people with rheumatoid arthritis, cancer, or other terminal conditions may suffer in their quality of life. These are difficult to quantify financially, but they are a major source of anxiety for medical





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professionals and patients alike. One way to successfully incorporate intangible costs into PE analysis is through the use of a quality-adjusted life year (QALY).

B. Outcomes (The second fundamental component of a pharmacoeconomic study is outcomes or benefits).[20] "Natural" units such as years saved, strokes averted, and peptic ulcers healed, etc. could be used to gauge the projected benefits.

- Units of "utility" - When it comes to the quality of health, utility is an economist's phrase for satisfaction or a sense of well-being. It is an attempt to measure the quality of the state of health and not just its volume. Direct measurement (using techniques such as time trade-off or standard gambles, or imputing them from the literature or expert opinion) can be used to derive estimates of the utility. They are frequently influenced by quality-of-life metrics from various illness conditions.

CHALLENGES

Pharmacoeconomic is still beset by the following issues: Developing standards of care Recruiting and retaining a skilled workforce for pharmacoeconomic-related tasks. Practitioners, government officials, and business leaders all benefit from regular updates on the latest developments in this field. Support for applied pharmacoeconomic research that is long-term in nature. Pharmacoeconomic research have not received the full attention they deserve. Pharmacists, in particular, have poor technical capabilities. Adapting studies from another nation will be difficult due to the absence of a suitable health care system database.

Pharmacoeconomics is still beset by the following issues: Developing standards of care Recruiting and retaining a skilled workforce for pharmacoeconomic-related tasks. Practitioners, government officials, and business leaders all benefit from regular updates on the latest developments in this field. Support for applied pharmacoeconomic research with predictable sources of financing Pharmacoeconomic studies are underutilized, despite their potential significance and use. Inadequate technical expertise among healthcare personnel, particularly pharmacists. Poor patient safety. Research adaptation from another country is hindered by the lack of a suitable database in the healthcare system [11].

Economic evaluation's primary issues remain the same: identifying standards or criteria for best practices. An effort to build a team of experts in Pharmacoeconomic outcomes. Teaching the important components of this field to practitioners, government officials and private sector administrators. Stable funding for Pharmacoeconomic analysis.

REASONS FOR EVALUATION

Costs: There are many ways to measure the cost; they are as follow

1. Cost/unit (cost/tab, cost/vial)
2. Cost/treatment
3. Cost/person
4. Cost/person/year
5. Cost/case prevented
6. Cost/life saved
- Cost/DALY (disability-adjusted life year)

Outcomes (benefits): It is prime to consider both positive and negative results, along with the profit. A positive outcome is a measure of drug efficacy. Drawbacks include side effects, Treatment failure, and development of drug resistance.

PHARMACOECONOMIC EVALUATION:[18]

Pharmacoeconomic evaluations have many problems. All economic evaluations follow a standard format that incorporates measuring inputs (costs) and outputs directly. Perspectives are the most common problem in Pharmacoeconomic assessment. In any economic examination, these Perspectives are essential. The study must be undertaken from either the high service perspective (which involves direct costs) or the societal perspective in that sport, though (indirect cost). Low budgets are the biggest obstacle for health care management when looking at the health system from a societal standpoint. It is a lot more expensive and offers a smaller set of advantages. The societal approach, on the other hand, is far more costly and offers just a small number of advantages. Reducing the number of hours that people must labour in order to find work is advantageous from a societal standpoint.





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METHODS OF PHARMACOECONOMIC EVALUATION: There are numerous pharmaco-economic studies that assess the costs, clinical and humanistic results associated with various treatments. Innovative therapies are more readily accepted by healthcare professionals, administrations, and the general public when their cost effectiveness is clearly demonstrated using the evaluation procedures outlined above. There are four major types of pharmaco-economic analysis: A: Cost-minimization analysis, B: Cost-effectiveness analysis, C: Cost-benefit analysis, D: Cost-utility analysis. This analysis involves measuring only costs, usually only to the health service, and is applicable only where the outcomes are identical.

Cost-effectiveness analysis: In economics, cost-effectiveness is the most commonly used term to lead the appraisal process. When the health benefit and cost can be quantified in natural units (e.g., healed ulcer, saved years of life), it should be regarded a unique sort of evaluation. For instance. In other words, it compares treatments in a certain therapeutic area that have qualitatively equivalent results.

Cost-utility analysis: It is the same as cost-effectiveness analysis. Measured in cash, the costs in a cost effectiveness analysis have specific outcomes. A unit of advantage is generated in a cost-utility analysis, however. As a result, cost utility analysis in therapy looks at more than one treatment area, for example, the cost per quality adjacent life year for erythropoietin in kidney illness versus the cost per quality adjacent life year for coronary artery bypass grafting.

Cost-benefit analysis: An intervention's economic advantages are taken into account when calculating the benefit (example: monetary value of returning an employee to profession earlier). The value of something can be expressed in terms of its monetary value. Intangible but crucial benefits, such as alleviating worry or uneasiness, may be overlooked in a cost-benefit analysis. Cost-benefit analysis may also appear to discriminate against the elderly or the unemployed.

LIMITATIONS OF PHARMACOECONOMIC EVALUATION: [19] There are numerous issues that limit the practical use of health economics. Assumptions, assumptions, or selective reporting of outcomes may all be vulnerable to bias across the entire process. Because of the prevalence of research conducted or financed by pharmaceutical corporations, this is the general perception. Cost and efficacy differences appear to be more effective, and there is periodic bias toward research that benefit pharmaceutical corporations.

As a result, health economics might be abused as a marketing ploy from time to time. The same issues may arise in studies funded by health insurance companies. For a specialist, this isn't a problem because their prejudices are typically understandable. However, doctors and others may not be able to understand this economic appraisal effectively, which is why discrimination is necessary to reduce. Many doctors believe that rationing or cost-cutting in the name of health care is unethical, and as a result, they reject health economics as a whole. It is inappropriate to clean healthcare resources with inefficiency because it diminishes the physician's ability to provide his patients with the best possible care. Therefore, it is unethical not to evaluate the financial aspects of medical intervention.

There are three common difficulties: First and foremost, a short-term perspective limits the use of Pharmaco-economic evaluation to provide long-term savings for the health service in exchange for increasing spending today. As a result, it is difficult to shift funds across different financing sources. Prescriptions in primary care, for example, are frequently paid for on an individual basis from clinic services. As a result, any increase in primary health care drug treatment spending cannot solely be attributable to a decrease in hospitalizations in the future. Regardless of how cost-effective a unique remedy may be, it may still be prohibitively expensive. Health economics and pharmaco-economics, on the other hand, are relatively new fields of study that are still refining and fine-tuning their theories.

RECENT STUDIES ON PHARMACOECONOMICS: Until the early 1960s, pharmacy was not acknowledged as a clinical science in the healthcare system. Pharmacy education and research began to include fields within the pharmaceutical sciences such clinical pharmacy, drug information, and pharmacokinetics. In the 1970s, the field of pharmaco-economic was born. Cost-benefit and cost effectiveness analysis were initially developed by McGhan,



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Rowland, and Bootman from the University of Minnesota in their books released in 1973 and 1978, respectively. Cost-benefit analysis was used to evaluate the consequences of tailoring aminoglycoside dosages to burn victims with gram-negative septicemia by Bootman, et al. in an early pharmacy research study in 1979. Since its inception in 1983, the Ohio State University College of Pharmacy has offered a specialised pharmacy academic programme aimed at giving an overview of the use of cost benefit and cost effective analysis in healthcare, with a focus on pharmaceutical treatment. At initially, the term "pharmacoeconomics" was defined as "study of the costs of pharmacological therapy to healthcare systems and society," and it was used by Townsend's work to highlight the need for research efforts in this new discipline in 1986. "Pharmacoeconomics" was first published in 1992. Studies on specific patient populations, such as those with diabetes or prostate cancer or spinal cord injuries or ischemic heart disease or neurological disorders, have shown the effectiveness of sildenafil as well as its side effects and drug interactions and the socioeconomic factors involved in its use. For the treatment of erectile dysfunction in men, Sildenafil is the first-line medicine of choice. These variables should be taken into account when deciding whether or not to prescribe this drug: patient admittance, cost-risk benefit ratio and distribution channel, and prescription drug coverage.

Tissue plasminogen activator [t-PA] Alteplase (2mg/h) and Urokinase (2mg/h) are compared in additional case studies to see which is better in terms of effectiveness, side effects, and cost. catheter-directed treatment of acute peripheral arterial occlusive disorders including deep vein thrombosis. Reduced costs of administering medications with an abused liability are supposed to improve their therapeutic use. No one has ever tried it. In contrast, there is a significant worldwide publication on the impact of cost on prescribed medication use. For example, it has been proven that the high cost of 15 different nonopioid therapeutic medicines severely restricts their utilisation around the globe (including Europe, North America, Russia, and Japan). For a fair comparison of various viewpoints, it is necessary to assess drug cost-sharing approaches in the same population. There were 51 percent Ibandronate in year 1, and 39 percent each year after that. The model relies on a 10-year time horizon and a 3-year treatment period. There are three classes of bisphosphonates that are beneficial in reducing hip, vertebral, and wrist fractures. Ibandronate was found to have a lower fracture care cost per patient when compared to Alendronate and Risedronate, based on these hypotheses. Creating novel treatments for Alzheimer's disease and associated diseases is enthralling because of the business case. The 75+ age group is the fastest-growing demographic in developed countries, with 25% of them suffering from cognitive issues. 4 million people in the United States are believed to have alzheimer's disease. Indirect and direct costs of alzheimer's are estimated to cost US businesses US\$33 billion each year, of which US\$26 billion goes to employed carers suffering from depression, missing workdays, and increased healthcare costs.. Approximately 8 million older adults in the United States may suffer from mild cognitive impairment, a recently recognised category of memory loss that is distinct from more widespread cognitive impairments.

Steps in the Pharmacoeconomic Analysis [20]

Steps in the pharmaceutical economic evaluation process are important in the health care system and in almost every therapeutic field or medical service.

1) Identify the issue: What antiemetic regimen is the best value for preventing chemotherapy-induced vomiting (CIE)? can be a general question. One way to state the issue more succinctly and quantitatively would be to ask, "Which chemotherapy regimen has the best value for preventing acute CIE patients?"

2) Gather team members from diverse functional areas:

Some teams may comprise people from several disciplines, including as medicine, nursing, pharmacy, hospital administration and information technology and systems. The composition of these teams will vary according on their analysis.

3) Define the viewpoint:

Make sure you select a study perspective that is normally relevant to the issue. A health care system perspective, for example, is a good fit if you're dealing with a comparable issue as in Step 1.



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4) Approaches for treatment include pharmacological and non-pharmacological options. Identify your preferences and outcomes. All clinically relevant alternatives need to be included in this. Positive and negative clinical outcomes should be included in the outcomes analysis.

CMA, CBA, CEA, and CUA are the pharmacoeconomic approaches that can be used in your situation. Choosing the wrong drug can have an impact on both your health and your wallet if you use the wrong technique. In addition, the level of care provided is of paramount importance.

5) Setting a financial value on treatment options and outcomes for drug administration and cost of purchase, as well as the cost of positive and unfavourable medical consequences.

6) Make sure you have all the resources you need to conduct a thorough evaluation:

7) The amount of time and money required will vary from study to study. It may, however, include access to medical or digital records, as well as regular salaries for medical employees in general.

8) Look for consequences that may occur in the population being studied:

inpractise, identifying therapeutic preferences and outcomes These probability can be obtained and perhaps stated in terms of efficacy rates and the prevalence of ADRs through the use of primary literature and professional selection.

9) Consider the consequences of your choices: Decision analysis, including CEA, can be used to conduct a wide range of economic evaluations. While decision analysis and decision trees may not necessitate indefinite PE assessments, this is not always the case. However, they firmly endorse the decision that has been made. Results and probabilities are clearly displayed in a decision tree. In addition, it can be reduced to a single number for comparison purposes through algebra.

10) Discount costs, sensitivity analysis, and additional cost:

Reducing the potential costs and consequences to their current market value. Additional sensitive variables were investigated in a clinically relevant range, as well as their consequences. In some cases, it may be necessary to perform an incremental evaluation of the costs and outcomes.

11) Discuss the findings of your research:

To the cross-functional team and the appropriate committees, the study results were presented.

12) Intervention policies and procedures should be developed:

Develop a policy and an intervention based on the findings of the study to improve healthcare quality while still maintaining efficiency.

13) Educate and implement the policy:

Make sure to spend enough time and resources on the policy or intervention in order to get the best out of it. The healthcare professionals who will be affected by the legislation must also be trained in various ways, such as orally and in writing and online.

14) Documentation of further actions:

Data collection following policy and intervention implementation for a practical period, as this information will provide a reaction to the achievement and quality of policy or intervention.

Values of pharmacoeconomic studies [21]

Drug formulary finalization, producing data for marketing materials, adjusting a new drug's pricing and correcting an existing drug's price. Compliance with the licencing criterion for a drug. Medical reimbursement programmes that include a medicine. New strategies and initiatives in hospital and clinical pharmacy are being implemented. Clinical trials and drug testing.

WINDING UP: Despite the fast rise of clinical research in India, pharmacoeconomic is still in its infancy. For many Western countries, India is a cost-effective location for undertaking clinical research. Despite the fact that the India Chapter of ISPOR has been established, the platform for pharmacoeconomic still has to be established. We believe that clinical pharmacists, especially Pharm.D. Graduates will be more valuable in India than traditional pharmacists since they can apply economic ideas to their daily work in community and hospital pharmacies, respectively.

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A Comprehensive Survey of the Methods of Artificial Intelligence based Waste Management

Seema. S^{1*} and M.Suganya²

¹Research Scholar, School of Computer Studies, RVS College of Arts and Science, Sulur, Coimbatore, Tamil Nadu, India

²Associate Professor and HoD-IT, School of Computer Studies, RVS College of Arts and Science, Sulur, Coimbatore, Tamil Nadu, India

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*Address for Correspondence

Seema. S
Research Scholar,
School of Computer Studies,
RVS College of Arts and Science,
Sulur, Coimbatore, Tamil Nadu, India
E.Mail: seema.karuvath@gmail.com



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ABSTRACT

A comprehensive, integrated waste management system makes sure that collection and delivery are tracked in real-time. There are many diverse types of waste management, and they all include the disposal of hazardous items as well as solid, liquid, gaseous, and other wastes. Fortunately, the advance of artificial intelligence (AI) methods and machine learning has enabled a variety of computational approaches to the problem of waste management (WM) and e-waste available. We performed a comprehensive review to acquire an overview of the literature on the application of AI to waste segmentation and management systems. It was rare to find AI solutions that were expressly created to handle the unique characteristics and features of waste management systems. Since most waste management problems are inherently complex and poorly defined, it is evident that traditional strategies built on inflexible algorithms and mechanistic models do not always seem to provide an effective solution, especially in situations when there is a lack of data. We believe that our work will open the door for more investigation into the use of AI for trash management.

Keywords: Artificial Intelligence, Waste Management, Smart Bin, Machine Learning, Systematic Review





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INTRODUCTION

India, which has a population of over 1.3 billion, produces more rubbish than even China, which has the most people on earth. However, at this time, the sum of garbage produced per person in China and India is far less than in Western nations. By 2050, though, things may change because India is anticipated to produce far more trash than China, while China's waste creation is anticipated to develop considerably more slowly. India already produces the most waste in the world, and by 2050, that amount is predicted to significantly increase barring immediate action (Times of India-Article, 2020). According to Planning Commission report (2014), urban India yearly produces 62 million tonnes of trash (MSW). Additionally, it was expected that by 2030, the volume would rise to 165 million tonnes. However, India's solid waste collection competence is currently at about 70%, compared to almost 100% in many developed nations. Additionally, the environment ministry said in 2016 that 43 million tonnes of municipal solid trash were collected annually, of which 11.9 million were processed and 31 million were disposed of at landfills.

The impact of garbage on the environment, health, and other factors is lessened by waste management. Resources like paper, cans, glass, and others can all be recycled or reused with the aid of this. The disposal of hazardous materials as well as solid, liquid, gaseous, and other wastes is covered by many types of waste management. Real-time tracking of collection and delivery is ensured by a sophisticated, integrated waste management system. The ground-level mechanisms for waste collection, processing, and recycling can be improved and made more efficient by using technologies like the global positioning system, radio frequency identification, global system for mobile communications, machine-to-machine communication, and internet of things, as well as cutting-edge mobile and web-based applications. When it comes to trash management, several elements must be considered, including waste transportation, recycling, avoidance, and reduction techniques. Waste management (illustrated in Fig. 1) requires dealing with both solid and liquid waste. It also offers a variety of possibilities for recycling items

To overcome problems with waste management (WM) and e-waste, different computational approaches are fortunately being made possible by the introduction of artificial intelligence (AI) techniques and machine learning. AI and machine learning have shown effective in solving complicated issues, learning from mistakes, and managing ambiguity and incomplete data. We cannot afford to underutilize AI's ability to address a variety of WM issues, such as forecasting waste characteristics, detecting waste bin levels, predicting process parameters, vehicle routing, and overall WM planning. The waste management industry will look into the many AI models and techniques utilised in WM, application domains, performance factors, as well as the software platforms used to deploy such models. To get a broad picture of the research on the use of AI in waste segmentation and management systems, we conducted a structured review. A structured review directs researchers to identifying potential research gaps in that field of study who want to do new research on waste management system. All relevant papers are acquired from online sources such as google scholar, IEEE Open Access and Science Direct, summarised, and presented in our structured review in order to meet the research issues specified in the study. The entire body of research on the use of AI for waste segmentation and management is presented on this page. We discuss our empirical findings and responses to the research topics raised in this review in this study. This paper's main points are presented in the following order: In Section 2, the research's background is described. Section 3 discusses earlier study and its findings, while Section 4 concluded this paper.

Research Background

The essential phases of the review technique (design of the study, performance assessment standards) were discussed in this part, as indicated in Fig. 2.1.



**Seema and Suganya****Research Questions**

The objective of this Comprehensive Literature Review (CLR) is to learn more about the research that have been written regarding waste segmentation and management (WSM) using artificial intelligence (AI). A number of perspectives have been used to analyse studies in order to gain knowledge. For this Comprehensive Literature Review (CLR) study, the following five research questions (RQs) have been formulated.

RQ1: What are the several approaches that AI models are used in waste management?

RQ2: What AI models and algorithms are employed in applications for waste management?

RQ3: What are the evaluation metrics available for this study?

RQ4: How do different AI models' performances compare to those of alternative techniques?

RQ5: What are the methods used for Segmentation? Which approach proved most effective?

The majority of the papers we considered for our study, when we started in January 2021, were from 2015 to 2020, with some earlier studies incorporated as if needed. The databases we used were Science Direct, Open Access Journals, and IEEE publications. The criteria for inclusion and exclusion were developed during the selection criteria stage to ensure that the research included in this study was valuable, appropriate, and would aid us in achieving our main goal.

Inclusion standards

- Papers published solely for waste management.
- Studies presented using AI or machine learning or neural networks.
- Papers that described the approach and its efficacy metrics.
- Papers that discussed the datasets with different forms of data.

Exclusion standards

- Papers that failed to acknowledge the reliability of the results.
- The Paper was not journal or conference published.
- The classification in the paper did not make use of neural networks or machine learning.
- Lack of mention of any specific dataset in the paper.

Search Strategy

The following search terms were used to locate all previous research:

- "Waste Management" and " Segmentation" and "Artificial Intelligence"
- "Waste Management" and " Segmentation" and "Machine Learning"
- "Waste Management" and " Segmentation" and "Neural Networks"
- "Waste Management" and " Segmentation" and "Deep Learning"
- "Solid Waste" and " Management" and " Artificial Intelligence"
- "Waste Forecasting" "Prediction" and "Artificial Intelligence "

Literature Review

After careful inspection, 11 papers were chosen for review based on exclusion criteria. Table: 1 depicts the reviews of various AI Models.

Forecasting Techniques of Solid Waste Management

To safeguard public health, natural resources, and the environment, local governments place a high priority on managing municipal solid waste (MSW). Accurate estimate of the amounts of future waste accumulation is necessary for the design and operation of a successful MSW management system. This (Abbasi & El Hanandeh, 2016) study's major goal was to create a model for precisely estimating MSW creation, which will aid waste-related firms in better designing and running efficient MSW management systems. In the Logan City Council region of Queensland, Australia, four intelligent system algorithms—support vector machine (SVM), adaptive neuro-fuzzy inference



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system (ANFIS), artificial neural network (ANN), and k-nearest neighbours (kNN)—were tested for their capacity to predict monthly waste generation. Results indicated that artificial intelligence models might be successfully used to create forecasting models for municipal solid waste since they had strong prediction performance. By training on trash generation time series, machine learning algorithms can accurately anticipate the monthly generation of MSW. Municipal solid waste (MSW) generation trends projected into the future help address data inadequacies in developing a framework for sustainable MSW management. The study develops (Hoy et al., 2022) ensemble uncertainty analysis and Bayesian-optimized ANN models to estimate trends in MSW physical composition at the national level. Each MSW's substantial composition exhibits collinearity with many variables, according to Pearson correlation study, hence the MSW should be predicted based on its heterogeneity. In comparison to the default ANN models (11.1-44,400%), the Bayesian-optimized ANN models forecast with decreased relative standard deviations (3.64–27.7%). It anticipates the Malaysia produce 42,873 t/d of MSW for 2030, of which 44% will be food waste. The waste authorities can use the study's well-generalized ANN framework and insightful recommendations to create a circular economy through effective waste manage. Recently, artificial neural networks (ANN) have been used to anticipate MSW generation; however the validity and dependability of the stochastic forecast have not received sufficient attention.

The accurate forecasting of a system's operational capacity is essential for efficient and successful solid waste management. Models for predicting waste have received a lot of research, and their accuracy is constantly being tested. The factors for yard waste are time sensitive, and the effects of lag must be explicitly taken into account, in contrast to waste prediction models for mixed wastes. The lag periods associated with factors that aim to forecast municipal yard trash creation using machine learning techniques are especially examined for the first time in this work. Through correlation analysis, socioeconomic and meteorological variables with a weekly average are evaluated, and the significant variables are then used to create yard waste models (Vu et al., 2019). The variables in these models are then time-lagged over a variety of weeks using artificial neural networks (ANN). This contributes to the realization of a reduction in the error of the weekly yard trash generation prediction. The range of 1 to 11 weeks covered the optimal lag durations for each model. In an ANN model with three layers, 11 neurons in the hidden layer, and an ideal lag period of one week, the best model combined the ambient air temperature and population data. During the testing phase, a mean absolute percentage in accuracy of 18.72% was recorded. One model's mean squared error during training decreased by 55.4%, demonstrating the importance of lag time on the precision of weekly yard trash prediction models.

Techniques for Detection and Classification of Solid Waste

Separating the waste into its many components is one of the most crucial tasks in waste management, and it is typically carried out manually by hand-picking. (Adedeji & Wang, 2019) proposed intelligent waste material classification system, developed using the 50-layer ResNet-50 Convolution Neural Network model, which is a machine learning tool and serves as the extractor, and Support Vector Machine (SVM), which is used to classify the waste into different groups/types like glass, metal, paper, and plastic, among others, was made in order to streamline the process. On the Gary Thung and Mindy Yang-created trash image dataset, the suggested system is put to the test and is able to attain an accuracy of 87%. However, they used for a specific set of data images; need further more understanding of new set of parameters to fine tune the system.

Recycling of building trash is very valuable and significant, but it also conserves resources and preserves the environment. For that, (Xiao et al., 2019) proposed an solutions by extracting and classifying common construction waste kinds using near-infrared hyper spectral technology in order to increase the utilization rate of construction waste, lower processing costs, and increase processing effectiveness. To eliminate the repetition of hyper spectral data, they suggest the Pythagorean wavelet transform (PWT) to obtain the distinctive reflectivity. Examine the classification of building debris by using common materials as identifying items, such as wood, plastic, bricks, concrete, and rubber. They finally suggested the CT approach. We were able to complement each method and get rid of unstable findings by combining the results of the RF with the first derivative and the results of the ELM with the characteristic reflectivity. However, one crucial aspect of processing construction waste was enhancing the system's



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capacity to react to complex situations and segregate related categories. Successful waste management depends on accurate waste classification. However, the majority of recent studies have only paid attention to single-label trash classification from photos, which defies logic. They suggest (Liang & Gu, 2021) using a convolution neural network-based multi-task learning architecture (MTLA) that can simultaneously identify and locate wastes in photos. The MTLA is made up of a backbone network with new multi-level feature pyramid network, a collection of collaborative learning multi-task subnets, and proposed attention modules. We created the loss functions in accordance with the focused and joint concepts to accomplish joint optimization of waste detection and location. The proposed MTLA scored highly on numerous waste management-related activities and produced performance that was comparable to that of experts. On the multi-label waste classification job, its F1 score was over 95.50% (95.12% to 95.88%, with a 95% confidence interval), while on the waste localization test, its average precision score was over 81.50% (@IoU = 0.5).

The caliber of the knowledge necessary to make an informed decision is a prerequisite for effective environmental preservation. In order to facilitate planning procedures and plan waste management effectively, reliable data collecting is necessary. The machine learning-driven predictive analytical framework (MLDPAF) has been suggested (Huang & Koroteev, 2021) as a means of planning the management of waste and energy. First, a neural network can forecast how much garbage will be produced. Waste collection is now even better on energy expenses thanks to an improved machine learning algorithm that takes into account the erratic sustainable energy markets. Results demonstrated that suggested machine learning-based methods have been applied successfully to produce effective waste models. According to the simulation analysis, the proposed method reduces landfill analysis by 40%, transportation by 15% and trash quantity analysis by 90%.

Garbage segregation is the primary characteristic of the multi-featured smart bin (Pereira et al., 2019). Plastic waste, wet waste, dry waste, and finally wastewater from the auto clean feature will all have their own compartments in the smart bin. Additionally, it will contain ultrasound sensors that will trigger the bin to open when someone approaches it to dump trash in it, making it both hands-free and obviously more hygienic. The user will be informed of the amount and type of trash they dispose of via an analysis performed on the smart bin. Garbage disposal on a daily, weekly, and monthly basis will be studied using graphs and data from live data reception. However, the clear execution and comparison about the performance of proposed model would enhance and enrich the research for better understanding.

The development of autonomous waste management, which aids in effective and efficient garbage collection and recycling, is the main topic of (Nguyen et al., 2021) study. Waste management becomes more environmentally friendly as a result of improved waste management and a green energy-based strategy that results in less fuel usage overall. Specifically, a self-driving car, solar-powered sensor networks, trajectory planning, RFID recognition, etc. are used to automate the collection of waste from smart bins and transport it to a transfer station by an autonomous truck. They use open source software like OpenCV, TensorFlow, Arduino IDE, Keil C, and hardware like Jetson Nano, Arduino, STM32F4, and camera to build an autonomous truck and an autonomous bin. Based on lane marking detection and object avoidance detection, the autonomous truck can move to the autonomous bin.

Waste management has become a significant issue in the modern world due to rising urbanization. Therefore, effective waste management is essential for maintaining a clean and healthy environment. Solid waste tends to have a large influence on the environment since it does not degrade readily, despite the fact that government agencies in most countries offer a variety of alternatives for trash management. The study (Abeygunawardhana et al., 2020) focuses on a smart garbage bin powered by AI (Artificial Intelligence) that can categorize the three most prevalent types of solid waste: metal, glass, and plastic. The smart trash can separates the waste using machine learning and image processing techniques. Additionally, the system uses ultrasonic sensors to continuously monitor the level of garbage that has been collected. The most efficient paths for the available waste collectors to collect the filled bins will be generated using a dedicated mobile application. Additionally, this smart bin solves the problem of sorting out each waste item by using visual data as the source. Therefore, it is not considered to determine the category using expensive sensor devices and filtration methods. The smart bin can identify the type of solid waste, collect it into the



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designated container, and send notifications about the amount of rubbish in each container. Consequently, it is a mobile trash management system.

The classification of waste has always been crucial to societal well-being, resource recycling, and environmental preservation. An autonomous garbage classification system based on deep learning is suggested (Kang et al., 2020) in order to increase the effectiveness of front-end garbage collection. First, the entire garbage can system, including the hardware framework and mobile application, is designed. Second, the suggested trash classification technique is based on the ResNet-34 algorithm, and its network structure is further optimized by three factors: the feature reuse of the residual unit, the construction of a novel activation function, and the multi-feature fusion of input images. Finally, using artificial garbage data, the superiority of the suggested classification system is demonstrated. The suggested algorithm improves classification accuracy by 1.01%. According on the experimental findings, the system's classification cycle can be completed in as little as 0.95 seconds, and classification accuracy can reach 99%. From the above reviews, it is clear that the AI models using different algorithm and at the same time major research used ANN due to its effectiveness as given in fig 3.1. ANN and CNN are used in major papers. In Maximum of the Forecasting models ANN used and similarly CNN used in Classification and Segmentation of the Waste. SVM and kNN like algorithms also having literal choice of implementation. From the above reviews, the major metrics used for evaluation are depicted in the below Table 2. All major paper presented it performance based on the Accuracy / Precision / F1Score. There are few more papers which given importance to the R2, RMSE, MSE and MAPE.

CONCLUSION

The review's conclusions showed that a variety of stand-alone and hybrid AI models have been used to forecast and simulate waste management systems. AI models provide a different, effective strategy that has attracted a lot of interest from researchers. Waste management solutions powered by AI are primarily still in the research stage. A significant barrier to the introduction of AI systems is a lack of data. The majority of studies used AI models directly to address certain waste problems. Finding specifically designed AI solutions that addressed the special characteristics and features of waste management systems was uncommon. Therefore, it is clear that traditional techniques, based on rigid algorithms and mechanistic models, do not always appear to give an effective answer, especially in circumstances where there is a shortage of data, since most waste management challenges are fundamentally complicated and ill-defined. We think that our effort will pave the way for further research on the subject of waste management using AI.

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Table: 1 Various AI Models Applied in Waste management System

Study	Type	Application	Models	Datasets	Metrics	Tools
(Abbasi & El Hanandeh, 2016)	Forecasting Model	Municipal Solid Waste Management	SVM, ANFIS, ANN, kNN	Time series data	R2, RMSE, MAE, MAPE	MATLAB
(Adedeji & Wang, 2019)	Waste Classification Model	Waste Management	ResNet-50 - CNN and SVM	Trash image dataset	Loss and Accuracy	-
(Hoy et al., 2022)	Forecasting Model	Municipal solid waste	Ensemble based Bayesian-optimized ANN	Waste Production Daily.	ASM, MAF	MATLAB
(Vu et al., 2019)	Forecasting Model	Solid waste management	ANN	Open Data Portal of Daily collected Yard Data	R2, MAE, MAPE	MATLAB
(Xiao et al., 2019)	Waste Classification	Construction Waste Management	Random Forest, Pythagorean Wavelet Transform	NIR hyperspectral Camera Image Data	Accuracy	MATLAB





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(Liang & Gu, 2021)	Waste Classification	Multilabel Waste Classification	ResNet-50, CNN, MTL	WasteRL dataset	F1 Score, Precision, Exact Match Ratio, Hamming loss, Accuracy, Average Precision	-
(Huang & Koroteev, 2021)	Energy and Waste Management	Waste Treatment Energy Conservation System	Machine Learning-Driven Predictive Analytic Framework	Daily and Weekly waste Data	Average Sample Mean, Median Absolute Failure	MATLAB
(Pereira et al., 2019)	Waste Segregation and Optimization	Garbage Management	Networks and Devices	Daily Waste Data	Capacitive Reading	Atmega328P Microcontroller, IR Sensors, Capacitive Plates, Bluetooth, Servo Motor, Ultrasonic Sensor, Stepper Driver and Stepper Motor, Indication LED, Arduino IDE, R Studio
(Nguyen et al., 2021)	Waste Collection and Energy Conversion	Autonomous Waste Collection and Management for Smart University Campus	CNN, OpenCV, TensorFlow, Arduino IDE, Keil C	Real-time data	-	Jetson Nano, Arduino, STM32F4 and camera
(Abeygunawardhana et al., 2020)	Waste Management	Smart Bin	CNN, REST API	Trashnet Dataset	Accuracy	Arduino, Servo motor, and a Stepper motor
(Kang et al., 2020)	Waste Management	Garbage Classification	RESNET-34	Cifar-10 dataset, Collected a dataset with real time pictures and some online images	Accuracy, Loss	-





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Table: 2. Evaluation Parameter

Key	Evaluation Parameter	No of times used
RMSE	Root mean square error	2
R2	R-squared	2
R	Reflectivity	2
MAE	Mean Absolute Error	1
MSE	Mean square error	2
MAPE	Mean absolute percentage error	2
ACC	Accuracy	11
PC	Pearson correlation	1
ASM	Average Sample Mean	1
MAF	Median Absolute Failure	1



Figure: 1. Smart Waste Management

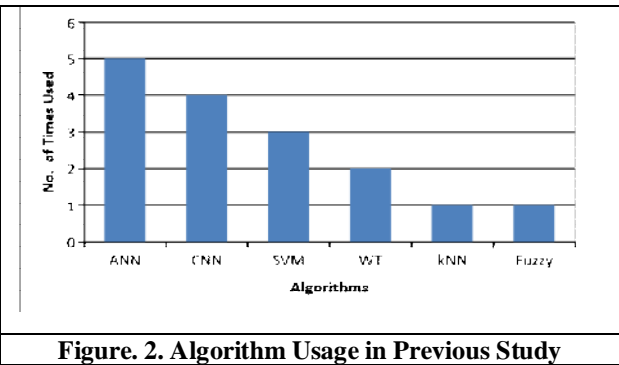


Figure: 2. Algorithm Usage in Previous Study





Insight Into Bulimia Nervosa Eating Psychological Disorder: An Updated Overview

M. Koushika¹, K.P.Thevikka², S.P Janani³, D Jose Prakash⁴ and R Prakash^{5*}

¹Student, Pharm. Chemistry, SRM College of Pharmacy, Chennai, Tamil Nadu, India.

²Student, Pharm.D, SRM College of Pharmacy, Chennai, Tamil Nadu, India.

³Student, Department of Pharmacology, C.L Baid Metha College of Pharmacy, Thorapakkam, Chennai, Tamil Nadu, India.

⁴Assistant Professor, Department of Pharmaceutics, Crescent School of Pharmacy, BSACIST, Chennai, Tamil Nadu, India.

⁵Associate Professor, Department of Pharmacology, Crescent School of Pharmacy, BSACIST, Chennai, Tamil Nadu, India.

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*Address for Correspondence

R Prakash

Associate Professor,
Department of Pharmacology,
Crescent School of Pharmacy,
BSACIST, Chennai, Tamil Nadu, India.
Email: prakasheeba@rediffmail.com



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ABSTRACT

Bulimia nervosa (BN) is a significant psychiatric disorder that mainly affects adults and young adult women. The disorder is characterized by high food intake condition marked by episodic binge eating followed by an effort to purge all excess calories commonly by vomiting, laxatives, diuretics, and excessive exercise. The main aim of the present review is to provide all related updated information to bulimia nervosa and its treatment. Based on published literature obtained from the various source like pubmed, science direct, MEDLINE and google scholar etc. It is seen that there are various screening techniques and associated treatment for bulimics. In addition to that they face several co morbidity issues and complications during the disorder. Moreover, Bulimia Nervosa is a treatable condition when identified at earlier stage and has diverse challenges to overcome.

Keywords: Bulimia nervosa, Binge, Purging, laxative



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INTRODUCTION

Eating disorders (EDs) are severe mental illnesses that usually begin in early adulthood or adolescent. These conditions have both physical and psychological consequences, and they often cause significant disability and anxiety [1]. Bulimia nervosa is an eating disorder which is characterised by mixture of emotions, attitudes, and actions, as well as physiological dysfunction [2]. Bulimics begin by eating a low-calorie diet, which contributes to food denial and nutrition deficiency. These evoke a hunger response, resulting in the uncontrollable consumption of large amounts of food and the attempt to self-medicate [3]. Over time, these behaviours may become more irrational and uncontrollable, leading to a food addiction, feelings about eating, weight loss, dieting, and body image issues [4-7].

Bulimics generally have preoccupation with body weight and shape, as well as repeated periods of uncontrollable overeating (binge eating) and aggressive steps to counteract the overeating feared consequences (purge) [8]. Because of the intense secrecy surrounding binge eating and purgative conduct, bulimia nervosa can be difficult to diagnose [9]. In 1979 the person who identified this first is Russell and described it as an ominous version of Anorexia Nervosa (AN) [10]. Later, it was classified as a separate condition, characterised by pathological eating behaviour in people of average weight [11]. Moreover Keel and Klump, who did a study in the historical events, believe they were closer to binge eating disorder (BED). The subtype in bulimia is purging and non purging type [12]. Patients with the purging subtype use a tool to get rid of the excess food which they had eaten before. Self-induced vomiting is common method, but it may also include the use of laxatives, enemas, or diuretics. Non purging bulimics compensate for binges by fasting or exercising intensely, but they do not purge on a daily basis. Bulimic patients, regardless of subtype, have a negative self-examination in regards to their body weight [13]. Fig.1 depicts the vicious cycle of bulimics.

ETIOLOGY AND RISK FACTORS

Bulimic patients eating patterns and activities are muddled by social stress, anxiety, emotions. They are afraid of gaining weight, of calories, and of food, in addition to other issues such as depression, anxiety, and a proclivity for self-harm, rash behaviour, and material misuse. The origin of the disease is unclear but researchers suspect it is caused by a combination of genetic, biochemical, psychological, social, behavioural and environmental factors [14]. The exact cause of bulimia nervosa is uncertain, although it is most likely multifactorial mainly due to abnormalities in interoceptive function, especially in the insula, can play a role in the binge behaviour that comes with this disorder. Previous study suggested that people with anorexia and bulimia nervosa show widespread anatomical and functional white matter abnormalities [15].

Individual risk factors in bulimia nervosa have received little systematic study. These types of research are critical for determining the effectiveness of preventive programmes. There have been several factors reported as potential risk factors for eating disorders [16]. The findings of two well-conducted observational studies are important. One research looked at risk predictors in an adolescent population, with a focus on personality variables [17]. Negative emotionality, a lack of interoceptive knowledge, and body dissatisfaction were all found to be strong predictors of future danger. The second study investigated predictors in people with BN using a case-control design [18]. Dieting exposure, poor self-evaluation, and some parental issues, such as alcohol misuse, parental obesity were all listed as important factors [19,20].

EPIDEMIOLOGY

INCIDENCE

The majority of eating disorder incidence studies have relied on psychiatric case registers or hospital medical records from specific areas. As a result, they give less importance to incidence in that community [21]. In Western countries, the prevalence of bulimia nervosa is increasing gradually [22]. Younger females are more prone to eating disorder in



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Western countries during the second half of the twentieth century because there was rise in the beauty pageants and in addition to it the magazines also publish more articles on weight loss methods especially for women [23-26].

PREVALENCE

Bulimia nervosa has a lifetime prevalence of 1.5 percent in women and 0.5 percent in men, according to the National Co morbidity Survey reports [27]. Previous studies, only about 15% of people are unconcerned about dieting, weight, or form, suggesting that sub threshold eating disorders are more common eating disorders is one of the most gender variant psychiatric disorders, but the gap is far narrower than commonly estimated. There was a change in estimates of the male to female ratio for eating disorders which took a change from 1: 20 to 1: 10. Another Recent community-based epidemiological research, on the other hand, found bulimia nervosa ratio of about 3 to 1 [28]. Estimates of the prevalence of eating disorders in men and women differ significantly, depending on whether complete or partial diagnostic criteria are used and whether studies are conducted in the community or in hospitals. It is seen that men have lower rates of eating disorders in all studies. In the United Kingdom, it is estimated that one in every 250 women and one in every 2000 men has been affected with AN, and the prevalence of bulimia nervosa and other forms of eating disorders is also high [29]. Figure 2 describes high prevalence of bulimia in women than men.

SCREENING OF BULIMIA PATIENTS

While several screening methods are available in primary care settings, few of them concentrate on the diagnosis of bulimia nervosa. The SCOFF questionnaire screens for eating disorders using five basic questions which can be remembered [30]. When a patient responds favourably to two or more questions, an eating disorder may be suspected with 84.6 percent sensitivity and 89.6 percent precision [31]. The negative predictive value for the SCOFF questionnaire is considerably high which construct this method worthy for screening in clinical practice. A new instrument, the Eating Disorder Screen for Primary Care was also used for screening which is no way less than SCOFF questionnaire method. When compared with SCOFF which had a likelihood Ratio (LR) of 0.25 the new instrument had a good performance with very less irregular response from the patients and a likelihood ratio of 0 (LR= 0). Both were equally successful in determining whether or not anyone is having bulimia disorder (LR = 11) [32]. A two-item bulimia nervosa assessment can also be useful as a screening method. For those who said yes to one of the two screening questions (Do you ever eat in secret?). With the following question, the gold-standard of a clinical assessment indicated a 16 percent prevalence of bulimia. Are you comfortable with your eating patterns? The predictive values of positive and negative responses were 22 percent and 91 percent respectively [33]. For bulimia nervosa, these two screening items have previously been shown to have a sensitivity of 1.00 and a specificity of 0.90. [34]. The Bulimic Investigatory Test, Edinburgh (BITE) questionnaire is a short test for identifying and explaining bulimia nervosa [35]. The BITE is a full set of 33 questions which contain 30 yes or no responses along with 3 graded questions that assesses the existence and severity of a binge-eating disorder at the same time. There are two scales known as symptom scale and the severity scale which are parts of the BITE. The symptom scale is made up of 30 yes/no questions; each "yes" answer is worth one point, and a score of 20 or higher indicates a binge-eating disorder. The severity scale is made up of three graded response questions that ask the patient to rate the frequency of their actions. This section's score of 5 or higher is considered clinically relevant. Severe is defined as a score of ten or higher. The BITE takes about 10 minutes to complete on average, and the practitioner can score it right away. Although this instrument was not created for primary care screening, it could be used to determine the degree of disease in patients who have already been diagnosed. The Eating Attitudes Test is extensively used in epidemiology investigations [36-39].

COMPLICATIONS

Generally half of the patients with bulimia nervosa only experience menstrual disturbances, like amenorrhea or oligomenorrhea [40]. The women with eating disorders may have menstrual irregularities due to reduced gonadotropin-releasing hormone, and also because of the hormone leptin, which usually get decreased with weight loss [41,42]. There is a advantage for normal or overweight bulimics who are less likely to experience amenorrhea because a certain amount of weight or body fat is required for normal reproductive functioning [43]. In bulimics, gastrointestinal (GI) tract abnormalities might occur and are usually the result of purging behaviours. Bloating,



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flatulence, and constipation are the most commonly reported GI symptoms [44]. It's possible that gastric emptying and motility will be postponed [45]. Excessive vomiting in a patient might result in gastroesophageal reflux disease and Mallory-Weiss tears. Rectal prolapse has been described, and the clinician should examine bulimia nervosa if it happens in a young lady [46]. Ipecac, an over-the-counter emetic, is frequently used by bulimics to induce vomiting. Approximately 8% of women with eating disorders may try ipecac as a treatment [47]. Ipecac has been linked to severe cardiac problems, such as cardiomyopathy and left ventricular dysfunction. The question of whether or not this dysfunction can be reversed is still being debated [48]. Patients may develop enamel erosion, particularly on the lingual surface of the teeth, calluses on the middle phalanges from using fingers to induce vomiting (Russell's sign), and sialadenosis, a noninflammatory enlargement of the salivary glands, as a result of excessive vomiting [49-50].

TREATMENT

The main goal of therapy is to break the cycle of bingeing and purging [51]. Selective serotonin reuptake drugs such as fluoxetine, citalopram, and sertraline have been shown to help with the symptoms of bulimia nervosa. Fluoxetine is the sole FDA-approved therapy for bulimia nervosa. In terms of lowering bingeing and vomiting frequency, a larger dose about 60 mg appears to be much more effective than a placebo [52]. There is little evidence that other drug classes can be used to treat this condition [53]. When compared to placebo, trazodone significantly decreased the frequency of binge-eating episodes. Monoamine oxidase inhibitors and tricyclic antidepressants are reserved for resistant cases because to their lethality and potential side effects. Because of the risks of bupropion in epileptics, it is avoided in patients with bulimia nervosa [54]. Topiramate, one of the antiepileptic drugs, has been shown to reduce binge episodes, but the side effects, particularly weight loss and cognitive problems, should be carefully monitored [55]. Patients with bulimia nervosa have benefited from cognitive-behavioural therapy and interpersonal psychotherapy in clinical trials [56]. Suicidality and concomitant psychiatric illness should be assessed in patients with bulimia nervosa because they are more likely than the general population to develop other mental illnesses [57].

COGNITIVE BEHAVIOUR THERAPY

The majority of bulimia nervosa patients do not need treatment in hospital, and ambulatory care is the preferred mode of treatment [58]. The norm and preferred psychiatric treatment for these patients is cognitive-behaviour therapy (CBT). Other methods of psychological care, such as interpersonal psychotherapy, have been demonstrated to be inferior to CBT, in several studies [59,60]. Fairburn first described this method of treatment for bulimia nervosa and it has two objectives: The first is to break the cycle of overeating and vomiting, and the second is to adjust inappropriate dietary behaviour [61].

The CBT method has three phases that is followed in the course of 20 weeks of treatment. The 3 phases are described, in the initial phase; bulimics are given lessons about this eating disorder and the specific action that worsen the disease. The treatment patients maintain accurate food charts, which are used in counselling sessions that include the frequency of bingeing and purging. The second phase involves directing patients to widen their food choices and longer period of time is devoted to addressing unhealthy eating habits, thoughts, and bodies. The third stage of treatment is focused on maintaining the patient's health and preventing recurrence. At the end of this session it was seen that 45 percent of bulimics avoided overeating and purging after completing CBT, and 35 percent had no issues after that for medical treatment.

PSYCHOPHARMACOLOGICAL TREATMENT

Over the course of eight weeks, one open clinical trial was published to investigate the efficacy and tolerability of fluoxetine (at an adult dosage of 60 mg) in combination with psychotherapy. There were about 20 participants in the age between 12 to 18 years old (mean 16.2, SD 1) and had a DSM-IV diagnosis of BN or ED not otherwise defined (EDNOS). For all participants, the median weight was above the 85th percentile of their age. The drug was well accepted by all participants, and none of them dropped out due to side effects. Ten of the 13 patients who participated in the study were given medication for at least one week, and the findings were based on their results. The results were similar to fluoxetine trials in adults with BN, with a substantial reduction in both binge and purge activity over the duration of the study. Daily binges and episodes of purging decreased by 67 percent and 56 percent,

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respectively, from baseline to the end of therapy (EOT). After progress, three of the ten patients (two BN and one EDNOS) met DSM-IV ED requirements at the end of the study [62].

PSYCHODYNAMIC THERAPY

This is another method for the psychotherapeutic treatment which involves 3 phases.

Phase I Therapists establish a positive working relationship with patients, frame the condition in psychodynamic terms, and assist patients in comprehending bulimic symptoms.

Phase II This phase focuses on incorporating alternative behaviours and addressing related issues, as well as strengthening self-monitoring and introspection, shame and guilt, perfectionism, and symptoms that serve as protection and coping mechanisms. Patients are advised to become more conscious of the emotional and social meanings of symptoms, as well as the functionality and symbolism of symptoms.

Phase III Patients should be able to recognise and thereby predict challenging circumstances in the final process, and they should be able to apply the techniques developed in counselling. Another critical aspect of this final stage is appreciating the progress made and acknowledging disappointments [63]. Thus with these manual treatment and therapeutic session the bulimia nervosa can be overcome.

CHALLENGES IN TREATMENT

Though we can identify bulimia nervosa by symptoms, there are many challenges in treatment BN. It include: biological factor, psychological factor, environmental factor.

BIOLOGICAL FACTOR

Eating disorders, according to the latest biological theory, is abnormal and overriding of usual neuron biologically controlled eating habits in reaction to the continued desire to become thin and fear in regarding normal weight. It was found in recent study that eating disorders have important genetic component to their aetiology. Moreover Genetic factors can play a key role in the development of bulimia nervosa to the tune of more than 50%.[64].

PSYCHOLOGICAL FACTOR

Shame and secrecy can prevent BN from being detected and treated once symptoms are reported. The family can play an important role in providing additional support to help control eating behaviour in between therapy. However, in BN, binge episodes or compensatory actions can be less apparent, making it difficult for parents to completely structure the atmosphere. Adolescents with BN are more likely to seek care for another psychological condition like mood anxiety disorder while still dealing with binge eating and purging due to the high degree of comorbidity. Diagnostic evaluation and updated progress monitoring may provide help to discover clinically relevant BN symptom[65].

ENVIRONMENTAL FACTOR

Bulimia nervosa, on the other hand, seems to be a culture-specific disorder. Many cases from non-Western countries were discovered to be free of weight issues. In the current debate, the idea that eating disorders are etiologically linked to the increase of social pressure arising from contemporary industrial society's or Western culture's ideals of female attractiveness holds a dominant role. If they are bullied by family and friends, and comments and instructions by authority people like doctors, nurses, teachers, coaches about the need to lose weight all play a role in the creation of eating disorders [66].

COMORBIDITY

When an eating disorder is established, there is a study of medical problems of eating disorders which are only partially discussed and, most of cases, comorbid psychological disorders come along with the eating disorder. These are the following examples of common co-occurring conditions. Mood affective disorder, anxiety disorder, substance use disorder. Adolescents with BN have the highest incidence of comorbidity (88 percent), with especially strong correlations with mood (49.9%) and anxiety (66.2%) disorders (Kiriike et al 1988).The high rate of suicidality in this population is particularly alarming. Suicidality was identified at higher rates in adolescents with BN than in adults

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with BN and in youth with any other ED diagnosis. Suicidal ideation was supported by more than half (53%) of adolescents with BN. About a quarter of the people in the study had a strategy, and more than a third had attempted before (17.1 percent had tried multiple times) [67].

MOOD AFFECTIVE DISORDER

Bulimia nervosa patients also exhibit various affective disorders. [68]. Now there is a finding which has discovered an increased level of co-morbidity between bipolar affective disorders and eating disorders, mainly bulimia nervosa and bipolar II disorders [69]. When the sub threshold forms of the conditions are included, the co morbidity becomes more evident. [70]. Mood disorders are a very common co morbid illness in people who have eating disorders. In some research, the lifetime prevalence of co morbid depression in people with eating disorders exceeds 75% [71, 72]. While bipolar disorder affects a small percentage of people with bulimia nervosa. Ten percent patients with a serious eating disorder will develop a co morbid bipolar disease at some stage during their treatment [73].

ANXIETY DISORDER

Patient with bulimia nervosa condition have a much higher chance of anxiety disorders in common and obsessive compulsive disorder especially. Anxiety disorders often begin in adolescence, prior to the development of an eating disorder, suggesting that they could be a risk factor for developing bulimia nervosa. [74]. In patients with eating disorders, the lifetime prevalence of obsessive-compulsive disorder (OCD) is about 40%. Panic disorder (11%), social phobia/social anxiety disorder (20%), specific phobic bias (15%), generalised anxiety disorder (10%), and post-traumatic stress disorder (PTSD) (13%) are all major contributors to comorbidity among these patients. [75,76]. Figure 3 represent the prevalence of various anxiety disorder.

SUBSTANCE USE DISORDER

Multiple drug use disorders are linked to eating disorders, with the risk being higher for bulimia nervosa and the binge eating/purging subtype of anorexia nervosa [77,78]. According to Columbia University's National Center on Addiction and Drug Abuse, 30 to 70 percent of bulimics have a substance abuse problem [79]. Tobacco, alcohol, and prescription and over-the-counter drugs, such as diet pills and stimulants, are among the most commonly abused substances. 31% of bulimia patients are alcoholics, and alcoholism is frequently linked to major depressive disorder and posttraumatic stress disorder [80]. Bulimia nervosa and alcoholism have also been shown to have strong family links [81].

PERSONALITY TRAITS DISORDER

Bulimia nervosa has been linked to impulsive, extroverted, low self-esteem, and dysfunctional personality disorders, while Binge eating disorder (BED) has been linked to avoidant nervous personality disorders [82].

OTHER PSYCHIATRIC DISORDER

Bulimia nervosa patients are worried about self-injury. According to survey, 34 percent of bulimia patients have made self-injury at some point in their lives, and 21.3 percent have done so in the last five months [83]. Patients often cut or slash their forelimbs, hind limbs, faces, and most of these injuries may lead to bleeding or scarring. The borderline personality disorder patients who self-injure themselves has high chance for eating disorder like bulimia than non injuring persons [84].

FUTURE DIRECTION

Eating disorders research in developing countries like India may be successful because it offers a rare opportunity to test the role of culture in the aetiology of eating disorders. In this regard, the relative prevalence of eating disorders in psychiatric facilities (approximately one case per year) may pose a problem. [85, 86]. Research of bulimia studies, patient should be enhanced and improved. The detailed study gives idea and will definitely give chances to identify and treat bulimia patients. The most prominent duty is that to identify the bulimics at the earlier stage. It is the duty of a physician as well as the family members to analyse the patient and their behaviour towards eating. Another important stage is recovery of patient towards the current therapy followed. There should be gradual improvement



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toward therapy, if not the mode of treatment should be changed and it must be enhanced. The figure 4 gives a critique of Bulimia Nervosa disorder.

CONCLUSION

Bulimia nervosa is a serious eating disorder which is expressed by mixture of emotions, thoughts, low self-worth and various psychological issues. There are various reasons for this disorder, but precise cause is unknown. The first step is to be taken to identify the bulimics at the earlier stage. It is important because it helps the therapist to treat and also it enhances for a faster recovery. The patients undergo several stresses and are afraid about their behaviour, hence they should be made to express their grief and dissatisfaction and suitable therapy should be given. Bulimia Nervosa is treatable condition which includes several challenges and co morbidity to overcome.

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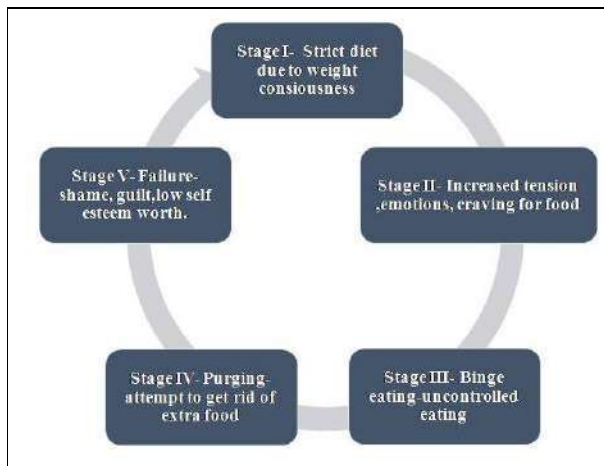


Figure 1 Vicious cycle of bulimia nervosa patients.

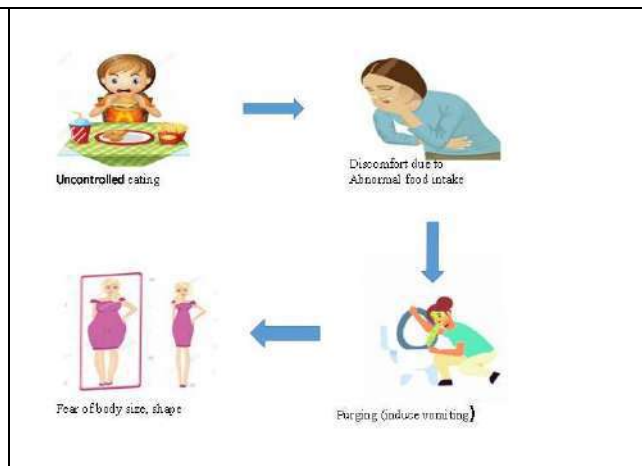


Figure. 2 Prevalence of bulimia among in sex

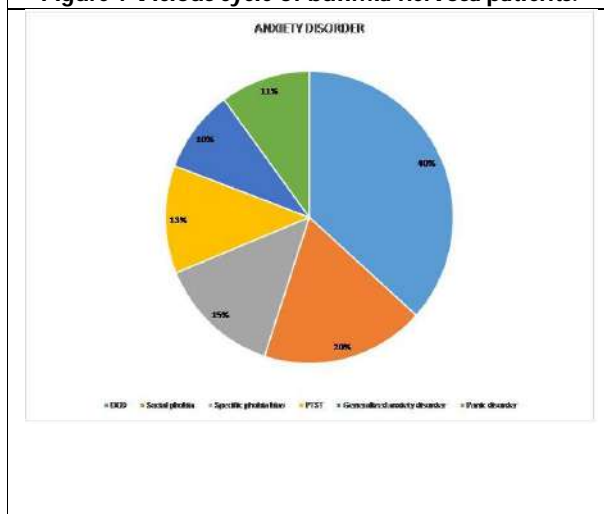


Figure 3 Prevalence of various anxiety disorders in bulimia patients.

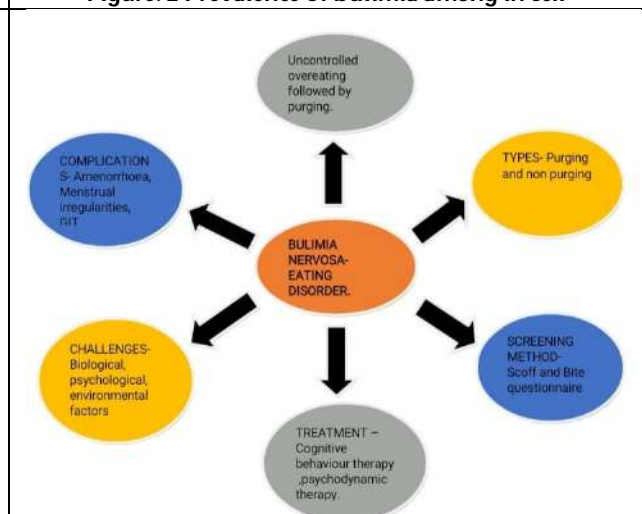


Figure 4 Critiques about Bulimia Nervosa.





A Study on the Profile Characteristics of MGNREGS dalit Women Beneficiaries in Northern Districts of Tamil Nadu

V. Thirumal Kannan¹ and T. Raj Pravin^{2*}

¹Doctoral ICSSR Research Scholar, Department of Agricultural Extension, Faculty of Agriculture, Annamalai University, Annamalai Nagar-608002, Tamil Nadu, India

²Associate Professor, Department of Agricultural Extension, Faculty of Agriculture, Annamalai University, Annamalai Nagar-608002, Tamil Nadu, India

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*Address for Correspondence

T. Raj Pravin

Associate Professor,
Department of Agricultural Extension,
Faculty of Agriculture, Annamalai University,
Annamalai Nagar-608002, Tamil Nadu, India



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ABSTRACT

Tamil Nadu is one of the leading state in the successfully implementation of Mahatma Gandhi National Rural Employment Scheme (MGNREGS). This present study was conducted in all the northern districts of Tamil Nadu to assess the profile characteristics of MGNREGS dalit women beneficiaries. The study was conducted in selected thirteen blocks representing one block from each district where there was more number of MGNREGS dalit beneficiaries. Proportionate random sampling procedure was used to select about three hundred MGNREGS beneficiaries from the selected thirteen panchayats in the study area. Based on judges opinion, nineteen variables were selected for studying the profile characteristics of the MGNREGS dalit women beneficiaries. This study revealed that majority of the dalit women respondents in this study belong to middle age category, were married having a nuclear family with five members, functionally literate with MGNREGS + wage earners as their main occupation. They have marginal landholdings, medium level of annual income and social participation. They live in pucca type houses with low level of farm power and have medium level of material possession. Majority of dalit women beneficiaries have medium level of economic motivation and mass media exposure, low level of extension agency contact and cosmopolitanism, medium level of achievement motivation, low level of risk orientation and high level of aspiration. This findings will be very helpful to our policy planners at the national and state level and district administrators at the regional level. Extension professionals at all department levels need to be involved towards strengthening this welfare scheme through effective use of social audits, deploying advanced information and communication technologies to improve the effectiveness and efficiency of this welfare scheme in achieving it's intended goals and objectives

Keywords: Profile characteristics, MGNREGS Dalit women beneficiaries, Northern Tamil Nadu





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INTRODUCTION

Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) is the largest public employment programme in the world. Largely implemented during the lean season in rural areas, it provides to the livelihood needs of the marginalized sections of our rural society. It has high level of female participation contributing to a degree of women empowerment resulting in higher real time wages. While MGNREGS provides a legal guarantee for about one hundred days of employment in a financial year to all members of any rural household willing to do public related unskilled manual work at the statutory minimum wage. The creation of durable assets from these manual works assist in soil and water conservation and other natural resource conservation. The long term benefits of environmental enhancement would also help us in increasing farm production. This will also create more and more employment opportunities in rural economy, resulting in sustainability and self sufficiency of rural households. The present study was undertaken in all the northern districts of Tamil Nadu to assess the profile characteristics of MGNREGS dalit women beneficiaries.

History of MGNREGS scheme

Government of India took a historic step by enacting the National Rural Employment Guarantee Act (NREGA) in 2005 by merging Swarnajayanthi Gram SwarojgarYojana (SGSY) and National Food for Work Programme (NFFWP) for providing livelihood security to rural unemployed. The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) was enacted through legislation on August 25, 2005 and implemented on February 2, 2006. The scheme was started in three phases, first in 2006 covering 200 districts, second phase in 2007- 2008 covering another 130 districts and in the third and final phase, the remaining districts have been notified under NREGA with effect from 1st April 2008.

RESEARCH METHODOLOGY

Though Tamil Nadu has very less population falling under the multidimensional poverty index, the northern districts in Tamil Nadu still remains as backward districts (Chengalpattu, Cuddalore, Dharmapuri, Kallakurichi, Kanchipuram, Krishnagiri, Ranipet, Salem, Tirupathur, Tiruvallur, Tiruvannamalai, Vellore, Villupuram) of Tamil Nadu on many socio- economic indicators as identified by the State Planning Commission (2022) and Niti Aayog (2021) on the basis of poverty, industrial backwardness, educational backwardness, drought & health backwardness. In this study, thirteen blocks namely Madurantakam, Mangalur, Harur, Kallakurichi, Uthiramerur, Uthangarai, Arakonam, Thalavasal, Madhanur, Minjur, Chengam, Gudiyatham, Kandamangalam was selected from the thirteen northern districts of Tamil Nadu purposively as they have more number of MGNREGS dalit women beneficiaries. Proportionate random sampling method was used to select the 300 women dalit women beneficiaries in this study. The data was collected using a well- structured interview schedule. Necessary efforts were made to cross- check the collected data from the respondents in this study. The map shows the study area (Figure 1). The selected districts, identified blocks and village panchayats are presented in (Table 1).

FINDINGS AND DISCUSSION

The findings and discussions on profile characteristics of MGNREGS dalit women beneficiaries are given below Table-2

Age

Majority (52.67 per cent) of the MGNREGS dalit women beneficiaries were found to belong to middle age group followed by 33.33 and 14.00 per cent in the old and young age groups. The findings might be due to the fact that more number of middle age women are taking up MGNREGS work in their respective village or in nearby villages as their social mobility is very less. The low wages of MGNREGS also discourage more participation of young age

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dalit women in this welfare scheme. Being literate also provides them with more job opportunities to take up jobs which are more remunerative than wages offered in MGNREGS. This might also be the possible reason behind such a response.

Marital status

Majority (78.67 per cent) of the MGNREGS dalit women beneficiaries in this study were married followed by 13.33 per cent of the beneficiaries belonging to widow/divorced category and only 8.00 per cent of the beneficiaries belong to unmarried category. The reason for this outcome is rural areas of Tamil Nadu, particularly in the most backward districts girls get married as soon as they reach puberty. This finding is in line with findings of Kumari Priyanka (2020) who also reported that majority of the MGNREGS respondents are married

Educational status

Majority (42.67 per cent) of the MGNREGS dalit women beneficiaries were functionally illiterate followed by illiterate (32.00 per cent) category and about 11.67 per cent of the beneficiaries have studied up to primary education level. Only 6.00 per cent of the beneficiaries were educated till middle education and a very meager amount of the beneficiaries 4.67 per cent and 3.00 has studied up to secondary and collegiate education. This may be due to their poor socio- economic status in the study area and also due to lack of infrastructure facilities (Physical and social infrastructure) to support education for the marginalized sections of our society who are all beneficiaries of MGNREGS in this study area.

Occupational status

Majority (52.00 per cent) of the MGNREGS dalit women beneficiaries have MGNREGA + wage earners as their main occupation, followed by 24.33 per cent of the beneficiaries engaged in MGNREGA + farming alone as their occupation. Only 13.00 percent and 10.67 percent of the MGNREGS dalit women beneficiaries had MGNREGA+ Farming+ Wage earners and MGNREGA as their main occupation. Though hundred days of work is promised under MGNREGS, the dalit women beneficiaries get work only for a very few days in a year to support their families. With income from MGNREGS not being sufficient to meet their livelihoods needs, they also work for wages in their respective or nearby villages in farm fields to support their family needs. This might be the possible reason for such an outcome in this study. This finding is in line with Raut Mangesh Arunrao et al., (2018) who also found that majority (57.50 percent) of the respondents were dependent on MGNREGS + labour. About 19.17 percent of the respondents were engaged in MGNREGS + Farming + Animal husbandry + other and about 12.5 percent are working in MGNREGS+ Agriculture labour+ Animal husbandry categories.

Farm size

About 47.00 per cent of the MGNREGS dalit women beneficiaries were reported to be marginal farmers, followed by 44.67 per cent of the dalit women beneficiaries belonging to landless labour category. Only 8.33 per cent of the dalit women beneficiaries were reported to have owned small sized farms. This finding derives support from findings Kanimozhi (2018) and Raut Mangesh Arunrao et al., (2018) who also observed that majority of the MGNREGS beneficiaries were reported to own marginal farms.

Annual income

Majority (65.33 per cent) of the MGNREGS dalit women beneficiaries were having medium level income as most of them were land owning marginal farmers and were beneficiaries of MGNREGS scheme and also work as wage earners in this study. This is followed by 28.00 per cent of the dalit women beneficiaries having low level of income and a very meager proportion (6.67 per cent) of the beneficiaries are having higher level of income. This finding is in accordance with the findings Badodiya et al., (2011) who also stated that a higher percentage of the MGNREGS beneficiaries (59.09 percent) had their annual income upto Rs.5000 to 9000 and belonged to medium income category.





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Social participation

About 47.33 per cent of the MGNREGS dalit women beneficiaries were reported to have medium level of social participation followed by 36.00 and 16.67 per cent of the dalit women beneficiaries coming under low and high level of social participation respectively. Absence of education, their poor socio- economic status in their respective villages and nearby villages, caste discrimination at rural areas in practice might be the possible reasons behind this outcome. This findings are supported by Mohanraj and Karthikeyan (2012) who also found that majority of the MGNREGS beneficiaries (55.83 percent) were reported to have moderate level of social participation

Socio Economic Status Parameters

Type of House

About 49.00 per cent of the MGNREGS dalit women beneficiaries were reported to live in pucca house followed by 33.67 and 17.33 per cent of the dalit women beneficiaries living under kutchra and hut houses respectively. Their medium level of annual income, majority (47.00 per cent) are them being owners of marginal lands and small farmers (8.33 per cent) in this study are the possible reasons behind this outcome. This findings also derives support from findings of Masenamma Chodipalli and Choudari Appa Rao (2017) who reported that 48 percent of MGNREGS SC respondents are living in pucca houses

Farm power possession

About 52.00 per cent of the MGNREGS dalit women beneficiaries were reported to have low level of farm power followed by 36.67 and 11.33 per cent of the dalit women beneficiaries having medium and high level of farm power respectively. Being marginal and small land owners and labourers, majority are dependent on MGNREGS and are wage earners in this study. So naturally, they need or use less farm power as revealed in this study. This is reflected in their farm power possession status. This findings is in accordance with the findings of Thirumal Kannan (2019) who reported low level of farm power possession among MGNREGS beneficiaries in Dharmapuri district

Material possession

Majority (58.00 per cent) of the MGNREGS dalit women beneficiaries were reported to have medium level of material possession followed by 28.00 and 14.00 per cent of the dalit women beneficiaries coming under low and high level of material possession respectively. Their medium level of annual income is also reported by majority (65.33 %) of the women beneficiaries in this study. Dalit women respondents with annual income Rs. 26,000 to Rs. 45,000 and high income annual level (Rs.45,000 to 60,000) reported by about 6 per cent of MGNREGS dalit women beneficiaries are the possible reasons behind this outcome as their annual income play an important role in their material possession status. This findings is in accordance with findings of Thirumal Kannan (2019) who found that majority (61.67 percent) of the MGNREGS beneficiaries have medium level of material possession in the Dharmapuri district of Tamil Nadu

Family type

Majority (72.00 per cent) of the MGNREGS dalit women beneficiaries were found to live under nuclear family and only 28.00 per cent of the dalit women beneficiaries were reported to be under joint family system. This findings is in line with findings of Lily Sangpui and Lalfakzuali (2019) who reported that majority of the MGNREGS respondents are living in nuclear family

Family size

Majority (76.00 per cent) of the MGNREGS dalit women beneficiaries had upto five members in a family whereas the remaining 24.00 per cent have more than five members in their family. These findings are supported by findings of Prashant Ramesh Naik (2020) who observed that that 50.00 per cent of the MGNREGS beneficiaries were having 5 members in their family



**. Thirumal Kannan and Raj Pravin****Economic motivation**

Majority (58.33 per cent) of the MGNREGS dalit women beneficiaries were reported to have medium level of economic motivation followed by 22.67 per cent and 19.00 per cent of the dalit women beneficiaries falling under low and high level of economic motivation respectively. Mostly finding jobs under MGNREGS within or in the nearby villages due to their less social mobility may be the possible reason behind such a response. This findings derives support from by findings of Dhulgand and Kadam (2019) who stated that majority of the MGNREGS beneficiaries were having medium economic motivation.

Mass media Exposure

Majority (56.00 per cent) of the MGNREGS dalit women beneficiaries were reported to have medium level of mass media exposure followed by 26.33 per cent and 17.67 per cent of the dalit women beneficiaries coming under high and low level of mass media exposure category. This findings derives support from findings of Hanumantha (2016), Archana (2016), Pallavi (2021) who also revealed that majority of the MGNREGS beneficiaries belonged to a medium level of mass media participation category.

Extension agency contact

Majority (62.67 per cent) of the MGNREGS dalit women beneficiaries were reported to have low level of extension agency contact followed by 21.33 and 16.00 per cent of the dalit women beneficiaries coming under medium and high level of extension agency contact respectively. The AAOs or AHOs are not made a part in the implementation of MGNREGS programme in Tamil Nadu unlike other states in our nation. This might be the possible reason behind such a response.

Cosmopolitaness

Majority (58.67 per cent) of the MGNREGS dalit women beneficiaries had low level of cosmopolitaness followed by 27.00 per cent and 14.33 per cent with medium and high level of cosmopolitaness. The MGNREGS workers mostly work in their respective villages or in their nearby villages. Mostly belonging to functionally literate category (42.67 per cent) and illiterate (32.00) categories, their social contact and extension agency contact is also mostly geographically restricted because of many social factors like age, education and their less social mobility. This might be the possible response for such an outcome. This finding is in line with findings of Bhuvana (2013) who revealed that majority of the MGNREGS beneficiaries had low level of cosmopolitaness.

Achievement motivation

Majority (64.67 per cent) of the MGNREGS dalit women beneficiaries were reported to have medium level of achievement motivation followed by 22.33 and 13.00 per cent of the dalit women beneficiaries coming under low and high level of achievement motivation category respectively. The reason for poor achievement motivation can be attributed to their poor socio economic status as most of them rely on MGNREGS + wage earners or work solely in MGNREGS for meeting their livelihood needs. Moreover mostly belonging to middle age (52.67 per cent) and old age categories (33.33 per cent) in this study was also the possible reasons for such an outcome. As age moves up in rural situation, with low level cosmopolitaness seen among majority (58.67 %) of the MGNREGS respondents naturally their achievement motivation will be very low as reflected in this study. This finding is supported by findings of Roy et al., (2013) and Archana (2016) who reported that majority of MGNREGS beneficiaries had medium achievement motivation.

Risk orientation

About 49.33 per cent of the MGNREGS dalit women beneficiaries were reported to have low level of risk orientation followed by 31.67 and 19.00 per cent of the dalit women beneficiaries coming under medium and high level of risk orientation. Their poor educational level with majority (42.67 per cent) being functionally literate and illiterate (32 per cent), majority belonging to middle (52.67 per cent) and old age categories (33.33 per cent), with medium (47.33 per cent) to low level (36.00 per cent) of social participation, medium (58.33 per cent) to low level (22.67 per cent) of economic motivation, low level (62.67 per cent) to medium level (21.33 per cent) of extension agency contact,



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majority (58.67 per cent) with less cosmopolitanism might be the possible reasons behind their low level of risk orientation. This findings derives support from findings of Bhuvana (2016) who stated that majority (74.17%) of the MGNREGS beneficiaries had medium level of risk orientation

Level of Aspiration

Majority (63.00 per cent) of the MGNREGS dalit women beneficiaries in this study is reported to have high level of aspiration followed by 24.67 and 12.33 per cent of the dalit women beneficiaries falling under low and medium level of aspiration respectively. Though dalit women beneficiaries of MGNREGS suffer from many social handicaps in this study, they want their children and family to rise up economically and socially. This may be the possible reasons behind such an outcome. This findings is in accordance with findings of Jayamta Roy (2012) and Roy et al., (2013) who observed that majority of the MGNREGS respondents had high level of aspiration

CONCLUSION

It could be concluded from this study that, Majority of the dalit women beneficiaries of MGNREGS scheme in Northern districts of Tamil Nadu belong to middle age category. Mostly they are married having a nuclear family of five members. They are functionally literate and have MGNREGS + Wage Earners as their main occupation. They have marginal landholdings with medium level of annual income and social participation. They live in pucca type houses, deploying less farm power and possess medium level of material possession. Majority of the MGNREGS dalit women beneficiaries have medium level of economic motivation and mass media exposure, low level of extension agency contact and cosmopolitanism. Majority of the dalit women respondents have medium level of achievement motivation, low level of risk orientation and high levels of aspiration. Our policy planners at the national and state level and district administrators at the regional level, extension professionals at all department levels need to be involved and made to work together in strengthening this welfare scheme through effective use of social audits, deploying advanced information and communication technologies to improve the effectiveness and efficiency of this welfare scheme in achieving its intended goals and objectives. Hence, the following implications are drawn so as for promote successfully implementation among the northern districts of Tamil Nadu

1. At present MGNREGA is providing guaranteed employment of only 100 days per family. Hence, increase in the number of days of employment per year per person would encourage more participation of women beneficiaries in this welfare scheme
2. Under MGNREGA, the female participation was found to be high. So, there should be the better work conditions like child care facility, medical aid facility and so on. This will empower the women by increasing their participation in the work force

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Table 1- Details of the study area

S.No	Study Districts	Identified Blocks	Selected Village Panchayats
1	Chengalpattu	Madurantakam	Mamandur
2	Cuddalore	Mangalur	Sirupakkam
3	Dharmapuri	Harur	Veerappanaickampatty
4	Kallakurichi	Kallakurichi	Ka. Alambalam
5	Kanchipuram	Uthiramerur	Arumbuliyur
6	Krishnagiri	Uthangarai	Mittapalli
7	Ranipet	Arakonam	Sembedu
8	Salem	Thalaivasal	Thalaivasal
9	Tirupathur	Madhanur	Vadacheri
10	Tiruvallur	Minjur	Neithavoyal
11	Tiruvannamalai	Chengam	Paramanandal
12	Vellore	Gudiyatham	Ramalai
13	Villupuram	Kandamangalam	Gengarampalayam





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Table 2- Profile characteristics of MGNREGS dalit women beneficiaries in Northern Tamil Nadu

(n=300)

Profile Characteristics	Category	Frequency	Percentage
Age	Young (upto 35 years)	42	14.00
	Middle (About 35 up to 45 years)	158	52.67
	Old (More than 45 years)	100	33.33
Marital status	Married	236	78.67
	Unmarried	24	8.00
	Widow/Divorced	40	13.33
Educational status	Illiterate	96	32.00
	Functionally literate	128	42.67
	Primary education	35	11.67
	Middle education	18	6.00
	Secondary education	14	4.67
	Collegiate education	9	3.00
Occupational status	MGNREGA only	32	10.67
	MGNREGA + Wage earners	156	52.00
	MGNREGA + Farming alone	73	24.33
	MGNREGA + Farming + Wage earners	39	13.00
Farm size	Landless labourers	134	44.67
	Marginal farmers (<1 ha)	141	47.00
	Small farmers (1-2 ha)	25	8.33
Annual income	Low (up to Rs. 26,000)	84	28.00
	Medium (Rs.26,000 to Rs.45,000)	196	65.33
	High (Rs.45,000 to Rs.60,000)	20	6.67
Social participation	Low	108	36.00
	Medium	142	47.33
	High	50	16.67
Socio -Economic Status Parameters			
i) Type of House	Hut	52	17.33
	Kutcha	101	33.67
	Pucca	147	49.00
ii) Farm power possession	Low	156	52.00
	Medium	110	36.67
	High	34	11.33
iii) Material possession	Low	84	28.00
	Medium	174	58.00
	High	42	14.00
iv) Family type	Nuclear	216	72.00
	Joint	84	28.00
v) Family size	Upto 5 members	228	76.00
	More than 5 members	72	24.00
Economic Motivation	Low	68	22.67
	Medium	175	58.33





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	High	57	19.00
Mass media Exposure	Low	53	17.67
	Medium	168	56.00
	High	79	26.33
Extension agency contact	Low	188	62.67
	Medium	64	21.33
	High	48	16.00
Cosmopolitaness	Low	176	58.67
	Medium	81	27.00
	High	43	14.33
Achievement motivation	Low	56	18.67
	Medium	205	68.33
	High	39	13.00
Risk orientation	Low	148	49.33
	Medium	95	31.67
	High	57	19.00
Level of Aspiration	Low	74	24.67
	Medium	37	12.33
	High	189	63.00

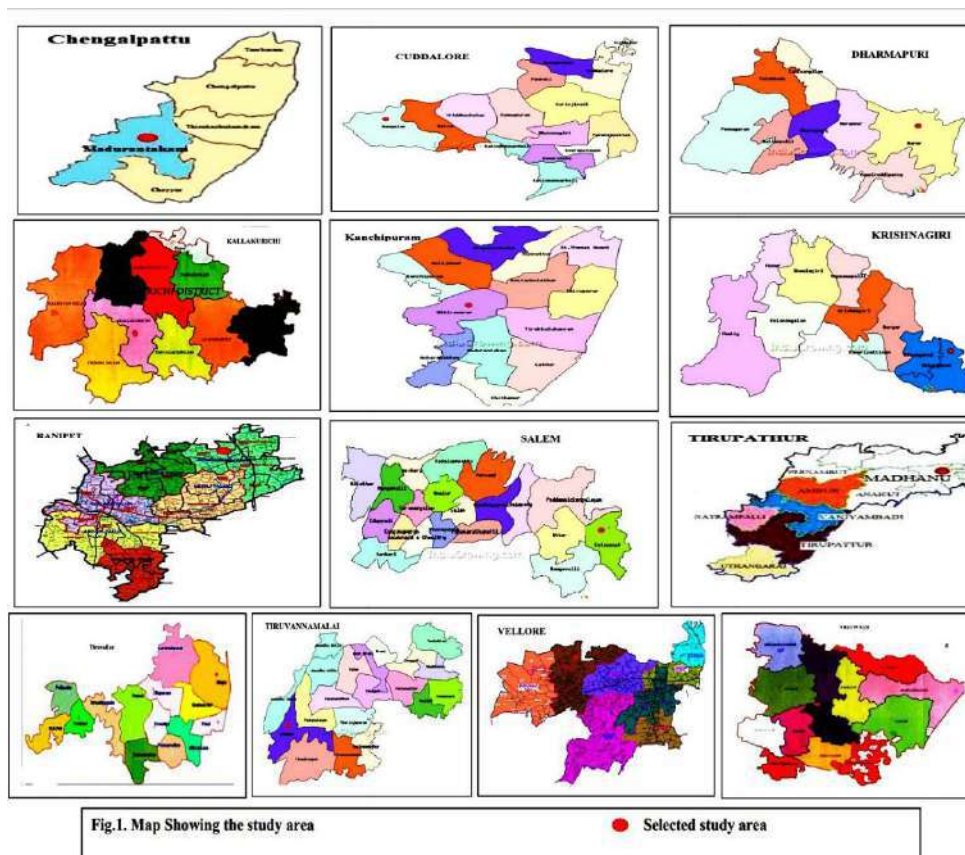


Figure 1- Map showing the study area





Analysis and Design of RCC Dome Structure by using Staad Pro

L.Maithri Varun^{*1} and Kadari Mrudula²

¹Assistant Professor, Department of Civil Engineering, Malla Reddy Engineering College, Hyderabad, Telangana, India

²Student, Department of Civil Engineering, Malla Reddy Engineering College, Hyderabad, Telangana, India

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*Address for Correspondence

L.Maithri Varun

Assistant Professor,

Department of Civil Engineering,

Malla Reddy Engineering College,

Hyderabad, Telangana, India

E.Mail: Varuncivil@mrec.ac.in



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ABSTRACT

Vaults surrounding close construction created from A.D periods that square measure made for getting enormous volume from the design. Regularly vaults square measure intended for uniform stacking over the plates. During this examination by applying reason hundreds over the nodal joints investigation and Design of substantial arch construction was done double-dealing STAAD.pro. A 8.49m ascent with 30m distance across arch and a help tallness of 14m was contemplated for the preparation. Load is allocated as plate load and accordingly the weight is allotted as reason load over the nodal joints. The protected hundreds were found from the arranging results against shifted stacking cases. A vault could likewise be framed as a thin shell produced by the upheaval of an ordinary bend concerning one in everything about tomahawks. The type of the vault depends abreast the sort of the bend and heading of the hub of unrest. The rooftop is acclimated cowl gigantic floor structures. The shell rooftop is helpful once inside the structure is open and doesn't contain dividers or points of support. Arches square measure utilized in kind of designs like top of roundabout regions, round tanks, display corridors, assembly halls and so on. Arches could likewise be made of brick work, steel, wood and fortified concrete cement. During this paper we tend to Design RCC arch rooftop structure by abuse manual procedures which supplies detail Design of RCC vaults. The strategy of arranging RCC vaults was plainly made sense of and from the Analysis and Design we tend to get the Meridional Reinforcement, circle Reinforcement of an arch and ring shaft Reinforcement. Catchphrases Dome, STAAD.pro, Nodal Joint Load, Shear Force and Bending Moment

Keywords: Construction, Reinforcement, Circle, Design, Analysis



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INTRODUCTION

A vault is a part of plan that looks like the empty higher a large portion of a circle. Vault structures manufactured from changed materials have a lengthy part of information ancestry stretching out into timeframe. Vaults first showed up as strong hills and in procedures filmable exclusively to the littlest structures, as circular hovels and burial places inside the antiquated Middle East, India, and consequently the Mediterranean. The Romans presented the enormous scope stone work half of the globe and in this way the earliest fantastic model like the Roman Pantheon, required genuine supporting dividers. Byzantine planners incredible a way for rising arches on docks, permitting lighting and correspondence from four bearings. The change from an isometric base to the subfigure vault was accomplished by four pendentives, altered three-sided a lot of brick work crooked each evenly and in an upward direction. Their peaks enthusiastic on the four wharfs, to that they led the powers of the vault; their sides joined to make curves over openings inside the four essences of the shape; and their bases met during a total circle to make the arch establishment. The pendentives arch could lay straightforwardly on this roundabout establishment or upon a barrel shaped divider, known as a drum, embedded between the two to broaden stature.

LITERATURE REVIEW

The IS code characterizes a vault as a: "Three-layered exceptional design made of one or a great deal of arced sections or imploded plates whose thickness region unit little contrasted with their various aspects. Thin shells region unit portrayed by their three layered load-conveying conduct, that is set by the unadulterated science by their structures, by the way inside which they're upheld, and by the personality of the applied burden". Vaults have a place with the class of focused skin structures that, because of their unadulterated math and little flexural unbending nature of the skin, will more often than not hold masses fundamentally by direct burdens working on their plane. Substantial shell structures region unit ready to traverse goliath distances with negligible amount of texture. Precisely foreseeing the clasping conduct of thin arch shells exposed to uniform outer strain could be a high level, high-ticket and time overpowering strategy which may exclusively truly be done exploitation PC. In any case, this technique is significant to safely Design Associate in nursing build a conservative and viable shell structure. top to bottom investigation has gone in to breaking down the way of behaving of shell arches however there has regardless to only be a model that conveys this information. so the point of this examination is to {produce} a model which may precisely deliver quick, useable investigation of mathematically astounding and flawed shell vaults with fluctuated limit conditions that might be utilized in the appearance of such designs.

Design Consumables

Cardboard or cereal boxes

Wooden craft dowels (package of 100)

Various paper types

Rubber bands (100–500)

Craft sticks (box of 1,000)

String

Tape (several rolls to share)

Paper cup (1 per team)

METHODOLOGY

Investigation and Design Dome Structure is generally done abuse the particulars given by the code of apply. For tremor powers partner powers investigation of construction the system utilized is Static method Equivalent Static Lateral Force procedure it's a worked on strategy to switch the effect of the unique stacking of an abrupt quake with a static power appropriated along the side during a construction for Design capacities. The applied complete

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unsteady power is normally assessed in two level bearings corresponding to the most structure tomahawks; it's expected that the structure answers in its rudimentary sidelong mode. To Design partner degreed break down a construction equipped for opposing the effect of a seismic tremor, it's important to starting indicate the powers on the construction. This procedure is that the least difficult and needs less computation gives and depends a shot the equation gave inside the code of apply.

The reflection corridor is expected double-dealing vault structure. Every one of the individuals are planned as just upheld part with the segment mounted. The system followed for arranging these vault structure and their components are displayed underneath.

3.2. Design Process Flow Diagram

- Design of shell structure
- Calculation of dome load
- Design of ring beam
- Design of column
- Calculation of loads
- Calculation of total load

3.2.1. Material Properties:

- Grade of concrete : M30
- Grade of Steel : Fe500

This work has been analyzed exploitation STAAD.Pro code. Dead load in terms of self-weight is taken into account for the analysis. Pressure of plates is taken as half dozen KN/m. burden of seven kN/m² is provided in accordance to IS 875 (Part2) Below table shows the gravity masses. For unstable weight, total burden and fifty % of burden is taken into account as per Table eight of IS 1893 (Part1): 2002.

Table .3.1. Gravity loads which are assigned to the RC buildings as per IS: 875 (Part 2)

Gravity Load)	Value
Slab load (dead load)	3 (kN/m ²)
Live load	3.5 (kN/m ²

3.2.2. Design Spectrum: (Source IS: 1893:2016)

- Type of Soil:
- Soil type 1: Soft,
- Soil type 2: Medium
- Soil type 3: Hard

Earthquake and Wind Load Data

The structures are additional at risk of lateral masses, because the height of building will increase the structures becomes versatile and vulnerable to harm. Therefore lateral masses are principally derived from unstable and wind masses that structure must be analyzed:

Table 3.2: Earthquake and Wind Load Considerations (IS 1893 (part-1):2016)

Seismic Zone	III
Zone Factor Z	0.16
Importance Factor I	1
Response Reduction Factor	3
Damping Ratio	0.05
Type of Soil	Medium
Basic Wind Speed (Vb)	39 m/sec
Design Wind Pressure Pz	0.960 Kn/m





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3.3. Define Load to following process

The loadings were calculated partially manually and rest was generated using STAAD.Pro load generator. The loading cases were categorized as: Self-weight, Dead load and Nodal Joint load.

3.3.1. Self-weight: The self weight of the structure can be generated by STAAD.Pro itself with the self weight command in the load case details.

3.3.2. Dead load: Dead load can also be generated by STAAD.Pro by specifying the plate thickness and the load on the plate is 2.5 kN/m.

3.3.3. Nodal Joint Load: Joint loads, both forces and moments, may be applied to any free joint of a structure. These loads act in the global coordinate system of the structure. The joint loads applying on the dome structure are various loads as 1, 1.5, 2, 2.5...49 kN.

Description of Components

A chord is the rod that defines the facet of a triangular panel. All chords meet the fanciful sphere at each ends to form nodes and a ball form with flat triangular aspects.

Design of Ring Beam

Figure shows the rough plan of a ring beam

The meridional push at the help will have a flat part which will make the supporting dividers burst outwards, causing its disappointment. To bear this even part of meridional push, a ring pillar is given at the foundation of the arch. The support gave in the ring shaft takes this loop pressure.

$$\text{Hoop Tension} = T1 \cos D / 2$$

$$T1 = \text{Meridional Thrust}$$

$$D = \text{Dia of base dome}$$

$$\text{Hoop Tension} = 57.51 * 0.970 * 12$$

$$= 334.7 \text{ mm}^2$$

So provide min% = 0.2% in beam

DESIGN AND RESULTS OF DOME

4.1. Designing Teamwork and Planning

A piece of a group of designers given the test of building an arch to convey one hundred twenty grams of coins, treats, or various materials chose by your instructor will have different materials to utilize like cardboard, picket dowels, tape, foil, paper, paper, stick, string, elastic groups, wire, frozen dessert sticks, paper cups, straws, pipe cleaners, paper clasps, screen, and different speedily open materials. Your design ought to be at least fourteen cm tall estimated from the most elevated of the vault to the most reduced.

4.2. Arranging and Design Phase

Contemplate the different ways that you'll have the option to utilize the materials gave to develop an arch design will add a skin or oversee of different materials, or have the casing be the finished item. On a different piece of paper, draw a graph of your arranged vault, and inside the case beneath, construct a posting of the components you feel that you may would like. You'll have the option to control this later and conjointly add a great deal of materials all through development.





CONCLUSION

From this project we tend to focus on transient information of vault, a few ongoing advancement and center exploitation it in vogue lodging. Primary way of behaving is examined of RC arch exploitation STAAD.Pro v8i. The accepted components of pillar is 220mm x 600mm, segment of breadth 600mm and plate thickness is 250mm region unit ok for conveying various burden. For the applied burden cases and blend structure comes underneath safe zone. Hence, a contemplation corridor utilizing a vault structure is implied and examined by taking various perspectives and standards into worries as recommended inside the Indian standard code books. The vault structures region unit planned with the help of the product bundle AUTOCAD and its examination region unit done exploitation Technology.

The development of arch construction utilizes the materials in a decent and affordable way, shells have a magnificent financial potential for the advancement of low-estimated structures to conceal monstrous regions. Long ranges region unit a ton of broad to make because of they need to commonly be made with one use type. Nonetheless, they need various advantages that will offset the underlying cost of the construction and furthermore the time of the advancement sum is a more modest sum. In this Rcc vault the outcomes and estimations are examined in light of the manual plan. Examination and burden estimation are finished by manual plan.

This plan is utilized for long range of arches.

In this plan we get the Reinforcement subtleties of ring shaft, meridional and loop support of RCC vault. The development of arch design utilizes the materials in a viable and efficient manner, shells have an extraordinary financial potential for the development of minimal expense structures to cover enormous regions. Long ranges are more sweeping to fabricate in light of the fact that they should generally be developed with a solitary use structure. In any case, they enjoy different benefits that might offset the underlying expense of the design and furthermore the length of the development time frame is less.

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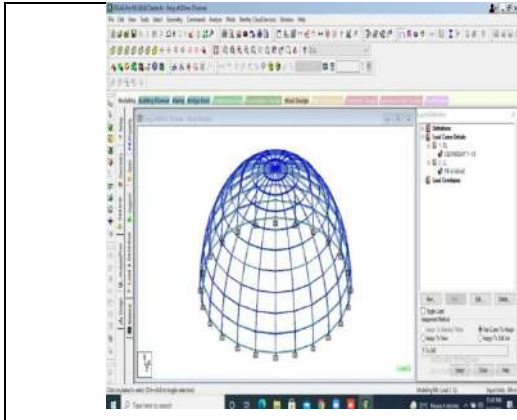


Figure 1: Modeling Dome Structure

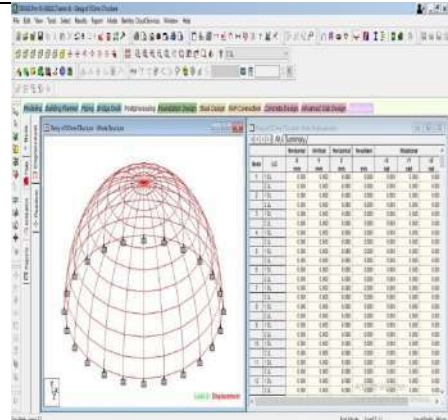


Figure 2: Applied nodal joint load

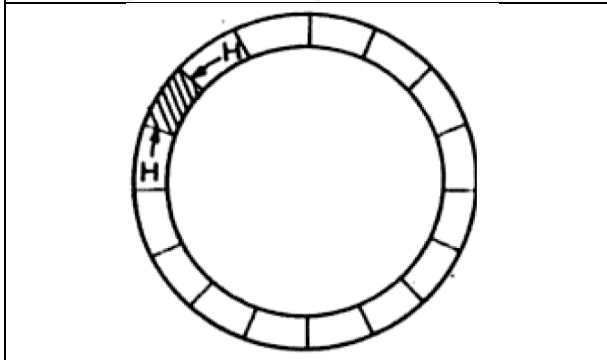


Figure 3. Design of view of Ring Beam

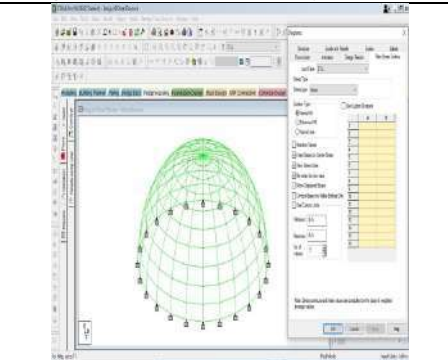
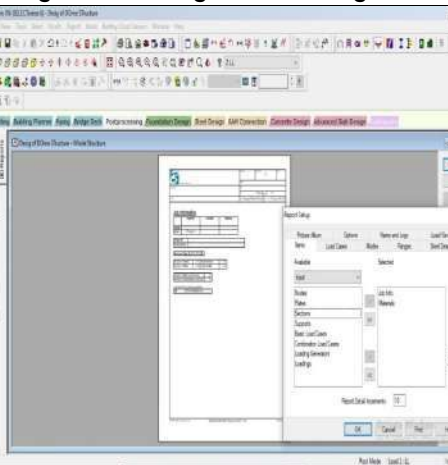
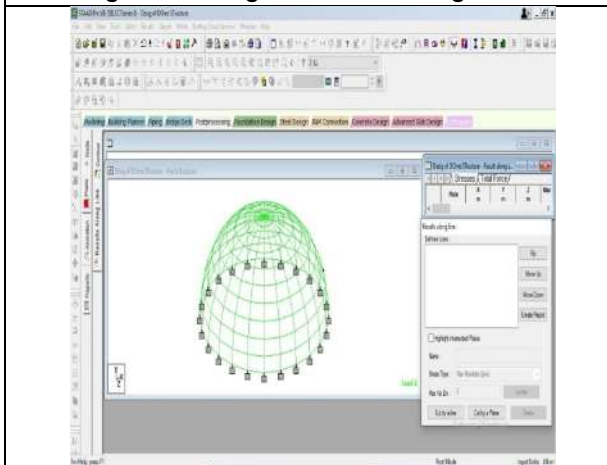


Figure 4. Arrangement of ring shaft:





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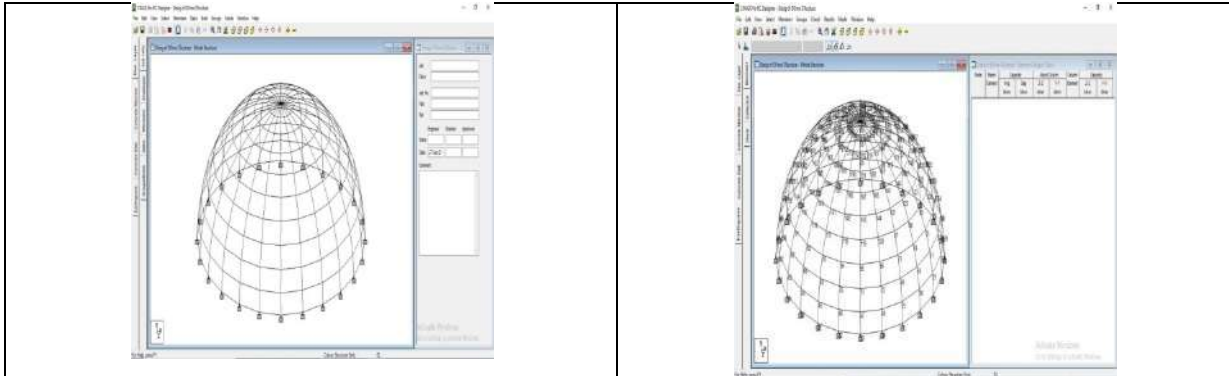


Figure 5. Designing Teamwork and Planning

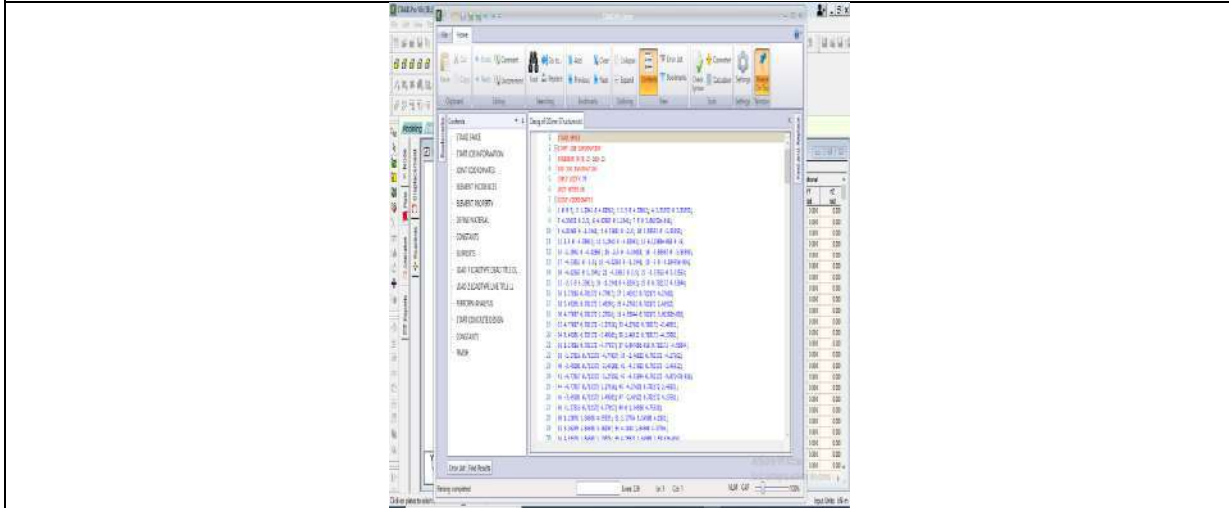


Figure 6. Arranging and Design Phase





Ageing Population of India – Protecting the Valuable and Vulnerable Asset

Priyanka Sharma^{*1}, Mansi Mathur² and Suyesha Singh³

¹Assistant Professor, Department of Business Administration, Manipal University Jaipur, Jaipur, Rajasthan, India

²Professor, Department of B. Com, HoD (B.Com), Poornima University, Jaipur, India.

³Assistant Professor, Department of Psychology, Manipal University Jaipur, Jaipur, Rajasthan, India.

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*Address for Correspondence

Priyanka Sharma

Assistant Professor,
Department of Business Administration,
Manipal University Jaipur,
Jaipur, Rajasthan, India.
E.Mail: priyankachotia1604@gmail.com



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ABSTRACT

A population of 1.3 billion in India makes it second most populated country across the globe, which also has one of the youngest population. The statistical data makes it clear that the population is ageing at faster pace which will pose lot of challenges for the economy. It is important for the economic well-being and development of economy to address the issue. The study thus focuses on various factors affecting ageing and the challenges that will be posed to the geriatric population. The secondary sources including the data from Government websites is taken into account for the study. Relevant literature was reviewed to understand the various factors and its implications. Study revealed that health is of prime concern as the physical and mental health at an age of 60 years and above is a big challenge. Life expectancy has increased due to increase in literacy and medical facilities. Due to changing socio-demographic factors, elderly population are forced to stay alone, in isolation with financial crunches. They also face physical and mental stressors due to which their quality of life deteriorates. Therefore, the Government and policy makers at various levels need to plan out strategies and policies for promoting the well-being of geriatric population, which in turn will make the society and country a better place to live in.

Keywords: Geriatric Population, Life Expectancy, Health Care, Work Force Participation





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INTRODUCTION

At present, India is ranked second most populated country across the world. It is one of the countries, having an average age of 29 years, thus being one of the youngest populations. The literacy rate in India (having a developing economy) has increased among the young population, which has led to a “demographic dividend”, as defined by United Nations Population Fund, as the working age population being greater than the dependent population which can lead to economic development. Because of the decrease in mortality due to various factors, it is predicted that India’s aged population i.e., above 60years will increase at a steady speed. As per the National Statistical Office (NSO) report, the senior citizens (aged 60 and above) in India will increase at a rapid rate with the projection to touch 194 million in 2031 from 138 million in 2021, a 41 per cent rise in a decade. As per the report, there is a need for the country to take care of the changing population structure where there would be 93 million males and 101 million females in 2031 from 67 million males and 71 million females in 2021. Considering the growth of elderly population in 10 years i.e. decadal growth of elderly people has risen from 35.5% in 2001-11 to 35.8% in 2011-21 to 40.5% in 2021-31. Thus, with the rising elderly population, the policymakers need to plan and take care of the needs of this population, if these added years are not managed well, there will be more negativity in the society. Policies, programmes, provisions to provide for the valuable assets of our society is the need of the hour. Planning and implementation of various schemes and processes needs to start, so that India can become a better country to stay.

LITERATURE REVIEW

Bloom et al., (2010) discussed that ageing of the population can be healthy by taking care of health and non-health associated risk factors, the participation by labour force and the savings will be reduced leading to the decrease in economic well-being. Fertility rates also play an important role and so the healthy ageing in population needs to be taken care of. It is not only the physical health but also the mental health which needs to be considered. Pilonia et al., (2019) stated that mental health like depression is becoming common especially in the female gender. Asaria et al.,(2019) mentioned the life-expectancy disparities taking into consideration urban and rural population for both the male and female gender. The study focussed on the impact mentioning the financials for the genders. Singh., (2013) explained that there should be increased awareness of financial literacy and various financial schemes and policies should be implementation by the Government, to deal with issues of ageing population in India. Also, there is an urgent need to develop financial market infrastructure for pension funds. Over the years government has suggested various measures for the care of the elderly population. Kalita., (2017) highlighted the challenges of the old age and also mentioned that though life expectancy has improved over the years due to better medical facilities, however poverty, illiteracy, absence of social security support system, lack of general awareness etc still pose as a major challenge for the elderly population. Chatterjee., et al.,(2018) indicated that several factors affect the selection private and public services of health care utilisation among the geriatric population in India. Various factors were identified which affects the choice of health care system among elderly population. The study concludes that the elderly having good income, higher literacy rates, less duration of hospitalization etc choose private health care system & vice versa.

Chattopadhyay et al., (2021) conducted research which gives insight of labour force participation among older adults. The research analysed work force participation among the age group of 60 years & above. They also discussed their job details, income levels, and social security benefits they are getting in India. It is concluded from the study that Indian Government should improve health facilities in rural India & provide for a robust social security system in the country. Demographic and social factors require attention by Government and policy makers for the concerns to be addressed at individual, family, society, state and national levels for protection of geriatric population.





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Objectives

- 1) To study the factors affecting ageing population in India.
- 2) To study the challenges faced by geriatric population.

“Population aging refers to changes in the age composition of a population in such a way that there is an increase in the proportion of older persons with respect to total population.” As per United Nations projects, India is a young country, but Indian elderly population will double by 2050. It is almost 19.6% of the entire population. As per National Statistical Office (NSO)'s report, the statistics shows that the older population within a age group of 60 and above will increase by 41%, from 138 million in 2021 to 194 million in 2031. Also, the elderly female population will outnumber elderly males. The elderly population of both the genders women and men is expected to rise to 100.9 million and 92.9 million respectively, in 2031. The present study considers the factors like life expectancy, health care, literacy rate & work force participation affecting the ageing population in India.

Life expectancy and health care

According to Kumar et al., (2022) population of most of the countries will face the problem of ageing. The study includes the United Nations SDG goals which mentions that the wellbeing and healthy living for everyone is necessary and especially for aged population who requires more care and attention, as they are more vulnerable related to their health issues, financial insecurity and loneliness. It focused on the changing needs of the country with respect to the ageing population in terms of growth, policies, trends in light with the sustainable development goals. As per the United Nations Population Fund (UNFPA) report, the population of India in the age group above 60 years, will most probably rise from 8.5% in 2011 to 19% of the total population by 2050. One of the major reasons mentioned thereby related to increase in life expectancy and low fertility rates (Kumar, 2022). Census of India 2011, mentioned that because of the decreasing fertility, the population aged under 15 years is forecasted to decrease from 30.8% to 19.8%, whereas middle age group of 15-59 will rise and that of people above the age of 60 years are expected to rise significantly.

The table above shows the life expectancy of male and female Indian population at age 60 and 80 years, it clearly depicts that there a rise year on year, declining fertility rates and improved health facilities are key contributors to the same. According to the National health survey (NFHS-5) it is mentioned that the fertility rates have declined, due to significant population control measures that means there is awareness being created among Indians population. According to Vaupel., (2010), the life expectancy of the citizens of most of the countries in the last decade has increased, there is an increase in lives of the people made advances in healthy living. Study by [Rau et al., \(2008\)](#), depicts that in countries having low mortality is credited to the decrease in mortality in old age which shows the pattern for women as well as men and is expected to grow at such a pace.

Active Ageing by WHO is defined as optimizing the opportunities for health, the participation and maintaining the security and their wellbeing as the population age. The way the lifespan has improved and increased; the pattern of health span has not increased in the similar manner. At an older age, the population health issues increase manifold. Many health conditions like heart problems, blood pressure, diabetic conditions, disabilities, diagnosis of various other diseases, becomes common problem at an older age, which needs to be addressed. Apart from physiological dysregulation, negative psychological impact, and the problems at older age increases. The prediction in some studies predict that in India male population is likely to suffer from disabilities more in comparison to women population. Lau et al., (2012) the model developed, predicts that with the changing time the rate of disability among both the gender and among all age group will increase. As per International Labour Organization, mortalities and disabilities in work in advanced countries is close to half of what is seen in countries, which are less developed or developing countries like India, China and Central and Eastern Europe. Such fatalities create a burden in the economy and especially for the older age the financial crises become a major concern.





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Apart from physical issues in older age, mental illness is also becoming prevalent. As per WHO report 2017, among aged population of 60 and above, around 20% of them suffer from some or the other type of neurological disorder (excluding headache disorders) and around 6.6% of all disability (disability adjusted life years-DALYs). Such kind of ailment is mainly 17.4% of the years spent with Debility (YLDs). In present scenario, dementia and depression has become very common ailment and approximately 5% and 7% of the world's aged population is affected by it, respectively. In India, the nuclear families are becoming a common phenomenon, children are moving out for their jobs, leaving their older parents to stay alone is common stressors that result in mental health problems in old age. Mental health even has a negative impact on physical health and vice versa. Elder abuse which can be physical as well as mental because of reasons like isolation, neglect, financial crunches, verbal or physical assault etc. leads to physical and mental disorders. Developing countries like India needs to figure out strategies and policies to take care of their needs.

Literacy rates

Literacy rate means that "percentage of population of a certain age group who can read and write." Rate of adult literacy is measured from the ages 15, and above, the youth literacy refers to the age group between 15 to 24 years, and the elderly rate is measured for people of age 65 and above. Researchers all over the world have come to the conclusion that education has a significant impact on fertility levels, preferences and regulation. The impact of education seen at the macro levels, is visible from the fact that countries with higher literacy rates have lower total fertility rates in comparison to the countries having lower education levels. This phenomenon is equally applicable to both developing and developed countries. In year 2022, India's literacy rate is 77.7%, male literacy rate being 84.7% & that of female 70.3%. Moreover, a country's overall level of Education has an important role to play in the improvement of the economic and social status of women. It was also proved that level of education exerts great significance on the number and spacing of children desired and eventually attained. Overpopulation is among the serious problems that our country is facing. Low literacy rate is one of the most important cause of overpopulation, being unaware of the methods to control population and usage of contraceptives and birth control measures are the main causes of over population in India.

Work Force Participation

India's ageing population has increased from 24.7 million to 138 million from 1961 to 2021 & it is further expected to increase by 56 million by year 2031. The ageing population in India has become a burden & a matter of concern as the government has failed to develop social security system in the country. Study shows that with increase in age, labor force participation declines, however in India 36% of the total elderly population (60 & above) are working. The pattern of work force participation is different in India, two-thirds of the elderly population are employed in agriculture and allied sectors, only 5 percent have a full-time job, and only 6 percent are covered by a pension schemes in India.

Surveys shows that older adults who have less education level, live alone, do not have any health insurance coverage or not covered by any pension system are expected to work beyond 60 years of age. The major reason for low participation in labour force by older adults is the health status. This is a major cause of concern for rural India. Among all economic categories in India, participation in work force also depends on health conditions. Older adults in urban area are expected to cover all work categories as the health facilities are better in urban areas. In older adults, women are expected to work beyond 60 years in comparison to their male counterparts. To increase older adult participation in labor force & to reduce dependency ratios, the Government should improve health facilities both in urban & rural areas. Also the state should provide for better social security coverage.

CONCLUSION

Surveys around the world have proved that education significantly influences the fertility levels, preferences and regulation. No doubt India, is striving hard to increase the literacy rates, still we have a long way to go. Government





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shoulder the responsibility of spreading awareness of education & promote it through various government schemes. Government should also follow the public private partnership to increase literacy rate in India and also to take care of the social security of older population. With the increase in ageing population in India, more & more adult are participating in labour force however it should be backed by robust social security system & better medical facilities. Developing countries like India is ageing faster and there is not much of the time to plan and adjust to the challenges that can be caused due to ageing population. Various environmental factors like social, political and economic factors are affected by the emerging changes in population of the country. There is a necessity to understand the factors affecting the health conditions, literacy rates, workforce participation etc so the planning and processes can be put in place at the earliest, and also the resources can be managed effectively for a better society and country at large.

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Table 01. Elderly Population in India

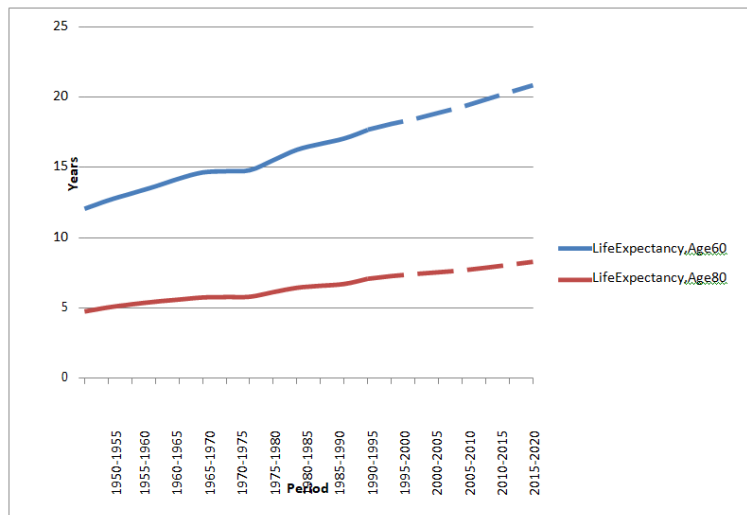
Source	Elderly Population (male & female) (in millions)
Census 1961	24.7
Census 1971	32.7
Census 1981	43.2
Census 1991	56.7
Census 2001	76.6
Census 2011	103.8
Census 2021	138

Source: NSO

Table 02. India's Projected Life Expectancy at Birth

Year	Male LEB	Female LEB
2011	64.9	68.2
2012	65.3	68.7
2013	65.8	69.1
2014	66.2	69.6
2015	66.7	70
2016	67.1	70.5
2017	67.6	70.9
2018	68	71.4
2019	68.5	71.8
2020	68.9	72.3
2021	69.4	72.8

Source : Estimated Indian Census-2011 Data and SRS based Life Table



Source: (United Nations 2015); dashed lines represent projected life expectancy

Figure 1: Steadily increasing life expectancies at older ages





Distribution and Morphology of Double-Hump Camel (*Camelus bactrianus*) in Ladakh Region, India

Dolker Lamo¹, Swati^{2*}, Vijay K Bharti³ and O P Chaurasia⁴

¹SRF, DRDO-DIHAR (Defence Institute of High-Altitude Research), Leh UT- Ladakh, India

²Scientist 'C', DRDO-DIHAR; Leh UT- Ladakh, India

³Scientist 'E', DRDO-DIHAR; Leh UT- Ladakh, India

⁴Director, DRDO-DIHAR; Leh UT- Ladakh, India

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*Address for Correspondence

Swati

Scientist 'C',

DRDO-DIHAR;

Leh UT- Ladakh, India

E.Mail: swatikeshri29@gmail.com



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ABSTRACT

Ladakh, a high-altitude region is a cold arid desert characterized by extreme temperature (-40°C in winter and +35°C in summer) and hypobaric-hypoxia. In such a challenging terrain, native animal resources play a vital role in the livelihood of native people. Ladakh is a home track of several unique indigenous livestock e.g., Yak, Ladakhi Cattle, Zanskar Pony, Changthangi Goat, Sheep and double-hump camel. The double-hump camel is distributed in the Nubra valley of the Ladakh region, India. To study their distribution, reproductive status, husbandry practices and economic value, we surveyed the entire home track and interacted with the camel farmers in August 2020. The findings indicated that these camels are distributed in the Nubra valley's Hunder, Diskit and Sumur villages. The total population of double hump camel was found to be 304 (150 males and 154 females) with an increasing population trend. They are seasonal breeders with varied gestation period from 12-14 months. These camels were reported with a low incidence of microbial-origin diseases. Their feeding behaviour varies and primarily depends upon twigs of shrubs, trees and sea buckthorn plants in summer and dry alfalfa or dough made up of oil and flour, jaggery and gram flour in winters. The double-hump camel safaris are a significant tourist attraction in the Nubra valley which is also the primary source of their farmer's livelihood. Furthermore, various users and stakeholders are looking forward to using these camels for logistic purposes as pack animals in this terrain. Despite of their importance in the region, there is a lack of scientific support and strategies for conserving this genetic resource, posing a threat to extinction in our country. Hence, further



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studies should be undertaken on conservation strategies, investigation on nutritional benefits of camel produce, high-altitude camel husbandry and breeding techniques to increase their welfare, health, population and utility.

Keywords: Double-hump camel, high-altitude, hypoxia, Ladakh, survey

INTRODUCTION

The genus *Camelus* includes three species, the double hump (*Camelus bactrianus*), the feral Bactrian camel (*Camelus ferus*), and the single hump (*Camelus dromedarius*). The double hump camels are primarily found in the semi-desert of Asia: Northern China, Southern Mongolia, Iran, Afghanistan, Pakistan, and Kazakhstan (Konuspayeva and Faye, 2010; Vyas et al., 2015) and the single hump camels live in the hot desert area (Gaili et al., 2000), however in some places they co-exist in the same farm e.g. Kazakhstan (Faye et al., 2008). Approximately 94% of the estimated world's camel populations are one-humped camels, while the rest 6% comprises the two-humped camels located in Asia (Yam and Khomeiri, 2015). In India, small population of the Bactrian camel is found mainly in the Nubra valley of the UT Ladakh. Ladakh region is a cold desert, comprises approx. 74809 sq.km area and falls between 31° 44'57" -36°N and 75° 15'-80°15'E and has a sparse vegetation and freezing temperature ranging from -40°C in winter and 35°C in summer. The typical way to access Nubra valley is by crossing one of the highest motorable roads in the world, i.e., Khardong la, which is at the height of 17200 ft, to the north of Leh. Nubra is subdivision and tehsil of UT Ladakh which is inhabited from a tri-armed valley and is cut by the Shayok and Nubra rivers. The mean altitude of the valley is 10,000 ft, i.e., 3048 m above mean sea level, and it is spread across 9,800 sq.km.

The Bactrian camels came from the ancient region of Bacteria (camel encyclopedia); these camels are migratory, and their habitat ranges from Rocky Mountains and Massifs to flat arid desert stony plains as well as dunes. These camels are adapted to arid plains and hills where water sources and vegetation are scanty, except some little drought-resistant shrubs. The habitat of Bactrian camel is sandy place (Makhdoomi et al., 2013); this nature of sandy and greenery coexistence has made them survive in this area for ages. Sand dunes on Shayok and Siachen River banks are also one of the beautiful, captivating things in the valley for camel rides. They can withstand extremely harsh conditions. Double humped camels have thick, shaggy coat which protects them in winters. They can go without water for longer days. Their large padded limbs help them to move in the sand faster. They are apparently good swimmer, and their smelling sense and sight is perfect. The camels seem more active in summer during their forest forage than those kept in captivity in winter. Ladakhi's word 'sna bong' which means (sna-five; bong-donkey) Bactrian camel can carry a load as much as a load of 5 donkeys put together. They can carry about 200-250 kg load and can travel for 50 km per day. Since these camels have a unique body characteristic and habitat, the present field survey was conducted to study the morphology, farm management practices and economical value and to know the current population status in Ladakh region.

MATERIAL AND METHODS

Door-to-door survey has been conducted in August 2020 in Hunder, Diskit and Sumoor village of Nubra valley, UT Ladakh and interacted with the farmers and recorded different observations like population status, feeding and farm management, disease management and socio-economic value of double hump camel and their by-products.





RESULTS AND DISCUSSION

Camel population in Ladakh

Leh, the central city of UT Ladakh, used to be an important trade center for central Asia before independence and partition, the traders from different nationalities e.g Yaqand (present Xinjiang), Punjab, Kashmir, Tibet, Kashgar, Kargilik (Yecheng), Urumuchi (Urumqi), and Khatan came for trade and exchange and bought with them materials like carpets, silk, gold, silver, pearls, corals, marijuana, leather and leather goods, and they use double humped camels to carry all their merchandise through the silk route that passes through Nubra, Leh and Yarkand. A detailed regarding the migration of all the historical camelid family is very well defined by Burger et al., (2019). The journey from Yarkand to Leh takes approximately one month, so several halts were made between this challenging journey, and travelers had to pass with a limited quantity of food and fodder. Therefore, difficulties like unbearable cold, starvation, little water, and grass could only be withstood by these double-hump camels, unlike the mules and horses: traders also use horses and mules for load, but 30% of the pack was fodder and water for their consumption only and that is why they preferred camels as their load carriers. The first Bactrian camel in Leh was bought through the Changchenmo route by Turk traders in 1870. These Bactrian camels are said to be the remnants of the silk route and due to the closure of the silk route around 1950, different traders have left them to Ladakh, and some of the Yarkandi traders used to sell off their sick or injured camels and horses at Leh and the number of camels has increased in Nubra by purchasing from one another (Haji Abdul).

In 1960, there were only 20 Bactrian camels reported in Nubra valley (Haji Abdul). Number of double humped camels documented during ages have been shown in Figure 1; along with the one found in the present survey. The present survey revealed that there are 66 households in Nubra having double hump camels, out of which the highest number was found in Hunder village followed by Diskit and Sumoor town with a total of approximately 304, which consist of 150 males and 154 female camels (Table 1).

Morphological characteristics of the Bactrian camel

The average Bactrian camel stands up to 63 to 69 inches. An average body height ranges from 63-64 inches, 65-66 inches and 67-69 inches at the age of 2-4 years, 5-10 years, and 10-20 years respectively. The average body length of an adult varies from 52 to 71 inches. Their thick coat color especially thick wooly long hairs on body, mane and beard ranges from sandy beige to dark brown (Figure 2, 3). The average circumference of the shank is up to 30.5-42 inches, the thickness of the skin around the abdomen is 0.56-1.29 cm and the circumference around the abdomen varies up to 70-96 inches (Lamo et al., 2020). They have a long triangular face with a face length of 14-21 inches with a split upper lip. Their closable nostrils along with long eyelashes help to keep themselves out of dust during frequent sand storms, and their thick lips allow them to feed on the prickly bushes. They have two humps, the anterior hump at the withers and the posterior at the loin. The rear hump is higher and broader than the anterior hump, and the height and circumference range from 8-20 inches and 29-42 inches. The camel hump mainly stores fats, and their humps are plump and pliable as when they got proper diet the hump becomes erect, and when their diets decline, these humps lean on the side. The humps act as the storehouse of body nutrients so that they can go without water and food for more than a week (Peilieu, 1984). However, this view is still debatable and needs further studies and evaluation of fat metabolism in camels.

Physiological characteristics of the Bactrian camel

These camels are well adapted to hypobaric-hypoxia prevalent in this region. The low blood glucose, higher liver metabolism, larger erythrocytes size, increased erythrocytes count, high hemoglobin, etc. like physio-biochemical change indicates high-altitude adaptation. Another recent report from our lab, revealed high triglycerides and low blood glucose level as compared to single humped camel, an important indicator of adaptation to high altitude (DIHAR Annual Report 2019; 2020; Bharti 2023). The respiration rate ranges from 8.0-14, the body temperature ranges from 24.0-32.0°C, the rectal temperature ranges from 32.0-38.0°C and heart rate ranges from 30.0-40.0 beats per



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minute (Lamo et al., 2020; Bharti 2023). These camels are well adapted to load carrying capacity in all climate and altitudes of Ladakh region (Bharti, 2023).

Reproductive characteristics of the Bactrian camel

In both males and females, reproductivity depends on nutrition level and its quality (Musa and Merkt 1975). The onset of puberty and breeding season in camels are affected by the geographical location, climate, and nutrition plan. Camel is considered to be a seasonal breeder with a marked peak in sexual activity (Wilson 1984).

Breeding age

The high pregnancy rate, neonatal loss, long gestation period, lactation period, seasonal breeding, and advanced age at first parturition led to hindrance in the growth and development which causes low reproductive efficiency in camels (Sahoo 2020). The first breeding age starts with the changes in sexual behaviour in both males and females. Yagil (1985) reported that puberty in females begins at 3-4 years of age, and their first calving happens at the age of 5 to 6 years. Chen and Yeun (1984) also added that puberty in Bactrian female camels reached the age of 3 years, but breeding is held until it reaches upto 4-5 years of age, till 15-20 years. Qureshi (1986) and Merkt et al (1990) reported that the male reaches puberty at the age of 4 years and the females at the age of 2- 3 years or can be less than that if we take proper care. According to farmers during the present survey in Nubra valley, the first calving age of the Bactrian camel was found to be 2-3 years and the gestation length was 12-14 months. Camels may foresee the suitable climate for breeding time which corresponds to the convenience of the availability of food resources, so that the calving happens in the good grazing period which increases the chance of survivability of the offspring (Sghiri and Driancourt 1999). However reproductive behaviour needs to be studied in detail to address these discrepancies of various reproductive and breeding parameters.

Calving interval

It has been observed that because of seasonality inbreeding, the calving interval in the Bactrian camel of Ladakh is long, but in a few cases, according to the local farmer, some camel's calves just after 1 year of first calving, but in most cases, they took 2 years for next calving, and also the gestation length varies from 12-14 months. The first calving age of the Bactrian camel in Ladakh is 2-3 years. Interestingly, the camel can become pregnant after 5-11 months of parturition with the gestation length of 1 year and 8-15 days if they are well fed and taken proper care.

Gestation Length

It was found that the gestation period of the Bactrian camel in Ladakh was 12-14 months. As per previous reports worldwide, the average gestation period in Bactrian camel is 13 months (Arthur et al., 1985; Yagil 1985). Few reports suggest that the mother carries their calves having 1 to 2 days delayed parturition than others, and their average gestation period is 402.2 ± 11.5 days (Chen and Yuen, 1984). These reproductive traits need further evaluation in farm conditions where the recording of breeding is well documented.

Breeding season

It has been observed that these camels are seasonal breeders. Still, due to their wide geographical distribution, their sexual behaviour varies, and the breeding season is related to periods of low temperature, low humidity, and increased rainfall (Skidmore, 2005). According to Wilson (1984), female camels reached their peak in sexual activity in a specific season. The duration of the breeding season and the intensity of sexual activity depend upon the climatic conditions of the area, nutrition, and its management. As the breeding season varies according to the different kinds of literature, it has been noticed that the breeding season of the Bactrian camel at the high altitude of Ladakh starts in November and terminates at the end of April or starting of May. The emergence of the breeding season may be related to an increase in day length (Chen and Yuen, 1984). This needs further validation in controlled farm condition.



**Dolker Lamo et al.,****Diseases and treatments**

Double humped camels are highly resistant to infectious diseases than other animal species residing in the same agro-ecological regions (Ali et al., 2019). The most common health ailments in camels observed by the farmers were eye injuries while browsing in the forest, prenatal death due to some activities like fighting among themselves and being attacked by the locals. Sometimes lung infection, abortion, leg fracture and skin problems were also observed. It was found that apart from diseases, the pregnant camels gave birth to their new-born calves in the forest which leads to predation by different predators like a stray dogs and wolves.

Management and Animal husbandry practices

These camels are resistant to the harsh climate and they do not require any special treatment to keep themselves warm since there is a shortage of plant materials in the forest during extreme winters. The farmers bring them back to the farmyard and provide them with various kinds of local feeds. During the survey, it was found that the farmers provided their camel with dry fodder of alfalfa (Figure 4), readymade feed, gram flour, jaggery, and wheat bran, dough made of flour mixed with mustard oil, salt, and water ad libitum. To house these camels, some farmers have constructed a proper shed of a stone wall without a roof. Most of them used net for fencing, a few have a wooden fence or sea buckthorn bushes fence, and some kept them in an open area in the farmyard (Figure 5, 6).

Economic contribution of the camel as a draught animal

During the central Asian silk route trade, Bactrian camels, horses, and mules played a significant role in carrying merchant's merchandise. But apart from camel, the other pack animals like horses and mules had some limitations as around 30% of them carry their own fodder for survival. However, the camel can travel without water and feed for a few days, and they can tolerate the harsh climatic conditions and can carry a double load (200-250kg) as a horse can carry. Before the emergence of motor cars, these camels were used to maintain logistics and transportation source for supply. Now, this mode of transportation of camels, mules, and horses is replaced by automobiles. Recently the tourism industry has increased in Ladakh. The camel safari is one of the primary recreational activities in the Nubra valley (Figure 7). The Central Asia Camel Safari, a registered cooperative society of camel farmers present in Hunder village, which manages all the camel safari activities here. A single camel earns approximately forty thousand to one lakh per season from camel safari only. They prefer male camels over females for riding purposes and female camels to enlarge their progeny. During the survey, farmers have also mentioned the health benefits of camel's milk and urine. It is believed that their produce has benefits in diabetes and urine for knee and joint pains. Usually, they do not practice camel milking, but sometimes there is a demand for camel milk from outsiders, so they milk them but never consume themselves. The farmers believe that milking the mother camel will affect the growth of the camel's calf.

Most of the time, camel remained in semi-wild conditions. The farmers bring them home only during the tourist season in summer (June-August). They get pregnant females in summer too so that they can take care of them. Rest of the season, camel remains in the community grazing area where seabuckthorn is a significant flora. Some households have harvested dried alfalfa, but some have to purchase from others, so it costs about 2500 rupees per quintal of dry alfalfa. So, feeding camel is costly affair and more aggravated in winters. The camel wool is also one of the important sources of income for the owners apart from camel safari. They get around 5-7kg of wool from a single camel per shearing. There are two varieties of wool according to the quality i.e., fine and coarse. The fine wool gets from the calf up to 3 years and an undercoat of adults, which is of good quality, and the coarse wool from the outer coat of adults. The fine wool is mainly used for weaving shawl, Goncha (Ladakhi traditional gown), Pheren (traditional dress worn by Muslims) sweater and the coarse wool is used for making ropes and Chali or woolen blankets primarily used in winter (Figure 8). As per discussion with local people, they fetch around 7000-28000 rupees per camel only from their wool, around 7000 rupees per shawl and 1300-1800 rupees per kg for the raw wool.

Since these farmers only prefer 1-5 number of camels to rear, when the camel number increases from their rearing capability, they sell it to the locals, as their value increases. It was used to cost them 500 rupees in 1960 and 1500 rupees in 1970, but the rate of these camels has increased since the camel safari for tourists started from 2000-2002.



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The value for camels has increased, and now in 2022 according to the survey, it cost up to 1.5 to 4 Lakhs (INR) per adult camel (Figure 9). This increasing price is linked with income generation through camel tourism and less availability of adult camel population.

Therefore, conservation program with scientific breeding should be implemented for improving their population size to meet the society requirements and maintain diversity. As we all know that how important it is to protect this endangered animal, the government should also contribute in safeguarding this animal in wild conditions, not in captivity, because most of the farmers have mentioned that by keeping these camels in captivity for a long time, their body conditions get weaker and their behavior also changes. Since there is less awareness among the farmers about the importance of camel milk and its products, they are also less aware of the value of camel wool products. So, the handloom industry should encourage practicing camel wool and including their wool in handicrafts to make camel handlooms. The government should also encourage value added dairy products to keep the camel population and the farmer's income stable.

CONCLUSIONS

The present survey on the double-humped camel population and their husbandry in Ladakh revealed that the Bactrian camel has played a vital role in this challenging terrain for decades as a source of transportation and logistic support. Nowadays, with the development of the tourism industry, these camels have become the primary source of tourist attraction for riding in Nubra valley of Ladakh, which play an important role in improvement of socio-economic status of camel farming society. However, more awareness and scientific training is required among the farmers regarding camel welfare, camel product value, farm and management, and health conditions. There is also need to conserve these livestock resources implying scientific breeding and conservation program.

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Conflict of Interest: None

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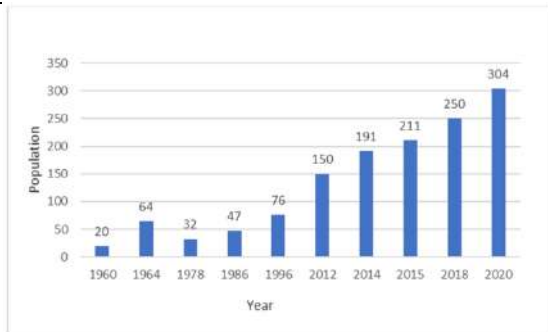
Table 1: Total camel population with age group in Nubra valley during the present survey (August, 2020)

Age group	Total number of camels
Under 1 years	31
4-5 years	63
6-12 years	114
Over 12 years	96
Total	304





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Source: 1960(Haji Abdul); 1964-2015 (Ranjan et al., 2015); 2018 (The better India.com) and 2020 (present survey-August 2020)

Figure 1: Number of double humped camel in Nubra valley, Ladakh



Figure 2: (a) Day old camel calf; (b) week-old camel calf



Figure 3: An adult Bactrian camel



Figure 4: Local Camel feed (dry alfafa)





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Figure 5: Different housing materials used for fencing (a) Wooden fence; (b) Net fence; (c) Stone wall fence; (d) Sea buckthorn bush fence



Figure 6: Camels in open yard





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Figure 7: Camel Safari in Nubra valley



Figure 8: (a) Camel wool fabric; (b) Camel woolen blanket; (c) Camel woolen shawl

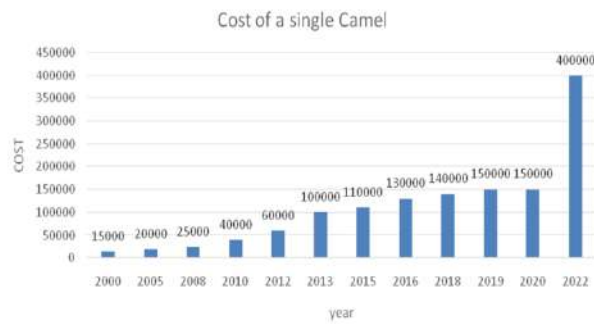


Figure 9: Rate list of camels from 2000-2022 in Ladakh





Exploring Nutritional and Biochemical Traits of *Pseudomonas syringae* pv. *tagetis* for Its Identification in Seeds of French Marigold (*Tagetis patula*)

Pinky Gurjar^{1*} and Laxmi Kant Sharma²

¹Research Scholar, Department of Botany, Raj Rishi Bhartrihari Matsya University, Alwar, Rajasthan, India

²Professor, Department of Botany, Raj Rishi Govt. College, Alwar, Rajasthan, India

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*Address for Correspondence

Pinky Gurjar

Research Scholar,
Department of Botany,
Raj Rishi Bhartrihari Matsya University,
Alwar, Rajasthan, India.
E.Mail: pink.g.1993@gmail.com



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ABSTRACT

The present study has investigated presence of *Pseudomonas syringae* pv. *tagetis* (*Pst*) in seeds of French marigold (*Tagetis patula*) by use of its biochemical traits. Total twenty five bacterial colonies were obtained from the diseased seeds of marigold and identified as *Pseudomonas* spp. through numerous biochemical tests. Further these were confirmed as *Pst* on the basis of LOPAT test, carbohydrate utilization, HR (hypersensitive reaction) and pathogenicity tests. The discoloured and symptom showing seeds were plated on nutrient agar medium and total 39 bacterial colonies were selected on the basis of colony morphology and response on King's B medium. From these isolates, totally 25 colonies were sorted for further identification test. They were gram negative, rod shaped, belonged to group 1b of LOPAT and utilized glucose, mannitol, inositol but unable to consume sucrose and starch in medium. Their host and pathogenicity test confirmed the pathovar as *Pseudomonas syringae* pv. *tagetis* (*Pst*).

Keywords: Bacterial leaf spot, French marigold, *Pseudomonas syringae* pv. *tagetis*, biochemical test, *Tagetes patula*





INTRODUCTION

Tagetes patula or French marigold is a famous member of family Asteraceae; native to North and South America and known for its extensive use in assembly of garlands, prettification and other well-known purposes like for extraction of pigment and oil. It is also popular as a source of medicines and some therapeutic purposes (Riaz et al. 2020). Besides being used as insecticide, fungicide, bactericide and larvicide for other crops, it is attacked by many pathogenic bacteria which annually results in heavy yield losses (Aktar and Shamsi, 2014; Politi et al., 2012; Zhang et al., 2013; Salehi et al., 2018; Mir et al. 2019). The pathovars of *Pseudomonas syringae* have a wide host range as they are known for infecting mostly economically important crop species, thus it is considered as the most common pathogen of plants (Lamichane et al. 2015). Additionally, regular occurrences of diseases caused by *P. syringae* pathovars remain as a global threat to production of different crops (Xin et al. 2018; O'Malley and Anderson 2021.) such as diseases of zinnia, common ragweed, sunflower and Jerusalem artichoke (Shane and Baumer, 1984) have been a matter of concern. One of the latest examples of such distressing effects of this pathogen is bacterial leaf spot (BLS) disease caused by pathovar *tagetis* in French marigold grown worldwide including India.

BLS is a devastating disease of marigold and is triggered by bacterium *Pseudomonas syringae* pv. *tagetis*. It is a seed-borne disease as it transmits from seeds to seedling and plant. It was first detected in the United States in the year 1978 and till then it has been reported from many countries of the world and causes heavy destruction of yield by infecting juvenile plants of marigold (Styer et al., 1980). The notable characteristic symptoms of this disease start with black spots development on cotyledon of saplings and necrosis of leaves enclosed by irregular circles of chlorotic soft tissue. In some severe cases distortion of apical growth resulting in death of the infected plant is also observed. It shows variability in symptom development pattern also as sometimes little; moist, dark-green spots are emerged on lower side of leaves which later covers upper layer also with brownish drawn-out de-coloration (Hellmers, 1955). As mentioned above, the marigold has immense importance as a source of medicinal compounds, details on its microbial pathogens and their early identification process is a necessity to decide approaches of crop protection so that monetary losses can be prevented, particularly for small-scale producers.

MATERIALS AND METHODS

Field survey and sampling

For collecting samples of French marigold, two field surveys were performed in the year 2019-2020 and total 117 samples of seeds were collected from fields of different districts of Rajasthan state. In initial investigation, the seeds were sorted on the basis of paleness of cotyledons, wrinkles or any other spot.

Screening of the pathogen

Out of the 117 samples, 76 samples showed discoloration and spots on seeds which later yielded in isolation of 39 bacterial colonies. On application of specific identification methods, 25 colonies were identified as *Pseudomonas syringae* pv. *tagetis* (Pst) which were further confirmed by host and pathogenicity assays. Before doing biochemical tests, the seeds' surface was sterilized by treating with 90% (v/v) ethanol for 1 min and then with 1% (v/v) NaOCl for next 5 min. Further, seeds were cleansed with autoclaved distilled water. Such decontaminated seeds were directly plated on nutrient agar (NA) medium and left for incubation at 28±2°C for next for 2-3 days. The different bacterial lumps grown under the seeds were picked and transferred on semi selective King's B (KB) medium for further identification process. The isolates which showed Pst type colony appearances were exposed to many biochemical tests.

Nutritional and biochemical analysis

As stated above 25 bacterial isolates were selected for their reaction towards Gram's- stain, KOH solubility, and catalase activity, LOPAT test (Levan production, Oxidase activity, Potato soft rot, Arginine dihydrolase activity, and Tobacco hypersensitive response) for early identification of pseudomonas spp. (Klement et al., 1990; Peix et al., 2018;



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Patyka et al., 2019). In addition to these initial tests, the isolates were confirmed for Esculin hydrolysis, Gelatin liquefaction, Indole production and utilization of metabolites like Ethanol, Erythritol, D-Galctose, Gluconate, myo-Inositol etc. (Lydon et al., 2011).

The isolates were tested for development of fluorescence also by streaking on KB (King's medium B) and observed under UV light (Mohan and Schaad, 1987). Likewise, leaves, stems and seeds showing symptoms of *Pst* were disinfected and their small parts were transferred on NA and tested for nutritional and biochemical features as stated above.

Pathogenicity And Host test

The isolates showing characteristic test of *Pst* were assessed for pathogenicity test on French marigold and other hosts such as Jerusalem artichoke (*Helianthus tuberosus* L.), sunflower (*Helianthus annuus* L.), a willow- leaf sunflower (*H. salicifolius* A. Dietr) and common ragweed (*Ambrosia artemisiifolia*) (Robinson et al. 2004). The leaves of host plants were punctured and the bacterial suspension maintained at 1×10^7 CFU/mL was injected in the middle vein while the control was inoculated with sterile tap water only (Rhodehamel and Durbin 1985; Peix et al., 2018). The inoculated leaves were then placed in at $25 \pm 2^\circ\text{C}$ and looked every day for development of any necrotic or pathogenic symptoms (Schaad and Kendrick, 1975; Saettler et al., 1989).

RESULTS AND DISCUSSION

The *P. syringae* pv. *tagetis* hosts members of family Asteraceae and incites apical chlorosis and bacterial leaf spots (Gulya et al., 1982; Hellmers, 1955; Rhodehamel and Durbin, 1985; Rhodehamel and Durbin, 1989; Shane and Baumer, 1984). Formerly also, it has been isolated from various plants and from weeds showing apical chlorosis. On the contrary, it is assessed for antagonistic activity for controlling Canada thistle in soybean and woolly leaf bursage in cotton (Budde and Ullrich et al. 2000; Sheikh et al., 2001; Gronwald et al., 2002). In this study, overall 76 seed samples displayed atypical colour and spots on seed coat which further brought out 39 types of bacterial colonies. From these isolates, 25 colonies were developed on NA medium and characterized as *Pst* on the basis of their response for nutritional and biochemical analytic tests as shown in table no. 1. The colonies developed on NA were whitish, mucoid, raised, smooth and glistening (Fig. 2 A and C).

All the isolates were Gram's negative and positive for KOH and catalase test and rod shaped (Fig. 1 B and Fig. 2 B&D). The isolates produced a yellow – green to blue fluorescence on King's B (KB) medium, confirming that the isolates are fluorescent pseudomonads (Mohan and Schaad, 1987). This pigment has been used as characteristic of many *P. syringae* strains (Lamichhane and Varvaro, 2013; Tymon and Inglis, 2017; Fuenzalida-Valdivia et al. 2022). These fluorescent pseudomonads were looked for their group on the basis of LOPAT test and they were -+++ (Fig. 1) and confirmed their position in LOPAT group Ib (Young and Fletcher 1997). Suzuki et al. (2003) also used LOPAT and other test to differentiate *P. syringae* pv. *pisi* from *Pst* in infected pea plants. The most studied *P. syringae* bacterial models had same pattern in some other study viz. *P. syringae* pathovar from tomato (Whalen et al. 1991) and cauliflower (Weibe et al. 1993) showed same response for KB medium and LOPAT test.

The results of morphology of colony and LOPAT directed that all the purified colonies are strains of *Pseudomonas syringae*. The results of different phenotypic (biochemical) tests lead to the confirmation of pathovar. Further positive results for D-Galctose, Gluconate, Glucose, inositol, mannitol, sorbitol utilization and negative results for starch hydrolysis and Glycerol and sucrose specified that all isolates are *Pst* which was further confirmed by host and tobacco HR test. In previous studies too, similar responses of biochemical and hypersensitivity reactions of *Pst* have been observed in marigold and other plants (Lydon et al. 2011; Song et al. 2015). Also, pathogenicity test showed development of chlorosis and necrosis with spot in different hosts tested (Table no. 2). In earlier studies also similar pattern has been observed in various members of family Asteraceae (Rhodehamel and Durbin 1985; Lydon et al. 2011; Suzuki et al. 2003; Zhang et al., 2002). Even there are surprising reports of symptom development by this



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pathogen in plants of Brassicaceae, Solanaceae and Cucurbitaceae family (Gulya et al. 1982). There are reports that host range of pathovars of *Pseudomonas syringae* is expanding frequently like in *Ageratum*, *Cirsium*, *Cordyline*, *Anemone*, *Argyranthemum Fuchsia*, *Lavandula*, *Arabidopsis thaliana*, *Geranium*, *Helianthus*, and *Tagetes* (Zavala et al. 2022). This is the reason the *P. syringae* has attracted scientists due to its diverse host range and toxin production (Xin et al. 2018).

In some key studies, the selective characteristics of pathogen of marigold were established on the basis of specific biochemical features (Jeevan et al. 2021). For *B. altitudinis*, *P. aeruginosa*, *B. aryabhatai*, *B. wiedmannii* and many more, biochemical characterization method was applied successfully (Margarita et al. 2017; Shah et al. 2022). In experiments exploring antimicrobial properties of *Pst*, it was identified and distinguished on the basis of nutritional requirements Grădila et al. 2022). For other pathovars of *P. syringae* biochemical and pathogenicity tests have made its early identification easier as commended in various studies (Chaturvedi et al. 2018; Jangir et al. 2018; Chaturvedi et al. 2015). Though there are developments of enormous advanced techniques for identification of bacterial pathogens from plants, the LOPAT, biochemical and pathogenicity tests are still important as colony type and difference in carbon source utilization plays a significant role in deciding pathovar of a species (Marques et al. 2016; Tymon and Inglis, 2017; Gomila et al. 2017; Chaturvedi et al. 2018; Saint-Vincent et al. 2020). Thus, the present study has established identification of *Pseudomonas syringae* pv. *tagetis* on by exhausting its biochemical traits.

CONCLUSION

We have performed an inclusive phenotypic and biochemical analysis of 25 strains of *Pseudomonas syringae* pv. *tagetis* isolated from the seeds of French marigold. The strains showed ability to utilize D-Galctose, Gluconate, Glucose, inositol, mannitol and sorbitol as sole carbon source in medium. We established an early detection of this seed borne pathogen of marigold as yet there is no effective control measure known for this pathogen other than use of infection free seed lots in the field. The significance of LOPAT and other biochemical tests has been established in many molecular detection experiments also and in our study we successfully demonstrated that these methods are vital to decide pathovar of *Pseudomonas syringae*. We have provided an extensive detail of these test methods and results which may be proven as a great source of reference in further studies.

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Table no. 1: Nutritional and Biochemical analysis of strains of *Pseudomonas syringae* pv. *tagetis* isolated from seeds of French marigold

S.No.	Carbohydrate source	Response	S.no.	Carbohydrate source	Response
1.	D-Arabinose	N	16.	Mannitol	Y
2.	Cellobiose	N	17.	Quinate	Y
3.	Citrate	N	18.	Ribose	Y
4.	Ethanol	Y	19.	Sorbitol	Y
5.	Erythritol	N	20.	Starch	N
6.	D-Galctose	Y	21.	Succinate	Y
7.	Gluconate	Y	22.	Sucrose	N
8.	Glucose	Y	23.	Trehalose	N
9.	Glutarate	N	24.	Triacetin	N
10.	Glycerol	N	25.	L-Valine	N
11.	Fructose	N	26.	D-Xylose	Y
12.	<i>myo</i> -Inositol	Y		Other characteristics	
13.	2-ketogluconate	N	27.	Esculin hydrolysis	N
14.	Lactate	N	28.	Gelatin liquefaction	N
15.	<i>myo</i> -Inositol	Y	29.	Tobacco Hypersensitivity test	Y

Table no. 2: Pathogenicity test on French marigold and other members of Asteraceae family and hypersensitivity reaction (HR) on tobacco leaves

Isolates	Pathogenicity reaction					Hypersensitivity reaction on tobacco
	French Marigold	Sunflower	Jerusalem artichoke	Willow leaf sunflower	Common ragweed	
<i>Pseudomonas syringae</i> pv. <i>tagetis</i>	H	M	H	H	H	+
	M	M	M	H	H	+

Rating scales were as follows: H- High (disease index 4.1 to 5.0); M- Moderate (2.6 to 4.0); L- Low (1.1 to 2.5); and 0- None (1.0); + Infiltrated area becomes necrosis.

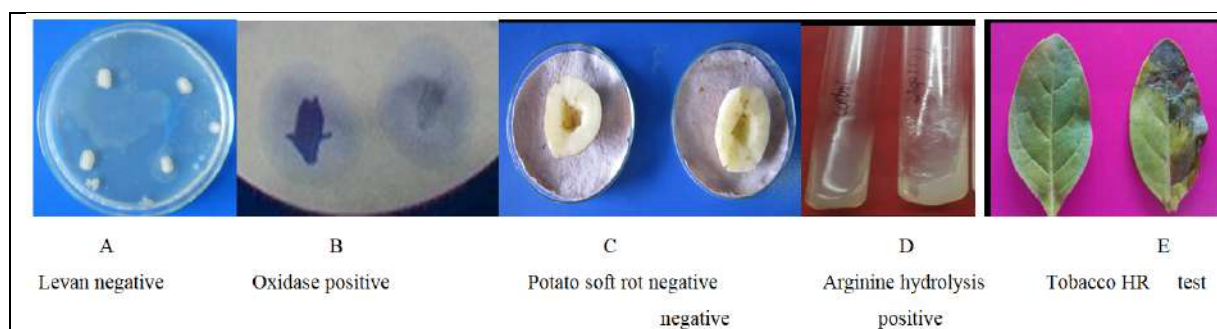


Fig. 1: Results of LOPAT explain that the response of pathogen *Pseudomonas syringae* pv. *tagetis* was -+++ that includes it in LOPAT 1B group



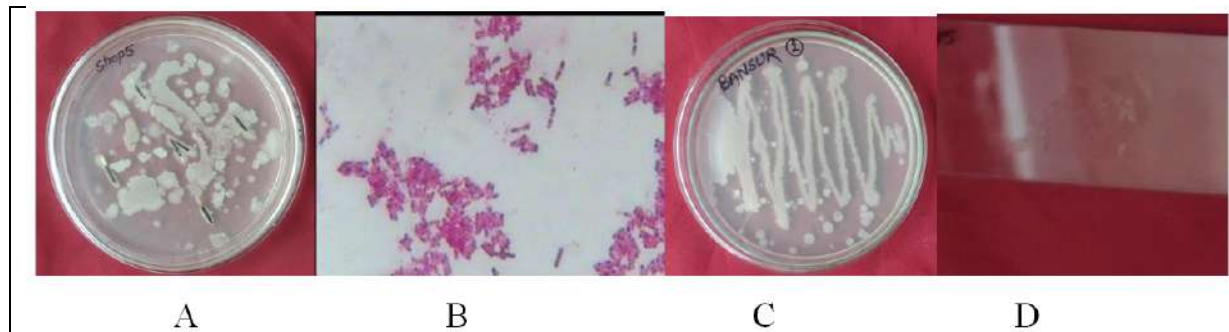


Fig. 2: Results of colony morphology, Gram's staining and KOH solubility test

A: White, glistening and mucoid colonies of *Pseudomonas syringae* pv. *tagetis* on NA

B: Rod shaped colonies in Gram's staining

C: Whitish glistening colony on NA

D: Bubbles indicating KOH solubility test





Electron Transfer Interaction Distinguishes High Dilutions Of Drugs From Their Solvent Medium Aqueous Ethanol

Sumit Ghosh¹, Raj Kumar Singh², Nirmal Chandra Sukul^{3*}, Nivedita Pandey⁴ and Anirban Sukul⁵

¹Research Scholar, Sukul Institute of Homeopathic Research, Santiniketan-731235, Birbhum, West Bengal, India

²Asst. Professor, Dept. of Botany, Government General Degree College, Mangalkote, East Burdwan, Burdwan University, West Bengal, India

³Professor (Retd.), Dept. of Zoology, Visva-Bharati University, Santiniketan-731235, Birbhum, West Bengal, India and President, Sukul Institute of Homeopathic Research, Santiniketan-731235, Birbhum, West Bengal, India

⁴State Aided College Teacher, Dept. of Geography, Panihati Mahavidyalaya, Sodepur-700110, Kolkata, CU, India.

⁵Director, Sukul Institute of Homeopathic Research, Santiniketan-731235, Birbhum, West Bengal, India.

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*Address for Correspondence

Nirmal Chandra Sukul

Professor (Retd.), Dept. of Zoology,
Visva-Bharati University, Santiniketan-731235,
Birbhum, West Bengal, India and
President, Sukul Institute of Homeopathic Research,
Santiniketan-731235, Birbhum, West Bengal, India
E.Mail : ncsukul@gmail.com



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ABSTRACT

High dilutions (HD) of drugs are usually used in homeopathy, a therapeutic system introduced more than 200 years ago. These HDs available in 90% ethanol are apparently similar in chemical composition to their solvent medium water-ethanol. The HDs are prepared by serial dilution from their mother tincture 1:100 followed by mechanical agitation or succession in several steps and are called potencies. Here we show that electron transfer (ET) interaction is a constant feature in HDs after dilution with deionized and distilled (DD) water 1:100. This property is absent in the controls (90% EtOH and Ethanol 30 cH). We have used two potencies 30 cH and 200 cH of two drugs *Cantharis vesicatoria*, an extract from beetle and *Lycopodium clavatum*, an extract of club moss. The potencies and their solvent medium were in 90% ethanol. They were diluted with DD water 1:100. UV-spectra of the test potencies show two peaks one at 200 nm and another around 222 nm wavelength. The second peak stands for ET interaction and is absent in the controls. Potencies of 20 more drugs tested show the same phenomenon. It is concluded that the ET is the distinguishing property of the test potencies. Potencies and controls, all in 90% EtOH, are different



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from each other. This is the first time that a scientific test has been introduced for differentiation of HDs of drugs from their solvent medium.

Keywords: High Dilutions, Homeopathic drugs, UV-Spectra, Electron transfer, Identification.

INTRODUCTION

Homeopathy, introduced in 1756 (Hahnemann, 1833), uses drugs in extreme dilutions which very often cross the Avogadro limit and therefore contain no drug molecules. It is difficult to explain the therapeutic and biological effects of a drug which has no original molecules. This deficiency has made homeopathy scientifically unsound. But there are clinical and experimental evidences which support that the HDs are not only effective on man but also on animals and plants (Sukul and Sukul, 2004; Banerjee *et al.*, 2019; Wei Ling, 2022). HDs have been reported to produce effect on lactose and protein in a cell-free medium (Sukul and Sukul, 2004, Mondal *et al.*, 2019; Mondal *et al.*, 2020; Mondal *et al.*, 2020). Homeopathic drugs are prepared from plant and animal products, metals and salts all of which constitute mother tincture (MT). The MTs containing drug molecules or particles are diluted with ethanol water solution in the proportion 1:100 and subjected to mechanical agitation or succussion to produce the first centesimal potency 1 cH. This process is followed up to produce higher potencies like 6 cH, 30 cH, 200 cH etc (Sukul and Sukul, 2004; Cook, 1988). Potencies cannot be separated from their solvent medium by standard chemical analysis. Purity of homeopathic potencies depend on the good manufacturing practice (GMP) of pharmaceutical companies. Common people purchasing homeopathic potencies over the counter have to rely on GMP certificate because there is no scientific test to verify the purity of the products. This study provides a scientific method which would help in identifying genuine homeopathic potencies. Recent experiments indicate that each potentized drug has specific water structure (Singh *et al.*, 2021a). In this study we tested two potencies of two drugs by electronic and vibrational spectroscopy and developed a method to differentiate genuine drugs from blank aqueous ethanol.

MATERIALS AND METHODS

Drugs

Two potencies 30 cH and 200 cH of *Cantharis vesicatoria* and *Lycopodium clavatum* were purchased from market at Kolkata in sealed vials. They were products of Dr. Reckeweg & Company, Germany (*Cantharis vesicatoria* 30 and 200 Lot number-2499IN370170, 2504IN370230. *Lycopodium clavatum* 30 and 200 Lot number-4494IN370200, 4501IN375190). All the potencies were in 90% EtOH. Using different percentages of ethanol a calibration curve was prepared. The concentration of ethanol in the test samples was checked from the calibration curve. The control (90% EtOH) was prepared from absolute ethanol (Lot number-20200105, Changshu Hongsheng Fine Chemical Company Limited, Jiangsu Province). Ethanol 30cH was prepared following the same procedure. The test potencies and controls were diluted with DD water 1:100.

UV-spectra

UV-spectra of all the test samples were taken in the wavelength range 200 nm to 300 nm at room temperature 24 °C, scan speed medium and data interval 0.5 nm. The baseline was set with deionised and distilled (DD) water. A UV-VIS spectrophotometer (SHIMADZU, Model- UV-VIS 1900i, Software-Lab Solutions UV-VIS) was used.

FT-IR spectra

Fourier transform infrared (FT-IR) spectra of the test potencies and ethanol controls were taken with the help of a Shimadzu IRAffinity-1S FT-IR spectrometer (Spectrum Two) on the attenuated total reflectance (ATR) technique at energy resolution 4 cm⁻¹. The base line was corrected for atmospheric humidity and CO₂. One drop of each sample was put into the sample groove and then the tip of a single reflection pure diamond crystal was brought in contact with the sample drop. The entire spectrum was recorded in the wave number range 4000-500 cm⁻¹. Each spectrum



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represents an average of 45 scans. Temperature and humidity were maintained in the laboratory at 24°C and less than 50%, respectively. Results are presented in figures 1-2.

RESULTS

UV-spectra

In the UV-spectra ethanol controls after dilution with DD water 1:100 show only a single peak at 200 nm. But all the four test potencies after dilution show two peaks one at 200 nm and another around 222 nm (Fig.-1). The first peak is due to ethanol water clusters (Singh *et al.*, 2022). The second peak around 222 nm stands for ET interaction between ethanol as electron acceptor and water as donor (Singh *et al.*, 2021b). The second peak is absent in both pure water and pure ethanol (Mulliken, 1955; Tsubomura and Mulliken, 1960; Ghosh *et al.*, 2008; Hea *et al.*, 2009; Tamer, 2017). Pure ethanol or pure water shows peak around 200 nm. So, the second peak at higher wavelength is due to ET complexes (Ghosh *et al.*, 2021). We observed similar results in 20 more drugs of different potencies.

FT-IR spectra

The highest frequency of OH stretching band is plotted against each test potency in figure 2. Ethanol controls show the lowest frequency with one exception. Decrease in the vibration frequency of the electron acceptor here ethanol indicates ET interaction (Tian and Yun, 2020). So vibrational spectra further confirm ET interaction.

DISCUSSION

Water and ethanol form a non-homogeneous solution having aggregates of water and ethanol, and also free water molecules (Dixit *et al.*, 2002; Yoshida *et al.*, 2001). Hydrogen bonding strength rises through a maximum at 20% EtOH, and declines with the increase in the percentage of ethanol (Burikov *et al.*, 2010). The difference in hydrogen bonding energy between water-ethanol, ethanol-ethanol, and water-water molecules is responsible for this phenomenon, which indicates presence of clathrate hydrate structures (Dolenko *et al.*, 2011). In the UV spectra peak I suggests absorbance by water rich clathrate hydrates but peak II at higher wavelength represents ET interaction. An analysis of FTIR spectra of EtOH-water mixture shows that EtOH molecules induce changes in hydrogen bonding network of water. The shape and size of hydrophobic unit of the solute (EtOH) produce these changes. Here water serves as a solvent (Zupancic and Grdadolnik, 2021). In homeopathic potencies drugs are initially used as solutes and aqueous EtOH as a solvent. So the drugs induce alternation in hydrogen bond network of the solvent. During the process of successive dilution and succussion the drug molecules gradually disappear but the drug-induced hydrogen bond network may be retained in the potencies. Water molecules interact with the hydroxyl and hydrogen atom of the methyl (CH₃) group in the water ethanol mixture (Oliveira and Vasconcellos, 2006). Clathrate hydrates in EtOH-water mixture are produced by the polyhedral network at hydrogen bonded water molecules. This polyhedral structures have cavities which contain small guest molecule, here drug molecules (Nguyen *et al.*, 2012). This is a process of nucleation. Traces of drug molecules have been reported in homeopathic potencies (Chattopadhyay, 2006; Chikramane *et al.*, 2010).

Mechanical agitation or succussion is used in the preparation of homeopathic potencies. Drug molecules in potencies disappear when dissolved oxygen or carbon dioxide, may take their place. Mechanical agitation has been reported to promote the process of nucleation (Mullin and Raven, 1962). ET interaction may occur in the aggregates. During dilution of the samples with DD water there is an increase in the free water molecules (Singh *et al.*, 2022) which may affect ET in the control. Potencies are characterized by specific water structure which involves hydrogen bonding strength, free water molecules and ET interaction (Singh *et al.*, 2022). All these factors may play a role in ET interaction in the diluted potencies.





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CONCLUSION

This study provides a scientific test to identify genuine homeopathic potencies as different from their ethanol water medium of identical ethanol content. The distinguishing factor is electron transfer interaction. The potencies and controls, although similar in chemical composition, are different from each other with respect to their water structure. Water structure concerns mainly hydrogen bonding strength, non-hydrogen bonded or free water molecules, and electron transfer (ET) interaction. Drug molecules and particles have induced a change in the water structure of the potencies and this change is retained when original molecules and particles disappear in the liquids. ET interaction is easily detected by UV and FT-IR spectra of the test samples.

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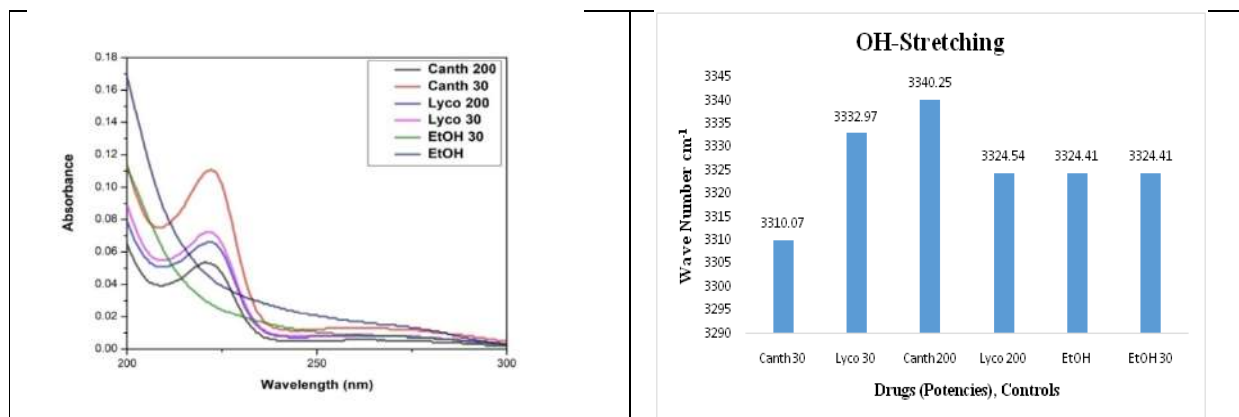


Fig.1- UV spectra of two potencies 30 cH and 200 cH of two homeopathic drugs Cantharis and Lycopodium, and also two controls, Ethanol and Ethanol 30 cH. They were diluted with Deionized distilled water 1:100 and the spectra were taken. The controls show a single peak, but the potencies show two peaks. The 2nd peak stands for electron transfer.

Fig.2- Histogram showing frequency shift of OH-stretching band of two potencies 30 cH and 200 cH of two drugs Cantharis and Lycopodium and also of Ethanol controls, all in 90% EtOH. They were diluted with deionized and distilled water 1:100 and then the FT-IR spectra were taken.





A Comparative Study on the Phytochemical and Antibacterial Effect of Seeds, Roots and Leaves of *Lawsonia inermis* against Wound Infection Causing Bacteria

P.Sivagurunathan¹, S.Sowndarya², B.Aswini², S.Vivekanandhan³, M. Lydia Rajakumari⁴, and C. Uma^{1*}

¹Assistant Professor, Department of Microbiology, Faculty of Science, Annamalai University, Tamilnadu, India.

²Ph.D Research Scholar, Department of Microbiology, Faculty of Science, Annamalai University, Tamilnadu, India.

³ Assistant Professor, Department of Microbiology, K.S.R College of Arts and Science for Women, Tiruchengode, Namakkal, Tamil Nadu, India

⁴Assistant Professor, Department of Microbiology, Indira Gandhi College of Arts and Science, Puducherry, India.

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*Address for Correspondence

C. Uma

Assistant Professor,
Department of Microbiology,
Faculty of Science,
Annamalai University,
Tamil Nadu, India.



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ABSTRACT

Humans rely on plants because of their therapeutic capabilities, and they play a significant role in the environment. The plant *Lawsonia inermis* was used in the current investigation. The plant, which is primarily found in subtropical and tropical regions. The present study investigated to find out the phytochemical and antibacterial activity of henna plants components (seeds, roots, leaves) against some wound infection-causing microbes (*Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis*, *Streptococcus pyogenes*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*). The phytochemical results of *L. inermis* leaf extract are rich in all the components except steroids and proteins, while *L. inermis* seed extracts are rich in all the components except steroids and leucoanthocyanin and the *L. inermis* root extract are rich in all the components except phlobatannin, leucoanthocyanin and proteins. The quantitative test in phytochemicals indicated the leaf extract contains more flavonoid (0.304 mg/g) than the other components and seeds contain more saponin (0.404 mg/g), and henna roots contain more terpenoid (0.124 mg/g). The antibacterial activity of ethanolic extracts of *L. inermis* leaves and seeds have high antibacterial action against both Gram-positive and Gram-negative bacteria causing wound infections.



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Roots showed intermediate growth inhibition when compared to leaves and seeds. The minimum inhibitory concentration (MIC) of the extracts ranged from 75 to 125 µg/ml.

Keywords: *Lawsonia inermis*, wound infection, antimicrobial activity, phytochemical studies

INTRODUCTION

Herbal remedies used in traditional folk medicine provide an interesting and still largely unexplored source in the creation and development of potential new chemotherapeutic medications that could help to address the rising problem of antibiotic resistance and toxicity of commercial antibiotics (Spellberg *et al.*, 2008) [1]. Medicinal plants are known as nature's best gift to cure some of the diseases of humans and animals. There are about 121 clinically useful prescription drugs that are derived from higher plants, about 70% of which came to the attention of pharmaceutical houses because of their use in traditional medicine (Abelson,1990) [2]. In all parts of the world, *Lawsonia inermis* (henna) is a very important medicinal herb. Herbal and natural folk medicine products have been used for centuries in every culture in the world. The truth regarding the benefits of these therapies has piqued the interest of scientists and medical professionals. In India, henna is widely utilised as a colouring agent in the cosmetics sector (Chengaiyah *et al.*, 2010) [3]. *L. inermis* (Lythraceae) is a perennial plant that goes by a variety of names in India, including Mehndi in Hindi, Mendika in Sanskrit, Mailanchi in Kannada, and Maruthani in Tamil (Kirtikarkr and Basu, 1956) [4].

The henna plant is one of these plants with medicinal properties, and it is now the focus of extensive scientific research. *Lawsonia inermis* (henna)(fig 1), a flowering shrub with a height of 2 to 6 m. It is the only species in the genus *Lawsonia* of the family Lythraceae. Henna *L. inermis*, produces a burgundy dye molecule, lawsone. The leaves of henna plants are oval-shaped and smooth. The length and width of the leaves are 2-3 cm and 1-2 cm, respectively. Henna shrubs are highly branched and possess a greyish brown bark. The chemical constituents of henna are Lawsone (2-hydroxynaphthoquinones) mucilage, mannite, gallic acid, and tannic acid. Quinones and particularly Naphthoquinones (NQs) are widespread among the secondary metabolites of the henna plant and they were found to possess antitumor, antibacterial, anti-inflammatory, antiparasitic, cytotoxic activities and others. (Rathi *et al.*, 2019)[5].

Henna is known to be utilised as a cosmetic agent for dyeing hair, nails, as well as skin (Pathirana *et al.*,1992) [6]. Thecolouring component in henna leaves is lawsone (C₁₀H₆O₃), which is well fixed by wool, silk, and the skin (Tommasi, 1920) [7]. Lawsone accounts for about 0.5-1.5 % of henna Its strong protein binding capacity is assumed to be the source of its bioactivity. The roasted seed powder is used for the treatment of ringworm. A concoction of the leaves is used for aseptic cleaning of wounds and healing (Kumar *et al.*, 2011) [8]. Ethnobotanical uses of the henna plant are numerous. It is used for a variety of medical and aesthetic purposes. Lawsone, which is responsible for the orange-red colour of henna leaves. It comes in an orange-red colour and is used to decorate hands, nails, and feet with leaf paste or powder. Jandice, skin illnesses, venereals infections, smallpox, and spermatorrhea have all been treated using henna leaves. Henna leaves, flowers, seeds, stembark, and roots are used to treat rheumatoid arthritis, headaches, ulcers, diarrhoea, leprosy, fever, leucorrhoea, diabetes, heart disease, hepatoprotective, and colouring purposes. It creates bioactive chemicals that have the potential to inhibit microbial development. The leaf decoction is used to clean wounds and heal them in an aseptic manner (Kumari *et al.*, 2012) [9].

A root is used in ayurvedic medicinal systems in the management of a range of diseases. On the other hand, leaves are valuable for the treatment of dysentery, diarrhoea, leprosy, as well as boils (Prajapati *et al.*, 2007) [10].A sterol from the roots of *L.inermis*, namely lawsaritol (Gupta *et al.*, 1993) [11] and 24 β-ethylcholest-4-en-3 β-ol and the stem bark of *L. inermis* as 3-methylnonacosan-1-ol. The defatted *L. inermis* seeds yielded two triterpenoid extracts (Handa *et al.*,1997) [12].



**Plant Description - Classification**

Kingdom	: Plantae
Subkingdom	: Tracheobionta
Super division	: Spermatophyta
Division	: Magnoliophyta
Class	: Magnoliopsida
Subclass	: Rosidae
Order	: Myrtales
Family	: Lythraceae
Genus	: Lawsonia
Species	: inermis

The flora on the skin is diverse. Infections can result when there is a breakdown in the integrity of the skin or when the immune defense is compromised. Cellulitis, erysipelas, impetigo, folliculitis, furuncles, and carbuncles are some of the most common types of skin infections. Multiple organisms can cause wound infection, including *Staphylococcus aureus*, *Streptococcus pyogenes*, *Bacillus subtilis*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, etc. (Grief et al., 2000) [13].

In the traditional systems of medicine, various plants have been used to promote wound healing. The leaves of *L. inermis*, commonly called henna, are used in the form of a decoction or ointment in the treatment of burns, skin inflammations, wounds, and ulcers. However, the effect of using these materials is left to the imagination. Since rural people have developed methods of taking care of their wounds by the application of a paste made from the dried and powdered leaves of the henna plant. In addition, henna is reported to show some other properties, including hypoglycaemic (Syamsudin and Winarno., 2008) [14], immunostimulant (Mikhaeil and Badria., 2004) [15], hepatoprotective (Chaudhary et al., 2010) [16], anti-inflammatory (Singh et al., 1982) [17], tuberculostatic (Sharma., 1990) [18], anti-cancer and antioxidant properties (Kamal and Jawaid., 2010) [19]. Bacterial pathogens are the leading cause of disease and death in human populations all over the world (Wilson et al., 2012) [20]. Antibiotic treatment for such infections is fraught with difficulties, as bacteria continue to acquire resistance to synthetic medicines (Livermore et al., 2012) [21]. Henna leaves, flowers, seeds, stem bark, and roots have been found to exhibit antioxidant, antidiabetic, hepatoprotective, hypoglycaemic, antimicrobial, anticancer, and wound healing properties (Goel et al., 2016) [22]. Based on the above-said problems, the present study was done to find out the antibacterial activity of local henna plant extracts against some wound infection-causing microbes.

MATERIALS AND METHODS**Plant material collection**

The fresh henna leaves, seeds, and roots were collected from different areas in Chidambaram. It was easily identified by its common morphological features that include a multibranched, deciduous shrub or small tree having a 2.6 cm height. The leaves and seeds were collected and washed thoroughly with water, air dried under shade, and ground using a pestle and mortar.

Plant extract preparation

The plant extract was prepared by dissolving 10 gm of dried plant powder in 100 ml of ethanol by using a Soxhlet apparatus for 24 hours continuously. The extract was filtered through Whatman No.1 filter paper. The filtered sample extract was concentrated and dried by using a rotary evaporator under reduced pressure.





Preliminary phytochemical screening

Qualitative phytochemical analysis

The **qualitative** phytochemical analysis of the ethanol extract was determined using the standard methods (Trease et al 1983, Kokate et al 1997, Hegde et al 2010) [23,24,25]. Test were performed for Steroids, Tannin, Saponin, Anthocyanin, Coumarins, Emodin, Alkaloids, Proteins, Phlobatannin, Leucoanthocyanin, cardiac glycosides, anthraquinones, phenol, Xanthoprotein, carbohydrates, terpenoids and Flavonoids.

Quantitative phytochemical analysis

The quantitative analysis of the ethanolic extract of *L. Inermis* was determined using the (Harborne, 1973; Obadoni and Ochuko, 2001) [26,27] methods.

Test organisms used

The test organisms are *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis*, *Streptococcus pyogenes*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*. They were procured from Raja Muthiah Medical College and Hospital (RMMCH) in Chidambaram, Tamilnadu.

Preparation of inoculum

Before performing the antimicrobial activity assay, each bacterial strain was refreshed in 5ml of Muller Hinton Broth (pH-7) separately under sterile conditions. Cultures were incubated in a shaking incubator at 160 rpm for 16 hours at 37°C. Each bacterial culture was maintained at a concentration of 10⁷ CFU/ml.

Antimicrobial assay (Disc diffusion method)

The **antimicrobial** activity of the crude ethanolic extract was determined using the disc diffusion method. Sterile millimetre-width discs were impregnated with 10µl of crude ethanolic extract at concentrations ranging from 20 to 100 µg/ml. Prepared discs were placed onto the top layer of the agar plates and left for 30 minutes at room temperature for compound diffusion. Negative control was prepared using the respective solvent. The Petri dishes were incubated for 24 hours at 37°C and the zone of inhibition was recorded in millimetres, and the experiment was repeated twice (Bauer et al., 1966) [23].

Determination of Minimum inhibitory concentration

The Minimum inhibitory concentration of aqueous and ethanol extracts (MIC) was determined by the broth dilution method. 3ml of sterile nutrient broth was taken in sterile test tubes and to this loopful of bacterial suspension (turbidity adjusted to 0.5 McFarland standard) was inoculated. The henna leaf aqueous and ethanol extracts were added to each test tube in increasing concentrations (25µl, 50µl, 75µl, 100µl, 125µl and 150µl). The content of the tubes was subjected to gentle shaking for proper mixing of the leaf extract. The test tubes were incubated at 37°C for 24 hours. A control tube was kept without the test organism (Guerin-Faubleet et al., 1996) [24].

RESULTS AND DISCUSSION

The present study was carried out in the Department of Microbiology, Faculty of Science, Annamalai University. The study proved that the *Lawsonia inermis* ethanolic extracts have antimicrobial action against some wound infection-causing bacteria. The purpose of this study was to determine the phytochemical efficiency of henna extracts, which were tested against bacteria that cause wound infection using the disc diffusion method.

Phytochemical Screening of *L. inermis*

Preliminary phytochemical screening of *L. inermis* leaves, seeds, and root extracts revealed the presence of various bioactive compounds, and the results are presented in Table 1. Phytochemical analysis was used to identify the metabolites present in ethanolic extracts of *Lawsonia inermis* (leaves, seeds, and roots). Table 1 shows that the qualitative analysis of all three (leaves, seeds and roots) contained tannin, saponin, flavonoid, terpenoid, cardiac glycosides, phenol, xanthoprotein, anthocyanin, coumarin, alkaloid, emodin, and carbs. Table 2 shows the



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quantitative analysis of flavonoid, tannin, saponin, alkaloid, phenol, and terpenoid content of *L. inermis* extracts. This study showed that Henna leaves have a higher flavonoid content (0.304 mg/g) when compared to seeds and roots and seeds contain higher saponin (0.404 mg/g) and henna roots contain more terpenoid (0.124 mg/g) content. Secondary metabolites are primarily responsible for plants' antibacterial actions (Gonzalez-Lamothe et al., 2009) [25]. In similar studies, According to Raja et al. (2013), the methanolic extract of *Lawsonia inermis* leaves contains glycosides, phytosterol, steroids, saponins, tannins, and flavonoids [26]. In an aqueous extract of *Lawsonia inermis* leaves, Upadhyay et al. (2011) found tannin, saponins, naphthoquinone, flavonoids, steroids terpenoids, and cardio glycosides [27]. Tannins, saponins, sterols, and carbohydrates were discovered in methanol extract, according to Kawo and Kwa (2011) [28]. According to Singh et al., (2014), plant hydroethanolic extracts contain alkaloids, glycosides, hydrolysable tannins, flavonoids, steroids, proteins, carbohydrates, and saponins [29]. According to Chaudhary et al study (2010) [16], *Lawsonia inermis* leaves contain a variety of nutrients, including proteins, carbohydrates, flavonoids, tannins, phenolic compounds, alkaloids, terpenoids, quinones, coumarins, xanthenes, and fatty acids.

Antibacterial activity of *L. inermis*

In the present research, it was identified that ethanolic extracts of *L. inermis* leaves and seeds have high antibacterial action against Gram-positive (*Staphylococcus aureus*, *Streptococcus pyogenes*, *B. subtilis*) as well as Gram-negative (*Escherichia coli*, *K. pneumoniae*, *P. aeruginosa*) bacteria. Roots showed intermediate growth when compared to leaves and seeds. The antibacterial activity of ethanol extracts of *Lawsonia inermis* (Henna) leaves ranged from 7 mm to 13 mm.

In this study, the ethanolic extracts of *L. inermis* leaves, seeds, and roots are used to compare the results. In the disc diffusion method, leaf extracts have antibacterial activity against *Staphylococcus aureus* with a maximum inhibition zone of 13mm (Table 3), but in other components, the diameter of the inhibition zone of henna seeds with ethanol against *S. aureus* is 10mm, and root extracts did not show any inhibition zone against *S. aureus*. *L. inermis* seeds with ethanol and the diameter of the inhibition zone of *S. aureus* was 10 mm, and the diameter of the inhibition zone of *E. coli* was similarly 10 mm, implying that the seed extracts are more active (Table 4). Table 5 shows the antibacterial activity of ethanolic extracts of *L. inermis* roots. At the highest concentrations of 100 µg/ml, *Streptococcus pyogenes* displayed the maximum zone of inhibition, *Bacillus subtilis* shows 11 mm, and *Pseudomonas aeruginosa* shows 10 mm. Other organisms did not display any inhibitory zones.

Phytochemical components of *Lawsonia inermis* exclusively have antibacterial efficacy against Gram-positive bacteria (Georgiou et al., 1999) [30]. Another study utilising methanol as a solvent found that *L. inermis* leaves have antibacterial action against *Pseudomonas aeruginosa* and *Escherichia coli* (Arun et al., 2010) [31]. According to certain studies, henna's colouring capabilities were also employed as a medicine to combat microbial infections in the hands and feet (Cowan, 1999; Mostefa Kara et al., 2010) [32,33]. In several experiments, ethanol extracts of the entire henna plant were discovered to have antibacterial action (Misra and Dixit, 1979) [34]. Ali et al. (2013), used methanolic extracts of *L. inermis* seeds to exhibit antibacterial activity against *S. aureus*, *P. aeruginosa* and *K. pneumoniae* [35].

MIC of *L. inermis*

The minimum inhibitory concentration (MIC) of ethanolic extract of henna leaf extract was tested against pathogens and were presented in table 6. In the current study, the examined isolates showed the minimum inhibitory doses of *Lawsonia inermis* ethanolic extracts were moderate (125 µg/ml). All of the isolates had a minimum inhibitory concentration (MIC) for ethanolic extracts that ranged from 75 to 125 µg/ml. MIC values were lower than those reported by others. Gull et al., (2013) reported the MIC values of acetone extract for *E. coli* and *B. subtilis* were 9.27 mg/ml and 2.3 mg/ml, respectively [36]. MIC values of 0.02 mg/ml for ethanolic extract against *S. aureus* and 0.38 mg/ml for ethyl acetate extract against *S. aureus* (Pandey and Kumar 2011) [37]. *E. coli*, *S. aureus*, *P. aeruginosa*, and *E. faecalis* had MIC values of 8–64 mg/ml for aqueous extract and 32–64 mg/ml for an alcoholic extract of *Lawsonia inermis* (Al-kurashy et al., 2011) [38]. The results of the present study concluded that the *Lawsonia inermis* leaf ethanolic extracts have a significant antibacterial action against bacteria that cause wound infections. The use of henna extracts





is of great significance as a substitute antibacterial agent in therapeutics. Future research into these characteristics of *L. inermis* (Henna) could pave the way for the discovery of novel antibacterial drugs derived from this amazing plant.

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Table 1: Phytochemical (Qualitative) Constituents of Ethanolic Extracts Analysis of *Lawsonia inermis* (Leaves, Seeds and Roots)

S.no	Phytochemical Analysis	Leaves	Seeds	roots
1.	Tannins	+	+	+
2.	Phlobatannin	+	+	–
3.	Saponin	+	+	+
4.	Flavonoid	+	+	+
5.	Steroids	–	–	+
6.	Terpenoids	+	+	+





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7.	Cardiac glycosides	+	+	+
8.	Leucoanthocyanin	+	–	–
9.	Anthocyanin	+	+	+
10.	Anthraquinones	+	+	+
11.	Proteins	–	–	–
12.	Coumarin	+	+	+
13.	Glycosides	+	+	+
14.	Phenol	+	+	+
15.	Xanthoprotein	+	+	+
16.	Alkaloid	+	+	+
17.	Emodin	+	+	+
18.	Carbohydrates	+	+	+

+ = indicates the presence of phytochemicals, - = indicates an absence of phytochemicals

Table 2: Phytochemical (Quantitative) Constituents of Ethanolic Extracts of *Lawsonia inermis* (Leaves, Seeds and Roots):

S.NO	QUANTITATIVE ANALYSIS	LEAVES mg/g	SEEDS mg/g	ROOTS mg/g
1.	Flavonoid	0.304	0.218	0.016
2.	Tannin	0.104	0.13	0.079
3.	Saponin	0.181	0.404	0.093
4.	Alkaloid	0.024	0.18	0.022
5.	Phenol	0.011	0.21	0.011
6.	Terpenoid	0.017	0.312	0.124

Table 3: Antibacterial Activity of *Lawsonia inermis* (Henna) Leaf Extracts Against Wound Infection-Causing Bacteria

Bacterial Pathogens	Zone of inhibition (mm)					Standard Ciprofloxacin 10µg/Disc
	Concentrations used (µg/ml)					
	20	40	60	80	100	
Gram-Positive Bacteria						
<i>Staphylococcus aureus</i>	7	8	9	10	13	22
<i>Streptococcus pyogenes</i>	-	-	8	9	10	20
<i>Bacillus subtilis</i>	7	7	8	9	10	18
Gram - Negative Bacteria						
<i>Escherichia coli</i>	7	7	8	9	12	21
<i>Klebsiella pneumoniae</i>	-	-	7	8	9	19
<i>Pseudomonas aeruginosa</i>	7	8	9	10	11	20

Table 4: Antibacterial Activity of *Lawsonia inermis* (Henna) Seeds Extracts Against Wound Infection-Causing Bacteria

Bacterial Pathogens	Zone of inhibition (mm)					Standard Ciprofloxacin 10µg/Disc
	Concentrations used (µg/ml)					
	20	40	60	80	100	
Gram-Positive Bacteria						
<i>Staphylococcus aureus</i>	-	-	8	9	11	20
<i>Streptococcus pyogenes</i>	-	-	8	8	9	18





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<i>Bacillus subtilis</i>	-	-	8	8	9	22
Gram-Negative Bacteria						
<i>Escherichia coli</i>	-	7.8	8	9	10	21
<i>Klebsiella pneumoniae</i>	-	-	8	8	8	19
<i>Pseudomonas aeruginosa</i>	-	-	-	8	8	20

Table 5: Antibacterial Activity of *Lawsonia inermis* (Henna) Roots Extracts Against Wound Infection-Causing Bacteria

Bacterial Pathogens	Zone of inhibition (mm)					Standard Ciprofloxacin 10 µg/Disc
	Concentrations used (µg/ml)					
	20	40	60	80	100	
Gram -Positive Bacteria						
<i>Staphylococcus aureus</i>	-	-	-	-	-	16
<i>Streptococcus pyogenes</i>	9	10	11	12	13	23
<i>Bacillus subtilis</i>	-	8	9	10	11	21
Gram- Negative Bacteria						
<i>Escherichia coli</i>	-	-	-	-	-	21
<i>Klebsiella pneumoniae</i>	-	-	-	-	-	14
<i>Pseudomonas aeruginosa</i>	-	7	8	9	10	22

Table 6: Determination of Minimum Inhibitory Concentration of Henna Leaf Extracts

S.No	Bacterial Pathogens	Ethanol Extracts (µg/ml)
1.	<i>Streptococcus pyogenes</i>	100
2.	<i>Staphylococcus aureus</i>	100
3.	<i>Bacillus subtilis</i>	75
4.	<i>Escherichia coli</i>	-
5.	<i>Klebsiella pneumoniae</i>	100
6.	<i>Pseudomonas aeruginosa</i>	125



Fig 1. *Lawsonia inermis*





m-Sharp Ordering on Neutrosophic Fuzzy Matrices

S.Princy Christinal Esther^{1*}, M.M.Shanmugapriya² and P.Poongodi³

¹Ph.D Scholar, Department of Mathematics, Karpagam Academy of Higher Education, Coimbatore-641021, Tamil Nadu, India

²Professor, Department of Mathematics, Karpagam Academy of Higher Education, Coimbatore-641021, Tamil Nadu, India

³Assistant Professor, Department of Mathematics, KG College of Arts and Science, Coimbatore-641035, Tamil Nadu, India

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*Address for Correspondence

S.Princy Christinal Esther

Ph.D Scholar,

Department of Mathematics,

Karpagam Academy of Higher Education,

Coimbatore-641021, Tamil Nadu, India

E.Mail:



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ABSTRACT

The intention of this paper is to familiarize the impression of m -Sharp Ordering on Neutrosophic Fuzzy Matrices (NSFM) using group inverses as a generality of Sharp Ordering on Fuzzy Matrices and some basic properties of a m - sharp ordering on NSFM are derived. Further, we prove that if any two NSFMs are under m-Sharp ordering then its membership, non-membership and indeterminacy fuzzy matrices are also under m-sharp order. Some elementary results under this m- sharp ordering are derived.

Keywords: Fuzzy Matrix, Neutrosophic Fuzzy Matrix, m -Regularity, Sharp ordering, m - sharp ordering.

INTRODUCTION

Researchers in economics, sociology, medical science, industrial, atmosphere science and countless other plentiful fields decide with the ambiguous, inexact and commonly deficient evidence of displaying inexact data. As a outcome, fuzzy set theory was familiarized by L. A. Zadeh [12]. Then, the intuitionistic fuzzy sets was established by M. A. Atanassov [1, 2]. Assessment of non-membership values is also not repetitively possible for the indistinguishable reason as in case of membership values and so, there exists an indeterministic portion upon which unwillingness persists. As a effect, Smarandache et al. [5, 10, 11] has announced the concept of Neutrosophic Set (NS) which is a overview of conventional sets, fuzzy set, intuitionistic fuzzy set etc.





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Using classical matrix theory, we couldn't solve the problems regarding several types of indecisions. That type of problems is cracked by using fuzzy matrix [4, 6]. Fuzzy matrix agreed with only membership values. These matrices cannot contract non membership values. Intuitionistic fuzzy matrices (IFMs) announced first time by Khan, Shyamal and Pal [8]. Kim and Roush have recognized a model for fuzzy matrices equivalent to that for Boolean Matrices by spreading the max.min operations on fuzzy algebra $F=[0,1]$, for elements $a,b \in F$, $a+b = \max\{a,b\}$ and $a.b = \min\{a,b\}$ [4]. In [7], Meenakshi have derived diverse types of ordering on regular fuzzy matrices. In [9], Poongodi et.al have given the new representation on Neutrosophic fuzzy matrices.

In this paper, the notion of m -Sharp Ordering on Neutrosophic Fuzzy Matrices (NSFM) as a generality of Sharp Ordering on Fuzzy Matrices are introduced and some essential properties of a m -sharp ordering on NSFM are derived.

Preliminaries

In this section, some elementary definitions and consequences desired are given. Let N_n symbolizes the set of all $n \times n$ Neutrosophic Fuzzy Matrices.

Definition 2.1

A matrix $C \in F_n$ is known as to be regular that there exist a matrix $U \in F_n$, to such an extent that $CUC=C$. Then, at that point, U is called g -reverse of C . Let $C\{1\} = \{U/CUC = C\}$. F_n signifies the arrangement of all fuzzy matrices of order $n \times n$.

Definition 2.2

A matrix $C \in F_n$ is known as right m -regular, assuming there exist a matrix $U \in F_n$, to such an extent that $C^mUC=C^m$, for some sure whole number m . U is named as right m - g inverse of C . Let $C_r\{1^m\} = \{U/C^mUC = C^m\}$.

Definition 2.3

A matrix $C \in F_n$ is known as left m -regular, assuming there exist a matrix $V \in F_n$, to such an extent that $CVC^m=C^m$, for some sure whole number m . V is named as left m - g inverse of C . Let $C_l\{1^m\} = \{V/CVC^m = C^m\}$.

Definition 2.4

For $C \in F_n^\#$ and $D \in F_n$, the m -sharp ordering denoted as $C \leq^\# D$ is defined as

$$C \leq^\# D \Leftrightarrow CC^\# = DC^\# \text{ for } C^\# \in C_r\{1^m\} \text{ and } C^\# C = C^\# D \text{ for } C^\# \in C_l\{1^m\}$$

Definition 2.5

A matrix $C \in F_n$ is said to have a group inverse if there exists a matrix $C^\#$ such that

- (i) $CC^\#C=C$
- (ii) $C^\#CC^\#=C^\#$
- (iii) $CC^\#=C^\#C$ for some positive integer m . Here $C^\#$ is called the group inverse of C and it is denoted by $C^\#$.

Definition 2.6

An neutrosophic fuzzy matrix (NSFM) C of order $m \times n$ is defined as $C = [X_{ab}, \langle c_{(ab)T}, c_{(ab)F}, c_{(ab)I} \rangle]_{m \times n}$, where $c_{(ab)T}, c_{(ab)F}, c_{(ab)I}$ are called enrolment worm (T), the non-participation (F) worm and the indeterminacy worm (I) of U_{ab} in C , which sustaining the condition $0 \leq (c_{(ab)T} + c_{(ab)F} + c_{(ab)I}) \leq 3$. For simplicity, we write $C = [C_{ab}]_{m \times n}$ where $C_{ab} = \langle c_{(ab)T}, c_{(ab)F}, c_{(ab)I} \rangle$. Let N_n symbolizes the arrangement of all $n \times n$ NSFM.





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Let C and D be any two NSFMs. The accompanying activities are characterized for any two-component $c_{ab} \in C$ and $d_{ab} \in D$, where $c_{ab} = [c_{(ab)T}, c_{(ab)F}, c_{(ab)I}]$ and $d_{ab} = [d_{(ab)T}, d_{(ab)F}, d_{(ab)I}]$ are in $[0,1]$ with the end goal that $0 \leq (c_{(ab)T} + c_{(ab)F} + c_{(ab)I}) \leq 3$ and $0 \leq (d_{(ab)T} + d_{(ab)F} + d_{(ab)I}) \leq 3$, then

$$c_{ab} + d_{ab} = [\max\{c_{(ab)T}, d_{(ab)T}\}, \max\{c_{(ab)F}, d_{(ab)F}\}, \min\{c_{(ab)I}, d_{(ab)I}\}]$$

$$c_{ab} \cdot d_{ab} = [\min\{c_{(ab)T}, d_{(ab)T}\}, \min\{c_{(ab)F}, d_{(ab)F}\}, \max\{c_{(ab)I}, d_{(ab)I}\}]$$

Here we shall track the elementary operations on NSFMs.

For $C = (c_{ab}) = [c_{(ab)T}, c_{(ab)F}, c_{(ab)I}]$ and $D = (d_{ab}) = [d_{(ab)T}, d_{(ab)F}, d_{(ab)I}]$ of order $m \times n$, their total indicated as $C + D$ is characterized as,

$$C + D = (c_{ab} + d_{ab}) = [(c_{(ab)T} + d_{(ab)T}), (c_{(ab)F} + d_{(ab)F}), (c_{(ab)I} + d_{(ab)I})] \dots(2.1)$$

For $C = (c_{ab})_{m \times n}$ and $D = (d_{ab})_{n \times p}$ their product indicated as CD is characterized as,

$$CD = (e_{ab}) = \sum_{k=1}^n c_{bk} \cdot d_{kb}$$

$$= \left(\sum_{k=1}^n (c_{(ak)T} \cdot d_{(kb)T}), \sum_{k=1}^n (c_{(ak)F} \cdot d_{(kb)F}), \sum_{k=1}^n (c_{(ak)I} \cdot d_{(kb)I}) \right) \dots(2.2)$$

Lemma 2.7

For $C, D \in N_{mn}$

- (i) If the row space of D contained in the row space of C then which is equivalent to $D = UC$ for some $U \in N_m$
i.e. $R(D) \subseteq R(C) \Leftrightarrow D = UC$ for some $U \in N_m$
- (ii) If the column space of D contained in the column space of C then which is equivalent to $D = CV$ for some $V \in N_n$
i.e. $C(D) \subseteq C(C) \Leftrightarrow D = CV$ for some $V \in N_n$

Lemma 2.8

For $C \in N_{mn}$ and $D \in N_{nm}$, the following hold.

- (i) The row space of CD, which is contained in the row space of C, i.e. $R(CD) \subseteq R(C)$
- (ii) The column space of CD, which is contained in the column space of D, i.e. $C(CD) \subseteq C(D)$

Lemma: 2.9

For $C = [C_T, C_F, C_I] \in N_{mn}$ and $D = [D_T, D_F, D_I] \in N_{nm}$, the following hold.

- (i) $C^T = [C_T^T, C_F^T, C_I^T]$
- (ii) $CD = [C_T D_T, C_F D_F, C_I D_I]$

Theorem:2.10

For $C, D \in N_n$, with $R(C) = R(D)$ and $R(C^m) = R(D^m)$ then a is right m -regular Neutrosophic Fuzzy Matrix $\Leftrightarrow D$ is right m - regular Neutrosophic Fuzzy Matrix.

Theorem:2.11

For $C, D \in N_n$, with $C(C) \subseteq C(D)$ and $C(C^m) = C(D^m)$ then a is left m -regular Neutrosophic Fuzzy Matrix $\Leftrightarrow D$ is left m - regular Neutrosophic Fuzzy Matrix.

Lemma 2.12. For $C = [C_T, C_F, C_I], D = [D_T, D_F, D_I] \in (N)_{n^{(m)}}$, if $C \leq B$ and $D < C$ then $D\{1_r^m\} \subseteq C\{1_r^m\}$ and $\overline{D\{1_r^m\}} \subseteq \overline{C\{1_r^m\}}$.





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m-Sharp Ordering on Neutrosophic Fuzzy Matrices.

In this section, we characterize a m-sharp ordering concerning m-group inverses of Neutrosophic Fuzzy Matrices. Some fundamental properties on a pair of m-regular neutrosophic fuzzy matrices under this ordering are discussed.

Definition 3.1

For $C \in N_n^{m\#}$ and $D \in N_n$, them -sharp ordering denoted as $C \lessdot D$ is defined as

$$C \lessdot D \Leftrightarrow C^m C^{\#} = D^m C^{\#} \text{ for } C^{\#} \in C_r^{\#} \{1^m\} \text{ and}$$

$$C^{\#} C^m = C^{\#} D^m \text{ for } C^{\#} \in C_l^{\#} \{1^m\}$$

Definition 3.2

A matrix $C \in N_n$ is known to have a right m-group inverse if there exists a matrix $C^{\#}$ such that

(iv) $C^m C^{\#} C = C^m$ and

(v) $C^{\#} C^m C^{\#} = C^{\#}$

(vi) $C^m C^{\#} = C^{\#} C^m$ for some positive integer m. Here $C^{\#}$ is termed as the right group inverse of C and it is denoted by $C_r^{\#}$.

Definition 3.3

A matrix $C \in N_n$ is known to have a left m-group inverse if there exists a matrix $C^{\#}$ such that

(i) $C C^{\#} C^m = C^m$ and

(ii) $C^{\#} C^m C^{\#} = C^{\#}$

(iii) $C^m C^{\#} = C^{\#} C^m$ for some positive integer m. Here $C^{\#}$ is termed as the left group inverse of C and it is denoted by $C_l^{\#}$.

Remark: 3.4

The m-Sharp Ordering is the particular case of m-Ordering. In broad-spectrum, morder need not involvem-sharp order and m-sharp order need not involvemT order.

Lemma 3.5

For $C = [C_T, C_F, C_I] \in N_n^{\#}$ and $D = [D_T, D_F, D_I] \in N_n$: The following are comparable.

(i) $C \lessdot D$

(ii) $C^m = D^m C_r^{\#} C = C C_l^{\#} D^m$

Proof:

(i) \Rightarrow (ii): Since $C \lessdot D$

then

$$C^m C_r^{\#} = D^m C_r^{\#}, \text{ for } C^{\#} \in C_r^{\#} \{1^m\} \text{ and}$$

$$C^{\#} C^m = C^{\#} D^m, \text{ for } C^{\#} \in C_l^{\#} \{1^m\}$$

Since C and D have m group inverse, then by Definition (3.2) and Definition (3.3)

$$(C^m C_r^{\#} C) = C^m$$

$$D^m C_r^{\#} C = C^m \rightarrow (1)$$





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Again $C(C_l^\# C^m) = C^m$

$$CC_l^\# D^m = C^m \quad \rightarrow (2)$$

From (1) and (2)

$$C^m = D^m C_r^\# C = CC_l^\# D^m$$

Hence (i) \Rightarrow (ii).

(ii) \Rightarrow (i):

Let $Z_r^\# = C_r^\# CC_r^\#$ then for $C_r^\# \in C_r^\# \{1^m\}$

$$\begin{aligned} C^m Z_r^\# C &= C^m (C_r^\# CC_r^\#) C \\ &= C^m C_r^\# C = C^m \Rightarrow Z_r^\# \in C_r^\# \{1^m\} \end{aligned}$$

Similarly $Z_l^\# = C_l^\# CC_l^\#$ for $C_l^\# \in C_l^\# \{1^m\}$

$$\begin{aligned} CZ_l^\# C^m &= CC_l^\# (CC_l^\# C^m) \\ &= CC_l^\# C^m \\ &= C^m \end{aligned}$$

$$\Rightarrow Z_l^\# \in C_l^\# \{1^m\}$$

To prove: $C^m Z_r^\# = D^m Z_r^\#$ and $Z_l^\# C^m = Z_l^\# D^m$

Consider,

$$\begin{aligned} C^m Z_r^\# &= C^m C_r^\# CC_r^\# \\ &= C^m C_r^\# = D^m C_r^\# CC_r^\# = D^m Z_r^\# \end{aligned}$$

To prove $Z_l^\# C^m = Z_l^\# D^m$

$$Z_l^\# C^m = C_l^\# CC_l^\# C^m = C_l^\# C^m = C_l^\# CC_l^\# D^m = Z_l^\# D^m$$

For this reason $C \overset{m}{\leq} D$

Lemma 3.6

For $C, D \in N_n^\#$

(i) If D has right m -group inverse and $R(C^m) \subseteq R(D^m)$ then $C^m = C^m D_r^\# D$ for each right m -group inverse $D_r^\#$ of D .

(ii) If B has left m group inverse and $C(C^m) \subseteq C(D^m)$ then $C^m = DD_l^\# C^m$ for each right m -group inverse $D_l^\#$ of D .

Proof

i. Seeing as $R(C^m) \subseteq R(D^m)$

$$\begin{aligned} \Rightarrow C^m &= xD^m \\ &= xD^m D_r^\# D \text{ for each } D_r^\# \in D_r^\# \{1^m\} \\ &= C^m D_r^\# D \end{aligned}$$

Consequently (i) holds.

ii. Seeing as $C(C^m) \subseteq C(D^m)$

$$\begin{aligned} \Rightarrow C^m &= D^m Y \\ &= DD_l^\# D^m Y \text{ for each } D_l^\# \in D_l^\# \{1^m\} \end{aligned}$$





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$$=DD_l^{\#} C^m$$

Consequently (ii) holds.

Lemma 3.7

For $C, D \in N_n^{m\#}$, $C \stackrel{m\#}{<} D \Leftrightarrow C^T \stackrel{m\#}{<} D^T$.

Proof:

$$C \stackrel{m\#}{<} D \Leftrightarrow C^m C_r^{\#} = D^m C_r^{\#} \text{ for } C_r^{\#} \in C_r^{\#} \{1^m\}$$

$$\text{and } C_l^{\#} C^m = C_l^{\#} D^m \text{ for } C_l^{\#} \in C_l^{\#} \{1^m\}$$

We know that $C_r^{\#} \in C_r^{\#} \{1^m\}$ iff $(C_r^{\#})^T \in C_l^{\#} \{1^m\}$

$$C^m C_r^{\#} = D^m C_r^{\#}$$

$$\Leftrightarrow (C^m C_r^{\#})^T = (D^m C_r^{\#})^T$$

$$\Leftrightarrow (C^T)_r^{\#} (C^T)^m = (C^T)_r^{\#} (D^T)^m$$

$$\text{Correspondingly } C_l^{\#} C^m = C_l^{\#} D^m \Leftrightarrow (C^T)^m (C^T)_l^{\#} = (D^T)^m (C^T)_l^{\#}$$

$$\Leftrightarrow C^T \stackrel{m\#}{<} D^T$$

Lemma 3.8

For $C \in N_n^{m\#}$ and $D \in N_n$ is m -potent, then the following are comparable:

- (i) $C \stackrel{m\#}{<} D$
- (ii) $DC^m = C^{m+1} = C^m D$

Proof:

Since $C^{\#}$ exists, $C^{\#} C^{m+1} = C^{\#} C^m C = C^m C^{\#} C = C^m$

$$C^{m+1} C^{\#} = C C^m C^{\#} = C C^{\#} C^m = C^m$$

To prove (i) \Rightarrow (ii)

Since $C \stackrel{m\#}{<} D$, we have,

$$C^m D = C^{m+1} C^{\#} D = C C^m C^{\#} D = C C^m = C^{m+1}$$

Correspondingly, $DC^m = DC^{\#} C^{m+1} = DC^{\#} C^m C = C^m C = C^{m+1}$

To prove (ii) \Rightarrow (i)

Since $C^m D = DC^m = C^{m+1}$

To prove $C^m C^{\#} = D^m C^{\#}$

$$C^m C^{\#} = (C^{m+1} C^{\#}) C^{\#} = (DC^{\#} C^{\#}) C^{\#} = D (C^{\#} C^m C^{\#}) = DC^{\#} = D^m C^{\#} \text{ (Since } D \text{ is } m\text{-Potent)}$$

$$C^{\#} C^m = C^{\#} (C^{\#} C^{m+1}) = C^{\#} (C^{\#} C^m D) = (C^{\#} C^m C^{\#}) D = C^{\#} D = C^{\#} D^m \text{ (Since } D \text{ is } m\text{-potent)}$$

Theorem 3.9

For $C \in N_n^{m\#}$ and $D \in N_n^{\#}$ then $C \stackrel{m\#}{<} D \Leftrightarrow C^m D = DC^m$ and $C \stackrel{m}{<} D$

Proof:

Since $C \stackrel{m\#}{<} D \Rightarrow C \stackrel{m}{<} D$, $C^m D = DC^m = C^{m+1}$ (By Lemma 3.8)

Conversely, $C \stackrel{m}{<} D$ and $C^m D = DC^m$

To prove: $C \stackrel{m\#}{<} D$

Since $C \stackrel{m}{<} D \Rightarrow C^m = C^m D^{\#} D$

$$C^m D = (C D^{\#} C^m) D = C D^{\#} (DC^m) = C D D^{\#} C^m = C C^m = C^{m+1}$$





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Since $C^m D = DC^m = C^{m+1}$

$$DC^m = D(C^m D^{\#} C) = C^m D D^{\#} C = C^m D^{\#} DC = C^m C = C^{m+1}$$

Again by lemma (3.8), $C^{m\#} D$

Theorem 3.10

For $C \in N_n^{m\#}$ and $D \in N_n^{\#}$ if $D \leq C$ and $C^{m\#} D$ then $D_{com^{\#}}\{1_r^m\} \subseteq C_{com^{\#}}\{1_r^m\}$.

Proof:

$$\begin{aligned} C^{m\#} D &\Rightarrow C^m D \\ &\Rightarrow D_r\{1^m\} \subset C_r\{1^m\} \text{ (By Lemma 2.12)} \end{aligned}$$

Let $D_{com^{\#}}$ be any commuting m group inverse of D .

To prove $C^m D_{com^{\#}} = D_{com^{\#}} C^m$

$$\text{Since } D \leq C \Leftrightarrow D_{com^{\#}} D = D_{com^{\#}} C \text{ and } D D_{com^{\#}} = C D_{com^{\#}}$$

$$\text{And } C^{m\#} D \Leftrightarrow C^m C_r^{\#} = D^m C_r^{\#}$$

$$\text{And } C_l^{\#} C^m = C_l^{\#} D^m$$

To prove $D_{com^{\#}}\{1_r^m\} \subseteq C_{com^{\#}}\{1_r^m\}$ it is enough to prove $C^m D_{com^{\#}} C = C^m$

$$\begin{aligned} \text{Consider } C^m D_{com^{\#}} C &= C C^{\#} D^m D_{com^{\#}} C \\ &= C C^{\#} (D^m D_{com^{\#}} D) \\ &= C C^{\#} D^m \\ &= C^m \end{aligned}$$

Therefore $D_{com^{\#}}\{1_r^m\} \subseteq C_{com^{\#}}\{1_r^m\}$

Lemma 3.11

For $C \in N_n$ and $D \in N_n$ we have the following $R(D^m) \subseteq R(C^m) \Leftrightarrow C(D^{\top})^m \subseteq C(C^{\top})^m$.

$$R(D^m) \subseteq R(C^m) \Leftrightarrow D^m = D^m X C$$

$$\Leftrightarrow (D^m)^{\top} = (D^m X C)^{\top}$$

$$\Leftrightarrow (D^m)^{\top} = C^{\top} X^{\top} (D^m)^{\top}$$





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$$\Leftrightarrow (D^T)^m = C^T X^T (D^T)^m$$

$$\Leftrightarrow C(D^T)^m \subseteq C(C^T)^m$$

Thus $R(D^m) \subseteq R(C^m) \Leftrightarrow C(D^T)^m \subseteq C(C^T)^m$.

Theorem 3.12

Let $C, D \in N_n^{m\#}$. If $C \overset{m\#}{\prec} D$, then $C \overset{m}{\prec} D$ and $DC^\#C = C$. Conversely $C \overset{m}{\prec} D, C \overset{\#}{\prec} D,$

$C(DC^\#D) \subset C(C)$ and $R(DC^\#D) \subset R(C) \Rightarrow C \overset{m\#}{\prec} D$.

Proof:

Clearly $C \overset{m\#}{\prec} D \Rightarrow C \overset{m}{\prec} D$ with respect to $C^\#$ and $D^m C^\# D = C^m$

Now, assume $C \overset{m}{\prec} D$ and $C(B^m A^\# D) \subseteq C(C^m)$ holds.

By lemma 3.7, since $C \overset{m}{\prec} D$ and $D^\# \in D_r\{1^m\}$, we have

$$C^m D^\# C = C^m, C^m D^\# D = D D^\# C^m = C^m$$

$$C(D^m C^\# D) \subseteq C(C^m)$$

$$\Rightarrow C C^\# (D^m C^\# D) = D^m C^\# D \text{ by lemma (3.7)}$$

$$\Rightarrow C D^\# (C C^\# D^m C^\# D) = C D^\# (D^m C^\# D)$$

$$\Rightarrow C C^\# D^m C^\# D = C^m C^\# D = D^m C^\# D$$

$$\Rightarrow C^m C^\# D = D^m C^\# D$$

$$\Rightarrow C^m C^\# D (D^\# C) = D^m C^\# D (D^\# C)$$

$$\Rightarrow C^m = D^m C^\# (C D^\# C)$$

$$\Rightarrow C^m = D^m C^\# C$$

$$\Rightarrow C^m C^\# = D^m C^\# C C^\#$$

$$\Rightarrow = D^m C^\#$$

Thus $C(D^m C^\# D) \subseteq C(C^m) \Rightarrow C^m C^\# = D^m C^\#$

Similarly, $R(D^m C^\# D) \subseteq R(C^m)$ and $C \overset{m}{\prec} D \Rightarrow C^\# C^m = C^\# D^m$

Hence $C \overset{m\#}{\prec} D$.





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Lemma 3.13

For $C, D \in N_n^\#$, then the following are equivalent:

- (i) $C \stackrel{m\#}{<} D$
- (ii) $C \stackrel{m}{<} D$ and $D^m C^\# D = C^m$
- (iii) $C \stackrel{m}{<} D$ and $D^\# C^m D^\# = C^\#$

CONCLUSION

Ordering moralities are decisive for classifying and grading real world problems. This article affords a distinct type of ordering named m-Sharp ordering which has extensive application in neutrosophic fuzzy matrices. This paper is an simplification of sharp ordering in regular fuzzy matrices to m-Sharp ordering on m-regular neutrosophic fuzzy matrices.

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RESEARCH ARTICLE

Structural, Electronic, Vibrational and Optical Properties of $Ga_x S_y$ ($x+y=2-5$) Nanocluster: A DFT Study

Amarjyoti Das^{1*} and R.K. Yadav²

¹Research Scholar, Department of Physics, North Eastern Regional Institute of Science and Technology, Nirjuli – 791109, Arunachal Pradesh, India.

²Associate Professor, Department of Physics, North Eastern Regional Institute of Science and Technology, Nirjuli – 791109, Arunachal Pradesh, India.

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*Address for Correspondence

Amarjyoti Das

Research Scholar,
Department of Physics,
North Eastern Regional Institute of Science and Technology,
Nirjuli – 791109, Arunachal Pradesh, India.
E.Mail: vickyzzworld@gmail.com



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ABSTRACT

A first principles study of the structural transformation, electronic, vibrational and optical properties of Gallium sulfide $Ga_x S_y$ ($x+y=2-5$) nanoclusters is made using B3LYP/6-311G(3df) method within Density functional theory (DFT). The different structures for a cluster possessing a definite chemical composition are optimized. For all the optimized structures the binding energy (BE), highest occupied and lowest-unoccupied molecular orbital (HOMO-LUMO) gaps, bond lengths of the optimized geometries has been calculated. For the most stable clusters harmonic vibrational frequencies, IR intensities, Raman activity and optical spectra are determined. With the growing of size of the cluster final binding energy (FBE) increases monotonically. The HOMO-LUMO gap fluctuates with cluster size up to $x+y = 4$ thereafter decreases. IPs are significantly higher than EAs justifies that clusters have more tendency to gain an electron than to lose one. For two, three and five atom clusters, higher frequencies are due to stretching mode of vibrations but in case of four atom clusters, higher frequencies are due to bending mode of vibrations. In visible region absorption spectrum is excessively feeble; however in Ultraviolet region most prominent and strong peaks appeared. So, it may be utilized as a promising material for the devices which works in the Ultraviolet region.

Keywords: Nanoclusters, Electronic properties, Vibrational frequencies, Optical Spectra, DFT.





INTRODUCTION

Study of nanocluster in recent days is very much important because it has a very large application in electronic and optoelectronic devices. Basically many materials of these devices are made from semiconducting materials, therefore it is very much vital to study the physical properties of these materials. Semiconductors and their compounds are of great interest due to their applicability in the fabrication of electronic and optoelectronic devices like solar cells, light emitting diodes (LEDs), photocells, photodetectors for fiber optics communications, solid state lasers such as in heterojunction lasers, avalanche photodiodes, high speed heterojunction transistors, sensors, integrated circuits (ICs) etc. Nanoclusters of metals or semiconductors can be considered as building blocks of future technologies. This is due to size-dependent electronic properties of these materials. With the variation of particle size, the properties of nanosized semiconductors have been changed [1]. Clusters containing chalcogenides are one of the most promising materials due to their practical usage possibilities in different fields like electronics, laser technology and photonic devices etc. [2]. Gallium sulfides bearing a leading role for research of the Gallium Chalcogenides nanocluster [3,4]. Gallium sulfide is most significant wide bandgap semiconductor such that which could be utilized as structure material for electrical sensors, photoelectric devices and nonlinear optics. Neelum Seeburrun, Hassan and H. Abdallah reported a study of neutral and anionic gallium sulfides using the density functional theory, the second-order Moller–Plesset perturbation theory (MP2), and coupled cluster singles and doubles, including noniterative triples [CCSD(T)] with the 6-311+G(2df) basis set. They investigated that lower energy structure prefers planar geometries. It has been observed that a sequential addition of a sulfur atom to the Ga_2S_n ($n = 2, 3$) cluster results in a general rise in the HOMO – LUMO gaps[5]. An ab-initio study of GaO_2 and GaS_2 made by Bu et al [6], they found that in lowest energy state GaO_2 and GaS_2 species classified as superoxide and supersulfide and in an excited state this character becomes vanishes.

The geometry, harmonic vibrational frequencies and the relative energies of the most stable Ga_2S_3 and Ga_3S_2 constitutional isomers and the respective neutral counterparts were recorded [7]. Due to the property of strong intralayer bonding and the weak interlayer van der Waals interaction between the GaS nanosheet, give rise to highly anisotropic structural electrical and mechanical characteristics that have made GaS appealing in photoelectric, electrical and nonlinear application[8]. Gallium sulfide super tetrahedral structure based on two units cluster can be used as building blocks for gallium-sulfide coordination polymers [9]. By introducing simultaneous evaporation of gallium sulfide, binary vapours have been deposited for the growth of polycrystalline thin films of SrGa_2S_4 [10-14]. However, an experimental study has been made on thermal conductivity of gallium sulfide and technics for generation of GaS thin film[15,16]. Nano-structured gallium sulfide(nanobelt) has been obtained and it can be used as a promising electron source for applications in field emission based devices[17]. On the theoretical side, a first principle study of GaS polytypes in the presence of pressure has been investigated [18]. Also electronic, dielectric properties of monolayered, nanostructured gallium sulfide has been defined using first principle DFT study[19,20]. The electronic and magnetic properties of intrinsic defects in a GaS monolayer by means of the first-principles method based on DFT has been studied by Hui Chen, Yan Li, Le Huang and Jingbo Li [21].

Although the electronic and vibrational properties of GaS nanocluster were determined using first principle DFT [22]. Till now various possible structures along with ionization potential, electron affinity, oscillator strength of most stable structure are not determined comprehensively. Therefore it is required to determine the electronic, vibrational and optical properties of this small nanocluster. In the present paper, applying the B3LYP-DFT/6-311G (3df) method, we introduce a extensive detail study of the structural stability, binding energy (BE), highest-occupied and lowest unoccupied molecular orbital (HOMO–LUMO) gaps, adiabatic and vertical ionization potential (IP) and electron affinity (EA), optical properties, vibrational frequencies, Raman scattering activities, of the tiny semiconductor binary Ga_xS_y ($x+y=2-5$) nanoclusters.





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METHODS

Density functional theory (DFT) is a phenomenally successful approach to find solutions of the fundamental Schrödinger equations that describe the quantum mechanical behavior of atoms and molecules. In case of DFT, a more general expression is superseded in the exact exchange of Hartree-Fock theory, the exchange-correlation functional; which may combine conditions for both the correlation of electrons and exchange energy. The DFT calculations requires a basis set, which is an approximate representation of the atomic orbitals (AOs) called contracted function and the Molecular orbitals(MOs) which are the linear combination of atomic orbitals.6-311G is a triple split valence basis set employs 6 Gaussian-type orbitals(GTOs),3 GTOs for inner valence,2 different GTOs for outer valence. The limitation of split valence basis set is that it permits the orbitals to change the size but don't allow to alternate the orbitals shape. Therefore it is much needed to employ a polarized basis set 6-311G (3df) to reduce the problem. Considering the three d functions for S atom and one f function are included for Ga atom. The functional B3LYP is composed of Becke's hybrid three-parameter exchange functional [23] with the correlation function of Lee, Yang, and Parr (LYP)[24].

B3LYP-DFT/6-311G(3df) version within the Gaussian code-09 was applied to obtain the optimized geometries of Gallium sulfide nanoclusters [25].For optical spectrum determination TDDFT formalism is regarded.

CALCULATION AND RESULTS

Stability of structures

Most possible geometrical structures have been explored such as linear chain, planar, ring and three-dimensional. By relaxing atomic positions lowest energy structures are obtained. The binding energy(BE) per atom is calculated for all the different possible optimized structures. The structures, which have the highest binding energy per atom are the most stable structures. To obtain BE we subtract the total energy of nanocluster from sum of the energies of the individual atoms present in the nanocluster and the resultant quantity is divided by the number of atoms. The harmonic vibrational frequencies are calculated for a more precise calculation and the corresponding zero point energy (ZPE) is subtracted from the earlier BE per atom and the result is regarded as the final binding energy (FBE) of the structure. The configuration with the highest value of FBE has been named as the most stable structure among all the optimized structures belonging to a specific chemical formula Ga_xS_y . All the optimized structures of $Ga_xS_y(x+y=2-5)$ are presented in "Figures 1-8".

The calculated bond length and bond energy of isolated dimer clusters S-S, Ga-S, Ga-Ga are 1.9 Å, 2.09 Å,2.73 Å and 4.47, 3.60 and 1.34 eV, respectively. The computed S-S bond length is good agreement with the experimental value (1.92 Å)[26]. The calculated Ga-Ga bond length is slightly greater than other theoretical value [28]. The calculated BEs and HOMO-LUMO gaps of all the optimized structures are given in "Table 1",for the most stable structures Ga-S,Ga-Ga, and S-S bond lengths are compared with others available values in "Table 2".

The possible geometrical structures of nanoclusters are individually discussed below-

$Ga_xS_y(x+y=2)$: only possible structure of two atom GaS (1A) nanocluster is linear. The GaS cluster has Ga-S bond length 2.09Å and $C_{\infty v}$ symmetry. The FBE of GaS cluster is 1.76 e V. No experimental value is available for comparison. $Ga_xS_y(x+y=3)$: Two compositions of nanoclusters are possible for three atoms which are Ga_2S and GaS_2 . Ga_2S : Two linear structure and one triangular structure are studied. Among those structures, Triangular planar(1D) structure is the most stable structure, which has FBE 2.33 eV and C_{2v} symmetry. For this configuration bond length between Ga-Ga and Ga-S is found 3.9 Å and 2.29 Å, respectively and similar values were calculated by Neeraj Misra et al [22]. GaS_2 :Two linear and one triangular structure have been investigated. Two linear structures SGaS and GaSS has lower FBE 1.68 eV and 2.02 eV respectively than triangular configuration (1G) which have FBE 2.30 eV. The Ga-S and S-S bond length of 1G structure is found 2.519 Å and 2.01 Å, respectively, which is in excellent agreement with other theoretical values [5]. Symmetry of this structure is C_{2v} .





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$Ga_xS_y(x+y=4)$: The optimized structures of four atom clusters have singlet, doublet and quartet ground state.

Ga_2S_2 : For Ga_2S_2 , four linear, two trigonal pyramidal and one rhombohedral geometries are studied. The rhombohedral (2E) and linear (2B) have similar FBE 2.47 and 2.41 eV, respectively. The rhombohedral (2E) structure is most stable one. The Ga-S bond length of stable structure is 2.26 Å, which is in excellent agreement with the value reported by others [7, 22].

Ga_3S : We have studied six different geometries; which includes two linear, two triangular planar, one rhombohedral and a trigonal pyramidal one. Among these various structures triangular planar (3D) and rhombohedral structure (3E) has maximum FBE. Although the triangular planar (3D) structure has highest FBE 1.99 eV but due to the presence of imaginary vibrational frequencies, this triangular planar structure is considered as unstable. Therefore, the rhombohedral (3E) structure is regarded as the most stable structure. The FBE of this structure (3E) is 1.85 eV which possess C_{2v} symmetry. The Ga-S and Ga-Ga bond lengths are 2.30 Å and 2.67 Å, respectively. There is neither experimental data nor theoretical data is available for comparison.

GaS_3 : Two linear, two triangular planar, one rhombohedral and two trigonal pyramidal structures has been investigated. From these optimized structures linear and triangular structures have almost the same binding energy per atom. The rhombohedral structure (4G) has highest BE than the linear and triangular one. Rhombohedral (4G) structure is regarded as the most stable structure having FBE 2.20 eV and C_{2v} symmetry. In this configuration, the S-S and Ga-S bond length is 2.11 Å and 2.28 Å, slightly smaller than the values reported by Neeraj Misra et al [22].

$Ga_xS_y(x+y=5)$: The optimized structures of five atom clusters have singlet, doublet, triplet and quartet ground state.

Ga_4S : Eleven different geometries, namely three linear, two triangular planar, two rhombohedral planar, one pentagonal, two trigonal bipyramidal, one rhombohedral pyramidal structure has been investigated. Among them, the rhombohedral pyramidal (5K) structure is considered as most stable with FBE of 1.91 eV and calculated bond length are for Ga-Ga 3.0 Å, for Ga-S 2.48 Å, respectively, which is in excellent agreement with values reported by Neeraj Misra et al [22].

Ga_3S_2 : Seventeen different geometries are optimized, which includes six linear, three rhombohedral, three triangular planar, two rhombohedral pyramidal and three trigonal bipyramidal. All the optimized structures have doublet ground state. The trigonal bipyramidal structure has the highest FBE of 2.32 eV, which is considered as the most stable structure having C_{2v} symmetry. Our calculated bond lengths are reported in "Table 2".

Ga_2S_3 : Twenty different structures are investigated, namely six linear, three rhombohedral, three triangular, three trigonal bipyramidal, two rhombohedral pyramidal, and two pentagonal. From these mentioned structures rhombohedral planar (7K), rhombohedral pyramidal (7R) and pentagonal structures (7J, 7N) have the highest and nearly similar binding energy per atom. Among them pentagon (7N) structure has highest binding energy per atom of 2.42 eV and C_{2v} symmetry. Presently calculated bond lengths are reported in "Table 2" and compared with the values [7].

GaS: Thirteen various geometries are optimized, which contains three linear, two triangular planar, three rhombohedral planar, two trigonal bipyramidal, two pentagonal and one rhombohedral pyramidal. It is found that the rhombohedral planar structure [8F] with FBE 2.37 eV having C_{2v} symmetry is the most stable one. Our values of bond lengths are reported in "Table 2" which is in good agreement with values [7].

The variation of FBE with cluster size ($x+y=n$) is shown in "Figure 9(A)". It is seen that FBE increases monotonically with cluster size.



**Amarjyoti Das and R.K. Yadav****Electronic structure**

The variation of the HOMO-LUMO gap with cluster size ($x+y=n$) for the most stable configurations are depicted in "Figure9(B)". The HOMO-LUMO gap fluctuates upto 4 atom cluster thereafter it decreases. The nanocluster containing even number of Ga atom for specific chemical composition has highest HOMO-LUMO gap. Our predicted HOMO –LUMO gap for Ga_2S_2 is a good agreement with other theoretical value.

Ionization potential and electron affinity

The energy needed to get rid of electron from a neutral cluster is called ionization potential (IP). Ionization energy reflects the ability of a cluster to release its electron. The energy difference between the cationic and neutral cluster is called the ionization potential. The energy liberated, when an electron is added to a neutral cluster is defined as electron affinity (EA). We calculated the electron affinity by the energy difference between anionic and neutral cluster.

A B3LYP-DFT functional and a basis set 6-311G(3df) has been used to determine the adiabatic and vertical IPs and EAs for the most stable nanoclusters for a specific chemical formula $Ga_xS_y(x+y=2-5)$. The calculated IPs and EAs are shown in the "Table 3" and the variation of IPs and EAs with cluster size is given in "Figure 10". From the figure, it is observed that the IP fluctuates upto four atom cluster thereafter it decreases and the EA shows zigzag behavior upto four atom cluster thereafter it increases, with cluster size. We have seen that smallest cluster have the highest IP and EA than the largest cluster. From the table, it also reveals the value of vertical ionization potential (VIP) is greater than adiabatic ionization potential (AIP) and conversely the value of vertical electron affinity (VEA) is smaller than adiabatic electron affinity (AEA). Furthermore, IPs are considerably greater than EAs, which explains why clusters tend to acquire an electron more than to lose one.

Vibrational frequencies

To calculate the mode of vibration of gallium sulfide nanocluster we have used B3LYP-DFT/6-311G(3df) method. With respect to the atomic displacements, the double derivative of the net energy of the system has been calculated. The obtained dynamical matrix is diagonalized. These calculations were carry out with the minimum energy configurations of $Ga_xS_y(x+y\leq 2-5)$ nanoclusters in order to ensure that they are true minima on the cluster potential surface (PES). If the calculated results have no imaginary frequency then the structures have been considered as stable one. We have also calculated the Raman scattering activities (Raman activity), infrared intensities (IR Int.), and relative infrared intensities(Rel. IR Int.), which are shown in "Tables 5-7". In the tables, the numbers in brackets signifies the multiplicity of the mode. We present details of these nanocluster below:

GaS: We found the symmetric stretching mode frequency at 436 cm^{-1} , which is IR as well as Raman Active both. Neeraj Misra et al also obtain the stretching mode frequency at 436 cm^{-1} [22], which is in excellent agreement with our value. No experimental result is available for comparison.

 $Ga_xS_y(x+y=3)$:

Ga_2S : For triangular(1D) structure, our predicted vibrational frequencies are $48,283$ and 372 cm^{-1} . The lowest frequency arises Due to bending mode of vibration where as the frequencies 283 and 372 cm^{-1} arises due to symmetric and asymmetric stretching mode of vibrations, respectively. All the frequencies are IR active and first two frequencies are Raman active. Our calculated results are same as calculated by previous workers[22].

GaS_2 : The calculated vibrational frequencies for triangular structure(1G) are $180,247$ and 590 cm^{-1} , which are in good agreement with the values of others[7] $181,248$ and 588 cm^{-1} . The lowest and hishest frequencies are obtained due to asymmetric and symmetric stretching mode of vibrations and the frequency 247 cm^{-1} is obtained because of the bending mode of vibration and it is both IR and Raman active.





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Ga_xS_y(x+y=4)

Ga₂S₂: For the rhombohedral structure (2E), our calculated vibrational frequencies are 97,141,202,293, 393 and 394 cm⁻¹. The frequencies 394, 141 and 97 cm⁻¹ are due to the bending mode of vibrations and 393 and 202 cm⁻¹ are asises from the breathing modes of vibrations and 293 cm⁻¹ is due to symmetric stretching mode of vibration. The highest frequency is IR active and the frequency 393 cm⁻¹ is Raman Active. Our predicted frequencies are in excellent agreement with other workers [22,7].

Ga₃S: The present vibrational frequencies for rhombohedral (3E) are 84,103,140,270,329 and 597 cm⁻¹, the highest one is highly IR active and 84, 140,329 and 597 cm⁻¹ are highly Raman active. The frequencies of 597 and 329 cm⁻¹ is due to the bending mode of vibrations. On the other hand the frequencies 140 and 270, 103 cm⁻¹ are due to symmetric and asymmetric stretching vibrations, respectively. No data is available for comparison.

Ga₄S: For this nanocluster, although rhombohedral (4G) structure has the highest FBE we have found an imaginary frequency which lead the structure is unstable. We have calculated the vibrational frequency for other possible configurations but unfortunately, no stable structure is found. However, the earlier worker [22] reported that the rhombohedral structure is the most stable one with positive vibrational frequency.

Ga_xS_y(x+y=5):

Ga₄S: For rhombohedral Pyramidal structure (5K), the presently obtained vibrational frequencies are 59.25, 59.83(2), 60, 95, 114, 253 and 268(2) cm⁻¹. The higher frequency of 268 and 253 cm⁻¹ possess asymmetric stretching vibrations and other frequencies are due to symmetric stretching mode of vibrations. Our predicted values are in good agreement with other theoretical values calculated by Neeraj Misra et al [22].

Ga₃S₂: The trigonal bipyramidal structure (6P) possess frequencies 73, 82, 106, 147, 148, 167, 216, 346, and 356 cm⁻¹. The higher frequencies 356 and 346 cm⁻¹ are due to symmetrical and asymmetrical vibrations. On the other hand other frequencies are due mixed mode of vibrations. Other workers [22] have reported similar values.

Ga₂S₃: For Pentagonal structure (7N), the calculated vibrational frequencies are 24, 106, 116, 157, 261, 273, 325, 379, and 516 cm⁻¹. It has been seen that the higher frequencies are due to symmetric and asymmetric mode of vibrations. However, lower frequencies are due to bending mode of vibrations. Our predicted frequencies are in excellent agreement with the other worker [22].

Ga₄S: The calculated vibrational frequencies for rhombohedral (8F) are 78, 83, 130, 200, 250, 327, 443, 522.02, and 522.92 cm⁻¹. The frequencies are arises due to Symmetric, asymmetric and bending mode of vibration. Our predicted values are an splendid agreement with the earlier worker [7].

Unfortunately no experimental data is available for comparison.

From the above discussion, we observed that among the all possible optimised structures the Linear GaS(1A), Triangular Ga₂S(1D), Triangular Ga₂S(1G), Rhombohedral Ga₂S(2E), Rhombohedral Ga₃S(3E), Rhombohedral Pyramidal Ga₄S(5K), Rhombohedral Ga₄S(8F), Trigonal Bipyramidal Ga₃S(6P) and Pentagonal Ga₂S(7N) structures are considered as most stable for a specific chemical composition Ga_xS_y(x+y=2-5). All the optimized Ga₃S cluster have their lowest imaginary frequency and we haven't found any stable configuration for Ga₃S. The Raman and IR spectra are addressed for characterising the structure. To analyse an infrared spectrum, we have comprehend the intensity and position of the peaks are related to the vibration of the atoms in the structure. Raman and IR spectra of all the most stable configuration is shown in "Figure 11-12".

Optical spectra and EELS

The optical spectra of most stable structures of Ga_xS_y (x+y=2-5) nanoclusters is calculated using TD-B3LYP-DFT/6-311G(3df) method. Absorption spectra of the most stable nanoclusters are shown in "Figure 13-15", for this we have plotted oscillator strength as a function of excitation energy. We observed that in visible region absorption spectrum





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is too weak however in ultraviolet region most prominent and strong peaks have appeared. For the most stable $Ga_xS_y(x+y=2-5)$ nanoclusters excitation energies with the largest oscillator strengths are given in the "Table 4".

GaS: In case of GaS nanocluster weak absorption peaks are observed in the energy range 3.9-4.18 eV. The strongest peaks is seen at 7.09 eV followed by two weak peaks 5.73 and 8.89 eV.

Ga₂S₃ (x+y=3):

Ga₂S: For the $Ga_2S(1D)$ nanocluster, weak absorption peaks have appeared from 3.53 eV to 4.42 eV. A very strong peak is observed at 5.88 eV. In the ultraviolet region, also some sharp peaks are seen at 8.3, 8.05, 7.1, 4.67 eV.

Ga₂S₂: The optical absorption spectrum of triangular $Ga_2S_2(1G)$ configuration shows weak absorption in the regions 3.3-4.67 eV, 5.01-5.97 eV. Strong absorption peaks appear at 7.09, 6.63 and 6.04 eV.

Ga₂S₂ (x+y=4)

Ga₂S₂: In case of $Ga_2S_2(2E)$ rhombohedral nanocluster weak absorption is observed in the regions 2.33-5.39 eV. Some prominent strong absorption peaks are observed at 5.64, 5.96, 6.33, and 8.44 eV.

Ga₃S: For $Ga_3S(3E)$ rhombohedral nanocluster, weak absorption observed in the range 1.4-3.4 eV. Multiple absorption peaks appear at 3.43, 4.25, 5.20, and 5.66 eV.

Ga₃S₂ (x+y=5):

Ga₃S: A strong and sharp peak appears at 5.72 eV for $Ga_3S(5K)$ nanocluster. However, multiple absorption peaks are observed at 6.47, 6.26 and 3.38 eV.

Ga₃S₂: In case of $Ga_3S_2(6P)$ trigonal bipyramidal nanocluster very less prominent absorption spectrum have appeared throughout the entire visible and ultraviolet region excepts two small peaks appear at 5.16 and 5.30 eV.

Ga₂S₃: For the $Ga_2S_3(7N)$ Pentagonal nanocluster weak absorption spectrum is observed in the energy range 2.17-5.46 eV. A slightly strong and sharp peak appears at 5.74 eV followed by peaks at 6.14 and 7.58 eV.

Ga₄S: For $Ga_4S(8F)$ rhombohedral planar nanocluster, we observed that the absorption spectrum are very weak in the range 1.78 – 5.64 eV. At the energy 5.97 eV a sharp peak has been seen.

CONCLUSIONS

We performed an ab-initio study of structural, electronic, vibrational and optical properties of $Ga_xS_y(x+y=2-5)$ nanoclusters using B3LYP-DFT/6-311G(3df) method. For Ga_xS_y nanocluster we have predicted the bond lengths, final binding energy (FBE), HOMO-LUMO gaps, adiabatic and vertical ionization potentials, and electron affinities, harmonic vibrational frequencies, IR intensities, Relative IR intensities and Raman scattering activities. Our predicted values are compared with the other workers data available. Unfortunately, no experimental data is available for comparison. Among all the nanocluster, clusters having $x=2$ Gallium atoms has large FBE. It is observed that FBE increases monotonically with cluster size. The HOMO-LUMO gap fluctuates with the increase in the number of atoms and decreases after four atom. The nanocluster containing even number of Ga atom has the highest HOMO-LUMO gap. Our predicted vibrational frequencies are ranging from 24 cm^{-1} to 597 cm^{-1} . In case of two, three and five atom cluster, higher frequencies prefer stretching vibration but in case of four atom cluster, higher frequencies prefer bending vibration.

IPs are significantly higher than EAs justifies that clusters have more tendency to gain an electron than to lose one. Among the most stable configuration, linear GaS nanocluster has largest and Ga_2S_3 pentagon structure has the lowest IP and EA. For each most stable cluster, optical absorption spectrum which is equivalent to electron energy loss spectrum has been computed. Since spectrum is unique for a particular cluster so it can be used for characterization of a specific cluster. We observed that in visible region absorption spectrum is too weak however in ultraviolet region most prominent and strong peaks have appeared. Therefore it can be used as a promising material for the device which works in the ultraviolet region.



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Table 1. Symmetry, multiplicity of the ground state, binding energy per atom and HOMO-LUMO gap in eV for all the configurations of $Ga_xS_y(x+y=2-5)$ clusters. Bold-faced ones are most stable configurations. The final binding energy (FBE) =BE-zero point energy (ZPE).

Cluster	Configuration	Symmetry	Multiplicity	BE/atom (eV)	ZPE (eV)	FBE (eV)	HOMO-LUMO gap(eV)
GaS	Linear(1A)	$C_{\infty v}$	2	1.79	0.027	1.76	1.65
Ga ₂ S	Linear GaSGa(1C)	$D_{\infty h}$	1	1.24			4.07
	GaGaS(1B)	$C_{\infty v}$	1	1.93			2.83
	Triangular(1D)	C_{2v}	1	2.37	0.044	2.33	4.27
GaS ₂	Linear SGaS(1F)	$D_{\infty h}$	2	1.68			1.52
	GaSS(1E)	$C_{\infty v}$	2	2.02			0.04
	Triangular(1G)	C_{2v}	2	2.36	0.063	2.30	2.60
Ga ₂ S ₂	Linear GaGaSS(2A)	$C_{\infty v}$	1	1.72			1.65
	GaSSGa(2B)	$C_{\infty v}$	1	2.48	0.07	2.41	3.87
	GaSGaS(2C)	$D_{\infty h}$	1	2.13			3.15
	SGaGaS(2D)	$D_{\infty h}$	1	2.32			3.96
	Rhombohedral(2E)	D_{2h}	1	2.51	0.09	2.42	2.33
Ga ₂ S ₂	Trigonal Pyramidal(2F)	C_{2v}	1	2.47			4.10
	Trigonal Pyramidal (2G)	C_{2v}	1	2.47			4.11
Ga ₃ S	Linear GaGaGaS(3A)	$C_{\infty v}$	2	1.43			1.18
	GaSGaGa(3B)	$C_{\infty v}$	2	1.89			1.19
	Triangular(3C)	C_{2v}	2	1.75			1.32
	Triangular(3D)	C_{2v}	2	2.04	0.05	1.99	1.66
	Rhombohedral(3E) Trigonal Pyramidal(3F)	C_{2v} C_s	2 2	1.94 1.93	0.095	1.84	1.21 0.24
GaS ₃	Linear GaSSS(4A)	$C_{\infty v}$	4	2.02			1.58
	SGaSS(4B)	$C_{\infty v}$	4	2.02			2.06
	Triangular(4C)	C_{2v}	4	2.00			1.41
	Triangular(4D)	C_{2v}	4	2.02			1.66





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	Trigonal Pyramidal(4E)	C_s	4	2.07			1.91
	Trigonal Pyramidal(4F)	C_s	2	2.07			1.91
	Rhombohedral(4G)	C_{2v}	2	2.31	0.11	2.20	1.44
Ga ₃ S ₂	Linear						
	GaGaGaSS (6A)	$C_{\infty v}$	2	1.52			0.99
	GaGaSGaS (6B)	$C_{\infty v}$	2	2.00			1.32
	GaGaSSGa(6C)	$C_{\infty v}$	2	1.57			1.90
	SGaGaGaS(6D)	$D_{\infty h}$	2	1.92			1.47
	GaSGaSGa(6E)	$D_{\infty h}$	2	2.26			1.44
	GaSGaGaS (6F)	$C_{\infty v}$	2	2.15			1.70
	Triangular(6G)	C_{2v}	2	1.60			1.11
	Triangular(6H)	C_{2v}	2	2.22			1.77
	Triangular(6I)	C_{2v}	2	1.88			1.33
	Rhombohedral(6J)	C_s	2	1.91			1.63
	Rhombohedral(6K)	C_s	2	2.25			1.60
	Rhombohedral(6L)	$C_{\infty v}$	2	2.26			1.61
	Rhombohedral Pyramidal(6M)	C_s	2	2.29			1.87
	Rhombohedral Pyramidal(6N)	C_s	2	2.14			1.54
TrigonalBipyramidal(6O)	C_s	2	2.21			1.60	
Trigonal Bipyramidal(6P)	C_{2v}	2	2.42	0.102	2.318	1.91	
TrigonalBipyramidal(6Q)	C_{2v}	2	2.26			1.64	
Ga ₄ S	Linear						
	GaGaGaGaS(5A)	$C_{\infty v}$	3	1.60			1.54
	GaGaSGaGa (5B)	$D_{\infty h}$	3	1.59			0.74
	GaSGaGaGa(5C)	$C_{\infty v}$	3	1.74			1.56
	Triangular(5D)	C_{2v}	1	1.69			1.45
	Triangular(5E)	C_{2v}	3	1.75			1.16
	Rhombohedral(5F)	C_{2v}	1	1.63			0.86
	Rhombohedral(5G)	C_{2v}	3	1.86			1.56
	Trigonal Bipyramidal (5H)	$C_{\infty v}$	3	1.96			1.61
	Trigonal Bipyramidal (5I)	C_{2v}	1	1.90			0.87
Pentagon(5J)	D_{4h}	1	1.96			2.16	
Rhombohedral Pyramidal(5K)	C_{4v}	1	1.99	0.076	1.914	1.68	
GaS ₄	Linear						
	GaSSSS(8A)	$C_{\infty v}$	2	1.52			0.99
	SGaSSS (8B)	$C_{\infty v}$	2	2.24			0.98
	SSGaSS(8C)	$C_{\infty v}$	4	2.05			0.81





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	Triangular(8D)	C _{2v}	4	2.08			0.93
	Triangular(8E)	C _{2v}	4	2.11			1.60
	Rhombohedral(8F)	C_{2v}	2	2.53	0.159	2.371	1.48
	Rhombohedral(8G)	C _{2v}	2	2.10			2.04
	Rhombohedral(8H)	C _{2v}	2	2.24			1.52
	Trigonal Bipyramidal (8I)	C _{2v}	2	2.10			1.94
	Trigonal Bipyramidal (8J)	C ₁	2	2.45			2.19
	Pentagon(8K)	C _s	4	2.20		2.342	1.41
	Pentagon(8L)	C _{2v}	2	2.49	0.148		1.90
	Ga ₂ S ₃	Linear					
GaSGaSS (7A)		C _{∞v}	3	2.30			2.23
GaSSGa (7B)		C _{∞v}	3	1.97			1.66
SGaGaSS(7C)		C _{∞v}	3	1.93			0.99
SGaSGaS(7D)		D _{∞h}	1	2.41			3.07
SGaSSGa(7E)		C _{∞v}	1	2.08			1.91
SSSGaGa (7F)		C _{∞v}	3	2.06			2.73
Triangular(7G)		C _{∞v}	3	2.32			2.63
Triangular(7H)		C _{∞v}	1	2.47			3.14
Triangular(7I)		C _{∞v}	1	1.57			1.17
Rhombohedral(7K)		C _{∞v}	3	2.53	0.137	2.393	1.20
Rhombohedral(7L)		C _{∞v}	1	2.26			2.38
Rhombohedral(7M)		C _{2v}	1	2.30			2.24
Trigonal Bipyramidal(7O)		C _s	3	2.16			2.22
Trigonal Bipyramidal(7P)		C _{2v}	3	2.13			0.88
Trigonal Bipyramidal(7Q)		C _{2v}	1	2.46			3.68
Rhombohedral Pyramidal(7R)	C _s	1	2.48			4.05	
Pentagon(7J)	C _s	1	2.53	0.134	2.396	2.12	
Pentagon(7N)	C_{2v}	1	2.55	0.134	2.416	2.12	

Table 2 :Bond lengths (in Å) for all most stable configurations of Ga_xS_y(x+y=2-5) clusters.

Cluster	Configuration	Bonds	Bond lengths(Å)	
			Present	Others
GaS	Linear(1A)	Ga-S	2.09	2.09 ^a
Ga ₂ S	Triangular(1D)	Ga-S	2.29	2.29 ^a
		Ga-Ga	3.99	3.99 ^a
GaS ₂	Triangular(1G)	Ga-S	2.52	2.52 ^b
		S-S	2.01	2.02 ^b
Ga ₂ S ₂	Rhombohedral(2E)	Ga-S	2.26	2.26 ^a 2.26 ^b
Ga ₃ S	Rhombohedral(3E)	Ga-Ga	2.67	
		Ga-S	2.30	
GaS ₃	Rhombohedral(4G)	Ga-S	2.28	2.67 ^a
		S-S	2.11	2.74 ^a
Ga ₂ S ₃	Pentagon(7N)	5Ga-1S	2.24	2.35 ^a
		2Ga-3S	2.35	2.35 ^a





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		5Ga-4S	2.34	2.35 ^a
		3S-4S	2.05	2.04 ^a
Ga ₃ S ₂	Trigonal Bipyramidal(6P)	1Ga-2S	2.70	2.63 ^a
		1Ga-3S	2.70	2.63 ^a
		4Ga-2S	2.63	2.63 ^a
		4Ga-3S	2.63	2.63 ^a
		5Ga-2S	2.63	2.63 ^a
		5Ga-3S	2.63	2.63 ^a
		1Ga-4Ga	2.78	3.32 ^a
		1Ga-5Ga	2.78	3.32 ^a
Ga ₄ S	Rhombohedral Pyramidal(5K)	1Ga-4Ga	3.00	3.00 ^a
		1Ga-2Ga	3.00	3.00 ^a
		2Ga-3Ga	3.00	3.00 ^a
		3Ga-4Ga	3.00	3.00 ^a
		1Ga-5S	2.48	2.48 ^a
		2Ga-5S	2.48	2.48 ^a
		3Ga-5S	2.48	2.48 ^a
		4Ga-5S	2.48	2.48 ^a
GaS ₄	Rhombohedral Planar(8F)	1S-2S	2.04	2.05 ^b
		2S-3S	2.04	2.05 ^b
		4Ga-3S	2.33	2.31 ^b
		4Ga-1S	2.33	2.31 ^b
		4Ga-5S	2.07	2.09 ^b

^a Neeraj Misra et al [22],^bSeeburrin et al [7]

Table 3: Adiabatic and vertical ionization potential (IP) and electron affinity (EA) in eV for the most stable configurations of the Ga_xS_y(x+y=2-5) nanocluster.

Cluster	Configuration	IP (eV)		EA(eV)	
		AIP	VIP	AEA	VEA
GaS	Linear(1A)	9.70	9.71	2.94	2.91
Ga ₂ S	Triangular(1D)	8.11	8.17	0.84	0.33
GaS ₂	Triangular(1G)	8.58	8.99	2.18	1.90
Ga ₂ S ₂	Rhombohedral(2E)	8.28	8.42	2.40	2.27
Ga ₃ S	Rhombohedral(3E)	8.62	8.88	2.94	2.58
GaS ₃	Rhombohedral(4G)	4.84	6.12	1.12	0.99
Ga ₂ S ₃	Pentagon(7N)	7.88	8.21	2.66	2.49
Ga ₃ S ₂	Trigonal Bipyramidal(6P)	7.16	7.71	2.78	2.27
Ga ₄ S	Rhombohedral Pyramidal(5K)	5.83	6.28	1.84	1.43
GaS ₄	Rhombohedral Planar(8F)	8.87	8.93	3.50	3.41

Table 5: Ga_xS_y(x+y=2-3) clusters : the calculated vibrational frequencies (cm⁻¹) and infrared intensities (IR Int. in Km mol⁻¹),relative IR intensities (Rel. IR Int.) and Raman scattering activities (Raman activity in A⁴ /amu.). Brackets following the frequencies contain the multiplicity of the mode.

Cluster	Configuration	Property	Values
GaS	Linear GaS(1A)	Present Frequency IR Intensity Rel. IR Intensity Raman Activity	436 16.37 1.0 89.41





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		Others	Frequency IR Intensity	436 ^a 16.36 ^a
Ga ₂ S	Triangular(1D)	Present	Frequency IR Intensity Rel.IR Intensity Raman Activity	48, 283, 372 51.15, 43.33, 36.55 1.0, 0.85, 0.71 10.5, 21.09, 0.56
		Others	Frequency IR Intensity	(48, 283, 372) ^a (0.33, 18.74, 278.23) ^a
GaS ₂	Triangular(1G)	Present	Frequency IR Intensity Rel.IR Intensity Raman Activity	180, 247, 590 6.39, 49.65, 2.55 0.13, 1.0, 0.05 5.26, 11.53, 29.2
		Others	Frequency	(181, 248, 588) ^b

^aNeeraj Misra et al [22],^bSeeburrin et al [7]

Table 6: Ga_xS_y(x+y=4) clusters : the calculated vibrational frequencies (cm⁻¹) and infrared intensities (IR Int. in Km mol⁻¹),relative IR intensities (Rel. IR Int.) and Raman scattering activities (Raman activity in A⁴ /amu.). Brackets following the frequencies contain the multiplicity of the mode.

Cluster	Configuration	Property	Values
Ga ₂ S ₂	Rhombohedral (2E)	Present	Frequency IR Intensity Rel.IR Intensity Raman Activity
		Others	Frequency IR Intensity
Ga ₃ S	Rhombohedral (3E)	Present	Frequency IR Intensity Rel.IR Intensity Raman Activity
		Others	Frequency IR Intensity
GaS ₃	Rhombohedral (4G)	Present	Frequency IR Intensity Rel.IR Intensity Raman Activity
		Others	Frequency IR Intensity

^a Neeraj Misra et al [22],^bSeeburrin et al [7]





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Table 7: Ga_xS_y(x+y=5) clusters : the calculated vibrational frequencies (cm⁻¹) and infrared intensities (IR Int. in Km^{mol}⁻¹),relative IR intensities (Rel. IR Int.) and Raman scattering activities (Raman activity in A⁴/amu.).Brackets following the frequencies contain the multiplicity of the mode.

Cluster	Configuration	Property	Values
Ga ₄ S	Rhombohedral Pyramidal(5K)	Present Frequency	59.25, 59.83(2), 60, 95, 114, 253, 268(2)
		IR Intensity	0.06, 0.45(2), 0, 0, 0, 12.36, 68.7(2)
		Rel.IR Intensity	0, 0.01(2), 0, 0, 0, 0.18, 1(2)
		Raman Activity	46.33, 0.12, 2.86, 4.4, 12.65, 74.49, 0.32
		Others Frequency	(59, 60, 61, 62, 95, 116, 259, 271, 272) ^a
		IR Intensity	(0.38, 0.38, 0, 0.03, 0, 0, 12.23, 69.11, 69.13) ^a
Ga ₃ S ₂	Trigonal Bipyramidal (6P)	Present Frequency	73, 82, 106, 147, 148, 167, 216, 346, 356
		IR Intensity	0, 0, 3.05, 12.18, 49.75, 1.90, 38.66, 34.56, 5.25
		Rel.IR Intensity	0.21, 0.23, 0.30, 0.41, 0.42, 0.47, 0.61, 0.97, 1
		Raman Activity	2.09, 9.14, 21.32, 2.66, 13.29, 10.67, 13.27, 0.89, 42.73
		Others Frequency	(72, 82, 106, 117, 157, 262, 273, 325, 380, 515) ^a
		IR Intensity	(0, 0, 2.90, 12.46, 50.20, 1.92, 38.78, 34.56, 5.39) ^a
Ga ₂ S ₃	Pentagon(7N)	Present Frequency	24, 106, 116, 157, 261, 273, 325, 379, 516
		IR Intensity	14.53, 3.62, 0, 0, 0.03, 9.15, 1.32, 36.16, 1.22
		Rel.IR Intensity	0.4, 0.1, 0, 0, 0, 0.25, 0.04, 1, 0.03
		Raman Activity	0.01, 0.12, 0.35, 7.33, 8.09, 32.16, 0.3, 11.02, 25.48
		Others Frequency	(24, 106, 117, 157, 262, 273, 325, 380, 515) ^a
		IR Intensity	(14.53, 3.61, 0, 0, 0.02, 9.21, 1.32, 36.12, 1.21) ^a
Ga ₄ S	Rhombohedral (8F)	Present Frequency	78, 83, 130, 200, 250, 327, 443, 522.02, 522.92
		IR Intensity	3.16, 3.69, 1.63, 9.91, 1.81, 33.81, 49.38, 24.24, 5.54
		Rel.IR Intensity	0.06, 0.07, 0.03, 0.20, 0.04, 0.68, 1, 0.49, 0.11
		Raman Activity	1.29, 3.13, 0.37, 35.59, 64.05, 329.6, 1585, 44.89, 31.94
		Others Frequency	(78, 84, 130, 202, 259, 329, 439, 518, 520) ^b

^aNeeraj Misra et al [22],^bSeeburrin et al [7]

Table 4: Excitation energies (ΔE, in eV) with largest oscillator strength(f) for all the most stable configuration of Ga_xS_y(x+y=2-5) clusters.

Cluster	Configuration	Excitation energy (ΔE, in eV)	Oscillator strength (f)
GaS	Linear(1A)	7.09	0.9379
Ga ₂ S	Triangular(1D)	5.89	1.3059
GaS ₂	Triangular(1G)	7.09	0.6476
Ga ₂ S ₂	Rhombohedral(2E)	6.33	0.3651
Ga ₃ S	Rhombohedral(3E)	5.20	0.1345
Ga ₂ S ₃	Pentagon(7N)	5.74	0.4992
Ga ₃ S ₂	Trigonal Bipyramidal(6P)	5.16	0.1294
Ga ₄ S	Rhombohedral Pyramidal(5K)	5.72	0.8463
Ga ₄ S	Rhombohedral Planar(8F)	5.97	0.3865



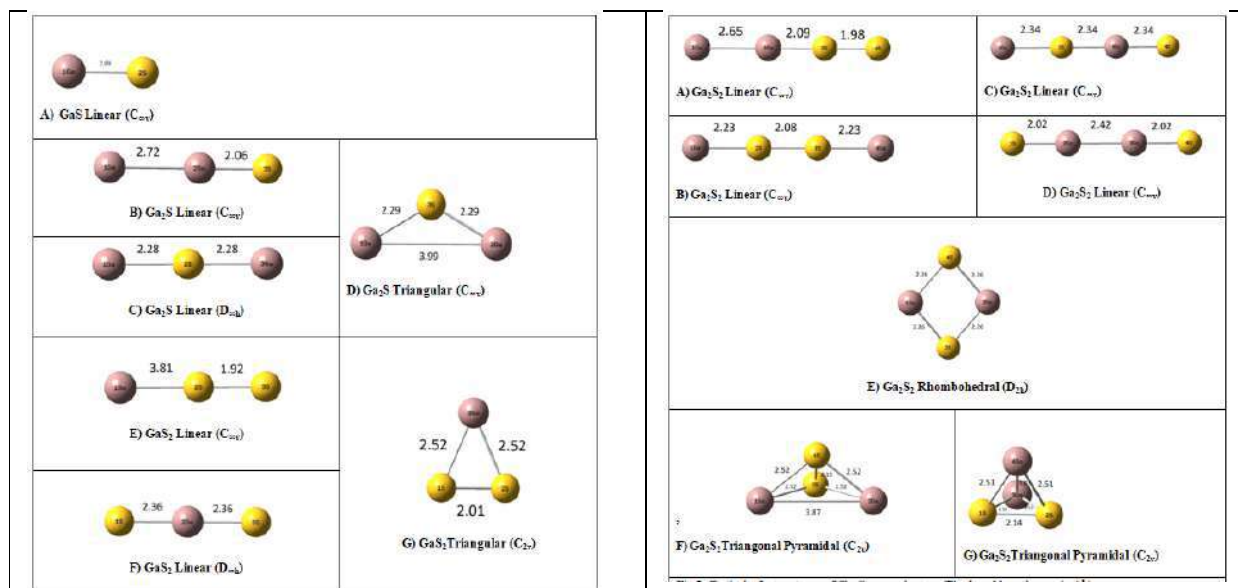


Fig.1. Optimized structures of Ga_xS_y (x+y=2-3) nanoclusters. The bond lengths are in Å.

Fig.2. Optimized structures of Ga₂S₂ nanoclusters. The bond lengths are in (Å)

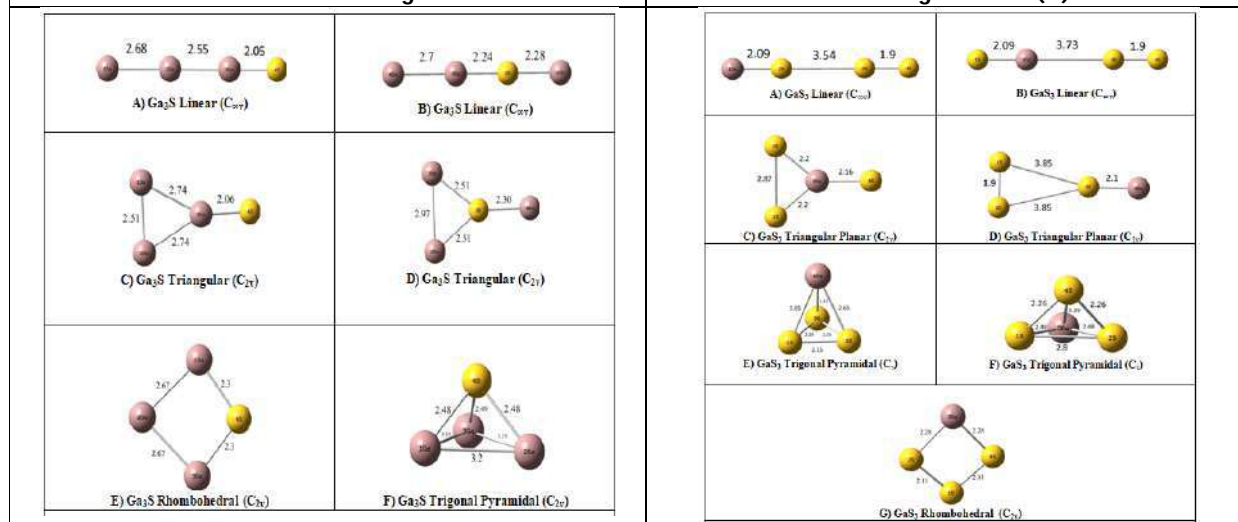


Fig.3. Optimized structures of Ga₃S nanoclusters. The bond lengths are in Å

Fig.4. Optimized structures of GaS₃ nanoclusters. The bond lengths are in Å.





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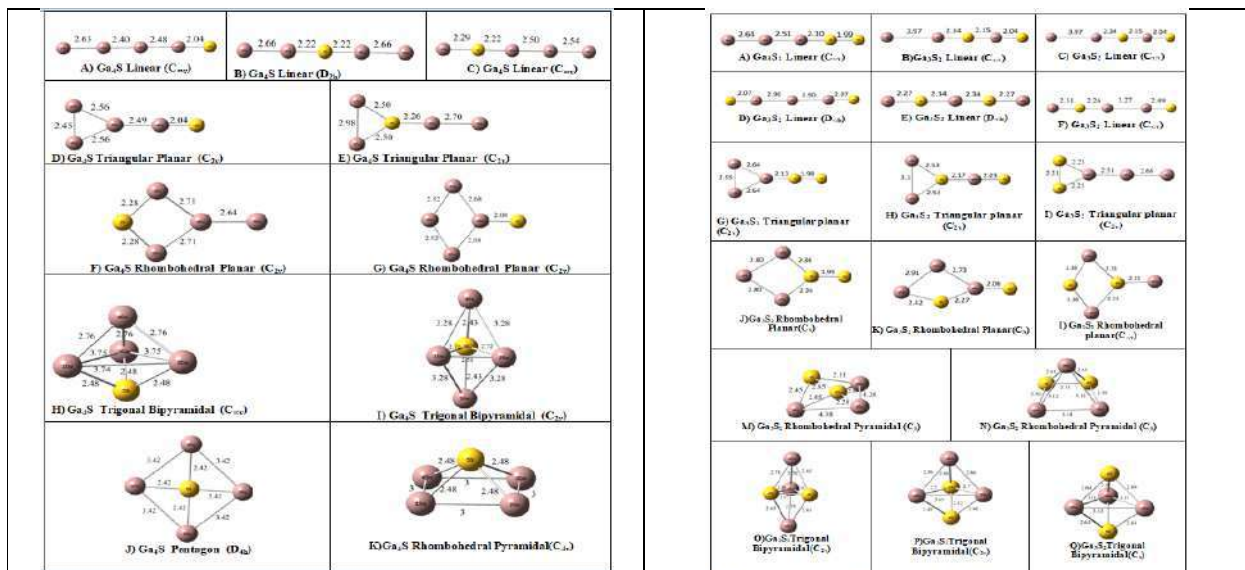


Fig.5. Optimized structures of Ga₄S nanoclusters. The bond lengths are in Å

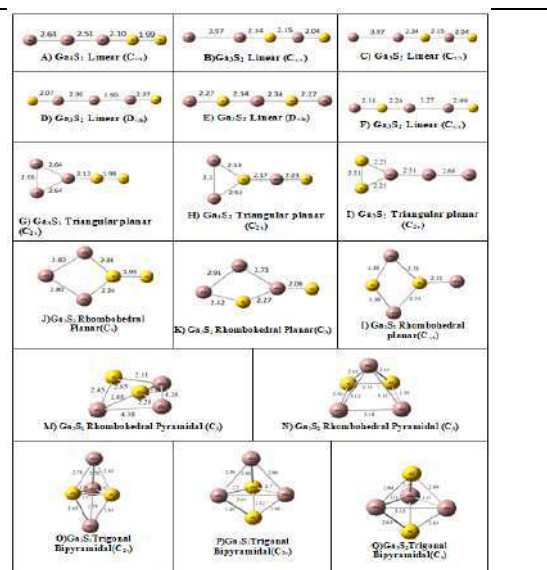


Fig.6. Optimized structures of Ga₃S₂ nanoclusters. The bond lengths are in Å.

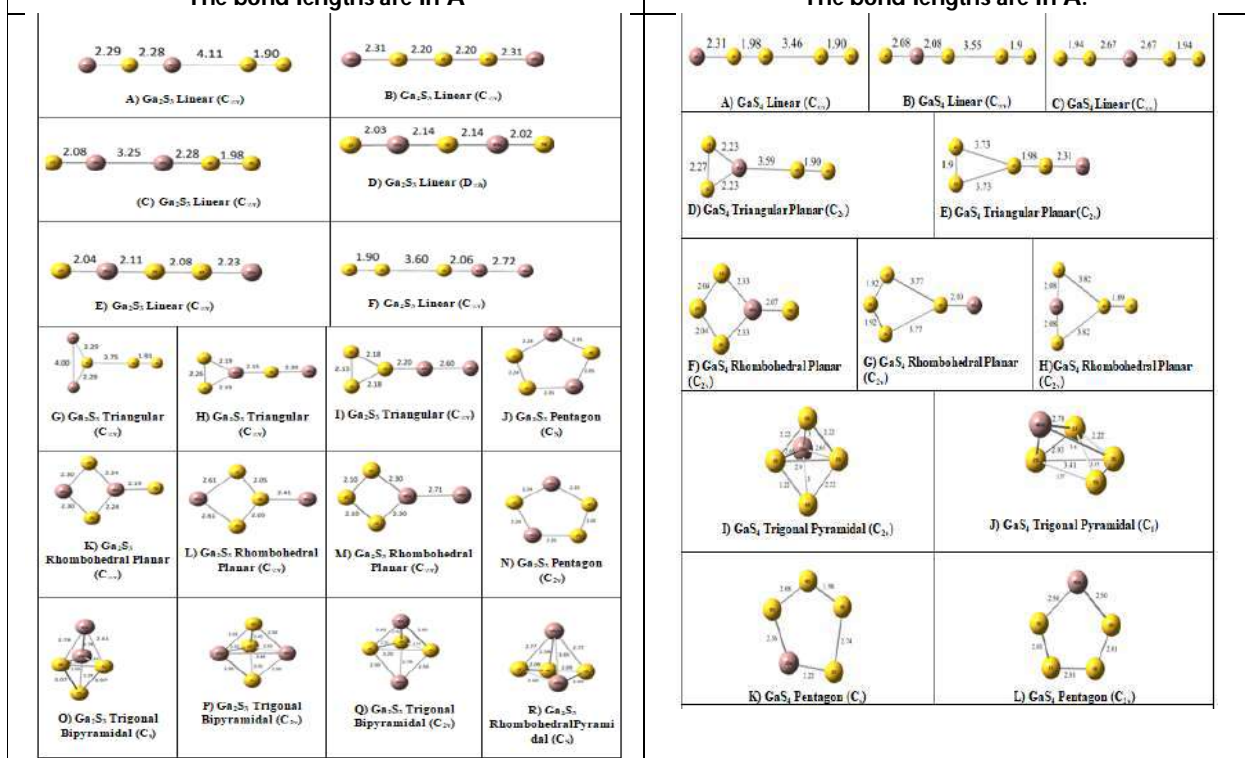


Fig.7. Optimized structures of Ga₂S₃ nanoclusters. The bond lengths are in Å.

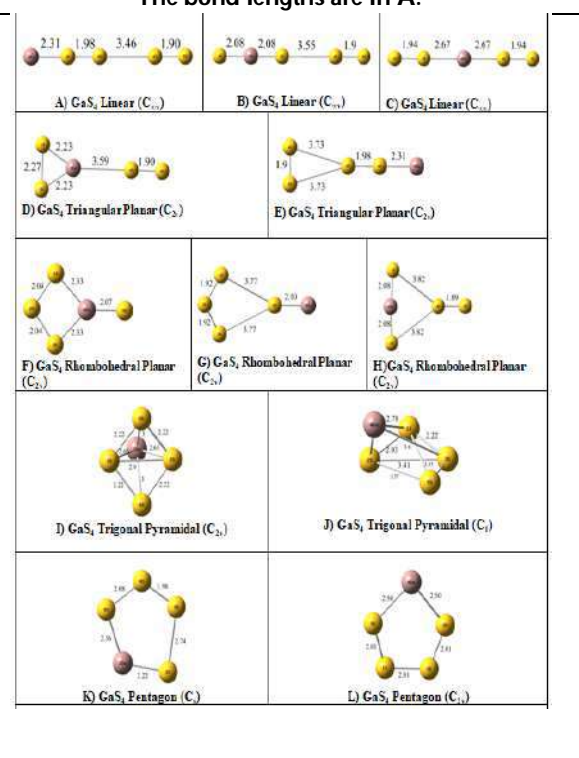


Fig.8. Optimized structures of GaS₄ nanocluster. The bond lengths are in Å.





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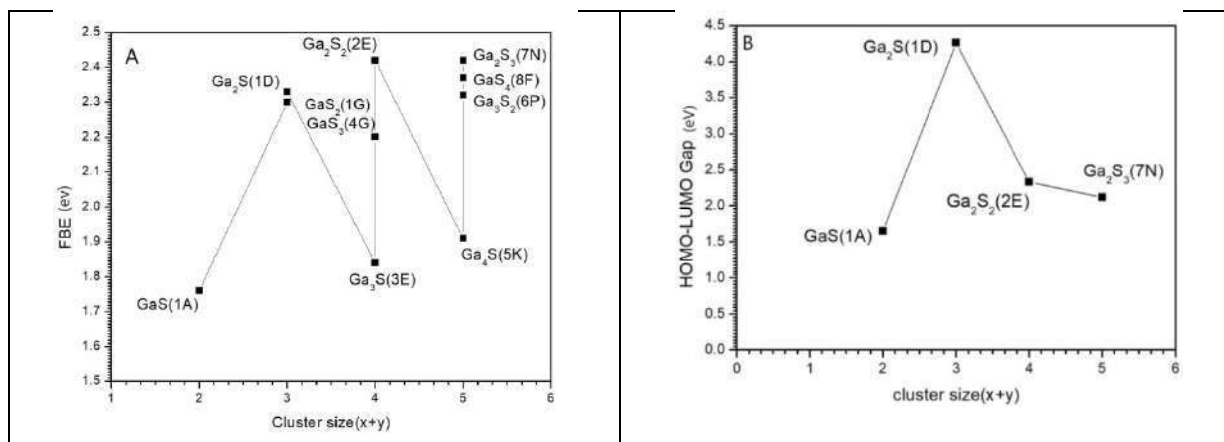


Fig.9: Variation of (A) Final Binding energy (FBE) and (B) HOMO-LUMO Gap with the cluster size

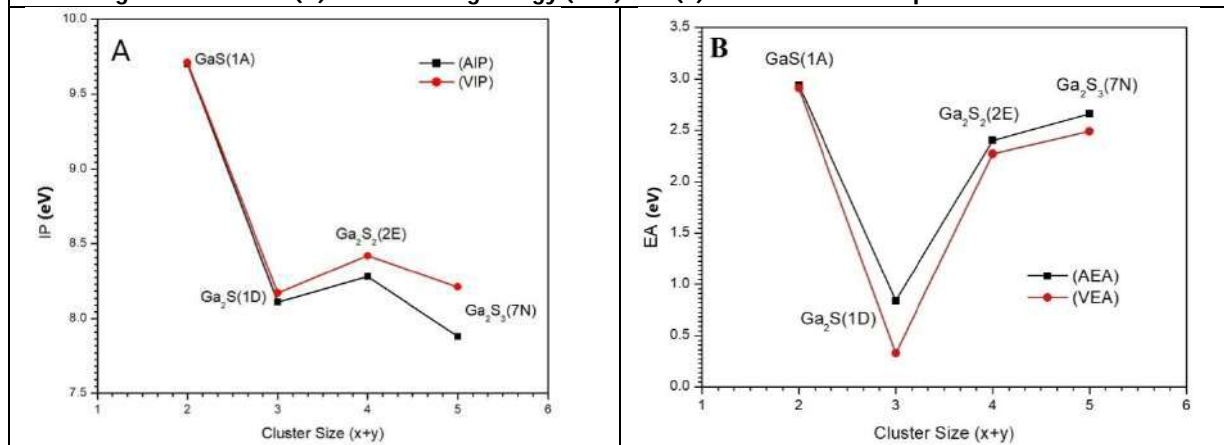
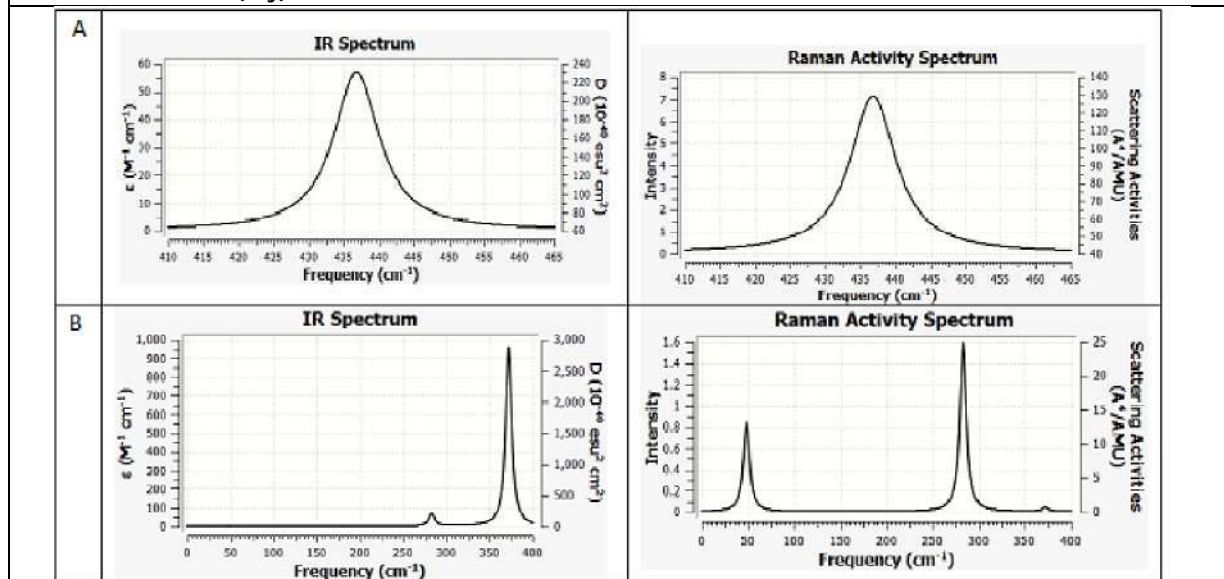


Fig.10 Variation of (A) adiabatic and vertical ionization potential and (B) adiabatic and vertical electron affinity with the cluster size(x+y).





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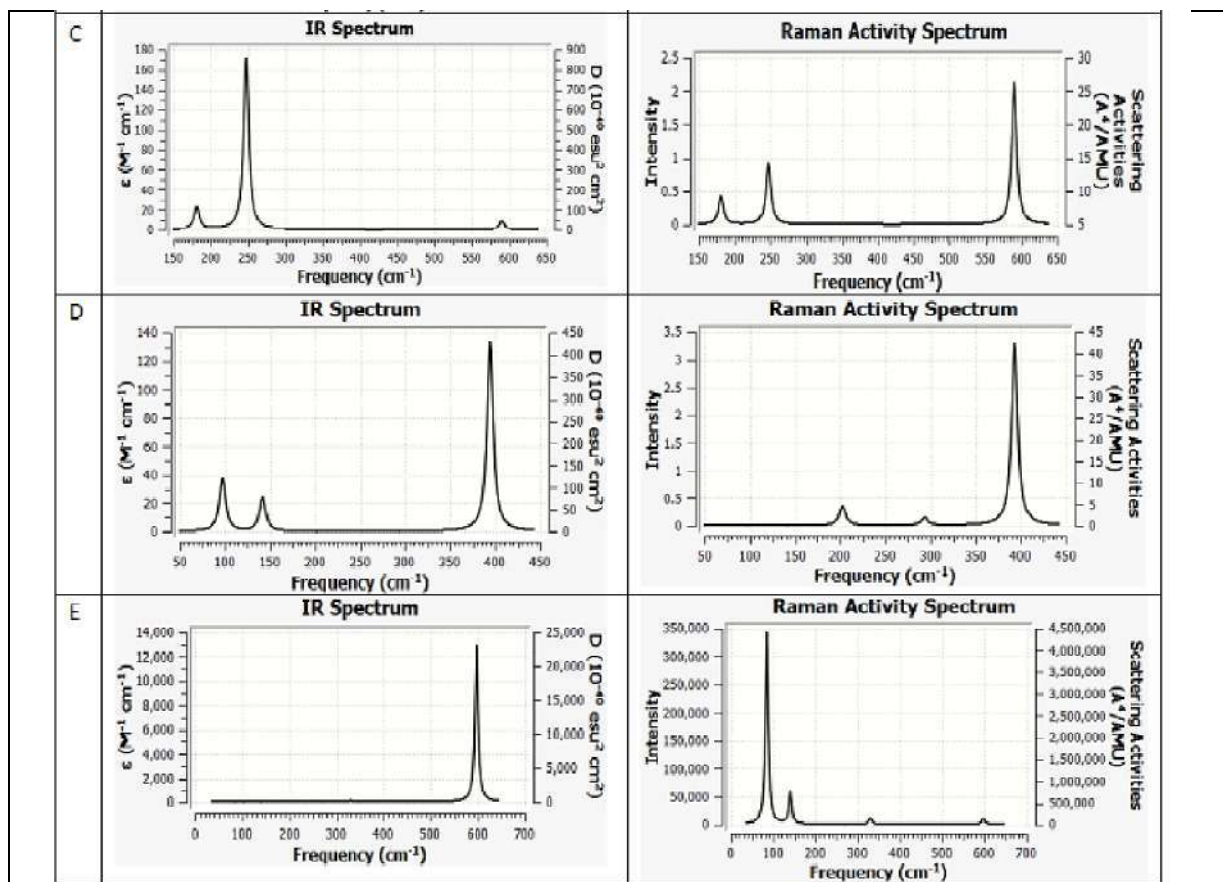
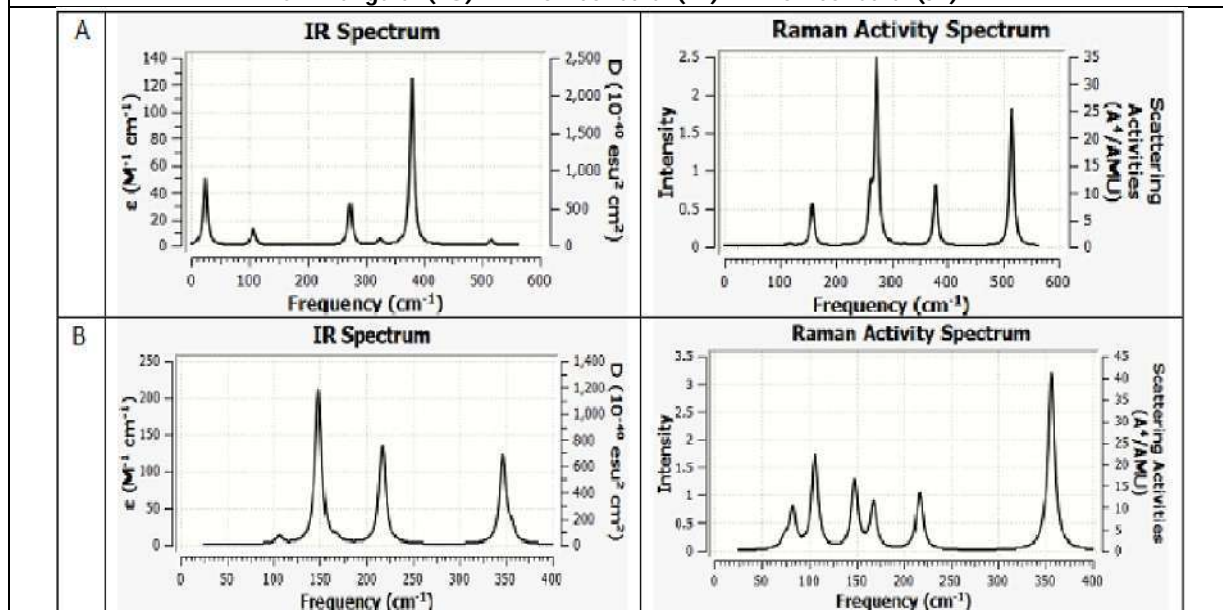


Fig.11: IR and Raman activity spectrum of most stable cluster up to four atom A. Linear (1A), B. Triangular (1D) C. Triangular (1G) D. Rhombohedral (2E) E. Rhombohedral (3E).





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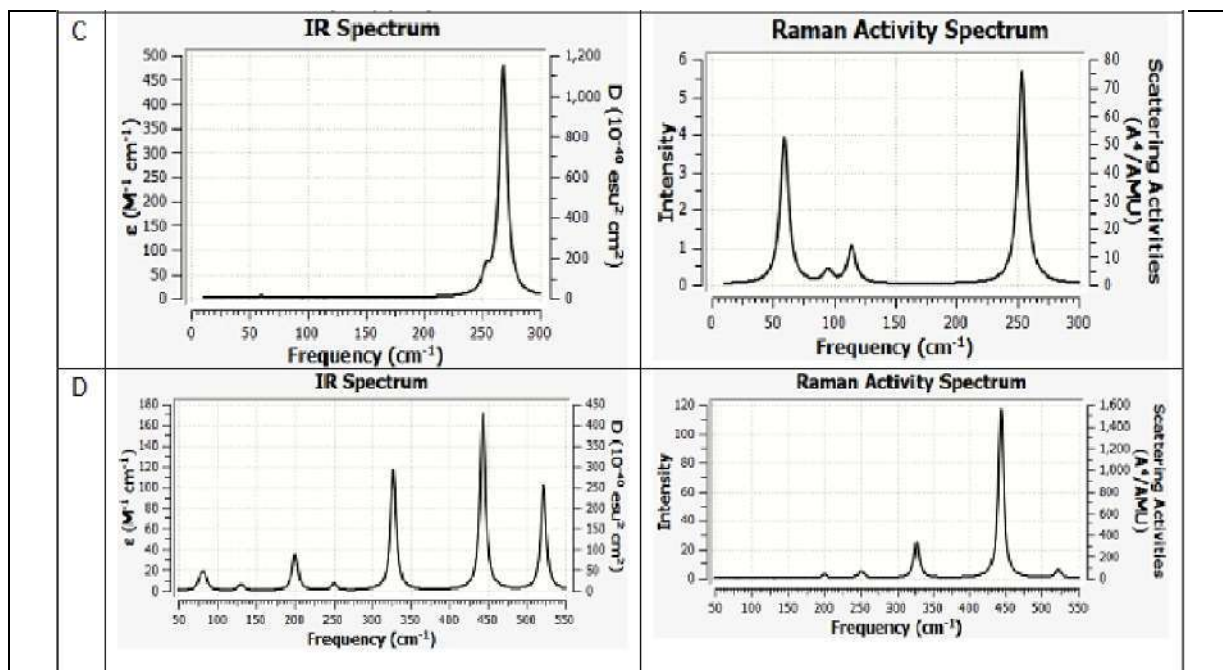


Fig.12: IR and Raman activity spectrum of five atom most stable A.Ga₂S₃ (7N) B.Ga₃S₂ (6P) C.Ga₄S (5K) D.GaS₄ (8F) nanoclusters.

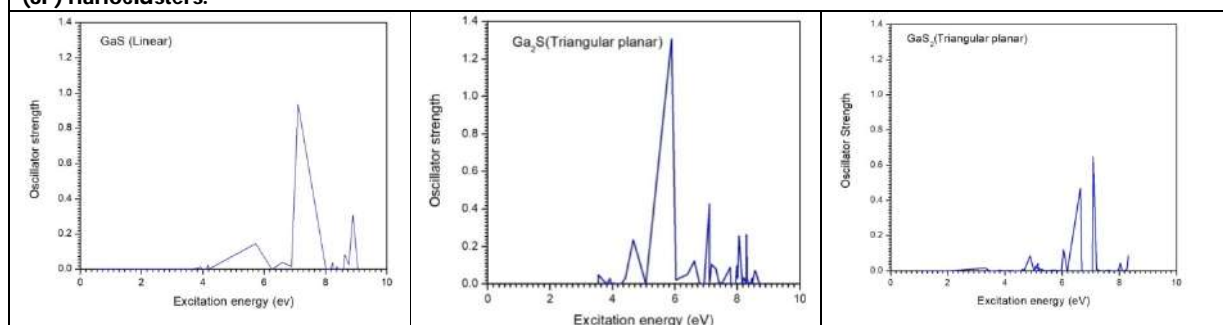


Fig.13 Absorption spectra of most stable structures of GaS(1A),Ga₂S(1D) and GaS₂(1G) nanoclusters.

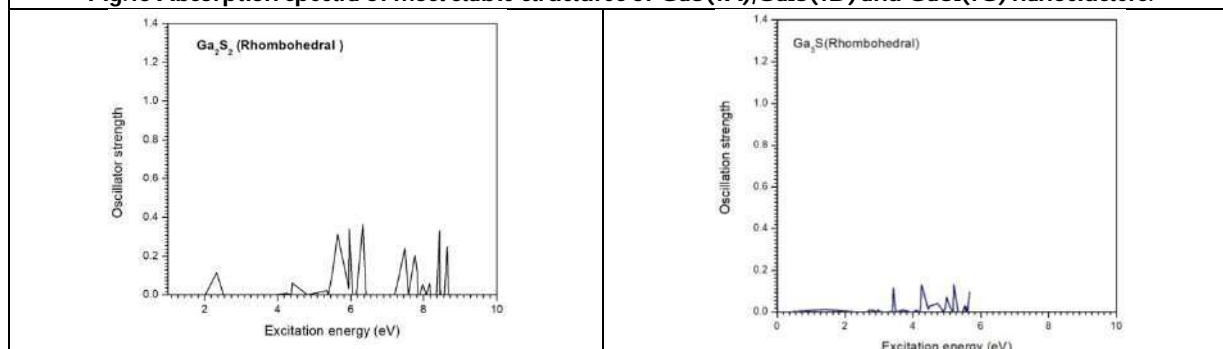


Fig.14 Absorption spectra of most stable structures of Ga₂S₂(2E) and Ga₃S(3E) nanoclusters.



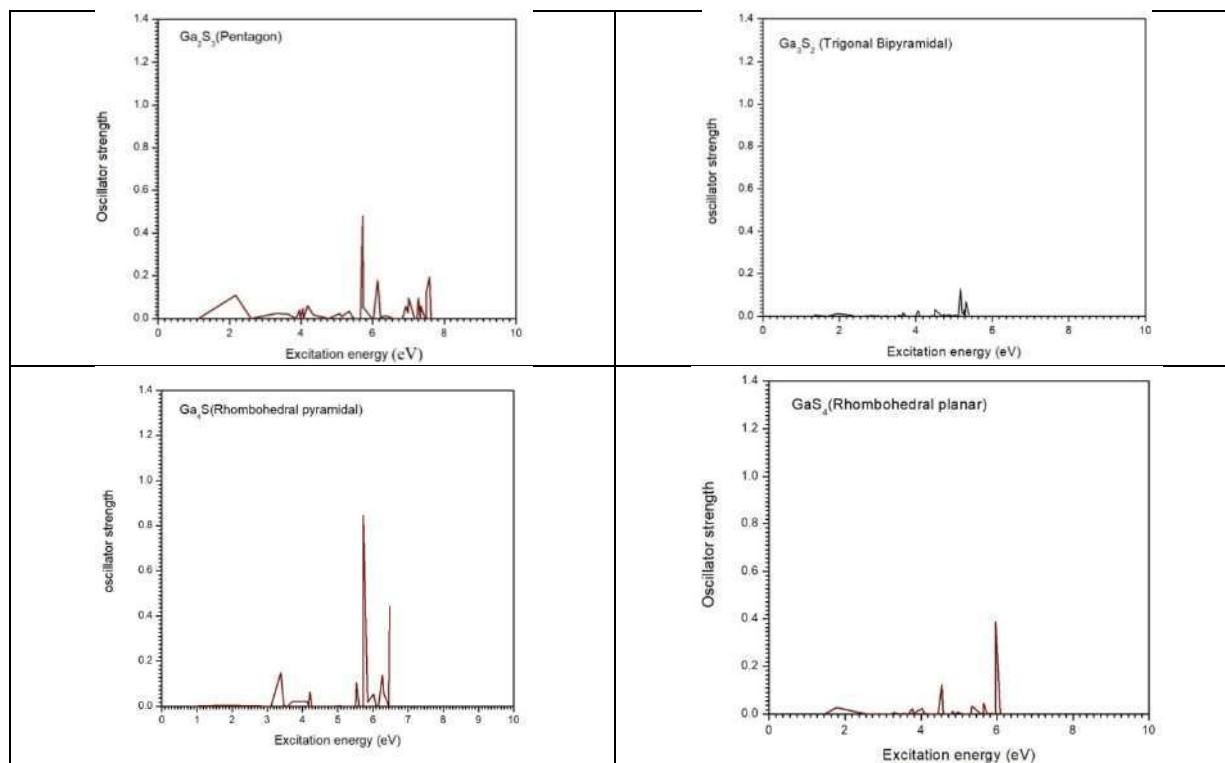


Fig.15 Absorption spectra for the most stable structures of Ga₂S₃(7N), Ga₃S₂(6P), Ga₄S(5K) and GaS₄(8F) nanoclusters





A Review on Transgender Law in India

Aishwarya.K^{1*} and Pranami Sharma²

¹Research Scholar, Department of Commerce, Christ (Deemed to be) University, Bengaluru, Karnataka, India.

²Assistant Professor, Department of Commerce, Christ (Deemed to be) University, Bengaluru, Karnataka, India

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*Address for Correspondence

Aishwarya.K

Research Scholar,
Department of Commerce,
Christ (Deemed to be) University,
Bengaluru, Karnataka, India



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ABSTRACT

Several individuals come to the understanding that the gender they were given at birth does not correspond to their gender identity or the gender they believe they really are. These people are frequently referred to as transgender. The Supreme Court issued a landmark decision in 2014, that paved the way for transgender rights to be upheld in India. The Supreme Court ruled that citizens have the right to self-identify their sexual orientation. It asserted that the fundamental rights enshrined in the Constitution apply equally to transgender people. Transgenders were granted legal status as the third gender in India. The Rights of Transgender Persons Bill, 2014 was a milestone move to protect the interest and rights of Transgenders. The Transgender Persons (Protection of Rights) Act, 2019 was implemented after making revisions to the Right of Transgender Persons Bill. The act has faced great deal of criticism visible through transgender community expressing concerns against several aspects of the act. The act has made it necessary to conduct a medical examination to be declared a transgender which is contradictory to the previous bill which mentioned self-identification. The objective of the study was to present the information regarding the act. It is essential to comprehend the features of the act to exemplify on areas that need to be focused. Also looked at aspects that are detrimental to protection and welfare of transgenders. The study is a systematic review of literature on the Transgender Persons (Protection of Rights) Act, 2019. The review process involved a step-by-step process of study identification, collection, screening, assessing and comprehending the various published and unpublished study available on the Transgender Persons Act, 2019. Through the process of systematic review an attempt is made to investigate the various aspects of the act. The findings denoted that a drastic literature gap exists. The studies have merely provided a generic outlook of the act. The attitude and impact of the act on the Transgender community should be rigorously researched on. More research



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and discussion leads to increased public understanding which is essential for fostering growth and improvement in any section of society. Many issues about the act's execution, timing, and the opportunities that are supposed to be produced remain unanswered. Gender determination might be challenging because of social and familial expectations. Despite the act being a major step in the right direction, transgender people's lives will not be improved by the law alone. Transgender people can make more progress if they are accepted by society. Unfortunately, transgender people are frequently subjected to discrimination and indifference from society, which can leave them feeling hopeless and deprived of chances. Education and training initiatives to alter common perceptions are crucial. It would help eliminate barriers in society and improve the efficacy of inclusion.

Keywords : Transgender, self-identification, legal status, rights, criticism

INTRODUCTION

Exclusion occurs at various levels of society. People are marginalised based on caste, culture, gender, social status, region, religious faith, and so on. Exclusion in society is to retain people away from resource base, opportunities, and rights. People are kept out of socio - political, cultural and economic activities. Exclusion of Transgender communities is observed in many countries including India. Transgenders have been the target of ridicule and disapproval. They are exposed to trauma and torture at the same time. Transgenders are subjected to appalling levels of discrimination, violence and oppression. Due to societal neglect, and unemployment, transgenders are more likely to experience poverty. (Felix, 2014) Majority of transgender who manage to free themselves from social confinement and find employment opportunities report workplace harassment, abuse, or discriminatory treatment. Reports of police harassing many transgender people are also found. Several transgenders commit suicide as a result of various layers of rejection from family, friends and society at large.

The biology of sex determination is usually based on chromosomes, anatomy, and hormones. However, the sexual identity of one person is not always the same as the biological sex as its more about the inner sense of being male, female or both. Transgender people claim that they have been identified as a sex which doesn't really match their gender identity. Being transgender means how you feel inside, transgenders self -identify their gender. It was only few years ago that the Government of India brought in laws that protect the interest of the Transgenders. (Saaviriti, 2020) Transgenders are equally talented and efficient like any other gender opportunity creation and societal acceptance has pushed them into the deep pits of discrimination, harassment, trauma and violence. In this study, the recent legislation introduced for the Transgender community is reviewed. The developments before the 2019 act are discussed first. The literature available on the act has been analysed using systematic review method. Further the important features of the act, the highlights and drawbacks of the act are discussed.

Over the years plethora of studies have been conducted on Transgenders, the history and discrimination faced by them. Transgenders are part of India's minority community. Transgenders are poorly acknowledged in Indian culture and lack cultural acceptance. They are frequently denied education, medical care, accommodation, and job opportunities. As a result, they have been forced to resort to petty metrics such as fraud, begging, and sex trade in order to survive. This has pushed the community members to experience physical violence, abuse and harassment. (Maithreyi, Siddharth, & Siva, 2016) Transgenders suffer from intense levels of anxiety and depression. It is detrimental to their quality of life. It's really the responsibility of society, in particular the government, to help ensure that transgenders are given a rightful place in society with acceptance and are recognized, regardless of the sex with which they want to identify. Irrespective of the sex, the society should ensure that every human being is acknowledged and valued, rules, regulations, and policies must be developed to make transgenders socially inclusive.



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The two genders officially given at birth are dependent on the physical characteristics of the child which denote as male or female. However, this does not confirm that the gender identity is matched. Transgenders consider a gender distinct from what was assigned to them at birth. The diagnosis of transgenderism is called as gender dysphoria, which is followed by several nations that consider transgenderism to be a mental disorder/illness. However, it affects the transgender's human rights to live a free life. UN has started taking measures to stop pathologizing transgenders by creating awareness programmes. (Peraza, et al., 2019).

Persons who are not gender conforming to the concept of society are often discriminated. A discussion over transgender access to toilets specifically designed for men or women has taken place over recent years. (Harisson & Michelson, 2017) The public's attitude to societal matters such as this depends mainly on two aspects, structuring and identity creation also known as identity priming. Priming of identity takes into account the concept of "us" v/s "them" of society. In a study, researchers selected a randomised survey strategy. The investigation was performed online. The study had two results. When questions were raised, in such a way that it promoted transgender bathroom access and health risk could be lowered to cisgender women and kids. The result was positive, it also implies, however, that respondents have supported transgender toilet access when the researchers positively formulated the questions. The researchers concluded that social opinions and public perception towards transgender people, their rights depend on the way the concerns were presented.(Kisha, 2017) A study was conducted to understand the attitude of people towards transgenders and the levels of negative attitude showed the extent of barriers that exists in people's minds regarding Transgenders.

(Ambast & Sheikh, 2016)The 2014 NALSA decision was one of the country's biggest steps in accepting transgenders into social system. The issue plaguing this community is the recognition of the self-identity and the names they choose. The law enforcement officials were directed to take initiatives to sensitise and prevent transgenders from being treated as untouchables among the public. The Transgender Rights bills was presented as a private member bill which was later modified by the Ministry of Social Justice and Empowerment. After few years the Transgenders Persons (Protection of Rights) Act, 2019 which has been formulated taking into account the (National Legal Services Authority v. Union of India, 2014) NALSA decision and the glitches in the previous bills. The research paper is classified under 3 sections – The second section explains the objectives and significance of the study. The third section elucidates the research Methodology and Discussions are carried out in the 4th section. The last section includes conclusion and scope for further research.

OBJECTIVES AND SIGNIFICANCE OF THE STUDY**Objectives**

1. To interpret the depth of studies conducted on Transgender Persons (Protection of Rights) Act, 2019
2. To review the features of the Transgender Persons (Protection of Rights) Act, 2019

Significance of the Study

People deserves to have equal access to live a healthy and respectable life. Transgenders are equally human like the other individuals. Their space in society is vulnerable and socially exclusive. Although they have existed from the time of evolution, they are discriminated, face abuse and harassment. It is essential to create awareness and normalize their existence. The age-old stigmas against the transgender community need to be deciphered. Studies have been conducted on the marginalised conditions of transgenders. The present general public is broadening their way of thinking and is accepting the fact that gender is not only classified into two categories. They have realized that just like others in society even the transgender community has the right to be treated with dignity. The landmark judgement in the recent decade has brought forth law for the protection and progress of the transgender community. The existence and benefits of the law need to be communicated to the transgender community. This will be possible only if the segments of the law are studied, analysed and discussed to comprehend its strength and weakness. The study attempts to gain better understanding of the act and analyse the literature available on the same.



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METHODOLOGY

The methodology incorporated is a review study. The review methodology is systematic in nature. Secondary data sources available in journals, government reports and authentic electronic content from various websites have been used. The articles were identified, screened, analysed and interpreted.

Inclusion/Exclusion Strategy – Research articles consisting of the keywords Transgender Persons (Protection of Rights) Act, 2019 published by authentic Journals from 2019 onwards were inclusive of the study. It also included grey literature like thesis, working paper, dissertation/thesis, conference proceedings and abstracts. Studies on the previous legislations that is the 2014 bill which were published before 2019 were excluded.

Search Strategy – The systematic review was conducted using the following databases – Google Scholar, Microsoft Academia, CORE, Taylor and Francis, Elsevier, Research Gate, SSRN and INFLIBNET. A google search was also done to find literature

RESULTS AND DISCUSSION

The concept of transgenders in India is as old as time. Transgender individuals have existed in the society since the existence of human civilization and there is evidence to support it in Ramayana, Mahabharata and Mughal period records. (Michelraj, 2015) Lord Rama in Ramayana had bestowed the privilege on the Transgenders. It was discovered that when Lord Ram returned from his exile, the male and female citizens of the kingdom were asked to remain within the Ayodhya city. The transgenders, who did not belong to either gender, waited for Lord Ram outside the city. Because of their devotion and loyalty, Lord Ram bestowed upon the Transgenders the ability to bestow blessings and good fortune on people during special occasions such as inaugural functions, marriages and childbirth. In Mahabharata, it was discovered that Aravan, Arjuna's son, had to be sacrificed to Goddess Kali in order for the Pandavas to win the battle of Kurukshetra. Although there was one condition: Aravan had to marry on his last night of existence. But there was no woman for Aravan to marry, Lord Krishna disguises himself as a woman named Mohini and marries Aravan. The Transgenders of Tamil Nadu refer to themselves as Aravanis because they believe they are the descendants of Aravan. Hijras were considered to be loyal, clever, and trustworthy during the Mughal period as political advisors and administrators.

Few years ago they've gained a name and a social standing. Transgender people are part of the LGBT community. They are quite a marginalised section in the Indian society, and as such, they face major legal, sociocultural, and economic challenges. Transgenders were declared as the third gender in India with the right to self-identify their respective sexual orientation in the year 2014. The 2014 bill was popularly welcomed as it was the very first supportive legal machinery in the country to protect and promote the interest of the transgender community.

Definition of transgender

"Transgender (sometimes shortened to "trans") is an umbrella term used to describe a wide range of identities whose appearance and characteristics are perceived as gender atypical—including transsexual people, cross-dressers (sometimes referred to as "transvestites"), and people who identify as third gender. Transwomen identify as women but were classified as males when they were born, transmen identify as men but were classified female when they were born, while other trans people don't identify with the gender-binary at all. Some transgender people seek surgery or take hormones to bring their body into alignment with their gender identity; others do not." (United Nations)

The Rights of Transgender Persons Bill - 2014

Transgender people's rights Bill 2014 was Tiruchi Shiva's private member bill. The bill demanded equal rights and set transgender reservations. It also proposed the establishment of a commission of state and national level to protect

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the transgender community. The bill discussed discrimination, refurbishment and recreation facilities for Transgenders. The rights of transgender individuals were discussed. It included empowerment programmes for the development of skills, the creation of jobs and measures for social welfare of Transgenders. Although the act was a welcome move that the trans community appreciated, lawmakers rebuked it for technical defects. A bill was published on transgender "protection," consisting of weakened provisions of the private member bill. The government that is the Ministry of Social Justice and Empowerment had changed the proposed bill that Shiva had introduced. The new bill was barely recognisable as the private member's proposal and showed an inability to understand the community and its issues. The bill was not accepted as it lacked sensitivity which the private member's bill contained. An updated version of the bill was therefore drafted and the government amendments were made and the bill and a standing committee report were scheduled to be presented in 2018. Due to the general elections being held, the Ministry of Social Justice and Empowerment reintroduced the bill in 2019.

In November 2019, the bill was passed. (Kiran, 2020) The proposed law claimed to safeguard transgender rights, however most trans activists claim it does the complete reverse. Trans activists say it's a major setback to India's already marginalised transgender community and overshadows a major breakthrough made in recent years. The Transgender Persons (Protection of Rights) Act, 2019 was an essential legislature. The 2018 bill and 2019 act faced many protests by the transgenders. The current study attempts to understand the literature availability on the act. It attempts to identify the strengths and weakness of the act. Rigorous studies on the law will assist in gaining better comprehension and thereby make progressive laws that are trans-friendly.

In view of the objectives of the study, the search for articles on the Transgender Persons Act (Protection of Rights) 2019 commenced to conduct a systematic review. There were plenty of news articles on the event. 16300 results were found in the news category with a Google search. Each of these items reported on the schedule and the procedure by which the bill was transformed into an act. Several news articles have noted the comparison between the government bill and the 2014 bill presented by Tiruchi Shiva whose efforts in 2014 is observed as pioneering action for the act in 2019 .

While many news articles were available on the electronic databases, research studies on the topic considering the inclusion and exclusion strategy were only a handful. With every database, the number of articles that were identified and relevant were less than 3. Number of studies that met the inclusion and exclusion criteria that were identified, screened for duplicates, extracted and interpreted were 12. The studies had merely highlighted the 2019 act. Three studies were found in the year 2021. Eight studies were found in the year 2020. One study was found in the year 2019.

Five out of the twelve articles have commented on drawbacks of the act. Only two out of the twelve studies have attempted to describe the act in detail. The studies were also found to be descriptive in nature. One study had compared the Indian laws with the Pakistan laws which was introduced in the year 2018. The number of studies makes it evident that studies on the act have not been conducted rigorously. The studies only touch upon the tip of the iceberg leaving out on essential areas that need to be addressed.

The studies included case studies that presented the struggle of Transgenders in day to day lives. A common aspect found in the studies is the highlight of the history of the Transgenders from the age-old tales to the recent 2019 act has been described. The articles have emphasised how the transgenders blessings were considered auspicious according to the Hindu culture and in contrast to recent times where Transgenders are insulted, discriminated and abused. Lack of societal inclusion and delayed efforts from the government for the upliftment of the Transgenders is said to be the reason for the marginalization of the Transgenders. A major portion of the studies address the past and briefly state the chapters of the act. The studies exclusive on the impact, effects or implementation of the act have not been conducted. The articles failed to address the stigma and societal exclusion faced by transgenders, also do not question the lack of effort to break the stigma. Substantial gaps were found in literature after the introduction of the



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act in 2019. Statistical analysis of the data was not found in any of the studies. The articles that met the inclusion and exclusion criteria are listed below –

Important Features of the Transgender Persons (Protection of Rights) Act, 2019

The act was introduced on July 19, 2019 in the Lok Sabha by Mr. Thaawarchand Gehlot the Minister of Social Justice and Empowerment. The act was constructed considering the drawbacks of the 2016 and 2018 bill according to the ministry.

• Definition Of Transgender Person

A transgender person is one whose gender at birth does not correspond to their identified gender. Transgender people, people experiencing intersex transitions, gender nonconforming people, and those who identify as kinar or hijra are all protected under the law. A person with an intersexual variation is one whose primary sexual features, external genitalia, or chromosomes deviate from the usual for either the male or female body at birth.

• Discrimination prohibition

An individual or establishment should not discriminate transgenders in the form of denying service or any form of unfair treatment in –

- a. Education
- b. Employment Opportunities
- c. Healthcare facilities availability and access
- d. Enjoy access to the, goods and services, facilities or opportunities available to public
- e. Right to movement
- f. Right to reside, rent or occupy property
- g. Right to hold private or public office
- h. Access to establishment providing custody for transgenders, both private and government owned

• Certificate Of Identity

- a. A transgender person can request a Certificate of Identity from the District Magistrate by submitting a written request, along with the necessary paperwork, in whichever format the applicant sees fit. A request on behalf of a juvenile must come from the child's legal guardian or parent.
- b. If a transgender person has surgery to transition from male to female, he or she must submit an application and a certificate from the hospital's Medical Superintendent or Chief Medical Officer. Both the application and the first granted certificate are sent to the District Magistrate so that they may be updated.
- c. Once the District Magistrate has received the request and is satisfied with the certificate granted by the Medical Superintendent or Chief Medical Officer, he or she can issue a certificate indicating the change to the gender.
- d. The person to whom the amended certificate will be provided shall have the right to change the first name and any official document relating to that person's identity to conform with the gender issued in the amended certificate.

• Welfare Measures

The Government shall take steps towards ensuring the full incorporation and participation of transgender people into society, protecting transgender rights and interests, facilitating their access to framed social welfare schemes, safeguarding, and providing transgender rehabilitation centres; Supporting and promoting training and autonomy methods; Development of schemes for their involvement in cultural activities.

• Right To Residence

- a. Transgenders have the right to reside in any property with their family or immediate family members, no exclusion shall be followed. Transgenders have equal rights to access all amenities without any discrimination
- b. A child cannot be separated from the parents or close family because the child is transgender, unless the court issues an order to protect the interest of the child
- c. If the parents or absence of guardian to cater and take care of the transgender person is absent, they are placed in a rehabilitation centre

• No Discrimination At Workplace

- a. No discrimination to be exercised against transgenders at public and private workplaces.



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b. A compliance officer has to be assigned to make reporting of discrimination and complaint handling effective.

• Health Care

Sex reassignment surgery facilities and information shall be provided by the government. Surveillance centres for Transgender HIV patients should be set up. The medical curriculum for transgenders will be revised and health insurance schemes will be formulated for the transgenders.

• Education

Educational institutions should have inclusive system to accommodate transgenders. Non-discriminatory access to all facilities in the educational institute should be followed. Providing scholarships to transgender and intersex students.

• National Council For Transgender Persons (NCTP)

The council will provide guidance and advice regarding transgender related policies and all matters affecting the transgender persons. It was set up in 2020. It constitutes four representatives from the Transgender community also one representative from the intersex community. NCTP is led by the Ministry of Social Justice and Empowerment.

• Functions of NCTP

Advise the Central government on the drafting transgender related policies, programmes, laws and projects; review and manage policies and programmes that are formulated to ensure equality and full involvement for transgender individuals; evaluate and control the activities of all the Government departments and Non-Governmental Organizations concerned. Build redressal mechanism to handle transgender persons' complaints and all other functions as the Central Government has assigned and prescribed with respect to transgenders.

• Offences And Penalties

The following offences and penalties are applicable pertaining to transgender individuals: Persuading transgender persons into labour which is forced or bonded (excluding forced public service), denial of accessing and using public utilities or spaces, withdrawal from the household and from the town on the ground of being transgender. Misuse of any nature, sexual, oral, emotional or economic is also an offence. Penalties vary from six months to two years along with a fine for these crimes.

Highlights of the Transgender Persons (Protection of Rights) Act, 2019

- The act was first move by the government to recognize the existence and address the issues faced by transgender community
- The right to self-identify as a transgender that is self-perceived gender with a certification of identity
- The act prohibits all forms of discrimination in education, healthcare and workplace
- Formulation of welfare schemes and vocational training programmes to make transgenders employable
- Setting up of a National Council to assist in policy formulation with transgender representation
- Free sex reassignment surgery in at least one government hospital in every state
- The act is an attempt to make Transgenders socially inclusive by stating inclusion in education, employment and holding office
- The medical curriculum will be reviewed and research on health issues that are generic to transgenders will be conducted
- An insurance scheme will be launched which would cover the expenses of the sex reassignment surgery, therapy and other related medical expenses.

Drawbacks of the Transgender Persons (Protection of Rights) Act, 2019

- The definition of a transgender is inclusive of intersex person. Both are different, transgender is about gender identity and intersex is about gender diversity.



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- Discrimination has not been specifically defined and the act lacks clarity regarding the punishment for discrimination
- Self-identification of gender is diluted as the certificate of identification is issued after the approval of District magistrate and a medical examiners report
- The procedure in case of denial of certificate of identification is not addressed. Whether the individual can reapply is also not mentioned
- The reservation in employment and education is not specifically discussed as the quotas include other backward categories as well
- The punishment for sexual abuse, assault or harassment of a transgender is two years which is much lesser than the punishment for a similar crime against male or female.
- The timeline for the launch and implementation of the welfare policies suggested are missing
- Lack of awareness programmes and information centres to assist transgenders
- Accountability and tracking mechanisms for intake of transgender in schools, colleges and jobs is missing
- The bill forbids begging, while some transgenders receive money in exchange for blessings, considering the act illegal will affect some of their livelihood.

While the act is a highly commendable move to protect the interest of the Transgender community it has been formulated without a deep analysis of the societal attitude towards transgenders.

RECOMMENDATIONS

The following recommendations are made in view of extensive understanding of the published literature:

- Transgenders are vulnerable to sexual abuse, harassment and violence, stringent policies to prevent sexual harassment and abuse should be introduced
- Certification of identity issuance scope should be broadened. It should not be based merely on clinical examination, as transgenders who have not undergone sex reassignment surgery also identify themselves as transgenders based on their feelings.
- Distinction in the definition of transgender and intersex individuals should be introduced
- Discrimination should be defined along with various forms of discrimination and the punishment for discriminating transgenders should also be formulated to curb discrimination.
- Rehabilitation centres functionalities need to be defined to understand the assistance it can offer transgenders
- Counselling services to families that abandon or are problematic towards transgender children and adults
- Reservation to transgenders can be provided on similar lines to physically challenged until transgender's become inclusive of the system.
- Social inclusion of Transgenders will not take place with legalisation, the stigma that exists in people's minds regarding the Transgenders needs to be eliminated through nationwide awareness campaigns
- Educational Institutions should inculcate social inclusion lessons in their curriculums to help break the generations of stigma revolving around Transgenders

CONCLUSION

The studies suggest that there is a literature gap in understanding the Transgender community's protection requirements. The government should encourage more studies to be conducted on policy formulation and development mechanisms to help the transgender community to make progress. Transgenders are equally talented and capable of achieving great marvels in life like the other genders. The lack of opportunities and societal stigma is the primary cause for their marginalization. Kalki Subramaniam a Transwoman was invited to talk at the Harvard Business School in 2017. Trinetra Haldar Gummaraju is a 24-year-old Trans woman who is a medical student in Karnataka. Trinetra has documented the journey of becoming a transwoman on social media, spreads awareness and breaks down on myths regarding transgenders. Laxmi Narayan Tripathi is a Bombay based transwoman who is a Bharatanatyam dancer and activist. Satyashri Sharmila is the first registered Transgender Lawyer based in Tamil Nadu. Manabí Bandyopadhyay is the first Transgender College Principal in India. Shabnam Bano was the first Transgender MLA. Transgender have strived to be part of the social system, while the support and resources play a



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major role in their achievements, it is also self-confidence and motivation that has helped them reach great heights. Campaigns and awareness programs can instill confidence and motivation in those transgenders who are struggling to survive in a society that is constantly belittling them through abuse and violence. While laws are essential for the progress and development of Transgenders, making the social system accommodative for Transgenders is necessary. The upcoming census has included the Third gender. Households that are headed by the Transgenders will also be recorded this is a positive initiative that highlights the existence and inclusiveness of Transgenders in the society. Many such initiatives should be started to curb excluding Transgenders. As humans, respecting differences and acknowledging the differences will result in the progress of humanity. Building an environment where every individual has equal access to live a happy life will be possible with awareness and acceptance. Awareness will bring a change and only that will make the society a better place for the transgenders to exist in. Change in the attitude of people will be a new dawn for the Transgenders community.

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Table 1 – Articles review related to Transgender Persons (Protection of Rights) Act, 2019

Author	Methodology	Description
Bhattacharya, S., Ghosh, D., & Purkayastha, B. (2022).	Descriptive	Article is a qualitative study, 15 transgender experience, challenges in claiming their rights in purview of the 2019 Act
Hitabhilash Mohanty, Susampad Hota (2021)	Descriptive	The article provides a timeline of the transgender's rights over the years. It highlights the legislations for transgenders in India, the 2019 act in particular.
Sayan Bhattacharya(2021)	Descriptive	The article provides summary of studies conducted on the lives of Transgenders and elaborates on the aid the act may offer in brief
Aastha Khanna, Divesh Sawhney (2021)	Commentary	The article is a critical commentary on the loopholes in the Transgender Persons Act 2019.
Fauzi Iqbal Hibatulloh, Gayatri Widya Indryani, Misa'al Rizqulloh Al Qodir, Asal Wahyuni Erlin Mulyadi (2020)	Descriptive	The article provides a description of the discrimination faced by the transgender and the legal mechanisms available to curb the discrimination
Dr Sangeetha Sriraam (2020)	Descriptive	The article covers the history of transgenders in India with reference to the evolution of laws by appraising the transgenders act.
Sejalsri Mukkavilli (2020)	Commentary	The author provides a commentary on the sex characterization segment of the Transgender act 2019.
Abhishek Raj (2020)	Descriptive	The author provides a timeline of the journey of transgenders over the years and highlights the features of the Transgenders act.





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Upasana Ghosh, Poulomi Ghosh (2020)	Descriptive	The study is an attempt to assess the Indian legal system's efficiency in safeguarding the interests of the Transgenders.
Pinki, Poonam Malik, Krishna Duhan and N Pavithra (2020)	Descriptive	The study provides a description of the status of Transgenders in India by highlighting the forms of discrimination faced and the legal resort available.
Ankana Bal (2020)	Descriptive	The study addresses the major pitfalls in the Transgender Persons (Protection of Rights) Act, 2019
Muhammad Abdullah Fazi, Maryam Bibi (2020)	Analytical	The study is a comparative analysis of the Transgender laws in Pakistan and India
Gautam Kumar, Vivek Kumar, Rajib Prasad, Prabir Kumar Deb (2019)	Case report	The article provides three case reports of Transgenders going through examination to prove identity as Transgenders in accordance with the laws.

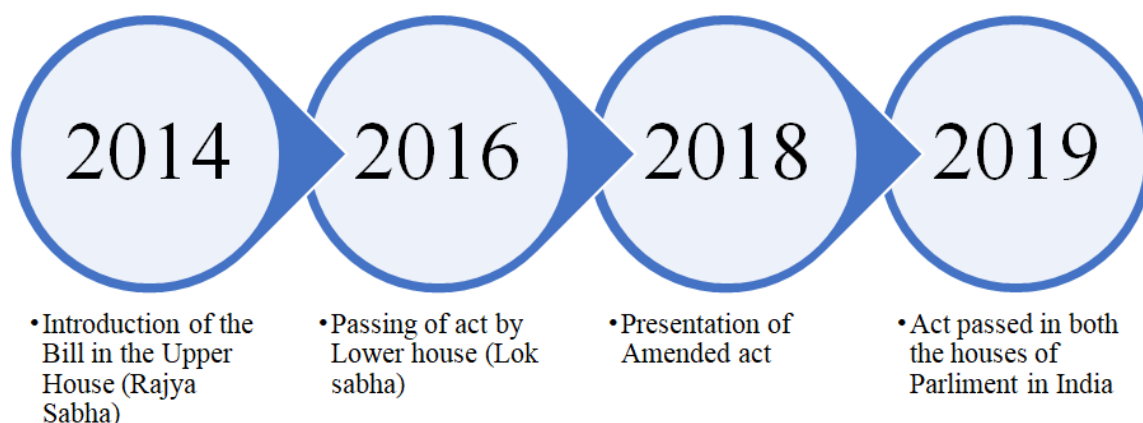


Figure 1 – Timeline of Transgender Persons (Protection of Rights) Act, 2019





Dual Axis Solar PV Panel Tracking System with MPPT Solar Charge Controller based on IoT

J.Samuel^{1*} and B. Rajagopal²

¹Research Scholar, Electrical and Electronics Engineering, Annamalai University, Chidambaram, Tamil Nadu, India.

²Associate Professor, Electrical and Electronics Engineering, Annamalai University, Chidambaram, Tamil Nadu, India.

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*Address for Correspondence

J.Samuel

Research Scholar,
Electrical and Electronics Engineering,
Annamalai University, Chidambaram,
Tamil Nadu, India.



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ABSTRACT

This Paper aims to create a PV model with IoT technologies to track solar power. This Proposed system combines dual axis with maximum power point tracking (MPPT). The converters equipped with maximum power point tracking (MPPT) technique is based on an algorithm which keeps on detecting the maximum instantaneous power of the PV array. Since the operating point of the array vary intermittently, so the MPPT algorithm is required to set the operating point so as to extract and deliver maximum instantaneous power to the load. It's increasing the PV panel Output voltage and current with the help of MPPT and dual axis tracking system. A IoT system needs to be designed, with powerful program, and be able to communicate in both directions. So, that paper suggest a dual axis tracking system based on the Internet of Things (IoT) that uses Wi-Fi to talk back and forth with the user to make them more comfortable. The user can monitor and track the connected load and check the status of the connected devices through a mobile app or web address.

Keywords: tracking, IoT, solar, system, paper, algorithm.

INTRODUCTION

Energy is very important to people, and more and more of it comes from finite, non-renewable sources. Solar power is used a lot these days all over the world. Since people are becoming more aware of the need to use less energy and the benefits of renewable sources, the solar photovoltaic market has grown quickly. To ensure enough power from the PV Modules, the Solar tracker must be carefully monitored and built. The traditional technique of monitoring



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involves careful personnel maintenance for continual monitoring. The data is collected straight from the device. Typically, solar power systems are built in isolated locations. The environmental factor might affect the performance of PV electricity. Solar tracking may be performed in a variety of ways. Wireless communication is one of the main techniques for gathering data on it. Moreover, wireless transmission enables remote monitoring and control of a solar energy system without the presence of workers at the installation site. Previous research has shown that wireless sensor networks may be used to monitor systems. However, there are several disadvantages to employing a wireless sensor network to transmit data. In the case of a wireless sensor network, more energy is used. Furthermore, there is a greater chance of threatening access and attacks. These disadvantages make it less trustworthy for data transfer. Many communication mechanisms, such as the Ethernet network and the Zigbee wireless network, may be utilized for monitoring.

Ethernet employs a network wire for data transmission. Consequently, there exist disparities as a result of the altering geographical context. In comparison to other modules, the Zigbee wireless network is expensive. Also, Zigbee is harder to create and more complex. Likewise, the signal's range is restricted. So, a monitoring system using an ESP8266 Wi-Fi module is used to address these issues. The Wi-Fi network has low mistakes, cheap expenses, and extensive signal reach. Wi-Fi Module enables users to interact and undertake monitoring at any time and location easily. Therefore, data transfer is more secure. In this project, a microcontroller and Wi-Fi module is used to construct a dependable and stable system for monitoring the operation of solar modules. Attention instructions are used to control the Wi-Fi module's functioning. Arduino is linked to the internet through a Wi-Fi module, and sensor data is shown on both an HTML website and an IoTapp. For this project, just a few commands are required.

LITERATURE SURVEY

- 1) The authors have implemented the MQTT technique utilizing stepper motors to do sun tracking. on the other hand, may also be thought of as solar tracker that can communicate both ways with the user and other system participants. The paper investigated the prospect of facilitating user- communication using the Internet of Things.[5]
- 2) The focus of this project is on bolstering the stability of the grid in the face of a surge in demand for electricity, particularly at the critical load level. In contrast, the PV cells and battery combo make up the bulk of the energy supply in that project. Because weather conditions fluctuate throughout the day, the amount of energy produced by PV cells likewise varies. The authors here have a system in place to regulate and track power production, ensuring a consistent supply of electricity to loads regardless of weather or other environmental factors. The microcontroller, assisted by the Internet of Things, has managed the input source connection to the load.[6]
- 3) In general, remote monitoring systems must use cutting-edge science and technology in the fields of communication technology and elsewhere to successfully collect, analyses, transmit, manage, and feedback information from far away. It also uses a lot of instruments, electronics, and computer programmers. Normal ways to monitor PV systems have problems, like not being able to be automated and not giving enough updates in real time. A good system for monitoring and controlling information about remote environments could help stop these problems. As part of this system, the PV station should have automated ways to figure out what's wrong.[7]
- 4) Preventive maintenance is very important for a PV system. This means finding the source of problems and figuring out what makes them happen. More attention is paid to the most well-known ones. Zigbee-based remote management and monitoring of PV systems has been shown to be inefficient on a large scale because it can't handle very long distances.[8]
- 5) Wi-Fi technology is also employed for household PV remote monitoring and control. In comparison to ZigBee, Wi-Fi (IEEE 802.11g) is preferred due to its high data rate of about 54Mbps and its operation at 2.4GHz (250Kbps). However, the network design of a micro grid works well with this method. Several PV monitoring systems are already active today. Data transfer in these systems is often handled using public wireless networks like GSM or other forms of wireless communication. However, the process of effective generation monitoring in real time is hampered by issues related to high operation and maintenance cost, which constrain the growth of



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monitoring system. The research explores an innovative IoT-based remote monitoring and control of a PV system.[9]

- 6) In order to remotely monitor a solar photovoltaic plant for performance assessment, a novel cost-effective approach based on IoT was deployed. This will make it easier to monitor the plant in real time, as well as do maintenance and repairs ahead of time, and analyses data from the past to learn from plant performance.[10]

From the literature survey, it is observed that IoT based smart monitoring system were redesigned various controllers such as Arduino uno, etc. and without considering Wi-Fi. Those controllers may not be power efficient as well as those works were not implemented effectively. Hence in the proposed work, monitoring and tracking system is going to be designed with Wi-Fi module such as NodeMCU (Wi-Fi module), it is cheap, easily programmed to send and receive the data. The following section will elaborate the architecture of the proposed system.

PROPOSED METHOD

The proposed work design and implementation can be divided into two sections.

- I) Monitoring system
- II) Tracking System

The solar photovoltaic monitor system collects data from various sensors like the voltage, current, temperature, humidity, and irradiance then send it to the next step via wired or wireless communication. The data are briefly kept in auxiliary devices such as data loggers, analyzed, and then delivered to the final stage. At the last level, data is received by the workstation, and the system then takes the necessary measures to configure the system appropriately. These data are accessible via the internet from any location at any time. The solar photovoltaic Tracking system effectively tracks the position of the sun and generates more electricity than its counterparts due to the increased direct exposure to sunlight. This design consists of a model that focuses on the use of a solar panel that would follow the movement of the sun, i.e., azimuthal altitude, automatically adjusting itself each time without human intervention.

Phase I

The First Phase is equipped with a NodeMCU for rapid Internet access. The NodeMCU operates on ESP8266 firmware and is linked to the Server. The NodeMCU is further linked to a voltage and current sensor, a dht11 (temperature and humidity sensor) and MPPT charge controller for monitoring the solar panel. The MPPT controller is more sophisticated and more expensive. It has several advantages over the earlier charge controller. It is 30 to 40 % more efficient at low temperatures. But making an MPPT charge controller is little bit complex in comparison to the PWM charge controller. The NodeMCU tries to maximize the input from the solar panel by controlling the duty cycle to keep the solar panel operating at its Maximum Power Point (MPP). Wi-Fi data can be transfer to the remote location via NodeMCU. It is equipped with various protections to protect the circuitry from abnormal conditions. Build a WiFi MPPT Solar Charge Controller, equipped with phone app datalogging telemetry. It is compatible with 80V 30A solar panel setups and all battery up to 50V. The project is based on an NodeMCU and runs on [Open Source MPPT Firmware \(Arduino IDE\)](#).

The heart of the charge controller is NodeMCU board. The NodeMCU senses the solar panel and battery voltages. According to these voltages, it decides how to charge the battery and control the load. The proposed IoT-based Arduino solar charge controller with MPPT is built by connecting a Solar PV panel, charge controller, battery, WiFi Module, and various sensor to various types of loads. The functional architecture of the proposed Arduino solar charge controller with MPPT is depicted in Fig. (1). The battery's voltage is applied to one of the microcontroller's ADC pins after it has reduced using a voltage divider circuit. The NodeMCU is linked to the WiFi module to send and receive messages via the controller Transmit and Receiver pins. When a user sends a message to the NodeMCU Wi-Fi module, it is routed to the controller, which is programmed to accept the message and compare it to a pre-



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defined voltage. The proposed IoT-based Arduino solar charge controller with MPPT is designed by perturb and observe or hill climbing algorithm are shown in Fig. (2).

AND OBSERVE OR HILL CLIMBING ALGORITHM

The Maximum Power Tracker uses an iterative approach to finding this constantly changing MPP (Maximum Power Point). This iterative method is called Perturb and Observe (p&o) or hill climbing algorithm. To achieve MPPT (Maximum Power Point Tracking), the controller adjusts the voltage by a small amount from the solar panel and measures power, if the power increases, further adjustments in the direction are tried until power no longer increases. P&O method is used for tracking the MPP. In this technique, a minor perturbation is introduced to, cause the power variation of the PV module. The PV output power is periodically measured and compared with the previous power. If the output power increases, the same process is continued otherwise perturbation is reversed. In this algorithm perturbation is provided to the PV module or the array voltage. The PV module voltage is increased or decreased to check whether the power is increased or decreased. When an increase in voltage leads to an increase in power, this means the operating point of the PV module is on the left of the MPP. Hence further perturbation is required towards the right to reach MPP. Conversely, if an increase in voltage leads to a decrease in power, this means the operating point of the PV module is on the right of the MPP and hence further perturbation towards the left is required to reach MPP are shown in the Fig. (3). Table: (1). Shows the comparison between static solar tracker system with dual axis solar tracker system. This comparison gives to identify which tracker system that more reliability on voltage, current and power. The comparison will be construct by both the systems. The Figure.(4) shows a graph of voltage and time of both the systems. The power that has been calculates from voltage and current that has been produce by solar panel. Overall, dual axis solar tracker system improves more on receive sun ray and produce more on voltage, current and power compare to Static solar system. The efficiency of the dual axis solar tracker system increases to 45%.

Phase II

An IoT application dashboard can be used to automatically or manually track the position of the sun using LDR sensors. LDR sensors provide data to the controller, which determines where the sun is (and as a result, the intensity of its light). A first servomotor (SM1) and a second servomotor (SM2) transform the data into commands to rotate the PV panel in the direction of the sun. In addition, the NodeMCU receives information about temperature, humidity, voltage, and current generated by the PV. Data taken by microcontrollers is sent to the cloud (web server) using an Ethernet shield attached to a NodeMCU. Solar tracking information from the IoT monitoring app can also be viewed in real-time via pre-created widgets. This IoT monitoring app was built in Blynk. The user can view all the solar tracker data on the dashboard of the IoT app when the smartphone or computer is connected to the internet. In this way, PV panels can be monitored for their performance and environmental conditions. When the dashboard widgets that they correspond to are in manual mode, the servo motors will also follow their directions. So, the user can optimize the system so that maximum energy is extracted from the PV panel by finding optimal environmental conditions. An IoT application also allows to monitoring and tracking when a threshold value is reached by a sensor.

RESULT AND OUTPUT

The idea of design is to hold and move the solar panel toward the sun position. The basic part of this design is using motor bracket to hold the motor and photovoltaic. Other than that, is black project box is used as storage for all component. The Figure.(5) and Figure 6 shows that, the circuit diagram and experimental setup of solar tracker respectively. Fig: (6). Shows the experimental setup of solar tracker. the parameter can be monitored from serial data. After a few second, the data stream created and send in the Blynk platform, as well as we get the details of PV panel and battery status of temperature, power, voltage and current from blynk application are shown in Fig. (7).



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In solar power system, **charge controller** is the heart of the system which was designed to protect the rechargeable battery. Fig: (8). Shows that the MPPT charge Controller with LED Display, A solar charge controller regulates the voltage and current coming from your solar panels which is placed between a solar panel and a battery. It is used to maintain the proper charging voltage on the batteries. As the voltage from the solar panel rises, the charge controller regulates the charge to the **batteries** preventing any overcharging.

CONCLUSIONS

The proposed model was developed using on NodeMCU. The output verified on both sections. The following conclusions are noted: As a conclusion, In Phase I, The MPPT algorithm has been developed successfully it makes flexible by giving stable output voltage and power. The monitoring system is equipped with NodeMCU (esp 8266) WIFI module in order to transfer the data from solar panel to IoT monitoring system. The other success part is to develop, the dual axis solar tracker has been developed successfully in phase II. The system can work in one condition which is the dual axis solar tracker must work within the WIFI coverage so that the user can attach the system with NodeMCU WIFI module and access the solar panel parameter via IoT monitoring System. MPPT of the device maximizes the solar panel power it controls the overcharging and deep discharging of the battery. as a result, depending on the application, the system can be monitored and tracked from a remote location.

Future Scope

This system only an initial investment in solar panels, and the tracking system is made at a reasonable price. Using an environmentally friendly method, a customer can make enough energy for themselves and use it in the right way. If this idea were to be used in a whole community, it could be linked to a grid where people could "sell" or "buy" the electricity that others made, making it more diverse. The net metering idea could be used to do this. Since this task can only be done on a LAN, port forwarding can be used to handle the load even if you are connected to a different network.

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Table: 1.comparision of static and tracking Solar System

Hours (Aug 8,2022)	From static solar panel			From solar tracking system		
	V	mA	mW	V	mA	mW
8" AM	16.8	1.23	34.664	18.3	3.41	62.403
9" AM	17.0	2.34	39.780	18.9	3.57	67.473
10" AM	17.6	2.51	44.176	19.4	3.98	77.212
11" AM	19.4	3.64	70.616	19.7	4.76	93.772
12" AM	19.8	4.45	88.110	20.4	5.40	110.430
1" PM	20.5	5.12	104.960	21.6	6.35	137.160
2" PM	21.1	5.94	125.334	21.4	6.11	130.754
3" PM	19.4	5.43	105.342	20.5	5.87	120.335
4" PM	17.2	5.01	86.172	19.6	5.26	103.096
5" PM	16.5	4.28	70.620	18.5	4.86	89.910
6" PM	16.2	2.87	46.494	17.5	3.75	65.625





<p>Fig. 1. Arduino Solar Charge Controller With MPPT</p>	<p>Fig.2. Perturb and Observe or Hill Climbing Algorithm</p>
<p>Fig.3:Power-voltage (P-V) curve of MPPT</p>	<p>Fig. 4. Voltage VS Time of Static and dual axis solar tracking system</p>
<p>Fig. 5: Circuit diagram of Solar tracking System</p>	<p>Fig. 6: Experimental Setup of Solar Tracker</p>
<p>Fig. 7.MPPT Output on Blynk App</p>	<p>Fig. 8. MPPT Charge Controller Output</p>





A Comprehensive Review on Roll of Herbs and Spices as Health Enlighteners in Cancer

Faruk Alam*

Associate Professor, Faculty of Pharmaceutical Science, Assam down town University, Panikhaiti, Guwahati, Assam 781026, India.

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*Address for Correspondence

Faruk Alam

Associate Professor,
Faculty of Pharmaceutical Science,
Assam down town University,
Panikhaiti, Guwahati,
Assam 781026, India.
E.Mail: faruk_2007a@rediffmai.com



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ABSTRACT

Cancer is among the leading causes of morbidity and mortality worldwide. Current therapy available for cancer treatment is associated with number of side effects. However, plants offer an alternative route for the treatment of cancer. The Plant Kingdom produces naturally occurring secondary metabolites which are being investigated for their anticancer activities leading to the development of new clinical drugs. *Pimpinella anisum*, *Cinnamomum tamala*, *Ocimum basilicum*, *Zingiber officinale*, *Curcuma longa*, *Papaversom niferum*, *Crocus sativus* etc have been clinically used as plant derived anticancer agents. The therapeutic effects of herbs and spices appear to be mediated by these phytochemicals, which also have a number of positive health effects, including anticancer, anti-inflammatory, antibacterial, antiviral, and antioxidant properties. The purpose of this brief review is to assemble current literature on some herbal drugs and to focus on their beneficial roles and drug targets in cancer therapy and chemoprevention. The present review summarizes the literature published so far regarding herbal medicine used as anti-cancer herbal drugs. This review discusses the demand for naturally-derived compounds from medicinal plants and their properties which make them targets for potential anticancer treatments.

Keywords: Herbs, Spices, Phytochemical, Mechanism, Cancer.





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INTRODUCTION

A large group of diseases are termed as cancer that vary in type and location but having one common thing i.e. abnormal cells growing out of control. It is continuously uncontrollable multiplying and accumulation of mass of abnormal cells (1). The Plant Kingdom produces naturally occurring secondary metabolites were produced by plant kingdom which are being explored for their anticancer activities leading to the development of new clinical drugs. The thought that simple plants, herbs and foods can have anti-cancer effects is sometimes a controversial subject. In the year of 2008, the National Cancer Institute (NCI) has screened for potential anticancer activities of about approximately 35,000 plant species (2). For every person who believes that herbs and plants can slow or even kill cancer cells, there is another who will only believe in the merits of chemotherapy.

Herbs and spices possess many beneficial health effects due to it contains many bioactive compounds and have chemopreventive properties, are mainly mediated by the BCL-2, K-ras and MMP pathways, caspase activation, the extrinsic apoptotic pathways, and the regulation of ER-stress- induced apoptosis. For example, herbs and spices could be good candidates for chemopreventive or chemotherapeutic agents for Colorectal cancer (CRC) management because of their antiproliferative action on colorectal carcinoma cells and inhibitory activity on angiogenesis(3). The different proposed mechanisms were established that herbs provide protection against cancer. Some phytochemicals from the herbs or extracts of herbs have been shown to inhibit one or more of the stages of the cancer process like initiation, promotion, growth and metastases (4,5). Herbal products may have some preventive benefits against the production of gene or chromosomal alterations that may lead to cancer by inhibiting phase I (procarcinogen activation) and inducing phase II (carcinogen deactivation) metabolic enzymes(6). The phase II enzymes glutathione S-transferase, quinone reductase, and uridine diphosphate-glucuronosyltransferase, which are responsible for the detoxification of carcinogens, are all significantly increased by the presence of diallyl sulphide, a compound found in garlic. Diallyl sulphide is also an effective inhibitor of the phase I enzyme cytochrome P450 (CYP)3A4 (5).

Both food and medicine have traditionally made extensive use of herbs and spices (Figure 1). They are used in cooking as taste enhancers, colourants, preservatives (antioxidants or antimicrobials), and substitutes for salt and sugar. In medicine, they are used to treat or lower the risk of noncommunicable chronic diseases linked to inflammation and oxidative stress (7). The bulk of the bioactive phytochemicals found in herbs and spices, including phenolic compounds, carotenoids, sterols, terpenes, alkaloids, glucosinolates, and other sulfur-containing substances, have strong antioxidant activity. The therapeutic effects of herbs and spices appear to be mediated by these phytochemicals, which also have a number of positive health effects, including anticancer (8), anti-inflammatory (9), antibacterial (10), antiviral (11), and antioxidant properties (12,13). The above statement accounts for the increasing interest in the health-promoting and protective properties of culinary herbs and spices. Research has begun to identify additional potential uses for spices and herbs in human health describe in figure 2, in addition to their culinary applications. Food products or dietary supplements may only display authorized health claims on their labels, which have been approved by the Food and Drug Administration (FDA) or the European Food Safety Authority (EFSA). These claims indicate that a food or food component may lower the risk of contracting a disease or other health condition. Health claims are accurate, understandable, trustworthy, and beneficial to the consumer. Scientific proof of the connection between a food category, a food, or one of its parts, and a health benefit is required for permitted health claims.

A medical intervention will be tested in clinical trials on human populations. Prior to the clinical trial, safety and efficacy of the proposed medicine are examined in *in-vitro* laboratory experiments and *in-vivo* research on animals. The FDA or EFSA may approve a medicine for clinical use following a successful clinical trial and continue to track its effects (14). Further investigation and an appeal for resubmission should be done in the event that a health claim is denied. Additionally, a nutrition claim may be added to the label in rare circumstances if a cause-and-effect connection cannot be proven. Foods that make nutrition claims have specific, advantageous nutritional qualities in terms of their energy content, minerals, or other ingredients, such as reduced salt or rich in fibre. The herb or spice



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can still be used as a food ingredient or additive even if neither a health nor a nutrition claim is accepted; however, the relevant claim would not be displayed on the product's label. The law of the nation in which the product will be sold will determine how the component is declared on the food label. The term phytochemomics has been offered as a cutting-edge analytical strategy in order to improve our comprehension of the mechanisms of action of the potential health-promoting qualities, phytochemicals, their bioactivity, and impact on human health and disease. For the purpose of validating or disproving nutrition and health claims made about foods, herbs, and botanicals abundant in phytochemicals, this multidisciplinary research area is crucial (15). As a result, the current study's objective is to analyze the most important findings about the culinary uses and medicinal qualities of herbs and spices, with an emphasis on the positive outcomes noted in clinical trials.

METHODS

All English-language works published before 2022 were searched in the literature. Electronic databases like Pub Med, Embase, Web of Science, Google Scholar, and Cochrane Library were used in the search. Cancer, Herbs, spices, physiologically active anti-cancer agents, clinical research, and chemotherapy medications were among the terms included in the search strategy. Reports (national, EU, and WHO), websites, and textbooks were used to gather background theory, laws, and regulations. Reports from the EU- system's scientific committees about spices and herbs have been the subject of regular meetings and much debate.

Life-saving benefits of herbs and spices

In recent years, there has been an increase in scientific and economic interest in the medicinal species that inhabit natural environments. Up to 80,000 flowering plants are utilized medicinally worldwide (16, 17). At least 118 of the top 150 prescription medications in the US are derived from natural sources: 74% of carbon dioxide is derived from plants, 18% from fungi, 5% from bacteria, and 3% from vertebrate animals like snakes and frogs (18).

This trove's potential for saving lives is enormous

- At least 70% of novel medications introduced in the United States in the previous 25 years, according to the National Cancer Institute, are derived from natural sources (19).
- At least 30,000 lives are saved each year in the United States by plant-derived anti-cancer medications like taxol, which was first isolated from the Pacific yew (20).
- Between 1960 and 1997(21), two medications made from the rose periwinkle of Madagascar's alkaloids enhanced the likelihood of remission for a child with leukaemia by 85%.

Chemopreventive Effect of Herbs and Spices

As yet, there are no data indicating that herbs and spices have an anticarcinogenic effect in humans, but there are several *in-vitro* studies and rodent *in-vivo* studies suggesting that certain herbs and spices may have a chemopreventive effect against the early initiating stages of cancer. Spices may be able to control inflammation, reduce the production of free radicals, limit the bioactivation of carcinogens, causes apoptosis in cancer cells, reduce free radical creation, and restrict microbial growth. Due to their low toxicity, they might be especially helpful as a mild dietary modification that could lower the risk for a number of disorders. Because many spices are powerful antioxidants, they may be especially important in reducing oxidative damage caused by environmental stress, including excess calorie intake (22). Spices can be added directly to foods, as has been done historically, or used as dietary supplements, which can significantly increase total antioxidant intake (> 1 mmol)(23). Some of the example of herbs and spices were listed below with their active constituents that have anticancer properties (Table 1). Herbs may fight cancer through a number of different processes. One or more steps of the cancer process have been proven to be inhibited by specific phytochemicals found in herbs or herb extracts (4,5). Inflammation and oxidative stress are risk factors for the development and progression of cancer as well as other pathological disorders(Figure 3). Herbs may protect against these conditions. Several naturally occurring water-soluble phenolic acids and flavonoids, including caffeic acid and quercetin, as well as lipid-soluble compounds like tocopherols, carotenoids, and sterols



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that may offer protection against the formation of genotoxic lipid peroxidation products like *trans*-4-hydroxy-2-nonenal are present in herbs and spices. Nuclear factor κ B (NF κ B) is activated by pro-oxidant and pro-inflammatory stimuli, which also trigger the mitogen-activated protein and nuclear factor κ B inhibitory protein (I κ B) kinases. This allows NF κ B to move into the nucleus, where it activates the expression of cyclooxygenase-2 (COX-2), results in the production of prostaglandins, and overstimulates cell division, which can result in the development of adenomas. Increased cell proliferation caused by pro-inflammatory and pro-oxidant factors, along with chromosomal instability brought on by oxidative stress, increases the risk of carcinogenesis (Figure 4). There are a surprising number of plants that may have anti-inflammatory properties. Curcumin, gingerol, and capsaicin, among other naturally occurring anti-inflammatory substances found in herbs and spices, seem to work by preventing one or more of the processes that connect pro-inflammatory stimuli with COX activation, such as the blocking of NF κ B translocation into the nucleus.

This review is focused on the pharmacokinetics and biochemical characteristics of ginseng, garlic (*Allium sativum*), black cohosh (*Actaea racemosa*), turmeric (*Curcuma longa*), green tea (*Camellia sinensis*), echinacea, arctium (burdock), flaxseed (*Linum usitatissimum*), and black cumin (*Nigella sativa*), which have chemo- These well-known herbs have been chosen because there is proof of their mechanisms of action and because they are frequently employed in traditional medicine as adjuvants in various cancer therapies. Some common herbs and spices with cancer-fighting properties are listed in Table 2.

RESULTS AND DISCUSSION

The findings of the studies mentioned above suggest that herbs and spices may be used in cancer chemoprevention in both *in vitro* and *in vivo* cancer models. Numerous active components in the aforementioned spices, such as *curcumin* in turmeric and piperine in black pepper, have been identified as potential cancer modifiers, numbering in the hundreds (8,41). There is little information available about the actual dietary intake amounts of spices and the pharmacokinetics of their active ingredients, despite a rapidly expanding body of experimental research that supports their ability to prevent cancer. Today, people value spices more and more for their possible health advantages as well as their culinary qualities. Some spices' antioxidant capabilities may be the source of the health benefits connected with their consumption. In other instances, spices' biological effects may result from their capacity to affect a range of cellular functions, such as those connected to drug metabolism, cell division, apoptosis, differentiation, and immunocompetence(8).

CONCLUSION

In conclusion, rigorous further research in preclinical and clinical studies is warranted to examine the possible chemopreventive capabilities of popular spices. The pharmacological characteristics of certain substances derived from spices or herbal supplements are the subject of extensive continuing research (e.g. curcumin, resveratrol). Poor bioavailability and pleiotropic mechanisms of action, which are challenging to examine in conventional "one compound-one molecular target" assays, have hindered fundamental and preclinical research on these substances. It should be noted that natural goods like spices include intricate blends of chemicals whose pharmacokinetics, solubility, and maybe pharmacodynamics might influence one another. Future research should analyse natural compounds' pleiotropic pharmacological effects using systems biology methods and taking into consideration their complexity.





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Table 1: Effect of some spices that have anticancer activity

Common name	Scientific Name	Family	Bioactive
Anise	<i>Pimpinella anisum</i>	Apiaceae	Anethole, phytoestrogen
Bay Leaf	<i>Cinnamomum tamala</i>	Lauraceae	Linalool, α -pinene, p-cymene, β -pinene and limonene, cinnamic aldehyde and phenylpropanoids
Basil	<i>Ocimum basilicum</i>	Lamiaceae	Eugenol, apigenin, limonene, ursolic acid, methylcinnamate, 1,8-cineole, α -terpinene, anthocyanins, β -sitosterol, carvacrol, cintronellol, farnesol, geraniol, kaempferol, menthol, p-coumaric acid, quercetin, rosmarinic acid, rutin, safrole, tannin, catechin
Cardamom	<i>Elettaria cardamomum</i>	Zingiberaceae	Limonene, caffeic acid, cineole
Cinnamon	<i>Cinnamomum cassia</i>	Lauraceae	(cinnamic aldehyde and cinnamyl aldehyde), tannin, mucus and carbohydrates
Cumin Seed Black (jeera)	<i>Nigella sativa</i>	Ranunculaceae	conjugated linoleic (18:2) acid, thymoquinone, nigellone (dithymoquinone), melanthin, nigilline, damascenine, and tannins
Cloves	<i>Syzygium aromaticum</i>	Myrtaceae	Eugenol, isoeugenol, gallic acid tannins, terpenoids, acetyleugenol, beta-caryophyllene and vanillin, crategolic acid, tannins such as bicornin, gallotannic acid, methyl salicylate, the flavonoidseugenin, kaempferol, rhamnetin, and eugenitin, triterpenoids such as oleanolic acid, stigmasterol, and campesterol, and several sesquiterpenes
Coriander	<i>Coriandrum sativum</i>	Apiaceae	Quercetin, caffeic acid, cineole, geraniol, borneol, 1,8-cineole, α -terpinene, β -carotene, β -pinene, β -sitosterol, cinnamic acid, ferrulic acid, γ -terpinene, kaempferol, limonene, myrcene, p-coumaric acid, p-cymene, quercetin, rutin, vanillic acid
Cumin	<i>Cuminum cyminum</i>		α -Pinene, β -pinene, γ -terpinene, p-cymene, cuminaldehyde, carvone, 1,8-cineole, β -carotene, β -sitosterol, caffeic acid, carvacrol, carvaol, geraniol,





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			kaempferol, limonene, p-coumaric acid, quercetin, tannin, thymol
Fennel	<i>Foeniculum vulgare</i>	Apeacea or Umbelliferae	α -Pinene, β -carotene, limonene, quercetin, benzoic acid, β -sitosterol, caffeic acid, cinnamic acid, ferulic acid, fumaric acid, kaempferol, myristicin, 1,8-cineole, p-coumaric acid, quercetin, rutin, vanillic acid, vanillin
Garlic	<i>Allium sativum</i>	Liliaceae	Alliin, diallyl disulfide, allyl isothiocyanate, alliinase, S-allylcysteine (SAC), diallyl disulphide (DADS), diallyl trisulphide (DATS) and methylallyl trisulphide
Ginger	<i>Zingiber officinale</i>	Zinziberaceae	Zingerone, zingiberene, ingerol, paradol, curcumin, shagoal, gingerenone A, Gingeols
Turmeric	<i>Curcuma longa</i>	Zinziberaceae	Tumerone, curcumine
Poppy seeds	<i>Papaver somniferum</i>	Papaveraceae	tocopherols other than vitamin E (alpha-tocopherol). alpha and gamma tocotrienols, campesterol, stigmasterol, sitosterol and delta 5-avenasterol, linoleic acid.
Saffron	<i>Crocus sativus</i>	Iridaceae	carotenoids. Safranal (2, 6,6-trimethyl-1,3-cyclohexadiene-1-carboxaldehyde, C ₁₀ H ₁₄ O), crocin, crocetin

Table 2. Sources and mechanism of some herbs and spices on cancer

Bioactive agent/ Source	Methods/ Measurements	Results	Ref.
Quercetin, curcumin, rutin, silymarin, whole ginseng mixture	Aberrant crypt foci suppression and effects of test compounds on evoking apoptosis.	Test compounds significantly suppressed aberrant crypt foci at different most effective concentrations. All test compounds except silymarin induced apoptosis, with quercetin being the most potent.	24
Curcumin (turmeric)	Intermediate biological markers by western blot, and incidence of hepatocellular carcinoma	81% reduction multiplicity and 62% reduction in incidence of hepatocellular carcinoma were observed. Curcumin-containing diet also reversed the increase in levels of p21ras, PCNA and CDC2 proteins.	25
Basil-leaf extract	Enzyme activities, lipid peroxidation	Basil-leaf extract was very effective in elevating antioxidant enzyme response by increasing significantly hepatic enzyme activities. Lipid peroxidation and lactate dehydrogenase activity were significantly decreased	26
Orientin and vicianin (Indian holy basil leaf)	Micronucleus count	Both compounds showed significant antioxidant activity <i>in vitro</i> , and therefore give significant protection to human lymphocytes against the clastogenic effect of radiation at low, non-toxic concentrations.	27
Carnosol (Rosemary)	Antimetastatic potentials by soft agar assay, B16/F10 rat cell migration, metalloproteinase activity	Carnosol exhibited antimetastatic potential; dose independently inhibited B16/F10 cell migration and decreased activity of metalloproteinase. Inhibition of activation of transcription factors NF κ B and c-Jun were also observed.	28





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Carnosol (Rosemary)	Antioxidant and enzyme activities	Carnosol suppressed the nitric oxide production and iNOS gene expression by inhibiting NF κ B activation, and provided possible mechanisms for its anti-inflammatory and chemopreventive action.	29
Citral (Lemon grass)	GST (glutathione S-transferase) activity	Electrophilic property characterised by the reactivity with intracellular nucleophiles including protein thiol or glutathione plays an important role in the induction of GST.	30
Lemon grass extract	8-hydroxy deoxyguanosine production	Inhibitory effects of lemon grass extract happened on the early phase hepatocarcinogenesis in rats.	31
Water extract of spearmint	Activity against mutagens NPD (4-nitro-1,2 phenylenediamine) and N-OH-IQ (2-hydroxyamino-3-methyl-3H imidazo [4,5-f]-quinoline)	Non-toxic concentrations inhibited mutagenic activity of N-OH-IQ in a concentration-dependent fashion but had no effect against NPD. Chloroform and methanol extracts of spearmint also possessed antimutagenic activity against N-OH-IQ.	32
Ginsenoside Rh2, Ginseng	MDA-MB-231 and MCF-7 breast cancer cell lines	Anti-proliferative and apoptosis. i. Induce changes in hypo-methylated genes ii. Mediate G(0)/G(1) phase cell cycle arrest iii. inhibit the production of inflammatory cytokines iv. Obstruct nuclear factor (NF)- κ B signaling and mitogen-activated protein kinase pathways	33&34
Diallyl disulfide, Garlic	MDA-MB-468 cancer cell line and female Swiss albino mice with EAC tumor	Decrease tumor growth and apoptosis. i. Induce apoptosis by promoting caspase-3 expression ii. Prevent oxidative degradation of anti-tumor protein, p53	35
Extracts of <i>Echinacea Purpurea</i> ,	BT-549 mammalian breast cancer cell	Inhibition of cell proliferation	36
Arctigenin, <i>Arctiumlappa</i> (greater burdock)	MDA-MB-231 breast cancer cells	Induce apoptosis. i. Activation of the ROS/p38 MAPK pathway, ii. Induction of mitochondrial caspase-independent pathways with increased Bax/Bcl-2 ratio	37
Arctigenin, <i>Arctiumlappa</i> (greater burdock)	MCF-7 and MDA-MB-231 human breast cancer cell lines	Anti-metastatic effect. i. Inhibiting the NF- κ B, Akt/MAPK signaling pathways, and MMP-9	38
Lignans, Flaxseed (dietary)	Athymic mice inoculated with human MCF-7 cancer cells	Inhibition of cell proliferation and induced apoptosis. Reduced mRNA expressions of cyclin D1, epidermal growth factor receptor and Bcl2	39
Thymoquinone, <i>Nigella sativa</i>	T-47D and MDA-MB-468 breast cancer cells	Induced apoptosis, i. Promote G (1) phase arrest via translation upregulation of procaspase-3 and Bax ii. Inhibition of cyclin D1 and cyclin E, and PARP cleavage alongside downregulation of the gene expression of survivin, Bcl-2 and Bcl-xL	40





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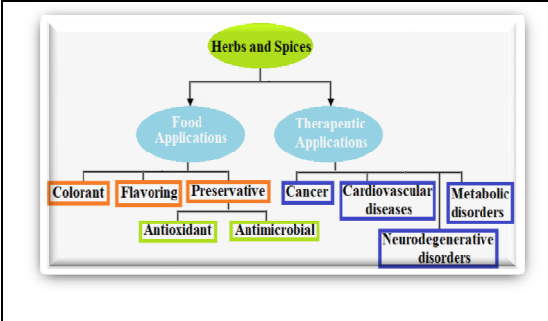


Figure 1: Uses of herbs and spices

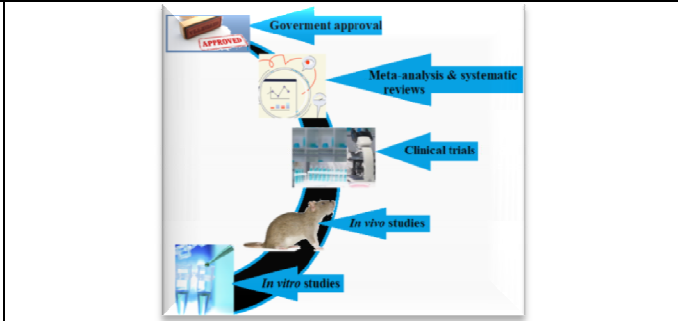


Figure 2: Different research procedure for the approval of health benefit of herbs or spices

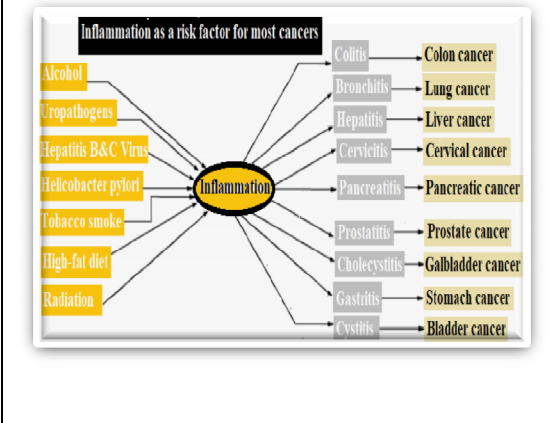


Figure3: Source of various cancers initiated by Inflammation

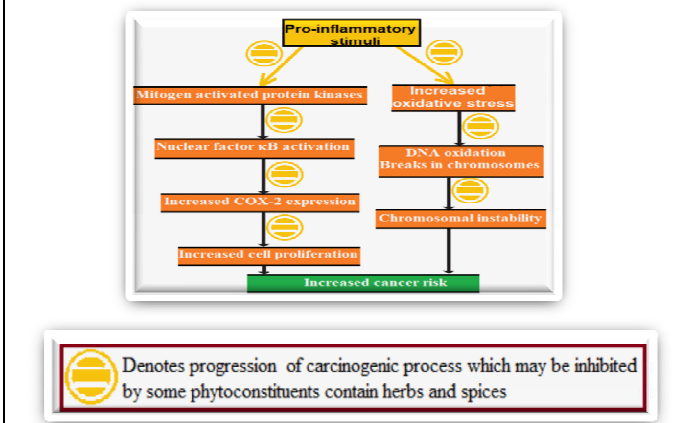


Figure 4: Chromosome instability and enhanced cell proliferation are both impacted by pro-inflammatory stimuli, and together they raise the risk of carcinogenesis.





Visual Scene Understanding for Self-Driving Vehicles using Mask R-CNN

R.Srijith¹, H.K.Vishal¹ and A.Beulah^{2*}

¹Student, Department of Computer Science and Engineering, Sri Sivasubramaniya Nadar College of Engineering, Chennai, Tamil Nadu, India.

²Assistant Professor, Department of Computer Science and Engineering, Sri Sivasubramaniya Nadar College of Engineering, Chennai, Tamil Nadu, India.

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*Address for Correspondence

A.Beulah

Assistant Professor,

Department of Computer Science and Engineering,

Sri Sivasubramaniya Nadar College of Engineering,

Chennai, Tamil Nadu, India.

E.Mail: beulaharul@ssn.edu.in



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ABSTRACT

Visual scene understanding for self-driving vehicles can be achieved with various computer vision techniques. In recent years, self-driving vehicles are receiving lot of attention in research. In self-driving vehicles, accurate, efficient, and fast identification of objects on the road is essential for safe navigation vehicles. Inaccurate predictions for the road obstacles can lead to road accidents. In spite of various object detection algorithms, the main drawback is that they do not identify the object masks for individual objects. Few deep learning techniques suffers from harsh quantization, resulting in slightly less accurate bounding boxes. These drawbacks can be mitigated by generating masks for the object and removing the harsh quantization. The Mask R-CNN, an extension of the Faster R-CNN architecture is used to perform instance segmentation. Mask R-CNN overcomes the harsh quantization of ROI-Pooling by introducing ROI-Align for extracting Region of Interests. In this paper, we use a highly accurate and fast model by training on a custom annotated dataset which segments and count the objects in the vicinity of the vehicle. The predictions are evaluated with mean Average Precision (mAP) metric.

Keywords: computer vision, instance segmentation, object detection, self-driving vehicles.





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INTRODUCTION

Self-driving vehicles do not require human intervention to take control to safely operate the vehicle [5]. Also known as autonomous or “driverless” cars, they combine sensors and software to control, navigate, and drive the vehicle. Autonomous vehicles have the potential to impact society significantly in the coming years. The prospect of widespread use of driverless cars brings with it many benefits: fewer traffic accidents and the economic toll caused by property damage, injury or resulting death. Energy costs will also be saved as these autonomous vehicles can maximize driving efficiency and reduce traffic congestion. Objects present in the vicinity of the vehicle can be recognized using various object recognition algorithms. This helps the autonomous vehicles to identify and avoid the obstacles around them. Object detection algorithms detects the objects present in a scene and generates bounding boxes around the objects according to the classes. Image segmentation segments the objects using a mask generated for the objects in a particular image. The widely used segmentation methods are semantic and instance segmentation. In semantic segmentation multiple objects from a specific class are identified as one entity. Whereas, in instance segmentation each individual object is identifies as a separate object. In this paper we prefer instance segmentation, because it segments the individual objects of the same class. This leads to count the number of objects of the same class present in the scene.

Most of the early object detection algorithms [3] were built based on the information present in the image itself. Due to the lack of effective feature representation in images earlier, sophisticated features had to be constructed which also consumed a lot of the limited computing resources. Viola and Jones [21] proposed a face detection algorithm which uses sliding windows. Histogram of Oriented Gradients (HOG) was designed to be computed on a dense grid of uniformly spaced cells, mainly was used in pedestrian detection [15]. Deformable Part-based Mode (DPM) was the peak of the traditional object detection methods. The DPM follows the detection philosophy of “divide and conquer”, where the training phase is dividing or decomposing the object into parts, and the inference phase is assembling the detections of different object parts [22].

From Minaee al.'s survey [16], the various ideas regarding image segmentation were understood. Before DNN was proposed, various features used for semantic segmentation are: Pixel color, Histogram of Oriented Gradients (HOG), Scale Invariant Feature Transform (SIFT), Local Binary Pattern (LBP), Speeded Up Robust Features (SURF), Harris Corners, Sub-pixel Corner, Smallest Univalued Segment Assimilating Nucleus (SUSAN), Features from Accelerated Segment Test (FAST), are just to name a few. There are both supervised and unsupervised approaches for semantic segmentation. Support Vector Machines (SVMs) are well-performing binary classifiers which can be used for image segmentation effectively. K-means clustering is an unsupervised clustering algorithm, which requires the number of clusters to be given beforehand. Intuitively, edge is important information for segmentation. There are several edge-based detection researches for image segmentation [1], [10], [13], [17], [18]. Subsequently, the need for better performing network architectures and more optimized training procedures arose. Convolutional Neural Network, Fully Convolutional Network, Parse Net, Feature Pyramid Network are some of the deep learning methods [9], [11] for semantic segmentation.

Instance segmentation performs object class-labels prediction followed by generating pixel-specific masks [2]. Instance segmentation largely aims to help robotics, autonomous driving, surveillance, etc. Hafiz et al.'s survey on instance segmentation, an extension of object detection, is used to identify the objects in the image by assigning different labels for every instance of the objects, even if they belong to the same class [4]. Recent days instance segmentation is performed using Mask R-CNN (Region-based Convolutional Neural Networks)[6], which uses state of the art deep-learning combined with data to scan and detect, segment and classify the objects and to estimate the position of the objects present around the vehicle. Nowadays, YOLO Mask is also considered as a better segmentation method [8]. Mask R-CNN is a relatively simple and flexible model for instance segmentation. Mask R-CNN furthers the Faster R-CNN, adding an object mask prediction branch in parallel as an improvement.



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This paper aims to process an image containing road scenery and segment the object classes in the image. We detect the objects in a road scenery simultaneously while generating high quality segmentation masks for each instance of the object. A segmentation model with improved efficiency and accuracy will be constructed and tested on real-time data. Further, we find the instance count of all the objects in each frame and display the count. As a result, the information of the visual scene from the image can be understood in a better way. Here, the objects that are to be detected are vehicles, pedestrians and other obstacles in a road scene. Instance segmentation will be the method used for this purpose. This will be a step forward in helping out self-driving cars with understanding the roads for automated driving of the vehicle. As this method combines object detection and semantic segmentation, it would give better results. As a result, the car can find the optimal path while avoiding the obstacles.

MATERIALS AND METHODS

The dataset used for this research is DIRS21-Dataset for Indian Road Scenarios [20]. This is a high-resolution dataset for developing perception systems for advanced driver assistance systems. This dataset contains 5093 road scene images including highway as well as city traffic conditions for Indian roads. All the images are in .jpg format. The resolution of each image is 1920 x 1080 pixels. All the images are diverse in different angles such as appearance, scale, illumination, season and weather. The dataset has 6 classes namely: 1 - Pedestrian, 2 - Rider, 3 - Bus, 4 - Car, 5 - Truck, 6 - Electric Auto (EA).

Self-driving vehicles need a visual scene understanding to automatically drive the car with safety. The visual scene consists of objects within vicinity such as pedestrians, cars, trucks etc. The proposed system to segment the objects in the visual scene is shown in Fig. 1. During the training phase, the training images are annotated using the VGG Image Annotator (VIA) tool. The annotations are stored in JSON format. These annotations are used for training the Mask R-CNN model on the dataset. We extract the features from the annotations during training. We generate the bounding box for the objects on-the-fly from their masks. We train only the Region Proposal Network, classifier and mask heads of the pre-trained Mask-RCNN model with the dataset. We use the pre-trained model which was trained previously on the MS-COCO dataset. As prescribed in the dataset we use, the model for 6 classes. During the validation phase, the performance evaluation is done using the mean Average Precision Metric. A part of dataset is used for the validation. The validation set is mainly used to give an approximate idea of error at any epoch and for hyper-parameter optimization. The images used for validation are also annotated precisely. The detected object is shown with its label and probability. The performance of the model is computed by comparing the prediction results of the validation dataset with the ground truth from the annotations.

During the testing phase, new test images are fed to the model and it detects the objects in the image with their respective labels and probabilities. Further, this system is extended for analyzing video, frame-by-frame. The instances of each class in the image are counted and displayed. This can be further applied on real-time video feed, such as the live camera video. We go through a couple of iterations adjusting the hyper-parameters to get the best results. The MASK R-CNN uses state of the art deep-learning methods to detect, segment and classify the objects and to estimate the position of the objects present around the vehicle. Mask R-CNN is a relatively simple and flexible model that performs instance segmentation by object detection while simultaneously generating high quality masks. Mask R-CNN extends the Faster R-CNN by adding an object mask prediction branch in parallel to the bounding box prediction branch as an improvement. The working principle of Mask RCNN is shown in Fig 2.

Res Nets [7] learn residual functions with reference to the layer inputs. These layers fit a residual mapping instead of a direct mapping. The network is formed by stacking residual blocks on top of each other. e.g. a ResNet-50 has fifty layers using these blocks. A Feature Pyramid Network, or FPN [12], is a feature extractor that produces proportionally sized feature maps for an input image of arbitrary size at multiple levels in a fully convolutional manner, whilst being independent of a backbone convolutional network. A Region Proposal Network (RPN) is a fully convolutional network (FCN) that proposes object boundaries with object scores [19]. A fully convolutional



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network [14] (FCN) uses a convolutional neural network to transform image pixels to pixel classes (Semantic segmentation). Fully convolutional network transforms the height and width of intermediate feature maps back to those of the input image, using the transposed convolutional layer. No dense layers are used in this architecture. We use a 1×1 convolutional layer to transform the number of output channels into the number of classes. The proposed model is simple to train, adding only a small computational load on top of the Faster R-CNN model. Another added advantage of Mask R-CNN is the ease of generalization with regards to other related tasks. Instance segmentation approaches using the Mask R-CNN have shown great results in recent benchmark instance segmentation challenges. For performance evaluation, MS-COCO dataset is used. The Mask R-CNN was the best performing model in all the benchmark COCO challenges.

RESULTS

This section details about the experimentation process and the results obtained. First, the 5093 road scene images are annotated using VIA annotator tool. The annotations are stored in JSON format. These annotations are used for further processing. The 70% of the images are used for training, 10% of the images are used for validation and the remaining 20% of the images are used for testing. During the training phase the features are extracted from the training images using the annotations. A bounding box is generated for the objects on-the-fly from their masks. The pre-trained weights which were trained previously on the MS-COCO dataset is used as the initial weight. As prescribed in the dataset we use, the model was trained for 6 classes.

In the validation phase, the performance evaluation of the built model is done using the mean Average Precision Metric (mAP). The validation set is just used to give an approximation of generalization error at any epoch but also, crucially, for hyperparameter optimization. The detected object is shown with its label and probability. The performance of the model is computed by comparing the prediction results of the validation dataset with the ground truth from the annotations. During the testing phase, new test images are fed to the model and it recognizes the objects in the image with their respective labels and probabilities. Further, we extend this approach and test the model on video data, frame-by-frame. We also count the instances of each class in the image and display them. We test the quality of data, not just the model, and go through a couple of iterations adjusting the hyper-parameters to get the best results. The output for an image step by step is presented in Table 1.

The metric used to evaluate the performance of the system is mean Average Precision (mAP). Mean Average Precision (mAP) is the current benchmark to evaluate the performance of object detection models. The mean of average precision (AP) values range from 0 to 1, calculated over recall values. The mean Average Precision is usually the average of AP for each class. However, there can be various interpretations of AP and mAP depending on the context. Average Precision is calculated as the weighted mean of precisions at each threshold, the weights being the increase in recall from the previous threshold. mAP formula is derived from the following metrics: Confusion matrix, Intersection over Union, Precision and Recall. The precision-recall curve encloses the trade-off between precision and recall, considers both false positives (FP) and false negatives (FN), hence maximizing the effect of both metrics. Precision- Recall curve is obtained by plotting the precision and recall values of the model as a function of the confidence score threshold of the model. This curve gives a better idea of the overall accuracy of the model. An input video of 3 minutes is taken for evaluation. 3 frames for each minute is being considered for evaluation to capture different instances from the video. The precision and recall are calculated and presented in Table 2.





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The model is also tested with ResNet-50. The compared mAP score is given in Table 3

CONCLUSION AND FUTURE WORK

In this paper a visual scene understanding for self-driving vehicles using instance segmentation is proposed. The dataset used is DIRS21-Dataset for Indian Road Scenarios. The road image is segmented using Mask R-CNN. In this system, the pedestrians and vehicles from both image and video data are segmented, Also, then number of instances of each class is also obtained for each image or frame of a video. The main use-case of our system is in self-driving vehicles. If an autonomous car is able to automatically detect the obstacles through a computer vision technique such as this proposed system, it is easily able to drive the vehicle without human intervention, knowing the visual scene context in which they are driving. This work can be further extended as detection of lanes in the road, traffic sign detection and optimal path prediction: which helps further in the process of improving the automation in self-driving vehicles.

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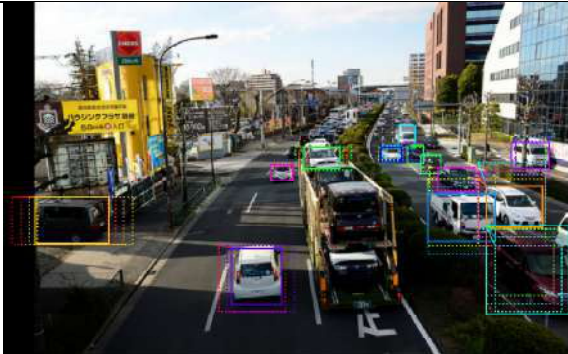
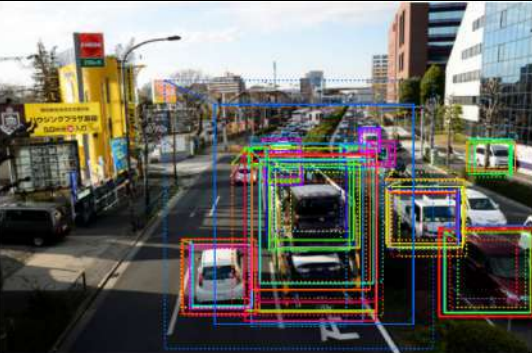
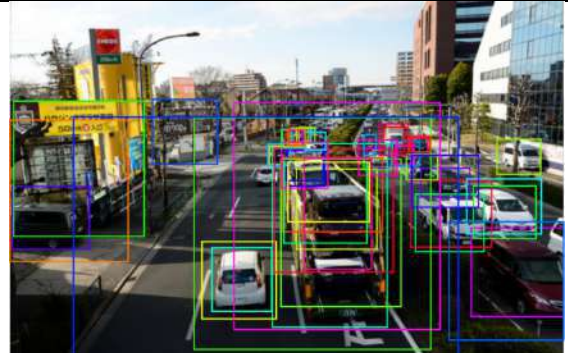




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Table 1. Step by step output for a given image

 <p>(a) Image used for model inspection</p>	 <p>(b)RPN Targets</p>
 <p>(c) RPN Predictions by top scores</p>	 <p>(d) RPN Predictions after non-max suppression</p>





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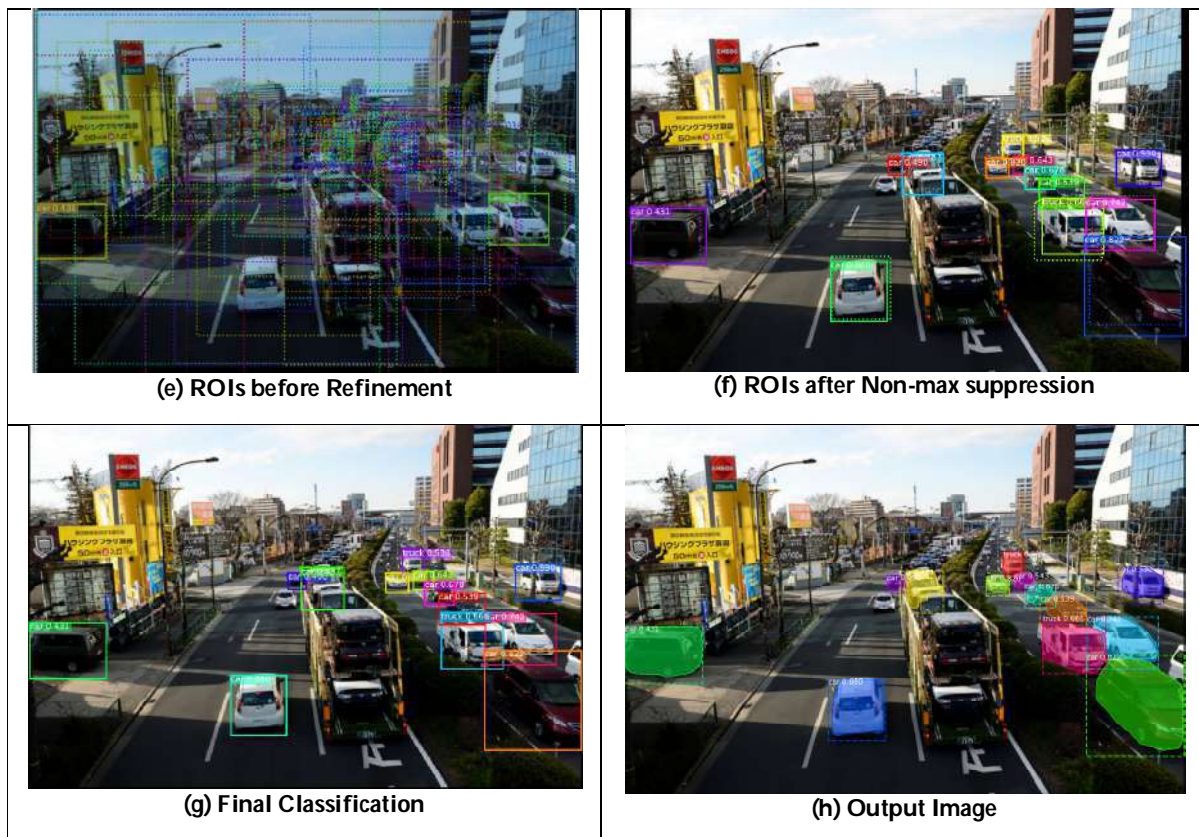


Table 2. Evaluation for an Input Video

Frame no	Ground Truth instances	Predicted instances	Precision	Recall
1	1 person 2 riders 1 truck 4 cars	3 riders 1 truck 4 cars	0.875	0.875
2	1 rider 3 cars 1 truck	1 rider 3 cars 1 truck	1	1
3	1 person 1 truck 2 cars	1 truck 2 cars	1	0.75
4	1 rider 3 cars 3 persons 1 truck	1 rider 3 cars 1 person 1 truck	1	0.75
5	1 rider 1 truck 3 cars	1 rider 1 truck 2 cars	1	0.8
6	1 rider 3 cars 1 truck	1 rider 2 cars 1 truck	1	0.8





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7	4 cars 1 truck	3 cars 2 trucks	0.8	0.8
8	1 rider 3 cars 1 truck	1 rider 3 cars	1	0.8
9	1 rider 5 cars 1 truck	1 rider 5 cars	1	0.857

Table 3. Model Comparison

Model	Backbone	mAP
Mask R-CNN	ResNet-50	0.4133
Mask R-CNN	ResNet-101	0.8528

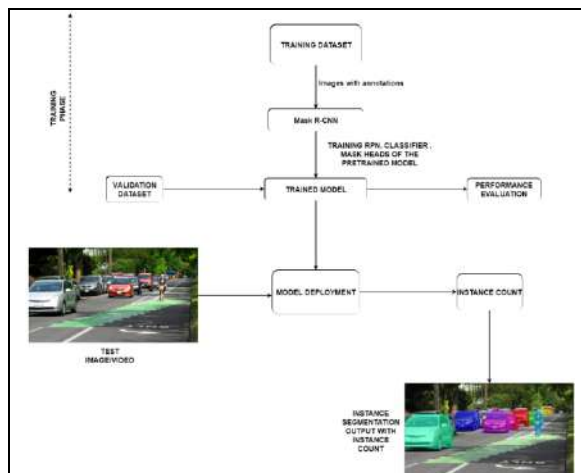


Fig. 2. Instance Segmentation in self - driving vehicles

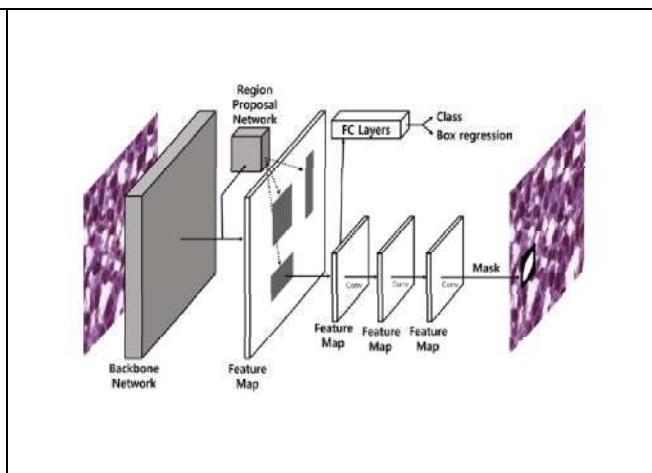


Fig. 2 Mask RCNN





Idiopathic Gingival Fibromatosis in 12 Years Old : A Case Report

M.Mhaske¹, Kalyani R.Reddy^{2*}, Shraddha Bhandari³, Pratiksha Surana² and Mithila Kakade²

¹Professor and HoD, Department of Periodontology, CSMSS Dental College and Hospital, Aurangabad, Maharashtra, India.

²PG Student, Department of Periodontology, CSMSS Dental College and Hospital, Aurangabad, Maharashtra, India.

³Assistant Professor, Department of Periodontology, CSMSS Dental College and Hospital, Aurangabad, Maharashtra, India.

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*Address for Correspondence

Kalyani R.Reddy

Department of Periodontology,
CSMSS Dental College and Hospital,
Aurangabad, Maharashtra, India.

E. Mail : reddykalyani927@gmail.com



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ABSTRACT

Gingival fibromatosis is a heterogeneous group of disorders characterized by progressive enlargement of the gingiva caused by an increase in connective tissue elements. Many cases are iatrogenic, some inherited while others are idiopathic. The basic objective is to investigate the cause (local / systemic), enhance the speech & ability of mastication by performing gingivectomy procedure in this subject. Gingivectomy was performed quadrant-wise, using scalpel assisted with diode laser under local anesthesia to restore the patient's esthetics and functional /masticatory needs. Excisional biopsy was done & tissue was sent to histopathology lab for further investigations. Histopathological investigations after excisional biopsy showed a lining of stratified epithelium focally keratinized with elongated rete ridges showing a tubular pattern and arborization. The subepithelial tissue was composed of interlacing bundles of dense collagen interspersed with loose fibrovascular connective tissue. After gingivectomy patient reported improved speech and ability to masticate thereby enhancing his overall wellbeing. Healing was uneventful & no recurrence was noticed till date.

Keywords: Gingival Fibromatosis, iatrogenic, biopsy, arborization. etc

INTRODUCTION

Idiopathic gingival fibromatosis (IGF) is an uncommon, benign, hereditary condition with no specific cause. IGF is characterized by a slowly progressive, non hemorrhagic, fibrous enlargement of maxillary and mandibular keratinized gingiva. It occurs either as an isolated disease or combined with some rare syndromes or chromosome



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disorders. According to Gorlin *et al*, IGF is most commonly associated with hypertrichosis, also occasionally associated with mental retardation and epilepsy. More recently, hearing loss and supernumerary teeth have been reported to be associated with HGF. The condition has also been reported in association with deficiency of growth hormone caused by lack of growth hormone release factor[1]. The hyperplastic gingival tissue is usually pale-pink, firm, has leathery consistency and presents a characteristic pebbled surface. Exaggerated stippling may be present. The enlarged tissues may partially or totally cover the dental crowns, can cause diastemas, pseudo-pocketing, delay or impede tooth eruption and can aggravate periodontitis due to poor oral hygiene.

In severe cases, it may lead to mastication and speech impediments or lip closure difficulties. The condition may be painful when tissues are traumatized during mastication. The condition may present as a nodular form characterized by the presence of multiple tumors in the interdental papillae or a more common symmetric form resulting in uniform enlargement of gingiva or a combination of both[2]. It may be unilateral or bilateral, localized or generalized and can affect both maxilla and mandible. The disease commences frequently when deciduous or permanent teeth begin to erupt. Females and males appear to be equally affected. Histologically, the affected tissues are generally composed of dense connective tissue rich in coarse collagen fibers and are highly differentiated with young fibroblasts and scarce blood vessels. The epithelium is hyperkeratotic with elongated rete pegs. Unusual findings include the presence of small calcified particles, amyloid deposits, islands of odontogenic epithelium and osseous metaplasia in the connective tissue and ulcerations of the overlying mucosa[3]. HGF is genetically heterogeneous and can occur in either autosomal dominant (common) or recessive forms. Families are affected across the generations and a positive family history is always present. In IGF, no causative agent can be identified and a family history is lacking. If the inheritance is autosomal dominant, then the phenotypic frequency is 1 in 750,000 people and the gene frequency is 1 in 350,000[4].

Case Report

A 12-year-old boy, accompanied by his parents reported with the complaint of swollen gums & inability to chew food [Fig- 1 & 2]. The patient presented with gradual and progressive enlargement of both upper and lower gingival tissues from the age of 8 years. The enlargement had led to incompetent lips, poor esthetics and also hindered in speech and mastication. He appeared apprehensive and lacked confidence due to gummy smile. There was no history of fever, prolonged medications, anorexia, weight loss, seizures, or hearing loss. Family and postnatal history was non-contributory and the patient did not have any history of epilepsy or any type of physical or mental disorder.

On examination, the patient had incompetent everted lips and a convex profile. An intraoral examination revealed generalized, gross, nodular enlargement of the gingiva involving the upper and lower arches, which were brownish pink in color, and had a firm, fibrous and leathery consistency. The teeth were barely visible as they were buried deep within the enlarged gingiva [Fig- 3, 4 & 5]. There was no hypertrichosis. Hematological investigations were within normal limits. Orthopantomogram showing stage of deciduous dentition [Fig-6] Intra-procedure excisional biopsy was performed with no.15 blade & external bevel incision was given. [Fig-7] The H & E stained tissue section shows a lining of proliferated stratified squamous epithelium with numerous melanocytes. Focally keratinized epithelium with elongated rete ridges showing a tubular pattern [Fig -8] The subepithelial connective tissue is mainly fibrous composed of haphazardly arranged bundles of collagen fibers with very few cellular components. On the basis of the medical, family, and drug histories and the clinical findings, this was diagnosed as Idiopathic Gingival Fibromatosis

Procedure

Gingivectomy procedure was performed in lower anterior region canine to canine region (53-63) [Fig- 9 & 10] followed by maxillary canine to canine (53-63) [Fig- 11 & 12]. After instillation of the desired level of local anesthesia, the bleeding points were marked using a pocket marker to the cervical line of teeth on either side of the gingival hyperplasia. The incision was made distal to 83 & 53. Scalpel with blade no. 15 was used for incisions (external bevel incision) on the facial, lingual, and cervical surfaces in both the arches. Laser was used for finishing the margins.



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A pressure pack was used to control postoperative bleeding. Once the bleeding was under control, a periodontal dressing (COE-PAK, Periodontal Dressing; was given to promote healing. The patient was recalled after 20 days for a checkup[Fig – 13, 14&15]. The same procedure can also be performed by electrocautery.

DISCUSSION

Gingival fibromatosis can occur as an isolated condition or be associated with other diseases or syndromes and can be localized or generalized. The different forms can be classified as following:[5]

- Isolated HGF
- Isolated IGF
- GF with hypertrichosis
- GF with hypertrichosis and mental retardation and/or epilepsy
- GF with mental retardation and/or epilepsy
- GF associated with other diseases as part of a syndrome.

The noncontributory histories (family, medical, postnatal and drug histories) and the clinical appearance of bilateral uniform enlargement of gingiva led to the diagnosis of a symmetric form of generalized isolated idiopathic gingival fibromatosis in the present case. The generalized form of isolated IGF is more common in male patients in contrast to the present case, while the localized type occurs in the female patients. Hereditary HGF tends to occur more frequently as a generalized type than IGF. The ratios of generalized to localized types in HGF and IGF have been reported as 15.2:1 and 1.6:1 respectively.[6] Though the cause of IGF is unknown, this appears to be a genetic predisposition. The condition may manifest as an autosomal dominant or less commonly as autosomal recessive mode of inheritance. Autosomal dominant non-syndromic forms have been genetically linked to the chromosome 2p21-p22 and 5q13-q2 .[7,8] It is possible that isolated GF may result from a single gene mutation while syndromic forms may result from alterations of multiple genes or perhaps a gene dosage effect [9]. Recently, a mutation in son of sevenless-1(SOS-1) gene has been held responsible for this rare hereditary condition. SOS-1 gene codes for a protein that activates the ras pathway, which signals cell growth. When the gene is not mutated, it is involved in the growth of normal, healthy gums. When mutated, it results in gingival fibromatosis. A recent report presented evidence that a single nucleotide-insertion mutation in codon 1083 of the SOS-1 gene localized to chromosome 2p21-p22 is the cause of HGF in humans[10].However, HGF displays genetic heterogeneity and mutations in other genes are also likely possible.

Histologically, the gingival hyperplasia is mainly due to an increase and thickening of collagen bundles in connective tissue stroma. The nodular appearance can be attributed to the thickened hyperparakeratinized epithelium. The cellular and molecular mechanisms that lead to this condition are not well understood. HGF keratinocytes seem to have an important role in pathogenesis by inducing extracellular matrix accumulation by fibroblasts [11] According to a recent report, increased proliferation and elevated production of extracellular matrix molecules, type I collagen and fibronectin could contribute to the clinically increased bulk of gingiva[12]. Several authors suggest that more the fibroblasts present, greater the chance for recurrence[13]. Enlargement usually begins with the eruption of deciduous or permanent dentition; it may rarely present at birth or arise in adulthood. The most extensive enlargement appears to occur during loss of deciduous teeth or in early stages of eruption of permanent teeth. It progresses rapidly during active eruption and decreases with the end of this stage [14]. The continuing recurrence of the enlargement following surgery and a permanent remodeling of tissue after extraction of teeth suggests the importance of the presence of teeth and the environment of gingival crevice in the pathogenesis of GF [15]. Emerson recommended that the best time for the excision of gingival enlargement is when all the permanent teeth have erupted [16]. Various procedures available for removal of GF include surgery, electrocautery and use of a carbon dioxide laser. If carbon dioxide laser is not available, the most effective method for removing large quantities of gingival tissue especially when there is no attachment loss and all the pocketing is false is the conventional, external bevel gingivectomy.¹⁷ In the case presented here, quadrant-wise gingivectomy was performed with periodontal pack placement for one week and 0.2% Chlorhexidine rinse twice a day for two weeks after each surgery.



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Orthodontic treatment will be subsequently carried out after completion of surgical protocol. It is conceivable that orthodontic treatment might stimulate recurrence in some patients by impeding periodontal hygiene maintenance and thereby necessitating repeat surgery following it. However, after orthodontic therapy, proper tooth repositioning and lip seal prevent mouth breathing, which might otherwise exacerbate the condition.

CONCLUSION

- The present case report highlights a nonsyndromic IGF and its management.
- Surgery significantly improved the patient's esthetics and masticatory functions.
- Maintenance of oral hygiene is important to prevent recurrence.

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<p>Fig-1: Preoperative Front view</p>	<p>Fig-2: Preoperative lateral view</p>
<p>Fig3 :Gingival overgrowth in anterior teeth regio</p>	<p>Fig- 4:Gingival overgrowth in lower arch</p>
<p>Fig -5:Gingival overgrowth in upper arch</p>	<p>Fig-6 : OPG showing Deciduous Dentition</p>
<p>Fig-7: Gingival tissue excised for Biopsy</p>	<p>Fig- 8 :Histopathological specimen showing stratified squamous epithelium with long slender rete pegs and connective tissue with dense collagen stroma</p>





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Fig 9: Gingivectomy incision in maxillary arch



Fig 10 :Gingivectomy procedure in maxillary arch



Fig-11: Preoperative view of the lower arch



Fig-12:Gingivectomy procedure in mandibular arch



Fig-13:Postoperative - increased clinical crown length



Fig-14:Postoperative –upper arch



Fig-15:Postoperative –Lower arch





Investigation of *Cereus repandus* Stem Extract as an Effective Green Inhibitor for Corrosion of Mild Steel in 1N Sulphuric Acid Medium

S. Gladiyarani¹ and Gunavathy^{2*}

¹Research Scholar, Department of Chemistry, Nirmala College for Women, Red Fields, Coimbatore – 641 018, Tamil Nadu, India.

²Assistant Professor and Head, Department of Chemistry, Nirmala College for Women, Red Fields, Coimbatore – 641 018, Tamil Nadu, India

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*Address for Correspondence

Gunavathy

Assistant Professor and Head,
Department of Chemistry,
Nirmala College for Women, Red Fields,
Coimbatore – 641 018, Tamil Nadu, India
E.Mail: gunavathyprakash17@gmail.com



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ABSTRACT

The effect of *Cereus Repandus* (CeR) stem extract on the corrosion of mild steel in 1N H₂SO₄ acid was investigated by weight loss method, scanning electron microscope and FTIR techniques. The results showed that the extract solution of plant serves as an effective inhibitor for the corrosion of mild steel in sulphuric acid media. The experimental results suggest that this plant extract was an efficient corrosion inhibitor and inhibitory efficiency increases with the increase in inhibitor concentration and it decrease with the increase in temperature. Scanning electron microscopic study offers a confirmatory evidence for the protection of mild steel by the inhibitor through adsorption.

Keywords: Cereus Repandus (CeR), Mild Steel, Inhibition Efficiency, FTIR, SEM.

INTRODUCTION

In recent years the use of inhibitors has been one of the best and most practical methods for protection against metal corrosion especially in acidic solution. Most of the efficient inhibitors are organic compounds that contain in their structures mostly nitrogen, sulphur or oxygen atoms [1]. Sulphuric acid is the medium which has been used for acid cleaning, acid descaling, and industrial cleaning because it is more effective and economical [2,3]. Major problems regarding the applications of these inhibitors are very expensive and their toxic nature often poses health and

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environmental challenges [4]. Some natural products have been found effective to control corrosion attack and reported by several authors as having the ability to protect metal corrosion in various aggressive acids [5]. Natural plant extracts are biodegradable, readily available, cheap and non toxic compounds. The major phytochemical constituents present in CeR extracts adsorb on metal surface and act as inhibitor. The present study investigate the inhibiting effect of stem extract of CeR on mild steel in sulphuric acid medium using the weight loss method, SEM and FTIR techniques.

EXPERIMENTAL**MATERIALS**

Mild steel specimens were cut into size with dimensions 5 x 1 x 0.2 cm and were abraded with different grades of emery papers, washed with distilled water, degreased with acetone and dried. The chemical composition of the mild steel in terms of element weight percentage was identified by Si' Tarc, Coimbatore. The metal compositions of mild steel [6] are shown in Table.1.

METHODS

Pre weighed mild steel specimens were suspended with the help of glass hook in 100 mL of 1N H₂SO₄ acid solution in the absence and presence of inhibitor at various concentrations under an immersion time period at room temperature. The specimens were removed after specified time interval, washed with distilled water, dried and reweighed. Experiments were performed for various concentrations such as,

- Concentration variations : (0.10 % v/v, 0.50 % v/v, 1.00 % v/v, 1.50 % v/v, 2.00 % v/v and 2.50 % v/v).
- Different time interval : 1 h, 3 h, 5 h, 7 h and 24 h.

The rate of dissolution of the metal was calculated in terms of Corrosion Rate (CR) using the expression [8],
$$\text{Corrosion Rate (CR)} = 87.6 \times W / DAT \text{ (mm/y)} \quad (1)$$

Where, mm/y - millimeter per year, W - loss in weight in milligrams, D - metal density in g/cm³ (7.86g/ cm³), A - area of the sample in square centimeters, T - time of exposure of the metal surface in hours. The percentage inhibition efficiency (IE %) of the inhibitors in terms of concentration has been calculated from the expression [9],

$$IE = \frac{\text{Weight loss without inhibitor} - \text{Weight loss with inhibitor}}{\text{Weight loss without inhibitor}} \times 100 \quad (2)$$

Where W₀ and W_i are the weight loss values in absence and in presence of the inhibitor respectively.

The effect of temperature on the corrosion rate of mild steel coupons in 1 H₂SO₄ solution at 303 K to 343K was also studied with same concentration of the extract.

RESULTS AND DISCUSSION**Weight loss measurements**

The weight loss methods of monitoring corrosion rate and inhibition efficiency are useful because of its simple application and high reliability. The calculated corrosion rate and inhibition efficiency values at different immersion periods are given in Table 2. The weight loss measurements showed that the corrosion rate of mild steel decreased on increasing CeR concentration at room temperature. There was also a decrease in corrosion rate with increase in immersion period up to 5 h. With prolonged immersion periods there was first increase and then decrease of corrosion rate. It indicates that CeR acts as a good corrosion inhibitor for mild steel.



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The inhibition efficiency increased with increase in concentration of inhibitor and reaches a maximum value of 96.46 % for 2.5 % concentration of CeR. The increase in inhibition efficiency and decrease in corrosion rate may be due to adsorption and desorption phenomena. The corrosion rate of mild steel and inhibition efficiency of various inhibitor concentrations at different immersion periods at room temperature are shown in the Figure.1. The effect of temperature on corrosion rate and inhibition efficiency was studied in the temperature range from 303 to 343 K. The values of corrosion rate and inhibition efficiency obtained from the weight loss measurement at different temperatures are listed in Table 3. From Table 3, it can be noted that corrosion rate increases with rise in temperature. The increase in corrosion rate can be attributed to an appreciable desorption of the inhibitor from the mild steel surface with increase in temperature. Due to more desorption of inhibitor molecules at higher temperatures, the greater surface area of mild steel comes in contact with acid environment. Effects of temperature on inhibition efficiency of CeR with various concentrations are shown in Figure. 2.

FTIR ANALYSIS

It has been well established that FTIR spectrophotometer has been powerful tool that can be used to identify the type of bonding particularly functional group present on organic compounds. Extracts contained organic compounds and these organic compounds were adsorbed on the metal surface providing protection against corrosion. FTIR analysis of metal surface can be useful for predicting whether organic inhibitors are adsorbed or not adsorbed on the metal surface [10]. In the present study, FTIR spectra were used to support the fact that corrosion inhibition of mild steel surface as well as providing new bonding information on the steel surface after immersion in inhibited H₂SO₄. Figure.3 shows FTIR spectrum of the protective film formed on the surface.

SURFACE MORPHOLOGY

The scanning electron microscope images obtained for mild steel surface immersed in 1N H₂SO₄ solution at 303 K temperature for 3 h immersion in the absence and presence of CeR extracts are given in Figure 4. SEM image of inhibited mild steel specimen showed a very protective film formed on the metal surface, which suppresses the rate of corrosion being responsible for the inhibition [11].

CONCLUSION

The stem of CeR extract acts as inhibitor for mild steel corrosion in 1N H₂SO₄ acid solution. The maximum inhibition efficiency of 96.46 % was observed at 2.50 % v/v at various immersion periods. Maximum inhibition efficiency of 95.83 % was obtained at 2.50 % of CeR concentration at different temperatures. The results of the both FTIR and SEM analysis were all in very good agreement to support the above conclusions.

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Table.1 Chemical Composition of Mild Steel Specimen as Element Weight Percentage

S.No.	Name of the Element	Weight percentage
1	Carbon	0.078
2	Manganese	0.190
3	Silicon	0.009
4	Phosphorus	0.008
5	Sulphur	0.008
6	Chromium	0.017
7	Copper	0.009
8	Cobalt	0.001
9	Aluminium	0.034

Table. 2 CR and IE of CeR on Mild Steel in 1N H₂SO₄ at Different Immersion Periods

Conc. of extract (% v/v)	1 h		3 h		5 h		7 h		24 h	
	CR (mm/y)	IE (%)	CR (mm/y)	IE (%)	CR (mm/y)	IE (%)	CR (mm/y)	IE (%)	CR (mm/y)	IE (%)
Blank	35.78	-	36.22	-	36.60	-	36.75	-	36.33	-
0.10	5.80	83.80	5.28	85.42	5.22	85.74	5.38	85.35	5.82	83.63
0.50	3.45	90.34	3.27	90.97	4.21	90.80	4.17	88.64	4.29	87.90
1.00	2.79	92.21	2.60	92.82	2.03	94.45	3.01	91.81	3.19	91.00
1.50	2.56	92.83	2.53	93.01	1.81	95.05	2.04	94.45	2.34	93.43
2.00	2.34	93.45	2.12	94.14	1.54	95.79	1.56	95.75	2.11	94.10
2.50	2.23	93.74	1.93	94.67	1.29	96.46	1.34	96.36	1.42	96.00





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Table. 3 CR of Mild Steel and IE of CeR at Different Temperatures

Conc.	303 K		313 K		323 K		333 K		343 K	
% v/v	CR	IE %	CR	IE %	CR	IE %	CR	IE %	CR	IE %
Blank	56.95	-	124.94	-	267.48	-	376.14	-	567.73	-
0.10	19.60	61.64	45.70	63.43	85.48	68.04	138.31	63.23	211.09	62.82
0.50	14.20	72.21	29.87	76.09	61.41	77.04	115.57	69.27	181.87	67.96
1.00	12.60	75.34	27.08	78.32	42.69	84.04	63.19	83.20	136.08	76.03
1.50	9.50	81.40	15.71	87.42	32.77	87.75	53.61	85.75	86.15	84.83
2.00	8.30	83.75	12.59	89.92	21.29	92.04	37.78	89.96	79.13	86.06
2.50	4.90	90.41	6.69	94.65	11.37	95.83	35.66	90.52	64.64	88.61

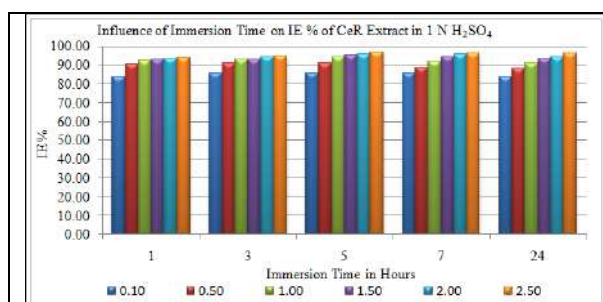


Figure 1. Effect of Immersion Time on Inhibition Efficiency of Mild Steel in 1 N H₂SO₄ Without and With CeR Stem Extract

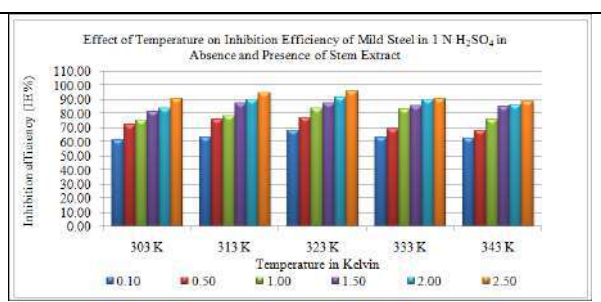


Figure 2. Effect Temperatures on Inhibition Efficiency of Mild Steel in 1 N H₂SO₄ Without and With CeR Stem Extract

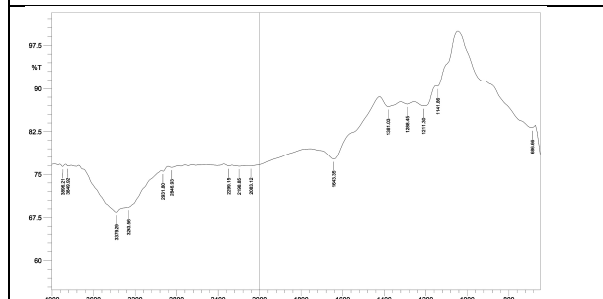
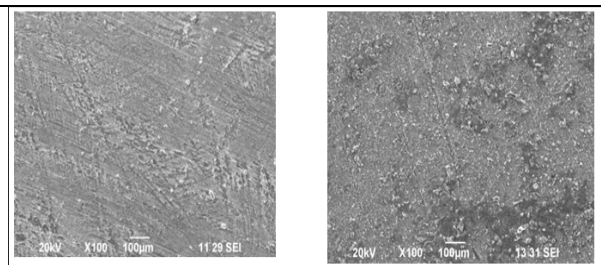


Figure. 3 FTIR Spectra of CeR Extract



**Figure. 4 Scanning Electron Microscopy (SEM) Images of Mild Steel Surface
a) MS in H₂SO₄ Solution b) Mild Steel in the Presence of Inhibitor**





Examining the Effect of Crime Prevention Through Environmental Design (CPTED) on Plotted Development Especially for Women's Safety: A Pilot Survey

Divya Pandey^{1*} and Vandana Sehgal²

¹Assistant Professor, Department of Architecture, Affiliated to Faculty of Architecture and Planning, Dr. APJ Abdul Kalam technical University, Lucknow, Uttar Pradesh, India

²Dean / Principal, Department of Architecture, Affiliated to Faculty of Architecture and Planning, Dr. APJ Abdul Kalam Technical University, Lucknow, Uttar Pradesh, India.

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*Address for Correspondence

Divya Pandey

Assistant Professor,
Department of Architecture,
Affiliated to Faculty of Architecture and Planning,
Dr. APJ Abdul Kalam technical University,
Lucknow, Uttar Pradesh, India
E. Mail : venkateswararaju.k@svcp.edu.in



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ABSTRACT

Analyzing the effect of the built environment on crime prevention started in the early 1970s in western countries. These studies were a kind of reaction to the increasing number of crime occurrences in the urban area. But in India, this study is still in a very early stage of development according to the context. To implement the CPTED as a tool, it needs an explanation to implement in Indian cities. This study aims to evolve and confirm a model of CPTED, which can be used as a framework for the development of residential neighborhoods, especially for women's victimization. A pilot survey is prepared and conducted in the Gomti Nagar area, a hot spot area in Lucknow. This survey is based on the parameters of CPTED, which are activity support, territoriality, maintenance, physical deterioration surveillance, etc. A questionnaire is prepared to analyze their perception of the effect of the built environment on women's safety and the weightage of variables.

Keywords: women safety, CPTED parameters, built environment, planned neighborhood,



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INTRODUCTION

A famous psychologist of America, Abraham Maslow, had derived a theory called Maslow's "hierarchy of need" or a theory of human motivation. It is a five-tier pyramid in which most psychological needs of a human being had been placed. The most primary requirement is placed at the bottom, and then another requirement is placed upward as per the importance of the motivation is needed in human life. This five-tier pyramid, the bottom tier, is filled with all physiological needs like- air, water, warmth, etc., the second tier is for safety, and security has been placed. From ancient times people use to settle where first they can find water and then safety. Initially, they secure them self from animals then invaders. Now people want to stay in a safe and secure neighborhood. Safety and security are also crucial indicators of quality of life derived by the world health organization, which defines the quality of life of a person in the context of the individual's surroundings' specific culture and ethics. It is a consciousness related to the situation of his or her life, which corresponds to their aim, projection, level, and distress of life. These things can be assessed by evaluating the person's physical and psychological health, beliefs, and relationships with society, and primary features of the environment where the person is living. There are eight facets of the environment, and safety and security are an essential part of them.

Violence against women- were important for the international organization for many years. World urban forum, which was held in Canada in 2006 and China in 2008, had women's safety as the main objective of the event. UN-habitat also supports safer cities and human settlements. It was mentioned by UN habitat that the safety of any space depends on three factors: governance, management, and planning or designing of cities. Women's safety also depends on awareness among society, people from an authority, and governance. After awareness, it is also important that how much people are willing to improve women's safety. The third important aspect of reducing violence against women has some mechanism to improve safety (Mtani, 2002). It is also important to make an explicit impact on gender-based violence and making local strategies to improve the women's right to safety (Whitzman *et al.*, 2014). Society or the local community characteristics also have a contribution to women's safety or violence against women. If we elaborate more on societal characteristics, it depends on societal trends prevailing at both the macro and micro levels. The societal trend on the micro-level means at the neighborhood level, and societal trends at the macro level mean at the city level or regional level. These characteristics are influenced by three factors: individual characteristics, characteristics of space, and physical features of the space. The individual characteristics depend on the education, income, age, ethnicity, perceived rate of victimization, sense of attachment, and experiential factor with space in the past. The second aspect of women's safety is the characteristics of space at the micro and macro levels. Micro and macro-level characteristics depend on the social factor: crime rate, type of activity happening at the space, political aspect, and security system. The other factor which influences social trends is the physical feature of the built environment (Tandogan & Ilhan, 2016). The women's perception of individual characteristics, local or community characteristics that get influenced by culture, tradition, trust among the residents, and the third are characteristics of the built environment.

METHODOLOGY

This research aims to identify the impact of built environment parameters on women's safety in a public place. Based on the literature study, the built environment parameters were derived, and for each parameter, multiple indicators were identified. For each indicator, their effect on women's safety was asked on the Likert scale of one to five. One mark for they highly do not agree that a specific indicator of the built environment impacts women's safety and five marks for they highly agree that the specific indicator of the built environment impacts women's safety. For the study, 103 residents were picked randomly from the case study area, i.e., Gomti Nagar, Lucknow from Uttar Pradesh, India, for the survey. Only females were sorted out for the interview. The female population who were selected for this project was homemaker, household worker, student, and working women. It has been ensured that the interviewee fully understood the question, and the purpose of the study was initially briefly discussed with the



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interviewee to avoid any confusion or misinterpretation. The interview was conducted by four methods first was by emailing the questionnaire. The second method was a telephonic interview. The third is through sharing online form, and the last is taking face to face interviews. The questionnaire was made in 2 languages to make the survey easier and better for understanding the interviewee one is in English. The second language is Hindi, which is the local mother tongue of the people.

Context

In this study, we will be taking Lucknow, Uttarpradesh, from India as an area of study. Lucknow is the capital of Uttar Pradesh state. According to the 2011 census, the population of Lucknow is 28.2 lakhs. Lucknow is the most unsafe place for women; it is the most unsafe place for women among India's 19 metropolitan cities. Lucknow is on top for the total number of FIR registered for the crime against women, and Lucknow is on top in the years 2017, 2018, and 2019 pushing Delhi in second place. The total number of FIR registered for a crime against women in 2016 is 2785, and in 2017 it is 2468. The Lucknow district is divided into two divisions by the police department: Lucknow urban and Lucknow rural. Lucknow Urban, which deals with the urbanized area of Lucknow city, and Lucknow rural, deal with the remaining fringe area of Lucknow district. Lucknow urban is again divided into 33 police station areas and Lucknow rural in 9 police station area, so Lucknow district has 42 police station areas within the Lucknow district boundary. For the study, the last three years data of crime has been gathered through the right to information act, 2005. After analyzing the data Gomti nagar and Thankurganj is among those police stations where the highest number of FIR has been lodged, Indira nagar and Gautam Palli is in the lowest registered police station. We will be taking Gominagar as our case study area for research.

LITERATURE REVIEW

Land Use land is a limited natural resource of our environment. Initially, when the population was limited, it was never considered as a limited resource. Only water and security was the main concern but slowly and steadily, when urbanization increased than land management started. Land use is part of the land management process. Land use is the outcome of different activities with land choice (Niazi & Kumar, 2019), or we can say that the function associated with the land parcel. Land management can be done by the planning of land uses. Planning can be loosened, or it can be compact. The location of different activities and street patterns both are part of the land-use planning process. It has been established that the crime location has a particular pattern with a different indicator of city growth (Brantingham & Brantingham, 2005). Previously it has been analyzed that the crime location has been centered towards the urbanized area's core. Even different specific types of crime are associated with a specific type of crime. The routine activity theory (FELSON, 1987), also suggests that the person's routine activity in a public place motivates a criminal to commit a crime because that criminal knows how that person will behave at a specific time of the day and specific location of the area. Street pattern shapes the land parcels, and it also determines the potential crime spot of the city (Suryavanshi *et al.*, 2001). Some land-use activities attract crime like alcohol shops, clubs, disco, and some land-use activities like cemetery repel criminal activity around them. The effect of any activity is between 0 to 50 meters. (Sypion-Dutkowska & Leitner, 2017)

Built Form It is the physical structure of the built environment. It demonstrates the city's physical characteristics (Živković, 2019); to analyze the urban form, we need to understand the size, shape, façade, and fenestration, etc, and the spatial arrangement of the built. Holistically if we analyze the above mentioned, we can analyze the urban form of the area. Defensible space theory (Oscar, 1996) suggested that the building height is one of the important aspects which leads to the occurrence of the crime in the area. As the building height increases, control and ownership of the ground get diluted, which leads to an increase in crime around the building. Size of the footprint or building size, which is a major aspect of urban form, doesn't have a strong effect on an increase in crime (Franck, 2010), But variety in plot size, shape, presence of variety in ownership of the building helps in reduction of crime at any place (Colquhoun, 2004).



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Surveillance has always helped in reducing the commitment of crime at any place. Criminals always search for those places where no one is watching them. Surveillance can be done either formally or informally. Formal surveillance can be done by police patrolling or by the installation of CCTV. Informal surveillance is done by the people from the building adjacent to the public space, and people on the street watch the public place; this type of surveillance is also called natural surveillance (Desyllas *et al.*, 2003). Natural surveillance can be improved by sight from adjoining structures through building opening, illumination, and land use around; it facilitates the public space user surveillance by the building's inhabitant (Subbaiyan & Tadepalli, 2012).

Territoriality The meaning of territoriality is any geographical location or setting possessed, used, engaged, occupied, or inhibited by any living being is called territoriality. Territoriality can be attained by doing an activity that any person achieves in space that is designated to them in common (Raffestin & Butler, 2012). In a private space, ownership is so strong that nobody else can intervene in that space; this is called primary territoriality, for example, home. When the number of public space users is so high that nobody can create any territoriality, then it is called public territoriality. Territoriality can be created at a place in between public and private space, which is secondary territoriality (Abdullah *et al.*, 2014). The creation of territoriality can be done by providing markers to that space like maintaining that space, putting any personalized item, physical barrier, etc.

Physical Deterioration The physical or built environment worsens to worse than the crime increases in that area. Physical deterioration works as a magnet for criminals. It works as an essential indicator for criminals as a better ground for committing any crime. They took it as a sign of a malfunctioned neighborhood (Taylor & Harrell, 1996). The vacant lot and vacant building work as a refuge area for criminal activity. It also manifests that nobody has authorized this space (Branas *et al.*, 2012). Vandalism also symbolizes the neighborhood decline, and it is the most unreported illegal activity. People who are residing at that place always knew about activity, so it translates into a rise in more families aspire to depart from the neighborhood and finally converts to the decline in housing prices in the area (Ceccato, 2012). According to Shideh Shakouri Asl, Azadeh Lak (Asl & Lak, 2017), for the livability of the women, reducing the size of abandoned land or building, wasteland, debris on the road are essential.

Access Control It means there is some restriction to enter any space. At the entrance of the space, access control helps to create a checking point. There must be a presence of the boundary around the space, then the presence of a defined entry for the user helps create access control. The building's entry point should be legible for the people; else they will be lost and feel uncomfortable. Legible entry and the presence of barriers both are essential variables of access control. Without creating above mentioned access control cannot be generated. Access control is one of the critical and initial parameters suggested in defensible space theory, situational crime prevention, and CPTED, which are base theories of crime prevention. The boundary should provide safety and security to the enclosed space but does not hinder the space's natural surveillance around that boundary (Saxena & Kamal, 2018). A perforated boundary can be designed to provide natural surveillance from the secured space. Natural surveillance can be achieved by designing the boundary using such material, which increase the perforation in the wall. A perforated wall also reduced the space for graffiti.

Entrapment Area These are the spaces where people get trapped in a space because of the neighborhood's faulty design. It happens because of the defective street pattern and street section design. Hiding space or niche, dead-end, unused side or back lane, and concealed hidden corner were created by not correctly planning the street layout. The street should be designed in a straight line, doglegged bends and corners should be avoided. It should always be furnished with a mirror, so space's visibility can be enhanced (Valentine, 1990). Niche or recessed doorways, especially at the entrance, are prone to accidents; entries should be avoided with alcoves and niches (Saxena & Kamal, 2018).

Activity Support Activity support can be defined as making any space livelier it can be done by plugging some informal activity or encouraging people to do some everyday activity at that space. The informal activity can be like pedestrian movement or exercising and playing; this can only happen when space is designed for community



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function and the activity mentioned above. A communal space has the quality to accommodate some other casual activity, like sitting, interacting, and spending some time relaxing and chatting. The program organized in the community's public space is like weekend aerobic workout sessions, mental or physical competition among the children (Sakip & Abdullah, 2012).

Lighting Due to the deficiency of illumination fixtures on the street and the neighborhood is entirely ill-lighted. It creates a pitch dark area, which became a potentially criminal activity environment (Painter, 1996) It is an initial step for preventing crime in the area, and it also creates a livable space. Lighting enhances confidence in the people. They feel more secure in the space where lighting has been done, and people will not be afraid of coming out at night also. Lighting is the most workable, affordable, and effective method to reduce crime at any place (Welsh & Farrington, 2008). Lighting on the street and pathway both are essential to reduce the fear of crime. Light color paint on the exterior surface of the building also enhances the visibility in the dark.

Signage Four types of signage are used to familiarize people with something. The first type of signage is identification signage; it designates available facilities and assistance. The second signage is information signage; this signage informs people about any instruction or guides any object or place. The stop sign on the traffic signal is informative signage. The third type is directional signage; it works as a way-finder and orient people about any place. The fourth type of signage is that regulatory signage uses to make people obey some regulation or law. These types of signage should be clear and legible to the people. They should be very strategically placed in public spaces. This signage should include local landmarks at the neighborhood level, inform street layout, inform about gateways, and inform natural features of the place. An effectively outlined signage allows people to orient themselves, the position of exits, and the space routes, making them feel secure against unwelcome and improper conduct by the people. Excessive use of signage should not be encouraged; it should be placed such that the natural surveillance would not get hampered. Placing signage on the windows should be strictly prohibited. All signage should be well lighted so that at night time information can be provided.

Maintenance and Management In broken window theory, Wilson and Kelling established that places where maintenance and management had not been done are more prone to crime. A broken window represents the place is not under some guidance and is not maintained and managed by someone. Well maintained and managed built space motivates people to use or spend time in that space; it enhances the positivity among the resident and user. Routine management and maintenance are needed for sending a festive efficacious spirit among the people. People take pride in their well maintained and managed neighborhood. People try to reside in a neighborhood that is well maintained. The act of maintenance and management can be judge by littering on the street, overgrown plant and grass of landscape, condition of public or government property; if these things are in good condition, that means space is under some guidance (Hedayati Marzbali *et al.*, 2012). A well-managed neighborhood will always maintain exterior walls, doors and windows, roofs, and property boundaries.

Community Deterioration A process when a social unit with some commonalities like location, ethics, language, etc., start getting inferior in quality is called community deterioration. A dilapidated community always prone to crime; it became a developing ground for criminal activity. Drinking alcohol, taking drugs, gambling in a public place (Paul cozens, 2012), and open defecation are all indicators of a deteriorated community. Psychological stressors, a threat to women's privacy, and sexual exploitation is the outcome of absent sanitation (Saleem *et al.*, 2019). A report by the world health organization (World Health Organization, 2008) who's title is violence prevention, the evidence-preventing violence by reducing the availability and harmful use of alcohol, states that alcohol's harmful consumption is a crucial giver of cruelty. It paves the way for violent behavior. An established study suggests that gambling has a strong relationship with women's victimization (Cunningham-Williams *et al.*, 2007).

Permeability A permeable space has more number of choices to enter. For crime, prevention permeability is a very precarious parameter. If any space has maximum permeability, then that space became more prone to crime because no restriction or no check will be there for people entering any space. If we reduce permeability to a minimum, then





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natural surveillance and the informal activity in the area will decrease, so any space always needs a balanced situation for permeability. A designed framework can be generated by which can measure permeability and estimate the degree of utilization of street networks (Cozens & Love, n.d.).

Place Making A way to improve the quality of various places in a neighborhood or space by using art, which plays a significant role in creating a conscious and unified effect in developing the space. Various research has been done where art is used to connect different detached social groups, which finally promotes compatibility and compassion among the resident. This quality of space finally helps in creating a secure society by decreased mutual violence, a very prompt reaction to the person who breaks the rule & enforcement of the law (Ross, 2016). Above all mentioned parameters, with the help of their indicator was surveyed. Women were asked their agreement or disagreement regarding specific indicators. To know their perspective that how much that specific built environment feature is helping in women safety or any specific activity of urban space or feature of space making it more prone to criminal activity. For example, they were asked that " how much do they agree that lighting can help in creating safe environment for women". Their agreement was taken in likert scale from 1-5.

RESULT AND DISCUSSION

For analysis of the survey for the perceptual datamean response of the entire question which is it based on. Through the mean response of each variable its weight of the question calculated. So for all fourteen parameter is based on the few variable. From the survey mean response of all variable based on the parameter is calculated then their weight of the is determined. After getting the weight and mean of the variable is calculated. By adding the all the mean and weight finally weight of the parameter is determined.

Here the weights are calculated by the equation,

$$w = \frac{\text{mean grade of particular question}}{\text{total of all means}}$$

This process is helping in identifying the mean of the each parameter and analyzing the weight of the each parameter. The weightage obtained by land use of built form, surveillance, territoriality, physical deterioration, access control, activity support, lighting, signage, maintenance and management, physical deterioration, permeability and place making is 6.71, 6.07, 7.75, 6.83, 7.27, 7.09, 7.29, 7.29, 7.96, 7.05, 7.02, 7.47, 6.87 and 7.31. After analyzing the graph and table it can be said that maximum weightage was given to Lighting and Surveillance while minimum to Built form. This perception analysis was conducted in likert scale of 1-5 where 1 marks will be given when they do not agree with the statement and 5 is for strong agreement with the statement. All the result are lying under 60-100 percentage that means that the perception of the women is they agree that every parameters has an impact on the women safety where the maximum influence is happening by light.

CONCLUSION

- Each and every parameter of built environment has some level of effect on occurrence of crime in any area.
- Provision of lighting helps in building confidence among the women to use the public space at night and they think that it will helps in reducing the crime in the area also.
- There should be policy or byelaws of built environment such that it increases the eye on street, which reduces the opportunity for motivated offender.

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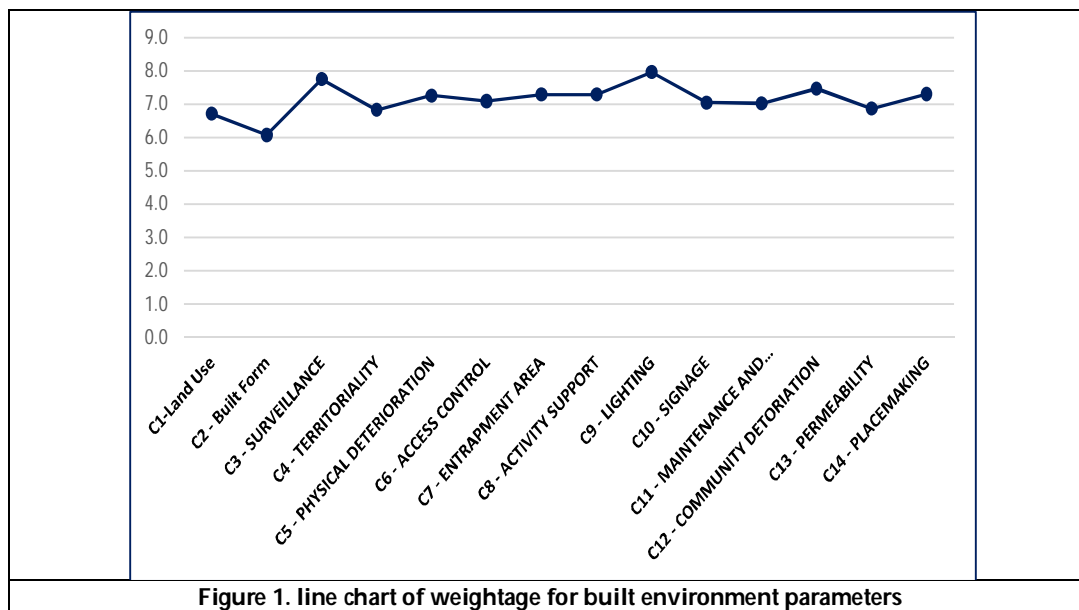
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A Supply Chain Model with Ordering Cost Reduction and Rework under Trade-Credit

S. Hemalatha^{1*} and K. Annadurai²

¹Assistant Professor, Department of Mathematics, SSM Institute of Engineering and Technology, Dindigul, Tamil Nadu, India.

²Assistant Professor, Department of Mathematics, M.V. Muthiah Govt. Arts College for Women, Dindigul, Tamil Nadu, India.

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*Address for Correspondence

S. Hemalatha

Department of Mathematics,
SSM Institute of Engineering and Technology,
Dindigul, Tamilnadu, India.
E. Mail : shemalatha1974@gmail.com



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ABSTRACT

The consequence of investing in reducing setup cost and trade credit financing on the integrated inventory models is an object of analysis for a long period of time in the integrated production-distribution single-vendor single-buyer inventory system. To fascinate more deals, the customer orders an amount greater than or equal to a fixed quantity, sellers frequently issue a trade credit. In this paper, a supply chain with a single vendor and a single buyer is demonstrated, along with an integrated production-distribution inventory model while considering the vendor's allowable delay period to the buyer. Further investment can further lower the cost of vendor setup. Reduced lead times and ordering costs are interdependent. In order to examine the order of quantity, a number of deliveries, optimal values of lead time, the joint total expected cost (JTC), lead time crashing cost, and the ordering costs, a mathematical model is developed by adopting the case that the ordering cost-time relationship is a linear function. The implications of the numerical illustration clearly show that the buyer trades off the advantages of payment delay. The sensitivity analysis of the ideal solution in relation to various system factors also yields some significant management insights.

Keywords: Trade credit, Ordering cost reduction, Lead time reduction, Rework, Integrated inventory model.

INTRODUCTION

In the last decade, reduction in ordering costs and lead time has attracted considerable research attention. Later, numerous researches addressed the reduction of ordering cost or lead time or both to extend their work. Many



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factors have been taken into consideration, and the integrated method has been under close scrutiny for years, in order to increase inventory control functionality. Goyal [25] was the first to explore a system with a single vendor - buyer that uses an integrated inventory model and his work inspired other academics to offer a variety of systems with integrated inventories. Banerjee [12] created a cooperative model of affordable batch size for buyers and sellers. Hill [28], Ben-Daya and Hariga [14], Abdul-Jalbar *et al.* [1], and Ben-Daya and Raouf [13], among others, explored a stochastic inventory system's lead time reduction with learning consideration. By controlling setup costs, Annadurai and Uthayakumar[3] established a (Q, r, L) model of inventory with products that are defective.

The majority of inventory control research in recent years has focused on creating more accurate and useful models intended for those who make decisions. In order to promote demand, the supplier will extend a period of trade credit with the retailer, which is a payment delay for the purchasing price. Giving the store access to such a credit period will promote supplier sales and lower the amount of available stock. Without a first payment, the store can simultaneously benefit from a period of credit to lower costs and boost profit. Additionally, the store might begin to compile sales receipts and receive interest on those revenues during this credit period. Trade credit might therefore be crucial to the inventory model for both suppliers and retailers. Tsao and Sheen [40] proposed rules for replenishment, promotion, and dynamic pricing for an item that is deteriorating. A vendor-buyer integrated cooperative model with various acceptable payment delays was developed by Chen and Kang in [18]. An EOQ model for perishable goods was created by Annadurai and Uthayakumar [6] by incorporating a trade credit partial system in the financing. In a study of an inventory model, Annadurai [8] discovered the quantity of purchases that are best made for things that decay exponentially under two degrees of trade credit.

In the framework of a two-echelon inventory system with predictable setup costs and lead times and a service level limitation, Uthayakumar and Priyan [41] adopted an acceptable delay in payments policy. Affisco *et al.* [2] demonstrated a model of joint economic lot size that results in a setup reduction and quality enhancement. Uthayakumar and Rameswari [42] established a supply chain concept under credit policy with varying lead times to encompass quality enhancement and lead time reduction. An ideal replenishment deteriorating product management approach with limitations and salvage value was established by Annadurai [7]. A capital expenditure function in place of the setup cost parameter was used in Billington's EPQ model from [15]. A model for integrated inventories with predictable lead times that includes supply chain system investments with quality enhancement was created by Vijayashree and Uthayakumar[43]. They also took into account the fact that the lead is the same for all customers and that it is reducible by paying an extra crash cost, which progressively rises with lead time. For defective goods, a model of economic production lot size, Das Roy *et al.* [21] used rework, backlogs, and stochastic demand. Vijayashree and Uthayakumar[44] presented a design of the supply chain's two echelons using a controlled lead time. Additionally, Vijayashree and Uthayakumar[45] expanded a model that included an exponential function for lead time crashing costs. Using the credit term, Arkan and Hejazi[11] created a co-ordinating order for a two-tier supply chain with adjustable ordering costs and lead time.

Credit-linked demand's effect on the retailer's ideal replenishing strategy was studied by Jaggi *et al.* in [32]. Deteriorating goods are not taken into account in their paper. By integrating degrading objects, Annadurai and Uthayakumar [5] expanded the model of Jaggi *et al.* [32]. Furthermore, Annadurai and Uthayakumar [9] constructed a concept of two tiers for inventory with demand that depends on the credit period, which include shortfall depending on financing of trade credit on two levels, and figuring out the retailer's ideal re - order strategy where both the vendor and the seller offer the period of credit to increase client demands. The benefits of attempting to lower setup costs can be easily understood using the just-in-time (JIT) production experience of the Japanese.

Yang and Pan [47] suggested a model for inventory that incorporates deterministic different lead times and investment in enhancement of quality. In the context of JIT and an EMQ manufacturing system, Das Roy *et al.* [20] created an integrated producer-buyer interaction. One of the first to articulate the idea of an interdependent lead times and ordering costs reduction approach was Chen *et al.* [17]. In a backorder price discount inventory model of periodic reviews, Ouyang *et al.* [35] took into consideration the interdependent reductions in lead times and ordering



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costs. The ordering costs and lead times savings in the inventory model with partial backorder for on-going reviews were presented by Ouyang *et al.* in [34]. In a supply chain framework, Vijayashree and Uthayakumar [46] established the idea of an interdependent reduction policy for ordering costs and lead times and also estimated the quantity of deliveries, order quantity, and the optimal lead times.

Reduced setup costs and controllable lead times are the foundations of modern production management, and have attracted research interest. Lead times and/or setup cost management have a direct or indirect impact on order quantity, service quality, and commercial acuity. However, in some real-world circumstances, lead times and setup costs can be managed and minimized in numerous ways. A vendor-buyer integrated cooperative model of inventory with reduced ordering costs and adjustable lead times has been suggested by Chang *et al.* in [16]. A vendor-managed integrated model of inventory with order cost reduction for a two-echelon system was presented by Zhang *et al.* [48]. Huang [29] created a model for integrated inventory while processing the orders at a reduced cost and allowing for payments to be delayed. The ordering cost reduction was taken into account by Annadurai and Uthayakumar [4] in a model for a statistical inventory with adjustable lead times and a service level.

A vendor-buyer integrated model of inventory with reduced order processing costs and allowable payment delays was examined by Huang *et al.* [20]. A price reduction for backorders and an inventory model with damaged items were created by Annadurai and Uthayakumar in [10]. A buyer-vendor model of supply chain with lower startup costs was established by Sarkar and Majumder [38]. A buyer-vendor integrated cooperative model of inventory with service level constraint, predictable lead times, and reduced ordering costs was presented by Sara *et al.* [37]. When the quantity received is unclear, Priyan and Uthayakumar [36] created a stock-based model for continuous reviews with lost sales rate, order processing costs and adjustable lead times. Hemapriya and Uthayakumar [27] explored an inventory model integrated with lead times that depended on the ordering cost.

A model of supply chain including trade-credit, rework, stochastic demand, and dependent ordering cost reduction for lead-times was developed by Das Roy [24]. A model of supply chain including transportation discounts, trade-credit financing, and stochastic lead times was put up by Kim and Sarkar [33]. A learning curve for production procedures interrupted by process restoration and reworks was put out by Jaber and Guiffrida [31]. Using current value, Tharani and Uthayakumar [39] suggested a unique method for supply chain safety-stock management integrated with manageable lead times. A supply chain integrated with exponential crashing costs due to lead time, uncertain demand reduction of setup costs, and rework was established by Das Roy [23]. By ensuring additional investment and consequently lowering setup costs, Hemalatha and Annadurai [26] presented an inventory-production-distribution system that is integrated for deteriorating items in fuzzy environments. Priyan and Uthayakumar [36] developed a continuous review inventory model with controllable lead time, lost sales rate and order processing cost when the received quantity is uncertain. The effect of delayed differentiation on an integrated inventory system with rework for several products from multiple vendors and buyers was examined by Chiu *et al.* [19]. A nonlinear EOQ model was created by Das Roy [22] for shortages with inflation, deterioration, and time-dependent demands.

The traditional inventory model makes the implicit assumption that it has flawless quality. However, it is frequently seen in the actual manufacturing environment that defective products are generated as a result of defective production procedures. It is necessary to reject, repair, or rework the problematic objects. There are always significant expenditures involved. In order to lower the expenses associated with quality, the system management with an imperfect manufacturing technique might take into account of capital investment in quality enhancement. This fact is taken into account in the current paper's integrated inventory model, which also allows for rework to be done on trade credit and allowed payment delays. The paper is structured as follows. In Section 2, the assumptions and notations are presented. The method of solution and the mathematical model are described in Section 3. Section 4 provides the solution algorithm. In Section 5 numerical examples are illustrated and Section 6 concludes the study respectively.





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Notation and Assumptions

Notations and presumptions from the model developed by Huang *et al.* (2010 b) are used. Below, we have outlined these notations for completeness and convenience.

The following variables and parameters are employed in the development of proposed model.

$A_C(L_t)$ Ordering costs for the buyer (\$ /order), a decision variable,

$$0 < A_C(L_t) \leq A_{C0}$$

A_{C0} Original ordering costs for the buyer (\$ /order)

C_{RW} Rework cost per unit of the vendor

D Demand

F_C Constant cost of transportation for each delivery (\$ /delivery)

h_{vC} Holding vendor costs (\$ /units/ timeunit)

h_{BC} Holding buyer costs (\$ /units/ time unit)

$I(S)$ Capital investment required to reduce setup cost, $I(S) = M \ln \left(\frac{S_{v0}}{S_v} \right)$

for $0 < S_v \leq S_{v0}$

I_{MC} Interest rate used to determine the vendor's annual potential interest Loss as a result of the payment delays

I_{BC} Interest should be paid annually to the bank per \$of stock

I_{SC} Annual interest on the buyer's deposit

K Safety factor

N Number of decision variable deliveries for each batch production

L_t Length of the decision variable lead times

$Z(L_t)$ Cost of lead time crashing of the buyer (units/ time unit)

P_C Unit purchase costs

Q Order quantity

R_C Production rate (units/ time unit)

R_O Buyer's reorder point

r_{vC} Vendor's unit production costs

r_{BC} Buyer's unit purchase costs

S_{v0} Production batch's initial setup costs

S_v Production batch setup costs for manufacturing, a decision variable

U The annual duration of the trade credit period

t Permitted delay in account settlement

X Demand for lead times per unit time, a random variable

θ Percentage of a production lot of flawed goods

$JTC(Q, L_t, N)$ Joint total expected cost per unit time





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Assumptions

In the model, the following presumptions are made:

- The integrated-inventory system is designed for a single buyer and a vendor.
- Demand is regarded as a deterministic and constant.
- There are flaws in the production process. Perfect and flawed goods of both categories are made.
- Rework of damaged goods is considered. Let θ be the percentage of damaged goods in a production lot of size

NQ . Therefore, the estimated number of defective items are θNQ . Rework cost is = $(C_{RW}\theta NQ)\left(\frac{D}{NQ}\right) = C_{RW}\theta D$.

- The inventory is evaluated on a regular basis. The purchasers make a purchase when the available inventory hits the reorder point R_o .
- The reorder point R_o is reached in the inventory position, the buyers make an order. The reorder point $R_o =$ expected demands during safety stocks + lead times, i.e. $R_o = DL_t + k\sigma\sqrt{L_t}$ where σ is the standard deviation and K is the safety factor.
- No shortage is allowed.
- Transport and other handling charges are covered by the buyer.
- A payment delay is permitted by the vendor to the buyer.
- For the purchaser to collaborate on the integrated strategy, the supplier offers specific trade credit duration U . As a result, the buyer postpones the replenishment account's settlement until the very last second of the vendor's permitted delay period.
- The buyer has the option to sell the products before the period of trade credit expires in order to generate revenue and collect interest I_{SC} . The vendor experiences an annual rate of opportunity interest loss I_{MC} where $I_{MC} = I_{SC}$, throughout the period of delayed payments.
- Lead time L_t is consisting of m mutually exclusive elements. The cost of crashing per unit time is represented by the i^{th} component, with the minimal duration a_i and the usual duration b_i . $C_i, i = 1, 2, 3, \dots, m$ that is $C_1 \leq C_2 \leq C_3 \leq C_4 \dots \leq C_m$. Let $L_{t0} = \sum_{i=1}^m b_i$ and L_t denotes the duration of the components of lead time 1, 2, 3... m , crashed

to their shortest time possible. Let us consider $L_{t_i} = L_{t_0} - \sum_{j=1}^m (b_j - a_j), i = 1, 2, 3, \dots, m$ and a cycle's cost for

lead time crashing $Z(L_t) = C_i(L_{t_{i-1}} - L_t) + \sum_{j=1}^{i-1} C_j(b_j - a_j)$.

Mathematical Model

This section includes a design for the integrated single buyer - vendor system with allowable payment delays is constructed. In an effort to minimize the joint total estimated costs, ordering costs reduction measures dependently and rework under trade credit.





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Buyer’s Expected Total Cost

The buyer's cycle length is $\frac{Q}{D}$, the relevant ordering costs and lead time crashing costs are $\frac{A_c D}{Q}$ and $\frac{DZ(L_t)}{Q}$ respectively. The cycle's estimated inventory is $\frac{Q}{2} + k\sigma\sqrt{L_t}$. The cycle stock's holding costs in this instance is $\frac{h_{BC}r_{BC}Q}{2}$ per unit of time because $\frac{Q}{2}$ is the expected cycle stock. As opposed to this, safety stock $k\sigma\sqrt{L_t}$ is kept all through the cycle. Therefore, in accordance with the trade credit policy, both the purchaser and the seller are required in order to pay this stock's holding expense in addition to the interest paid by the vendor at the rate of I_{BC} to this part of stock. As a result, total safety stock cost per time unit is $(h_{BC} + I_{BC})r_{BC}k\sigma\sqrt{L_t}$, which stands for holding cost and interest charged. The buyer has the option to sell the products within the credit period U , generate revenue, and accrue interest I_{SC} until the period of credit expires. Consequently, the purchaser's gained interest per unit of time is $\frac{D^2U^2r_{SC}I_{SC}}{2Q}$. On the other hand, after the permitted delay expires, the purchaser still has $(Q - DU)$ units that have not been sold. As a result, the buyer has a loan with an interest rate of I_{BC} for the unsold apartment's unpaid purchase price. As a result, $\frac{r_{BC}I_{BC}(Q - DU)^2}{2Q}$ is used to calculate the cost of opportunity interest per cycle for the unsold commodities.

Consequently, the overall cost to the consumer, which includes the expense of maintaining safety stock, ordering, holding, crashing lead times, earning interest, and paying opportunity interest is given as

$$JTCB(Q, L_t) = \frac{A_c D}{Q} + \frac{h_{BC}r_{BC}Q}{2} + (h_{BC} + I_{BC})r_{BC}k\sigma\sqrt{L_t} + \frac{DZ(L_t)}{Q} - \frac{D^2U^2r_{SC}I_{SC}}{2Q} + \frac{r_{BC}I_{BC}(Q - DU)^2}{2Q} \tag{1}$$

Vendor’s Expected Total Cost

The vendor’s expected holding cost (Huang *et al.* (2010 b)) can be expressed as $\left(\frac{Q}{2}\right)\left(\frac{N-2}{N}\right)\left(1 - \frac{D}{R_C}\right)h_{VC}r_{VC} + \left(\frac{Q}{2N}\right)h_{VC}r_{VC}$. Considering that a lot size's production quantity is NQ units and S_V is the setup costs for any vendor setup, the anticipated vendor's setup cost is $\frac{DS_V}{NQ}$. The purchaser also gets a bank loan for the price of the unsold item. As a result, the seller has an annual rate of interest loss I_{MC} where $I_{MC} = I_{SC}$ throughout the delayed payment's credit term. As a result, $\frac{Ur_{BC}I_{MC}NQ}{NQ/D} = DUr_{BC}I_{MC}$ represents the vendor's expected potential interest loss per unit. On the other hand, the manufacturing procedure is insufficient and reworking damaged goods is taken into account. In a production lot of size NQ , let θ represent the proportion of





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defective goods. Such that, the expected quantity of defective products is θNQ . Thus, $C_{RW}\theta D$ provides the expected rework cost. Hence, the vendor's overall cost encompassing of setup cost, opportunity interest loss, holding cost, and rework cost is stated as

$$JTCV(Q, N) = \frac{DS_V}{NQ} + \left(\frac{Q}{2}\right)\left(\frac{N-2}{N}\right)\left(1 - \frac{D}{R_C}\right)h_{VC}r_{VC} + \left(\frac{Q}{2N}\right)h_{VC}r_{VC} + C_{RW}\theta D + DUr_{BC}I_{MC}. \quad (2)$$

According to Huang *et al.* (2010 b), the vendor and the customer's joint total estimated cost per unit time can be represented as follows:

$$JTC(Q, S_V, L_t, N) = \tau M \ln\left(\frac{S_{V0}}{S_V}\right) + \frac{D}{Q} \left\{ S_V + A_C + NF_C + Z(L_t) + \frac{DU^2(r_{BC}I_{BC} - r_{SC}I_{SC})}{2} \right\} \\ + \frac{Q}{2} \left(\left(\frac{N-2}{N}\right)\left(1 - \frac{D}{R_C}\right)h_{VC}r_{VC} + \frac{h_{VC}r_{VC}}{N} + h_{BC}r_{BC} + \frac{P_C I_C}{1 + I_C t} \right) \quad (3) \\ + C_{RW}\theta D + (I_{BC} + h_{BC})r_{BC}k\sigma\sqrt{L_t} + DUr_{BC}(I_{MC} - I_{BC})$$

for $0 < S_V \leq S_{V0}$, where $M \ln\left(\frac{S_{V0}}{S_V}\right) = I(S)$ is the logarithmic investment function and τ is the annual fractional

opportunity cost of capital. In this case, $M = \frac{1}{\eta}$, and η represent the percentage reduction in S per dollar of investment.

We assess the problem by lowering the cost of ordering while reducing the lead time. In particular, we take into account the circumstance when the cost of ordering is a time-dependent linear function. According to Chen *et al.* (2001), it is presumable that ordering costs and lead time reductions have the relationship that follows.

$$\left(\frac{L_{t_0} - L_t}{L_{t_0}}\right) = \omega \left(\frac{A_{C_0} - A_C}{A_{C_0}}\right) \quad (4)$$

and the linear correlation between lead times and ordering costs reduction percentages is described by the constant scaling parameter $\omega > 0$. The ordering cost A_C can be expressed as a linear function of L_t by taking into consideration the relationship (4), that is,

$$A_C(L_t) = x + yL_t \quad (5)$$

where $x = \left(1 - \frac{1}{\omega}\right)A_{C_0}$ and $y = \frac{A_{C_0}}{\omega L_{t_0}}$. By substituting Equation (5) for Equation (3), we obtain

$$JTC(Q, S_V, L_t, N) = \tau M \ln\left(\frac{S_{V0}}{S_V}\right) + \frac{D}{Q} \left\{ S_V + (x + yL_t) + NF_C + Z(L_t) + \frac{DU^2(r_{BC}I_{BC} - r_{SC}I_{SC})}{2} \right\} \\ + \frac{Q}{2} \left(\left(\frac{N-2}{N}\right)\left(1 - \frac{D}{R_C}\right)h_{VC}r_{VC} + \frac{h_{VC}r_{VC}}{N} + h_{BC}r_{BC} + \frac{P_C I_C}{1 + I_C t} \right) \quad (6) \\ + C_{RW}\theta D + (I_{BC} + h_{BC})r_{BC}k\sigma\sqrt{L_t} + DUr_{BC}(I_{MC} - I_{BC})$$

for $0 < S_V \leq S_{V0}$.





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Constrained non-linear programming appears to be the optimal solution for the aforementioned problem. To solve this kind of non-linear problem, we ignore temporarily the constraint $0 < S_V \leq S_{V0}$ and reduce the overall cost function $JTC(Q, S_V, L_t, N)$ over Q, S_V, N and L_t with classical optimization technique. For fixed value of N and given $L_t \in [L_{t_i}, L_{t_{i-1}}]$, $JTC(Q, S_V, L_t, N)$ can be demonstrated to be a concave function of L_t . As a result, at the optimal solution, the joint total estimated cost (JTC) achieves a global minimum.

Theorem 3.3 At the optimal solution, when the JTC reaches a global minimum Q^* and S^* for a fixed value of N and given $L_t \in [L_{t_i}, L_{t_{i-1}}]$.

Proof: The first and second partial order derivatives of $JTC(Q, S_V, L_t, N)$ with regard to Q, S_V and L_t for $L_t \in [L_{t_i}, L_{t_{i-1}}]$ are as follows:

$$\frac{\partial JTC(Q, S_V, L_t, N)}{\partial Q} = -\frac{D}{Q^2} \left\{ S_V + (x + yL_t) + NF_C + Z(L_t) + \frac{DU^2(r_{BC}I_{BC} - r_{SC}I_{SC})}{2} \right\} + \frac{1}{2} \left(\left(\frac{N-2}{N} \right) \left(1 - \frac{D}{R_C} \right) h_{VC}r_{VC} + \frac{h_{VC}r_{VC}}{N} + h_{BC}r_{BC} + \frac{P_C I_C}{1 + I_C t} \right), \tag{7}$$

$$\frac{\partial JTC(Q, S_V, L_t, N)}{\partial L_t} = \frac{Dy}{Q} + \frac{DC_i}{Q} + \frac{1}{2\sqrt{L_t}} (I_{BC} + h_{BC}) r_{BC} k \sigma, \tag{8}$$

$$\frac{\partial JTC(Q, S_V, L_t, N)}{\partial S_V} = \frac{D}{Q} - \frac{\tau M}{S_V}, \tag{9}$$

$$\frac{\partial^2 JTC(Q, S_V, L_t, N)}{\partial Q^2} = \frac{2D}{Q^3} \left\{ S_V + (x + yL_t) + NF_C + Z(L_t) + \frac{DU^2(r_{BC}I_{BC} - r_{SC}I_{SC})}{2} \right\} > 0, \tag{10}$$

$$\frac{\partial^2 JTC(Q, S_V, L_t, N)}{\partial L_t^2} = -\frac{1}{4\sqrt{L_t}} (I_{BC} + h_{BC}) r_{BC} k \sigma < 0. \tag{11}$$

It is clear from Equation (11) that for a fixed Q, S_V and $N, JTC(Q, S_V, L_t, N)$ is a concave function of L_t . If Q, S_V, L_t and N are fixed then the minimum value of $JTC(Q, S_V, L_t, N)$ occurs at the finish line of $L_t \in [L_{t_i}, L_{t_{i-1}}]$. Also, if N is fixed and $L_t \in [L_{t_i}, L_{t_{i-1}}]$ is given then $JTC(Q, S_V, L_t, N)$ is a convex function of Q as $\frac{\partial^2 JTC(Q, S_V, L_t, N)}{\partial Q^2} > 0$. Thus, at the optimal solution, $JTC(Q, S_V, L_t, N)$ achieves a global minimum Q^* . On the other hand, by setting Equations (7) and (9) equal to zero, for a given value of $L_t \in [L_{t_i}, L_{t_{i-1}}]$, we obtain,

$$Q = \sqrt{\frac{2D[S_V + (x + yL_t) + NF_C + Z(L_t) + \frac{DU^2(r_{BC}I_{BC} - r_{SC}I_{SC})}{2}]}{\left(\left(\frac{N-2}{N} \right) \left(1 - \frac{D}{R_C} \right) \right) h_{VC}r_{VC} + \frac{h_{VC}r_{VC}}{N} + h_{BC}r_{BC} + \frac{P_C I_C}{1 + I_C t}}}, \tag{12}$$





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and $S_V = \frac{\tau MQ}{D}$. (13)

Hence, the proof. The technique is for determining the optimum values of (Q, S_V, L_t, N) and $JTC(Q, S_V, L_t, N)$ is provided below.

Solution Algorithm

Step1 : Set $N = 1$.

Step2 :For every $L_t \in [L_t, L_{t-1}]$, $i = 1, 2, 3, \dots, m$ follows the Steps(2.1) – Steps(2.3) until no change occurs in the values of Q and S_V . Denote the solution by (Q^*, S_V^*, L_t^*, N) .

Step (2.1). Start with $S_{V_1} = S_{V_0}$.

Step (2.2). Apply the value of S_{V_1} in Equation (12) to get Q_1 .

Step (2.3). Utilizing Q_1 determines S_{V_2} from Equation(13).

Step 3 :Compare S_V^* with S_{V_0} .

Step 3.1.If $S_V^* < S_{V_0}$, then go to Step 4.

Step 3.2.If $S_V^* > S_{V_0}$, then for given N , Let $S_V^* = S_{V_0}$ and thereby using

Equation (12) evaluate the new Q^* , then go to Step 4.

Step 4 :Using Equation (6), calculate the appropriate $JTC(Q, S_V, L_t, N)$.

Step 5: Find $\min_{i=0, 1, 2, 3, \dots, m} JTC(Q_i, S_{V_i}, L_t, N)$. If $JTC(Q^*, S_V^*, L_t^*, N) = \min_{i=0, 1, 2, 3, \dots, m} JTC(Q_i, S_{V_i}, L_t, N)$, then for fixed N , $(Q_i^*, S_{V_i}^*, L_t^*)$ is the optimum solution.

Step 6 : Set $N = N + 1$ and utilize the Steps (2) – (5) to find $JTC(Q_N^*, S_{V_N}^*, L_{t_N}^*, N)$.

Step7 : Proceed to Step 6, if $JTC(Q_N^*, S_{V_N}^*, L_{t_N}^*, N) \leq JTC(Q_{N-1}^*, S_{V_{N-1}}^*, L_{t_{N-1}}^*, N - 1^*)$, or else, proceed to Step 8.

Step8 :If $(Q^*, S_V^*, L_t^*, N^*) = (Q_{N-1}^*, S_{V_{N-1}}^*, L_{t_{N-1}}^*, N - 1^*)$, then $JTC(Q^*, S_V^*, L_t^*, N)$ is the minimum value and $(Q_i^*, S_{V_i}^*, L_t^*, N)$ is the optimum solution.

Numerical Example

In this section, an appropriate illustration of the proposed model is presented.

Example 1With the same data as Uthayakumar and Rameswari (2013) and Das Roy (2020), we propose an inventory system as: $A_{C_0} = \$ 200$ per order, $D = 6000$ units per year, $C_{RW} = \$ 3$ per unit, $F_C = \$100$ per shipment, $I_{SC} = \$ 0.02$ per unit, $h_{BC} = \$250$ unitsper year, $h_{VC} = \$ 200$ units per year, $\sigma = 7$ units per week, $K = 2.33$, $L_{t_0} = 8$ weeks, $U = 0.1$ year, $R_C = 7500$ units per year, $r_{BC} = \$ 0.2$ per unit, $r_{VC} = \$ 0.2$ per unit, $r_{SC} = \$ 30$ per unit, $S_V = \$ 400$ per setup, $\theta = 0.05$, $I_{MC} = 0.02$, $I_{BC} = 0.06$, $P_C = 10$, $I_C = 0.15$, $M = 18000$ and $t = 0.25$. The ordering costs A_C is the linear function of L_t , by assuming that the connection between ordering costs and time is a linear function such





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that, $A_c(L_t) = x + yL_t$, where $x = \left(1 - \frac{1}{\omega}\right)A_{C_0}$, $y = \frac{A_{C_0}}{\omega L_{t_0}}$, $L_{t_0} = 8$, $\omega = 5.00$ and $A_{C_0} = 200$. The buyer's

lead time comprises three elements, as illustrated in Table 1.

Implementing the proposed technique, It produces the best lead time solutions $L_t^* = 4$, number of deliveries $N^* = 2$, ordering quantity $Q^* = 400$, lead time crashing cost $Z(L_t^*) = \$22.4$, ordering cost $A_c(L_t^*) = \$180$, and the optimum JTC represented as $JTC(Q, S_v, L_t, N) = 27793$. The outcomes of using the suggested algorithm approach are depicted in Table 2 and Table 3 and the Figures 1 and 3 display corresponding representations in graphical form. Also, for the linear case, we obtain the optimization result for the given example and is summarized in Table 4 and Table 5 and in Figures 2 and 4, the corresponding graphical representation is displayed.

Sensitivity Analysis

In this section, the optimum ordering quantity Q and setup cost S_v with the lowest total projected cost are examined, as are the implications of changes in the system variables D , $A_c(L_t)$, h_{vC} , h_{BC} , I_{MC} and I_{BC} . Whenever a particular parameter varies (decreases or increases) by 10% and the other parameters remains the same. Hence the optimum values of Q , S_v , and $JTC(Q, S_v, L_t, N)$ are determined. Tables 8 – 14 present the findings of the sensitivity analysis, which are shown graphically in Figures 7 – 13. Additionally, sensitivity analysis is made sure of by altering the value of ω in example 1 to 10, 7.5, 3.5, and 2 and examining the consequences on the optimum solution. The findings of the system parameter sensitivity analysis are represented graphically in Figures 5–6 and presented in Tables 6–7. The subsequent results can be made based on the findings of Tables 6 – 14 and Figures 6 – 13:

- From Table 6, it is significant to remember that diminishing the value of ω will lead to a rise in the ordering quantity Q and decreases the JTC represented as $JTC(Q, L_t, N)$.
- For numerous numbers ranging from 3000 units to 9000 units with a 600 increment, Table 8 provides the optimal solution. Increases in demand results increases in order quantity Q . This result has implication on the holding cost, ordering cost as well as delivery cost. Therefore, an increase in demand will lead to the joint total projected cost increasing $JTC(Q, S_v, L_t, N)$ and decreases in setup cost S_v .
- As the buyer's ordering cost $A_c(L_t)$ increases, $JTC(Q, S_v, L_t, N)$ and the order quantity is expected to increase as well. This is because the typical overall cost is significantly affected by the divergence from the ideal solution for high ordering cost values. In Table 9, this observation is displayed.
- Table 10 illustrates that when the vendor holding cost h_{vC} increases, $JTC(Q, S_v, L_t, N)$ increases. This is expected; due to the vendor holding expenses is the significant components of the typical overall cost. In addition, order quantity Q and setup cost S_v decreases with increase in vendor holding cost h_{vC} .
- Table 11 ensure that, increase in $JTC(Q, S_v, L_t, N)$ and decrease in the ordering quantity Q when the buyer holding cost h_{BC} increases.
- Table 12 shows the data connected with the influence of transportation cost F_C on the optimum solution. It is expected that $JTC(Q, S_v, L_t, N)$ and the order quantity would increase when the cost of transportation increases.
- From Table 13, it's important to note that increase in the interest payable leads to a rise in $JTC(Q, L_t, N)$ and the order quantity Q remains same.



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- From Table 14, we note that the JTC decreases when the interest charge rises, and the order quantity rises.

CONCLUSION

In this study, rework able items are considered for a single-vendor model of the single-buyer supply chain. This article investigates ordering cost and lead time reduction for financing on trade credit. By taking the assumptions of ordering cost and lead time reduction follows a linear relation. Also, vendor allows buyer a delay in payment and invests an extra capital to minimize the cost setup. The primary contribution is to reduce the supply chain model's joint total estimated cost with ordering cost reduction and rework under trade-credit by optimizing concurrently the number of deliveries, order of quantity, lead time crashing costs and ordering costs. The steps of the method are demonstrated using a numerical representation. A thorough sensitivity analysis of how the parameters' effects on the decisions are given is also provided. According to the sensitivity analysis, we draw several managerial implications. The consequences of the mathematical illustration clearly show that the buyer trades off the advantages of payment delay. Additionally, a graphic illustration is given to support the proposed methodology. By accounting for shortage and backordering, this research can be furthered. There are a few other ways this research can be expanded as well. We could, for example, change the constant rate of demand to a more accurate fluctuating demand rate over time that varies with selling price, time, and other factors.

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Table 1:Data on lead time

Lead time component	Minimum duration _a (days)	Normal duration b _i (days)	Unit crashing cost _c (\$/week)
1	6	20	2.8
2	6	20	8.4
3	9	16	3.5

Table 2:Optimum values for various lead time values

L_t (weeks)	$Z(L_t)$ (\$)	$A_c(L_t)$ (\$)	N	S_v (\$)	Q	$JTC(Q, S_v, L_t, N)$ (\$)
8	0	200	1	104	347	29256
			2	120	400	28635
			3	130	435	29239
			4	139	463	30127
			5	147	489	31102





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			6	154	512	32101
			7	160	534	33099
6	5.6	200	1	104	348	28951
			2	120	401	28317
			3	131	436	28915
			4	139	465	29797
			5	147	490	30769
			6	154	513	31765
			7	160	535	32761
4	22.4	200	1	105	352	28763
			2	121	405	28091
			3	134	440	28669
			4	140	468	29537
			5	148	493	30497
			6	155	516	31484
			7	161	538	32472
3	57.4	200	1	108	359	29070
			2	124	413	28320
			3	134	447	28858
			4	143	475	29698
			5	150	500	30636
			6	157	523	31604
			7	163	544	32576

Table 3:Example 1 optimal solution summary

L_t (weeks)	$Z(L_t)$ (\$)	$A_C(L_t)$ (\$)	N	S_V (\$)	Q (units)	$JTC(Q, S_V, L_t, N)$ (\$)
8	0	200	2	120	400	28635
6	5.6	200	2	120	401	28317
4	22.4	200	2	121	405	28091
3	57.4	200	2	123	413	28320

Table 4:Optimum values for various lead time values (Linear case)

L_t (weeks)	$Z(L_t)$ (\$)	$A_C(L_t)$ (\$)	N	S_V (\$)	Q	$JTC(Q, S_V, L_t, N)$ (\$)
8	0	200	1	104	347	29256
			2	120	400	28635
			3	130	435	29239
			4	139	463	30127
			5	147	489	31102
			6	154	512	32101
			7	160	534	33099
			1	104	346	28778





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6	5.6	190	2	120	399	28167
			3	130	434	28777
			4	139	462	29668
			5	146	488	30646
			6	153	511	31648
			7	160	533	32648
4	22.4	180	1	104	347	28420
			2	120	400	27793
			3	131	435	28394
			4	139	464	29280
			5	147	489	30253
			6	154	512	31251
3	57.4	175	1	106	354	28649
			2	122	407	27954
			3	133	442	28521
			4	141	470	29381
			5	149	495	30335
			6	155	518	31316
			7	162	540	32299

Table 5:Example 1 optimal solution summary (Linear case)

L_t (weeks)	$Z(L_t)$ (\$)	$A_c(L_t)$ (\$)	N	S_v (\$)	Q (units)	$JTC(Q, S_v, L_t, N)$ (\$)
8	0	200	2	120	400	28635
6	5.6	190	2	120	399	28167
4*	22.4*	180*	2*	120*	400*	27793*
3	57.4	175	2	122	407	27954

Table 6:Effects of ω on the linear case's optimal solution

ω	L_t (weeks)	$Z(L_t)$ (\$)	$A_c(L_t)$ (\$)	N	S_v (\$)	Q (units)	$JTC(Q, S_v, L_t, N)$ (\$)
	8	0	200	2	120	400	28635
10	6	5.6	195	2	120	400	28242
	4*	22.4*	190*	2*	121*	403*	27942*
	3	57.4	188	2	123	410	28145
	8	0	200	2	120	400	28635
7.5	6	5.6	193	2	120	400	28212
	4*	22.4*	187*	2*	121*	402*	27897*
	3	57.4	183	2	123	409	28072
	8	0	200	2	120	400	28635





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3.5	6	5.6	186	2	119	398	28107
	4*	22.4*	171*	2*	120*	398*	27657*
	3	57.4	164	2	121	405	27792
	8	0	200	2	120	400	28635
2	6	5.6	175	2	119	395	27940
	4*	22.4*	150*	2*	118*	394*	27339*
	3	57.4	138	2	120	399	27403

Table 7: Summary of ω on the linear case's optimal solution

ω	L_t (weeks)	$Z(L_t)$ (\$)	$A_c(L_t)$ (\$)	N	S_v (\$)	Q (units)	$JTC(Q, S_v, L_t, N)$ (\$)
10	4	22.4	190	2	121	403	27942
7.5	4	22.4	187	2	121	402	27897
3.5	4	22.4	171	2	120	398	27657
2	4	22.4	150	2	118	394	27339

Table 8: Effect on demand rate (D)

%	D	S_v	Q	$JTC(Q, S_v, L_t, N)$
-50	3000	155	258	19719
-40	3600	144	288	21507
-30	4200	136	318	23221
-20	4800	130	347	24881
-10	5400	125	376	26501
0	6000	121	405	28091
10	6600	118	433	29656
20	7200	115	461	31202
30	7800	113	489	32732
40	8400	111	517	34250
50	9000	109	545	35756

Table 9: Effect on ordering cost for the buyer ($A_c(L_t)$)

%	$A_c(L_t)$	S_v	Q	$JTC(Q, S_v, N)$
-50	100	115	382	26566
-40	120	116	387	26878
-30	140	117	391	27186
-20	160	119	396	27491
-10	180	120	400	27793
0	200	121	405	28091
10	220	123	409	28385
20	240	124	414	28677
30	260	125	418	28966
40	280	127	422	29251
50	300	128	426	29534





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Table 10: Effect on vendor holding cost (h_{VC})

%	h_{VC}	S_V	Q	$JTC(Q, S_V, N)$
-50	100	132	439	25985
-40	120	129	431	26420
-30	140	127	424	26848
-20	160	125	417	27268
-10	180	123	411	27683
0	200	121	405	28091
10	220	119	399	28493
20	240	118	393	28889
30	260	116	388	29279
40	280	115	383	29664
50	300	113	378	30044

Table 11: Effect on buyer holding cost (h_{BC})

%	h_{BC}	S_V	Q	$JTC(Q, S_V, N)$
-50	125	133	444	21556
-40	150	130	433	22880
-30	175	127	424	24193
-20	200	125	417	25498
-10	225	123	410	26797
0	250	121	405	28091
10	275	120	400	29380
20	300	119	396	30665
30	325	118	392	31947
40	350	117	389	33227
50	375	116	386	34504

Table 12: Effect on transportation cost (F_C)

%	F_C	S_V	Q	$JTC(Q, S_V, N)$
-50	50	115	382	26566
-40	60	116	387	26878
-30	70	117	391	27186
-20	80	119	396	27491
-10	90	120	400	27793
0	100	121	405	28091
10	110	123	409	28385
20	120	124	414	28677
30	130	125	418	28966
40	140	127	422	29251
50	150	128	426	29534





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Table 13:Effect on vendor’s opportunity interest loss (I_{MC})

%	I_{MC}	S_V	Q	$JTC(Q, S_V, N)$
-50	0.01	121	405	26591
-40	0.012	121	405	26891
-30	0.014	121	405	27191
-20	0.016	121	405	27491
-10	0.018	121	405	27791
0	0.02	121	405	28091
10	0.022	121	405	28391
20	0.024	121	405	31391
30	0.026	121	405	34391
40	0.028	121	405	37391
50	0.03	121	405	40391

Table 14:Effect on buyer’s interest charge (I_{BC})

%	I_{BC}	S_V	Q	$JTC(Q, S_V, N)$
-50	0.03	105	351	28776
-40	0.036	109	363	28681
-30	0.042	112	374	28563
-20	0.048	115	384	28424
-10	0.054	118	395	28266
0	0.06	121	405	28091
10	0.066	124	415	27898
20	0.072	127	424	27691
30	0.078	130	434	27469
40	0.084	133	443	27235
50	0.09	136	452	26987

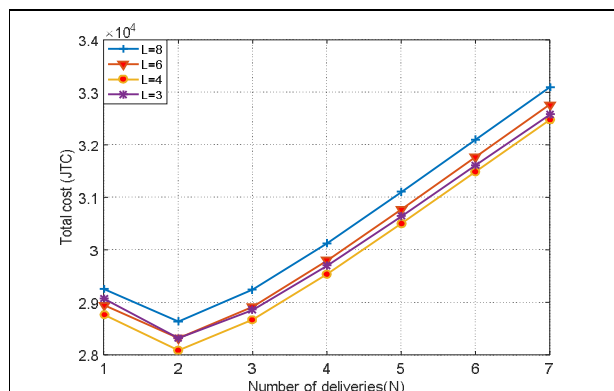


Fig.1 Graphical representation of the optimal solution in $JTC(Q, S_V, L_t, N)$ when $L_t = 3$ to 8 of Table 2

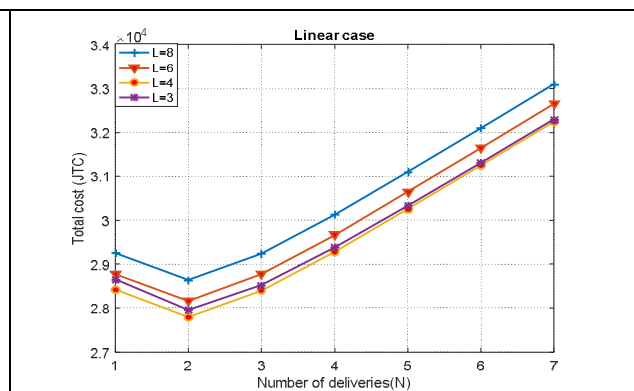


Fig. 2 Graphical representation of the optimal solution in $JTC(Q, S_V, L_t, N)$ when $L_t = 3$ to 8 of Table 4 (Linear case)





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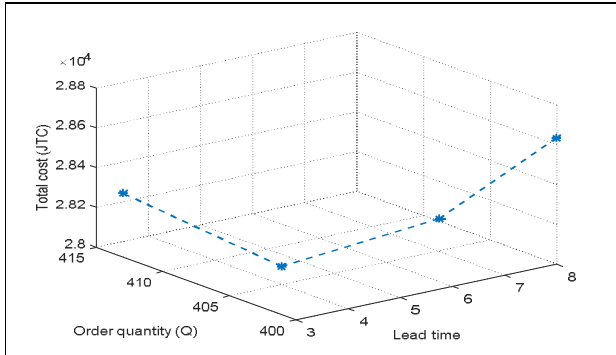


Fig.3 Graphical representation of optimal solution in $JTC(Q, S_V, L_t, N)$ when cost of orders are determined on lead time of Table 3

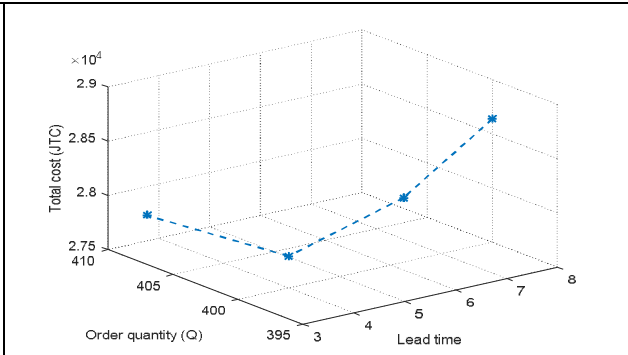


Fig. 4 Graphical representation of optimal solution in $JTC(Q, S_V, L_t, N)$ when cost of orders is determined on lead time in linear case of Table 5

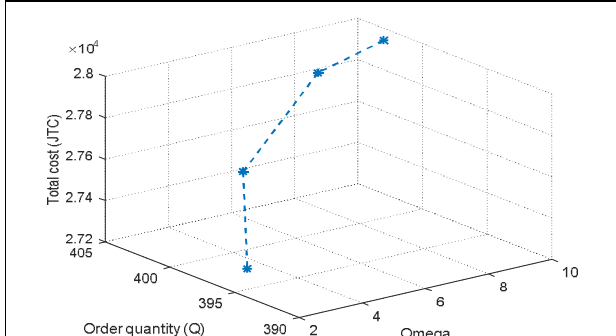


Fig. 5 Graphical representation of ω optimal solution

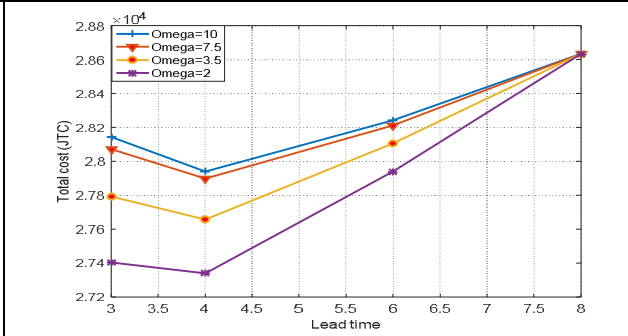


Fig.6 Effect of ω optimal solution

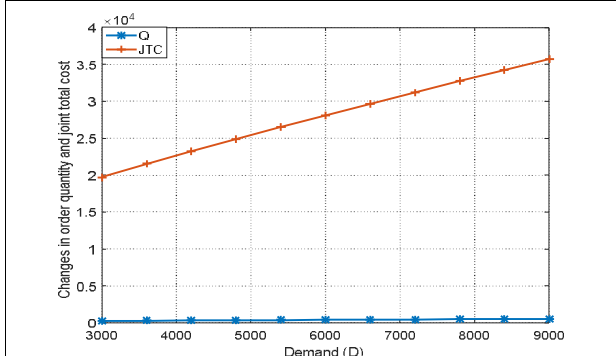


Fig.7 Effect of demand rate

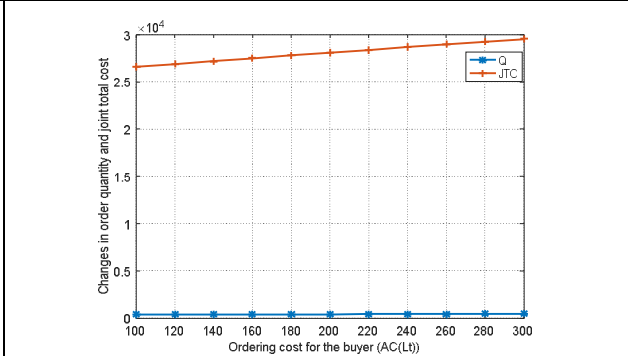
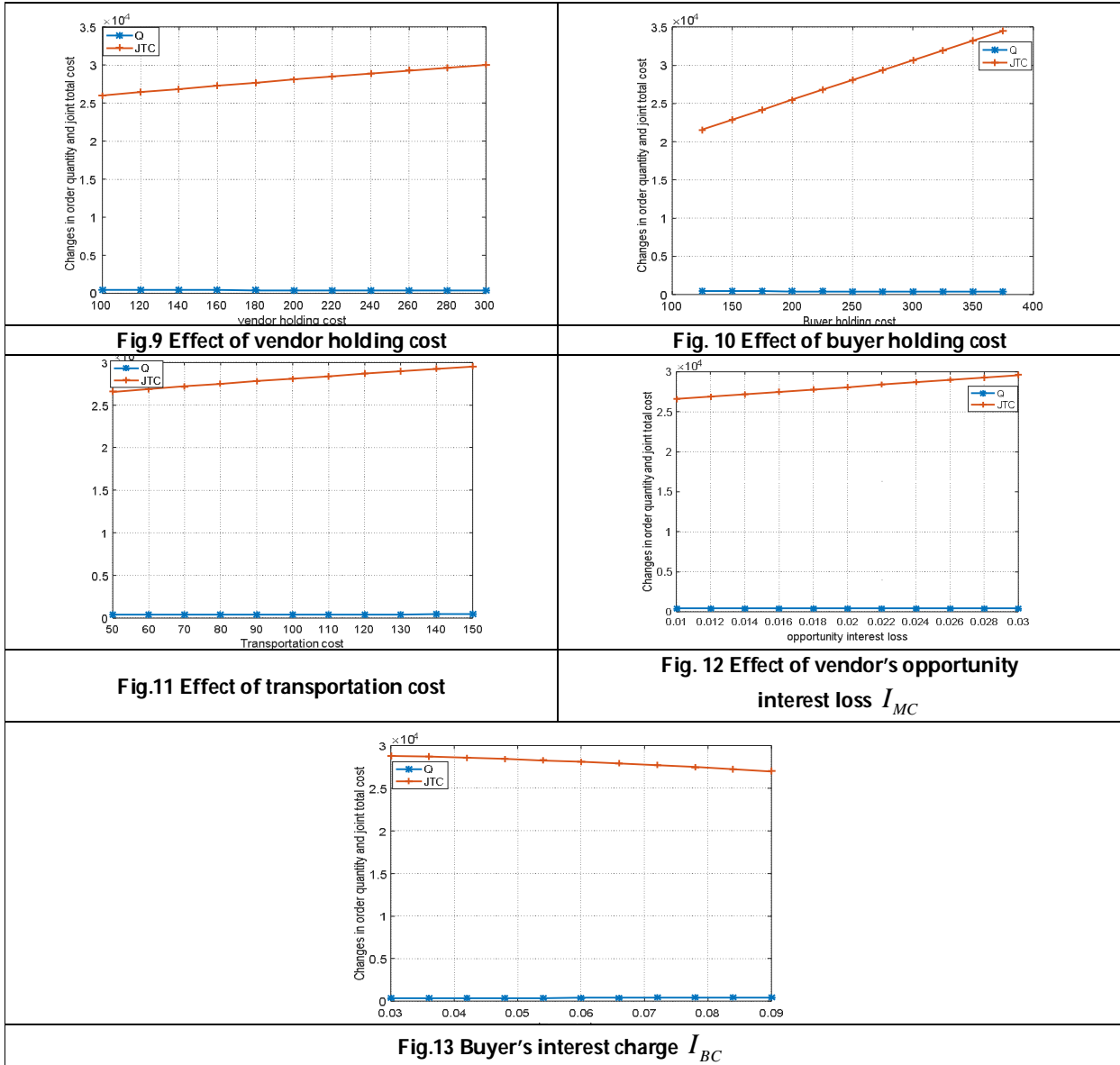


Fig.8 Effect of ordering cost





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Awareness and Attitude Building: Potent Mediators towards Beti Bachao Beti Padhao Scheme in India

Meenakshi¹ and Ritu Bakshi^{2*}

¹Research Scholar, Department of Educational Studies, Central University of Jammu, Jammu and Kashmir, India.

²Associate Professor, Department of Educational Studies, Central University of Jammu, Jammu and Kashmir, India.

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*Address for Correspondence

Ritu Bakshi,

Associate Professor,

Department of Educational Studies,

Central University of Jammu,

Rahya-Samba, India.

Orchid Id-0000-0001-9867-2216



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ABSTRACT

The concept of "women empowerment" includes the activity of improving the position of women through knowledge, awareness, literacy, and training. In order to be empowered, a person must also be given the necessary freedom and choices to make decisions that will affect their lives and given authority in a sphere of society where they previously lacked it. Despite the existence of policies regarding women's empowerment, there are still large gaps between the development of these policies and "real" community practise. In particular, rape, kidnapping, abduction, dowry-related crimes, molestation, sexual harassment, eve-teasing, and other crimes against women are common in India. Women continue to experience discrimination and marginalisation at all levels of society, despite the government's numerous efforts. This is true whether it comes to political participation, access to healthcare for reproductive needs, economic participation, social participation, or participation in society at large. India is ranked at position 112/153 in the Global Gender Gap Report 2020 due to the absence of meaningful efforts being made to address the aforementioned injustices against women. Only by giving women more power can their dignity be preserved. With this goal in mind, the Beti Bachao Beti Padhao Scheme was introduced at the national, state, district, and local levels to raise public awareness about preserving and educating girls. The present paper focuses on various schemes and initiatives led by govt. of India and also explores the awareness of general masses towards Beti Bachao Beti Padhao Scheme.

Keywords: Women, Women Empowerment, Global Gender Gap, Beti Bachao Beti Padhao Scheme





INTRODUCTION

In Indian society, women are typically viewed as existing solely for the benefit of their families. According to Indian scriptures, a woman's fourfold function is to be a mother, a wife, a homemaker, and a daughter in that order. As a result, women's roles are established and predefined in Indian society. Since the time of the Vedic civilization, Indian women have been expected to fulfil their social (playing the roles of daughter, sister, wife, daughter-in-law, sister-in-law, mother, and grandmother) and biological responsibilities (to give birth to children). Indian ladies are trained to feel feelings of sacrifice, self-denial, and altruism. On the other hand, the Indian government is continually implementing new programmes or laws to raise the status of women in the nation. As the Indian government established the National Policy for Women's Empowerment (2001) and proclaimed 2001 as the "Year of Women's Empowerment" (Swashakti). However, despite all of the efforts made by the government or by NGOs, women still face discrimination in India. It is bad for India when one lady is at the pinnacle of her career and the other is a victim of domestic abuse. Moreover, Indian society is said to be a 'Patriarchal society' and it seems in the status of women here, as they have been victim of male- dominated family or society. The fundamental bias that results from our proud patriarchal attitude is the root of the problem. Still today, we are killing female foetuses while celebrating the birth of a male child. Girls are taught to be silent, and the terrible mentality that "boys will be boys" is encouraged, which is a horrible example of social conditioning in our society. Even couples with higher levels of education engage in superstitious rituals like praying for a boy child. As the sex ratio continues to deteriorate, female foeticide cases rise, and child marriages continue unabated, we are turning into submissive observers. (Bakshi,2015). The lack of Finance, insufficient nutrition, gender biasness, abortion of female fetuses, rape, sexual- harassment, dowry have been the most issues before the women in India. Since medieval age, women have been victims of domestic-violence, exploitation, torture or humiliation. They have been discriminated in socio- economic, cultural or educational spheres. The brutal gang rape incidents reveal flaws in our society, especially pertaining to the mindset of the people. The common moral and ethical degradation of our humanity is to a great level accountable for disrespect for women in the present scenario (Bakshi,2017). A large percentage of Indian women still are considered as an unpaid servant for household tasks, as they don't have say in decision making of their family. More than half of India still categorises a woman as a "Homemaker" and a man as a "Bread-winner". This way of thinking lowers the standing of women in society. This psychological condition, which distinguishes between men and women, is not a political one A woman is expected to live exclusively for her family from childhood until old age, taking on home duties as well as those of her family members as a daughter, sister, wife, mother, sister-in-law, and other roles. Because it goes against what are considered to be societal norms, women are not supposed to work in any job they choose. The situation for women is changing over time, yet there are still many issues that they must deal with. Women have made great strides in recent times, but they still have a long way to go. Moreover, they do need a training or capacity building programs for enhancing their techno-pedagogical skills for excelling in different field and also for contributing their best in the development of the nation (Sharma,R. *et.al.*,2022). Women now have to deal with a lot of security issues since they are leaving the safe heaven of the home. In addition to this, Indian women deal with a variety of other issues in their daily lives. Some of these issues are as under:-

Malnutrition. In Indian culture, it is customary for the woman to eat the least and last among the family members. They were unable to obtain the necessary meals needed to keep a healthy body as a result. Malnutrition is mostly caused by poverty in rural areas, where it occurs most frequently. "The women of South Asia are not given sufficient care, which results in a higher degree of malnutrition among the South Indian women than anyplace else in the world," the UNICEF Report from 1996 indicates explicitly.

Maternal Mortality India has the highest mortality rating in the entire world. Women are not provided the required attention, which causes malnutrition, and as a result, the majority of them marry young. Then, when the body is not prepared to carry a child, early marriages result in unplanned pregnancies. All of this causes complications, which could cause gynecological issues, which could get worse over time and culminate in mortality.



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Lack of Education Numerous other issues stem from a lack of education. The bad health of the children is caused by the inability of an illiterate woman to adequately care for her children or to be aware of the dangerous diseases and treatments. She might not even be particularly conscious of hygiene, and her lack of awareness of hygiene could harm the family's overall health.

Violence Women are treated unfairly frequently in Indian society because they are viewed as an inferior category. Due to the prevalence of violence against women in India, Women experience physical and psychological abuse both in urban and rural settings. However, women just perform unpaid work and are not given credit.

Lack of Power Many women lack authority because they are unable to make decisions on their own regarding important aspects of their lives, such as marriage, education, careers, or employment. For every single matter, women must have the male family members' consent. Even they have no voice in the crucial decisions affecting the family.

Early Marriage Generally family fixes marriages in India. However this scenario is changing in the urban areas but in rural areas it has been same upto now. A girl is not consulted but is told to marry a guy, whom her family has chosen for her. From starting girl is taught not to going against her husband's wish. All this type of thinking leads mistreatment or disrespect to the women.

Dowry: Dowry has long been a contentious topic in India, and now it is affecting people's reputations. Cases involving dowry harassment and dowry death are frequently brought before Indian courts. The payment of dowry by a girl's parents at the time of her marriage has become customary, especially in the northern region of India. When a female brings a large amount of dowry, her husband treats her generously and with respect. And if a girl does not bring dowry in accordance with the expectations of her in laws, she would be subjected to verbal and physical abuse. Due of dowry, many newlywed ladies are pushed to death.

Female Infanticide and Feticide It has been a serious issue before the government of India. Women are forced to abort and kill the girl child. The number of females per 1,000 males in the 0–6 age range has significantly decreased, which has led to the nationwide introduction of the BBBP Campaign. Nearly 50% of the nation's population is female. Therefore, it is important to empower them for the benefit of our nation by granting them equal rights so that they can live happy, discrimination-free lives. With this goal in mind, the BBBP campaign was initiated at the national, state, district, and community levels to raise public awareness about the need to protect and educate girl children. The girls will become independent and financially secure as a result. The BBBP Campaign seeks to accomplish this through fostering improved coordination between various government agencies and other partners in order to maximise the effectiveness of welfare services offered to women and girls. In order to achieve this, tactics must be developed and planned that will boost social mobilisation and speed up communication among people regarding the equal worth of girls and their education by all citizens, including the youth and various women's groups.

REVIEW OF RELATED LITERATURE

In his research study, Sharma (2015) recommended Five new cutting-edge suggestions for enhancing change through "Beti Bachao, Beti Padhao" which include spreading knowledge about the programme through education and ICT, raising awareness through community radio stations, and using campaigns to modify behaviour. According to a study by Rani (2016) on knowledge regarding Beti Bachao Beti Padhao Programme, indicated that Women were aware of the increased awareness of the programme and the general effectiveness of all media elements pertaining to female feticide and abortion, as well as the advantages of the programme, etc. In his research, Bilal Ahmed Bhat and Ghulam Ud Din Qurashi (2019) examined that Orthodox families used to go for female feticide or abandoning the Girl child. Social and family constraints did not allow the girls to go to school or to opt for higher studies. The study also talked there are many challenges and problems faced by girls in India like Rape and sexual assault, Dowry





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deaths ,poverty, education, lack of lady teachers in the schools, Domestic violence, Harassment in public places, Eve teasing , Inadequate nutrition and health and safety issues etc. Another study by Parmar Shiva and Sharma Amit (2020) on 'Beti Bachao Beti Padhao campaign: An attempt to Social Empowerment' indicated that the BBBP initiative helps women become more socially empowered. The bulk of society is increasingly acknowledging the rights of girls. According to the study's findings, there has been a noticeable shift in people's attitudes against gender inequity, and prenatal gender selection has significantly decreased. According to a study conducted by Meenakshi, Sharma & Bakshi (2022) Women needs to be more empowered and skill based education should be provided to them for making them self –reliant as during the pandemic time, Women's micro Self Help Groups (SHG's) contributed to the creation of masks, sanitizers, and protective equipment has boosted the idea of entrepreneurship and proved to be a valuable resource for the country. As a result, education that is based on need and skill opens up a wide range of entrepreneurship opportunities for everyone and ultimately paving the way for gender equality for all. Another study conducted by Sharma, M. R., & Bakshi, R.(2022)states that Schools must train students especially females for occupations that are expected to be emerge in upcoming future, challenges that have yet to be acknowledged and technologies that have yet to be perceived. Further they emphasized that the school environment, as well as teaching and learning processes, must change in order to encourage healthy habits and skills among students, preparing them to actively contribute to a sustainable future.

Statement of the Problem

The present study stated as "Awareness And Attitude Building: Potent Mediators Towards Beti Bachao Beti Padhao Scheme In India.

Objectives of the Study

1. To study the awareness and attitude of University students towards Beti Bachao Beti Padhao Scheme with regard to the following:

- General awareness of the BBBP Scheme.
- Declining Child Sex Ratio (CSR).
- Gender Imbalance and discrimination.
- Education and Infrastructure.
- Implementation of Scheme.

Delimitation of the Study

1. The present study was delimited to the Post graduate students of Central University of Jammu.
2. The Sample was delimited to 100 Post-graduate students.

RESEARCH METHODOLOGY

Research Method	Population	Sample	Sampling Technique	Statistical Technique
Descriptive Method	Post Graduates Students	100 Post Graduates Students	Random Sampling	Percentage count

Interpretation

Findings of the Study

The findings of the present study are discussed under following dimensions:

With regard to Awareness of initiatives being taken under Beti Bachao Beti Padhao Scheme

All the 100% students were aware of Beti Bachao Beti Padhao Scheme. About 84.6% students were aware of 'APKI BETI HAMARI BETI' programme and 15.4% were unaware of it and they have neither heard of it and nor read about it. Moreover only 23.1% students were aware of 'BALIKA MANCH' or 'COLLECTOR KI CLASS' programme while 76.9% were unaware of any such initiatives.



**Meenakshi and Ritu Bakshi****With regard to declining Child Sex Ratio**

It is quite shocking that only 56.4% were aware of declining sex ratio in the country whereas 43.6% were not aware of it. About 82.1% students considered female foeticide and female infanticide as the main reason for low child sex ratio in the country while 17.9% students considered other factors as the main reason for declining Child Sex Ratio. About 94.9% students agreed that abortion deteriorate mother's health and only 5.1% students think that abortion doesn't deteriorate mother's health. About 79.5% students considered declining child sex ratio as a major indicator of women disempowerment whereas 20.5% students think that there are so many other indicators of women disempowerment and low CSR is not one among them.

With regard to Gender Imbalance and Discrimination

About 51.3% students were in favour that girls are getting equal rights at par with boys whereas 12.8% students feels that there exist discrimination between boys and girls in case of providing basic educational and other facilities. About 84.6% students thinks that women are still deprived of basic rights and dominated by males in the society whereas 15.4% students think that women are also enjoying the same rights and doing great in every field. About 87.2% students think that gender stereotypes are still deep rooted in our educated society whereas 12.8% students think that society is heading towards gender equality and there exists no gender stereotype in the society.

With regard to Education and Infrastructure

About 92.3% students think that lack of education among girls is one of the major obstacle in the path of empowering girls whereas 7.7% students think that lack of education is not a major obstacle that hampers the path of women empowerment. Also, majority around 87.2% students think that women empowerment is a critical aspect of achieving gender equity and equality. About 79.5% students think that community members like ASHA, ANM workers can do a lot by creating mass awareness among people in defying the age old biases and 20.5% students think that ASHA and ANM workers are not doing well in uprooting the age old biases in the society. About 76.9% students think that University has taken necessary steps for ensuring safety and security of females in the campus and 23.1% students feel that there is still need to ensure safety and security of females. Whereas about 87.2% students think that university has successful in providing functional toilets and basic facilities to the females in the campus and about 12.8% students shows their dissatisfaction regarding functional toilets and basic facilities.

With regard to Implementation of Scheme

About 64.1% students think that University has initiated campaigns and organized seminars for creating awareness about the initiatives being taken by Beti Bachao Beti Padhao Scheme whereas 35.9% students think that University has not taken much efforts for creating awareness among students regarding Beti Bachao Beti Padhao Scheme. Around 92.3% students think that effective implementation of various initiatives under BBBP can reduce the gender imbalance in our country. Also, majority of students around 94.9% think that there is a need to sensitize the masses about gender equity and equality for the successful implementation of Beti Bachao Beti Padhao Scheme.

Recommendations

1. There should be consistency in creating awareness and spreading knowledge regarding different initiatives and programmes undertaken under the Beti Bachao Beti Padhao Scheme.
2. Number of schools should be raised and educational resources should be made available, such as scholarships and awards for deserving female students, in order to re-engage girl dropouts.
3. The status of girls, which is a potent strategy, might be used to raise awareness and modify attitudes, particularly in areas where female foeticide is known to be widespread.
4. Providing and maintaining the correct hygiene facilities as well as ensuring that restrooms are available on public sites like schools, colleges, and institutions would help increase enrollment.



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5. Training and capacity building programme should be organized from time to time for sensitizing the students and masses regarding declining child sex ratio and removing gender stereotypes. Gender sensitization training for personnel along with basic digital upskilling would go a long way in ensuring better implementation of the scheme.
6. Gender representation should also be a part of the implementation of a gender-sensitive plan. The face of this programme should be community-level workers that frequently interact closely with the populace and are well-versed in the local environment. Local frontline workers like those employed by ASHA, Anganwadi, and Mahila Mandals should play a major role in the implementation of the programme.

CONCLUSION

On the basis of above findings it can be concluded that majority of students have heard about Beti Bachao Beti Padhao Scheme but a major chunk of the students are not aware of different initiatives taken under Beti Bachao Beti Padhao Programme. Women empowerment is a critical aspect of achieving gender equity and equality as women constitute the half of the population and their contribution in the society is at a large level. So, for their better participation in the development of the nation, we need to provide them a conducive environment which should be free from all prejudices and stereotypes as the findings of the study also revealed that gender stereotypes are still deep rooted in the society and there is a need to sensitize the masses and students regarding the declining child sex ratio and gender equity. Only then gender imbalances and discrimination can be removed and successful implementation of Beti Bachao Beti Padhao Programme can be achieved.

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Table 1: Distribution of respondents according to awareness and attitude regarding Beti Bachao and Beti Padhao Scheme

S. NO.	STATEMENTS+	YES	NO
1.	Do you know about Beti Bachao Beti Padhao scheme of Govt of India?	100%	-
2.	Have you heard of Govt. initiatives "APKI BETI HAMARI BETI' AND SUKANYA SAMRIDHI YOJANA?	84.6%	15.4%
3.	Have you heard of Balika Manch or Collector ki class or been part of this in the school?	23.1%	76.9%
4.	Do you know that child sex ratio is low in our country?	56.4%	43.6%
5.	Do you know that female infanticide and feoticide are the main reasons for decreasing sex ratio?	82.1%	17.9%
6.	Do you aware about sex determination process?	92.3%	7.7%
7.	Do you know that abortion deteriorate mother's health?	94.9%	5.1%
8.	Do you think that declining CSR is a major indicator of women disempowerment?	79.5%	20.5%
9.	Do you think that girls are getting equal rights in the society at par with boys?	48.7%	51.3%
10.	Do you think that Female infanticide is the best way to control the family and population?	71.8%	28.2%
11.	Has your family ever discriminated between girl and boy in providing basic educational and other facilities?	12.8%	87.2%
12.	Do you think that women are still deprived of basic rights and are dominated by the males in the society?	84.6%	15.4%
13.	Do you think that lack of education among girls is one of the major obstacle in the path of empowering the girls?	92.3%	7.7%
14.	Do you think that gender stereotypes are still deep rooted in our educated society?	87.2%	12.8%
15.	Do you think that community members like panches, sarpanches and frontline workers like ASHA and ANM workers can play an important role to defy the age old biases against the girl child in the society?	79.5%	20.5%
16.	Has your University initiated campaigns, organized seminars for creating awareness about Beti Bachao Beti Padhao?	64.1%	35.9%
17.	Has your University taken necessary steps for ensuring the safety and security of females in the campus?	76.9%	23.1%
18.	Has your University provide the functional toilets and basic hygiene facilities to the females?	87.2%	12.8%
19.	Do you think that BBBP scheme will be helpful in overall development of girls?	87.2%	12.8%
20.	Do you think that there is a need to sensitize the masses about gender equity and equality?	94.9%	5.1%
21.	Do you think that women empowerment is a critical aspect of achieving gender equity and equality?	87.2%	12.8%
22.	Do you think that effective implementation of various initiatives under BBBP can reduce the gender imbalance in our country?	92.3%	7.7%





Mandelic Acid: A Simple, Mild and an Efficient Organocatalyst for Biginelli Reaction

Gopula Venkatesh Balkishan^{1*}, Pathan Moshin Khan² and Thomare Mahendra Ramdas³

¹Assistant Professor, Department of Chemistry, Anandibai Raorane Arts, Commerce and Science College, Vaibhavwadi, Maharashtra, India.

²Sr.Executive, Department of Analytical Method Development Lab (R & D), Jamjoom Pharmaceutical Company, Jeddah- 21442, Saudi Arabia

³Assistant Professor, N. B. Mehta Science College, Bordi, Tal. Dahanu, Dist. Palghar, Maharashtra (401701) India.

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*Address for Correspondence

Gopula Venkatesh Balkishan

Assistant Professor,
Department of Chemistry,
Anandibai Raorane Arts,
Commerce and Science College,
Vaibhavwadi, Maharashtra, India
E. Mail : gopulavenkatesh@gmail.com



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ABSTRACT

Mandelic acid is an efficient simple organic molecule acts as a catalyst for the one-pot three component synthesis of 3,4-dihydropyrimidin-2-(1H)-one derivatives via Biginelli reaction between β -keto ester, diversified aromatic aldehydes and urea or thiourea under thermal conditions. Small organic molecules, organocatalysts, have been used as catalysts for the Biginelli reaction in small quantities compared to Bronsted and Lewis acids. Mandelic acid is a small organic molecule although it is an acid but has never been tested to synthesize 3,4-dihydropyrimidine-2-(1H)-ones. Mandelic acid is an inexpensive and non-toxic molecule that has been successfully tested here as a catalyst for a three-component, one-pot synthesis of 3,4-dihydropyrimidin-2-(1H)-one derivatives through the Biginelli reaction between β -keto esters, various aromatic aldehydes and urea or thiourea under thermal conditions using catalytic amount of 20 mol% in acetonitrile solvent heated to reflux for 10 h to give high yield. This synthetic method includes inexpensive, non-toxic catalyst and carried out in a simple operational procedure.

Keywords: mandelic acid, biginelli, 3,4-dihydropyrimidin-2-(1H)-one, β -keto ester, aldehydes, urea, thiourea, organocatalyst



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INTRODUCTION

The Biginelli reaction is one of the multicomponent reactions and is very suitable for the synthesis of 3,4-dihydropyrimidin-2-(1H)-ones. 3,4-Dihydropyrimidinones (DHPM) are a very important group of organic compounds in the recent past since they were discovered with biological and pharmacological properties such as antiviral, antitumor, and anti-inflammatory properties, antibacterial, anti-inflammatory and lower blood pressure. (S)-monastrol, (Figure-1) [1][2] is one of those compounds which show important pharmacological properties as mentioned above. The dihydropyrimidinone ring is also found in many natural products, which has shown that considerable effort has been devoted to the synthesis of these heterocycles [3][4][5][6][7][8]. These DHPMs emerge as an integrated skeleton of several calcium channel blockers, antihypertensives, α_1 -adrenergic antagonists, and neuropeptide Y (NPY) antagonists [9]. Classically, the Biginelli reaction was carried out under strongly acidic conditions with heating, and the yield was low to moderate in Scheme-1 [10].

To increase the efficiency of the Biginelli reaction, many catalysts have been developed to synthesize these DHPM molecules more efficiently such as H_2SO_4 , [9] $BF_3 \cdot Et_2O$ / $CuCl$ [11], $BiCl_3$ [12], $CeCl_3 \cdot 7H_2O$ [13], $Cu(OTf)_2$ [14], $TiCl_4$ [15], $LiBr$ [16], Gallium(III) halides [17], Metal triflimide [18], *p*-toluenesulfonic acid [19], polystyrenesulfonic acid (PSSA) [20], $Cu(OTf)_2$ [21], $ZrCl_4$ [22], $FeCl_3 \cdot 6H_2O$ [23], $RuCl_3$ [24], $Bi(NO_3)_3 \cdot 5H_2O$ -TBAF [25], SrI_2 [26], Indium(III) bromide [27], ytterbium(III)-resin [28], ionic liquids ($BMIImPF_6$ and $BMIImBF_4$) [29], ceric ammonium nitrate (CAN) [30], $Mn(OAc)_3 \cdot 2H_2O$ [31], lanthanide triflate [32], indium(III) chloride, [33] lanthanum chloride [34], TFA [35] silica/sulfuric acid [36], vanadium(III) chloride [37], TMSI [38], montmorillonite/KSF [39]. In addition to these, the Biginelli reaction has also been reported by utilizing nanomaterials [40][41][42], nano-composite [43], zeolites [44][45][46], polymer [47], ultrasonic irradiation [48], microwave [49][50][51][52], ball milling [53], and microdroplets [54]. The use of small organic molecules known as Organocatalysts [55][56][57][58][59], are very fast growing area in field of synthetic organic chemistry which replacing the use of metal-based Lewis acids. Organocatalysis offers many advantages for synthetic organic chemistry. In contrast to many transition metal catalysts, most organocatalysts are stable to air and water, easily handled experimentally, relatively nontoxic, and readily separated from the crude reaction mixture [60]. Keeping in mind the growing interest in developing green processes and procedures in organic synthesis [61], organocatalysts are considered to be a more eco-friendly and user-friendly alternative to traditional counterparts. Because of these many advantages of organocatalysts, few organocatalysts have been explored in the synthesis of DHPM derivatives such as baker's yeast [62], hydrazine type [63], oxalic acid [64][65], citric acid [66], Boric acid [67], phenylboronic acid [68], L-proline [69], carboxylic acids [70] Lactic acid [71].

To continue our work on novel methods of using organocatalysts [59, 72] in synthetic organic chemistry, we wanted to report an efficient use of mandelic acid and an effective method. The result is very simple to synthesize derivatives of 3,4-dihydropyrimidin-2-(1H)-ones through the Biginelli reaction in good to high yields under thermal conditions. In addition to the methods mentioned above, numerous methods are available in the literature for the synthesis of 3,4-dihydropyrimidin-2-(1H)-one derivatives via the Biginelli reaction. But the exposure of organic catalysts for DHPM synthesis is available in small quantities. Mandelic acid is inexpensive and readily available. To our knowledge to date, the potential of mandelic acid as a mild organic catalyst has not been extensively tested in organic synthesis. We think it is useful to explore the potential of mandelic acid to synthesize DHPMs derivatives under controlled conditions.

MATERIALS AND METHODS

In this work following reagents were used without further purification; benzaldehyde and other aldehydes, ethylacetoacetate, mandelic acid, urea, thiourea, acetonitrile, ethanol (Loba Chemie) 4-methylbenzaldehyde, 3-methoxybenzaldehyde (Sigma-Aldrich)



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The general procedure of Biginelli reaction is represented as follows: A solution of the appropriate aldehyde **1** (1.0 mmol), urea or thiourea **2** (1.5 mmol), β -keto ester **3** (1.0 mmol), mandelic acid (20 mol%, 0.2 mmol) in acetonitrile (10 mL) is heated to reflux for 10 h. Then it is cooled to room temperature, and poured into ice-water about 50mL. The solid products are filtered, washed with ice-water and dried and recrystallized from ethanol to afford the pure product **4**.

RESULT AND DISCUSSION

We started the study with the reaction of benzaldehyde, ethyl acetoacetate and urea using mandelic acid as a catalyst in acetonitrile under thermal conditions (scheme-2) as a model reaction and the results are summarized in Table-1. a) Reaction conditions: Benzaldehyde (1.0 mmol), Urea (1.5 mmol), Ethyl acetoacetate (1.0 mmol), catalyst, solvent acetonitrile (10ml) refluxed for the appropriate time. b) Isolated yields. Initially the reaction was carried out without a catalyst for an appropriate time no progress was observed (Table-1, entry 01). 1 mole % of catalyst was introduced and the reaction was carried out up to 20 hr, obtained yield was in a very low quantity (Table-1, entry 02). The reaction was gradually progressed with the increasing catalyst amount with reaction time was slightly decreased (table-1, entry 03 & 04). Due to gradual progress of the reaction, catalyst amount was increased to 10 mole % to see the development by reducing the reaction time up to 15 hr, 74% yield was obtained (table-1, entry 05). To obtain high to excellent yields, we keep modifying the catalyst amount (table-1, entry 06). The best reaction conditions were obtained by using the catalyst of 20 mole% and the reaction was completed in 10 hr, 93% yield was obtained (table-1, entry 07). Without any further modifications in the reactions conditions, the above obtained conditions were used for further investigation.

After obtaining the best reaction conditions; 1.0 mmol of benzaldehyde, 1.0 mmol of ethyl acetoacetate, 1.5 mmol of urea, 20 mol% mandelic acid as a catalyst in 10ml of acetonitrile refluxed for 10 hr, in order to explore the scope and generality of the present reaction conditions, diversified aldehydes and analog of urea i.e. thiourea were employed to Biginelli reaction using our optimized reaction conditions (Scheme-3). The obtained results are summarized in table-2. a) Reaction conditions: Aldehyde (1.0 mmol), Urea/thiourea (1.5 mmol), β -keto esters (1.0 mmol), mandelic acid 20 mol%, in acetonitrile (10ml) refluxed for the 10h. b) Isolated yields. Apart from parent benzaldehyde, aldehydes having electron-donating groups such as methoxy and group like bromo-, chloro-, also electron withdrawing group like nitro were treated with ethyl acetoacetate and urea, which resulted to the formation of the corresponding DHPM derivative 84-92% yields (Table 2, entries 1-5). The analogue of urea i.e. thiourea also tested for the same reaction with benzaldehydes bearing chloro, nitro and methoxy groups giving corresponding product with 82-90 % yield (Table-2 entries 6-10). Overall, the current method is simple and an efficient one to produce diversified DHPM derivatives.

CONCLUSION

In conclusion, we have established a simple and an efficient method for a one-pot three-component synthesis of 3,4-dihydropyridiminone derivatives from aldehydes with β -keto esters and urea or thiourea using easily available mandelic acid as an organocatalyst in acetonitrile under thermal conditions which is easy to conduct with high yields.

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**Gopula Venkatesh Balkishan et al.,****Spectral Data**

4a.¹H NMR (DMSO-d₆, δ ppm): 1.162 - 1.198 (t, 3H), 2.370 (s, 3H), 4.052 - 4.129 (q, 2H), 5.418 - 5.423 (d, 1H), 5.590 (s, 1H), 7.262 - 7.391 (m, 4H), 7.708 (s, 1H) 4b.¹H NMR (DMSO-d₆, δ ppm): 1.174 - 1.274 (t, 3H), 2.351 (s, 3H), 4.057-4.162 (q, 2H), 5.374 - 5.380 (d, 1H), 5.878 (br, 1H), 7.197 - 7.218 (d, 2H) 7.440- 7.0478 (t, 2H), 8.089 (br, 1H)

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Table-1: Optimization of the reaction conditions in the synthesis of DHPM^a

Entry	Catalyst (mole %)	Time (hr)	Yield ^b (%)
01	None	20	0
02	1	20	25
03	2	18	30
04	5	18	48
05	10	15	74
06	15	12	85
07	20	10	93



Gopula Venkatesh Balkishan *et al.*,Table-2: Scope of Aldehydes with urea/thiourea and β -keto esters in the synthesis of DHPM derivatives^a

Entry	Aldehyde (R)	Urea/thiourea (X)	β -keto ester	Product (1)	Yield ^b %
01	H	O	Et	4a	93
02	4-Cl	O	Et	4b	90
03	4-Br	O	Et	4c	94
04	4-OMe	O	Et	4d	92
05	4-NO ₂	O	Et	4e	74
06	3-NO ₂	O	Et	4f	85
07	H	S	Et	4g	78
08	3-NO ₂	S	Et	4h	75
09	4-OMe	S	Et	4i	72
10	4-Cl	S	Et	4j	80

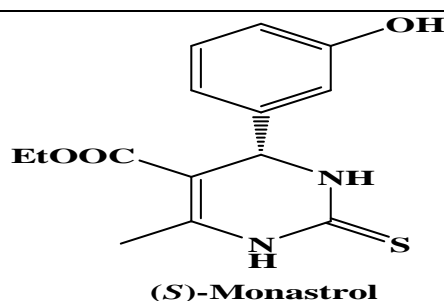
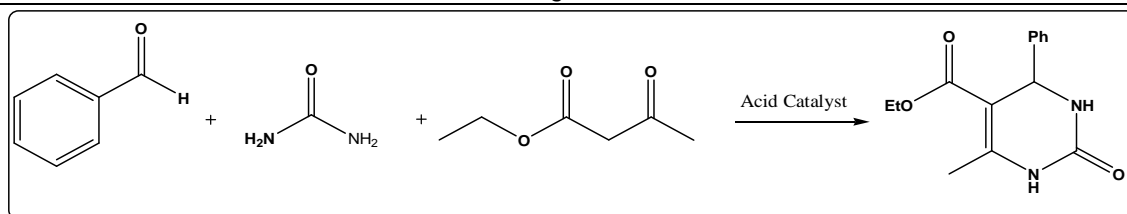
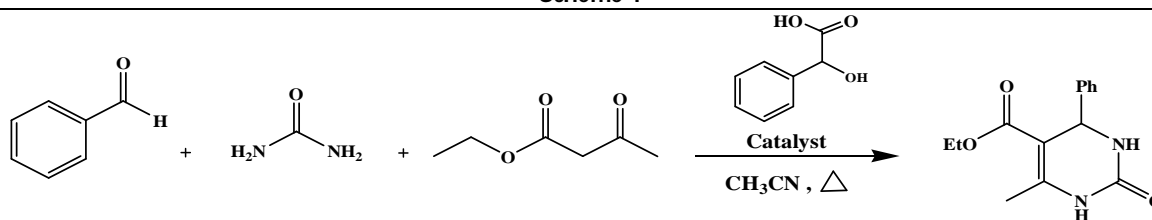


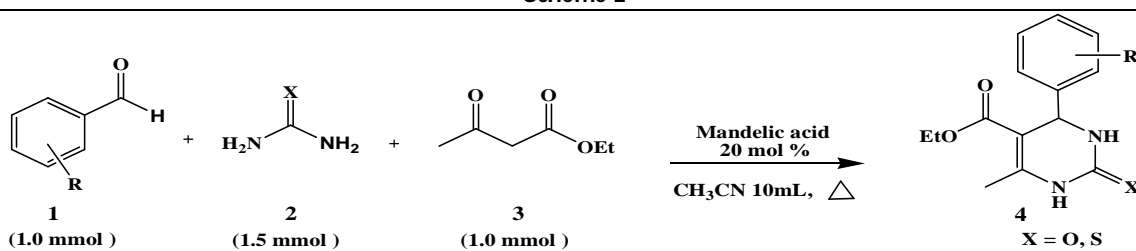
Figure-1



Scheme-1



Scheme-2





Translations in Bipolar Valued Vague Subrings of a Ring

B.Deeba^{1*}, S.Naganathan² and K.Arjunan³

¹Assistant Professor, Department of Mathematics, Idhaya College for Women, Sarugani, Sivaganga, Tamil Nadu, India.

²Assistant Professor, Department of Mathematics, Sethupathy Government Art's College, Ramanathapuram, Tamil Nadu, India.

³Assistant Professor, Department of Mathematics, Alagappa Government Art's College, Karaikudi, Tamil Nadu, India.

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*Address for Correspondence

B.Deeba

Assistant Professor,
Department of Mathematics,
Idhaya College for Women,
Sarugani, Sivaganga, Tamil Nadu, India.
E. Mail : bdeeba85@gmail.com



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ABSTRACT

In this paper, new definitions are introduced and translations of bipolar valued vague subring of a ring are presented. These properties will be useful to further research work.

Keywords: Fuzzy subset, vague subset, bipolar valued fuzzy subset, bipolar valued vague subset, bipolar valued vague subring, height, normal and translations.

INTRODUCTION

In 1965, Zadeh [15] introduced the notion of a fuzzy subset of a set, fuzzy sets are a kind of useful mathematical structure to represent a collection of objects whose boundary is vague. Since then it has become a vigorous area of research in different domains, there have been a number of generalizations of this fundamental concept such as intuitionistic fuzzy sets, interval valued fuzzy sets, vague sets, soft sets etc. Grattan-Guinness [8] discussed about fuzzy membership mapped onto interval and many valued quantities. Vague set is an extension of fuzzy set and it is appeared as a unique case of context dependent fuzzy sets. The vague set was introduced by W.L.Gau and D.J.Buehrer [7]. Lee [9] introduced the notion of bipolar valued fuzzy sets. Bipolar valued fuzzy sets are an extension of fuzzy sets whose membership degree range is enlarged from the interval $[0, 1]$ to $[-1, 1]$. In a bipolar valued fuzzy set, the membership degree 0 means that elements are irrelevant to the corresponding property, the membership degree $(0, 1]$ indicates that elements somewhat satisfy the property and the membership degree $[-1, 0)$ indicates that elements somewhat satisfy the implicit counter property. Bipolar valued fuzzy sets and intuitionistic fuzzy sets look





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similar each other. However, they are different each other [9, 10]. Fuzzy subgroup was introduced by Azriel Rosenfeld [2]. Ranjit Biswas [12] introduced the vague groups. Cicily Flora. S and Arockiarani. I [4] have introduced a new class of generalized bipolar vague sets. Anitha. M.S., et.al.[1] defined as bipolar valued fuzzy subgroups of a group and Balasubramanian.A et.al.[3] have defined the bipolar interval valued fuzzy subgroups of a group. K.Murugalingam and K.Arjunan[11] have discussed about interval valued fuzzy subsemiring of a semiring and Somasundra Moorthy. M.G.,[13] gave a idea about the fuzzy ring. Bipolar valued multi fuzzy subsemirings of a semiring have been introduced by Yasodara.B and KE.Sathappan[14]. Deepa.B., et.al.[5] defined as bipolar valued vague subrings of a ring. Here, the concept of bipolar valued vague subring of a ring is introduced and established some results. Particularly, translations of bipolar valued vague subring of a ring are introduced in this paper.

Preliminaries

Definition 1.1. [15] Let X be any nonempty set. A mapping $M : X \rightarrow [0, 1]$ is called a fuzzy subset of X.

Definition 1.2. [7] A vague set A in the universe of discourse U is a pair $[t_A, 1-f_A]$, where $t_A : U \rightarrow [0, 1]$ and $f_A : U \rightarrow [0, 1]$ are mappings, they are called truth membership function and false membership function respectively. Here $t_A(x)$ is a lower bound of the grade of membership of x derived from the evidence for x and $f_A(x)$ is a lower bound on the negation of x derived from the evidence against x and $t_A(x) + f_A(x) \leq 1$, for all $x \in U$.

Definition 1.3. [7] The interval $[t_A(x), 1-f_A(x)]$ is called the vague value of x in A and it is denoted by $V_A(x)$, i.e., $V_A(x) = [t_A(x), 1-f_A(x)]$.

Example 1.4. $A = \{ \langle a, [0.5, 0.6] \rangle, \langle b, [0.7, 0.8] \rangle, \langle c, [0.4, 0.9] \rangle \}$ is a vague subset of $X = \{a, b, c\}$.

Definition 1.5. [9] A bipolar valued fuzzy set (BVFS) A in X is defined as an object of the form $A = \{ \langle x, A^+(x), A^-(x) \rangle / x \in X \}$, where $A^+ : X \rightarrow [0, 1]$ and $A^- : X \rightarrow [-1, 0]$. The positive membership degree $A^+(x)$ denotes the satisfaction degree of an element x to the property corresponding to a bipolar valued fuzzy set A and the negative membership degree $A^-(x)$ denotes the satisfaction degree of an element x to some implicit counter-property corresponding to a bipolar valued fuzzy set A.

Example 1.6. $A = \{ \langle a, 0.5, -0.3 \rangle, \langle b, 0.4, -0.6 \rangle, \langle c, 0.4, -0.7 \rangle \}$ is a bipolar valued fuzzy subset of $X = \{a, b, c\}$.

Definition 1.7. [5] A bipolar valued vague subset A in X is defined as an object of the form $A = \{ \langle x, [t_A^+(x), 1-f_A^+(x)], [-1-f_A^-(x), t_A^-(x)] \rangle / x \in X \}$, where $t_A^+ : X \rightarrow [0, 1]$, $f_A^+ : X \rightarrow [0, 1]$, $t_A^- : X \rightarrow [-1, 0]$ and $f_A^- : X \rightarrow [-1, 0]$ are mapping such that $t_A(x) + f_A(x) \leq 1$ and $-1 \leq t_A^- + f_A^-$. The positive interval membership degree $[t_A^+(x), 1-f_A^+(x)]$ denotes the satisfaction region of an element x to the property corresponding to a bipolar valued vague subset A and the negative interval membership degree $[-1-f_A^-(x), t_A^-(x)]$ denotes the satisfaction region of an element x to some implicit counter-property corresponding to a bipolar valued vague subset A. Bipolar valued vague subset A is denoted as $A = \{ \langle x, V_A^+(x), V_A^-(x) \rangle / x \in X \}$, where $V_A^+(x) = [t_A^+(x), 1-f_A^+(x)]$ and $V_A^-(x) = [-1-f_A^-(x), t_A^-(x)]$.

Note that. $[0] = [0, 0]$, $[1] = [1, 1]$ and $[-1] = [-1, -1]$.

Example 1.8. $[A] = \{ \langle a, [0.3, 0.6], [-0.6, -0.2] \rangle, \langle b, [0.3, 0.4], [-0.5, -0.3] \rangle, \langle c, [0.2, 0.6], [-0.5, -0.2] \rangle \}$ is a bipolar valued vague subset of $X = \{a, b, c\}$.

Definition 1.9. [5] Let $A = \langle V_A^+, V_A^- \rangle$ and $B = \langle V_B^+, V_B^- \rangle$ be two bipolar valued vague subsets of a set X. We define the following relations and operations:

- (i) $[A] \subset [B]$ if and only if $V_A^+(u) \leq V_B^+(u)$ and $V_A^-(u) \geq V_B^-(u)$, $\forall u \in X$.
- (ii) $[A] = [B]$ if and only if $V_A^+(u) = V_B^+(u)$ and $V_A^-(u) = V_B^-(u)$, $\forall u \in X$.
- (iii) $[A] \cap [B] = \{ \langle u, \text{rmin}(V_A^+(u), V_B^+(u)), \text{rmax}(V_A^-(u), V_B^-(u)) \rangle / u \in X \}$.
- (iv) $[A] \cup [B] = \{ \langle u, \text{rmax}(V_A^+(u), V_B^+(u)), \text{rmin}(V_A^-(u), V_B^-(u)) \rangle / u \in X \}$. Here $\text{rmin}(V_A^+(u), V_B^+(u)) = [\min \{ t_A^+(x), t_B^+(x) \}, \min \{ 1-f_A^+(x), 1-f_B^+(x) \}]$, $\text{rmax}(V_A^-(u), V_B^-(u)) = [\max \{ t_A^-(x), t_B^-(x) \}, \max \{ 1-f_A^-(x), 1-f_B^-(x) \}]$.





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$1-f_B^+(x) \}$], $rmin(V_A^-(u), V_B^-(u)) = [\min\{-1-f_A^-(x), -1-f_B^-(x)\}, \min\{t_A^-(x), t_B^-(x)\}]$, $rmax(V_A^-(u), V_B^-(u)) = [\max\{-1-f_A^-(x), -1-f_B^-(x)\}, \max\{t_A^-(x), t_B^-(x)\}]$.

Definition 1.10. [5] Let R be a ring. A bipolar valued vague subset A of R is said to be a bipolar valued vague subring of R (BVVSR) if the following conditions are satisfied,

- (i) $V_A^+(x-y) \geq rmin\{V_A^+(x), V_A^+(y)\}$
- (ii) $V_A^+(xy) \geq rmin\{V_A^+(x), V_A^+(y)\}$
- (iii) $V_A^-(x-y) \leq rmax\{V_A^-(x), V_A^-(y)\}$
- (iv) $V_A^-(xy) \leq rmax\{V_A^-(x), V_A^-(y)\}$ for all x and y in R.

Example 1.11. Let $R = Z_3 = \{0, 1, 2\}$ be a ring with respect to the ordinary addition and multiplication. Then $A = \{< 0, [0.5, 0.7], [-0.8, -0.5]>, < 1, [0.4, 0.6], [-0.7, -0.4]>, < 2, [0.4, 0.6], [-0.7, -0.4]>\}$ is a bipolar valued vague subring of R.

Definition 1.12. Let $A = \langle V_A^+, V_A^- \rangle$ be a BVVSS of X. Then the following translations are defined as

- (i) $?(A) = \{< x, r \min\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x)\}, r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x)\}> / \text{ for all } x \in X\}$.
- (ii) $!(A) = \{< x, r \max\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x)\}, r \min\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x)\}> / \text{ for all } x \in X\}$.
- (iii) $Q_{(\alpha, \beta)}(A) = \{< x, r \min\{\alpha, V_A^+(x)\}, r \max\{\beta, V_A^-(x)\}> / \text{ for all } x \in X\}$ and α in $D[0, 1]$ and β in $D[-1, 0]$.
- (iv) $P_{(\alpha, \beta)}(A) = \{< x, r \max\{\alpha, V_A^+(x)\}, r \min\{\beta, V_A^-(x)\}> / \text{ for all } x \in X\}$ and α in $D[0, 1]$ and β in $D[-1, 0]$.
- (v) $G_{(\alpha, \beta)}(A) = \{< x, \alpha V_A^+(x), -\beta V_A^-(x)> / \text{ for all } x \in X\}$ and α in $[0, 1]$ and β in $[-1, 0]$.

Definition 1.13. Let $C = \langle V_C^+, V_C^- \rangle$ be a BVVSR of a ring R and $s \in R$. Then the pseudo bipolar valued vague coset $(sC)^p = \langle (sV_C^+)^{V_p^+}, (sV_C^-)^{V_p^-} \rangle$ is defined by $(sV_C^+)^{V_p^+(a)} = V_p^+(s) V_C^+(a)$ and $(sV_C^-)^{V_p^-(a)} = -V_p^-(s) V_C^-(a)$, for every $a \in R$ and $p \in P$, where P is a collection of BVVSSs of R.

Definition 1.14. Let $A = \langle V_A^+, V_A^- \rangle$ be a BVVSS of X. Then the height $H(A) = \langle H(V_A^+), H(V_A^-) \rangle$ is defined as $H(V_A^+) = r \sup V_A^+(x)$ and $H(V_A^-) = r \inf V_A^-(x)$ for all x in X.

Definition 1.15. Let $A = \langle V_A^+, V_A^- \rangle$ be BVVSS of X. Then A is called bipolar valued normal vague subset of X if $H(V_A^+) = [1]$ and $H(V_A^-) = [-1]$.

Definition 1.16. Let $A = \langle V_A^+, V_A^- \rangle$ be a BVVSS of X. Then ${}^\circ A = \langle {}^\circ V_A^+, {}^\circ V_A^- \rangle$ is defined as ${}^\circ V_A^+(x) = V_A^+(x)H(V_A^+)$ and ${}^\circ V_A^-(x) = -V_A^-(x)H(V_A^-)$ for all x in X.

Definition 1.17. Let $A = \langle V_A^+, V_A^- \rangle$ be a BVVSS of X. Then ${}^\Delta A = \langle {}^\Delta V_A^+, {}^\Delta V_A^- \rangle$ is defined as ${}^\Delta V_A^+(x) = V_A^+(x)/H(V_A^+)$ and ${}^\Delta V_A^-(x) = -V_A^-(x)/H(V_A^-)$ for all x in X.

Some Theorems.

Theorem 2.1. [5] If $A = \langle V_A^+, V_A^- \rangle$ and $B = \langle V_B^+, V_B^- \rangle$ are two BVVSRs of a ring R, then their intersection $A \cap B$ is also a BVVSR of R.





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Theorem 2.2. If $A = \langle V_A^+, V_A^- \rangle$ is a BVVSR of a ring R, then

- (i) $?(A) = \langle ?V_A^+, ?V_A^- \rangle$ is a BVVSR of R;
- (ii) $!(A) = \langle !V_A^+, !V_A^- \rangle$ is a BVVSR of R;
- (iii) $Q_{(\alpha, \beta)}(A)$ is a BVVSR of R;
- (iv) $P_{(\alpha, \beta)}(A)$ is a BVVSR of R;
- (v) $G_{(\alpha, \beta)}(A)$ is a BVVSR of R;
- (vi) $!(?(A)) = (?(!A)) = \langle [\frac{1}{2}, \frac{1}{2}], [-\frac{1}{2}, -\frac{1}{2}] \rangle$ is also a constant BVVSR of R;
- (vii) $P_{\alpha, \beta}(Q_{\alpha, \beta}(A)) = Q_{\alpha, \beta}(P_{\alpha, \beta}(A)) = \langle \alpha, \beta \rangle$ is also a constant BVVSR of R.

Proof. (i) For every x, y in R, $?V_A^+(x - y) = r \min\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x - y)\}$

$$\begin{aligned} &\geq r \min\{[\frac{1}{2}, \frac{1}{2}], r \min\{V_A^+(x), V_A^+(y)\}\} \\ &= r \min\{r \min\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x)\}, r \min\{[\frac{1}{2}, \frac{1}{2}], V_A^+(y)\}\} \\ &= r \min\{?V_A^+(x), ?V_A^+(y)\}, \text{ for all } x, y \text{ in R.} \end{aligned}$$

For every x, y in R, $?V_A^+(xy) = r \min\{[\frac{1}{2}, \frac{1}{2}], V_A^+(xy)\}$

$$\begin{aligned} &\geq r \min\{[\frac{1}{2}, \frac{1}{2}], r \min\{V_A^+(x), V_A^+(y)\}\} \\ &= r \min\{r \min\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x)\}, r \min\{[\frac{1}{2}, \frac{1}{2}], V_A^+(y)\}\} \\ &= r \min\{?V_A^+(x), ?V_A^+(y)\}, \text{ for all } x, y \text{ in R.} \end{aligned}$$

For every x, y in R, $?V_A^-(x - y) = r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x - y)\}$

$$\begin{aligned} &\leq r \max\{[-\frac{1}{2}, -\frac{1}{2}], r \max\{V_A^-(x), V_A^-(y)\}\} \\ &= r \max\{r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x)\}, r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(y)\}\} \\ &= r \max\{?V_A^-(x), ?V_A^-(y)\}, \text{ for all } x, y \text{ in R.} \end{aligned}$$

For every x, y in R, $?V_A^-(xy) = r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(xy)\}$

$$\begin{aligned} &\leq r \max\{[-\frac{1}{2}, -\frac{1}{2}], r \max\{V_A^-(x), V_A^-(y)\}\} \\ &= r \max\{r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x)\}, r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(y)\}\} \\ &= r \max\{?V_A^-(x), ?V_A^-(y)\}, \text{ for all } x, y \text{ in R.} \end{aligned}$$





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Hence ?A is a BVVSR of R.

$$\begin{aligned}
 \text{(ii) For every } x, y \text{ in } R, !V_A^+(x - y) &= r \max\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x - y)\} \\
 &\geq r \max\{[\frac{1}{2}, \frac{1}{2}], r \min\{V_A^+(x), V_A^+(y)\}\} \\
 &= r \min\{ r \max\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x)\}, r \max\{[\frac{1}{2}, \frac{1}{2}], V_A^+(y)\}\} \\
 &= r \min\{!V_A^+(x), !V_A^+(y)\}, \text{ for all } x, y \text{ in } R.
 \end{aligned}$$

$$\begin{aligned}
 \text{For every } x, y \text{ in } R, !V_A^+(xy) &= r \max\{[\frac{1}{2}, \frac{1}{2}], V_A^+(xy)\} \\
 &\geq r \max\{[\frac{1}{2}, \frac{1}{2}], r \min\{V_A^+(x), V_A^+(y)\}\} \\
 &= r \min\{ r \max\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x)\}, r \max\{[\frac{1}{2}, \frac{1}{2}], V_A^+(y)\}\} \\
 &= r \min\{!V_A^+(x), !V_A^+(y)\}, \text{ for all } x, y \text{ in } R.
 \end{aligned}$$

$$\begin{aligned}
 \text{For every } x, y \text{ in } R, !V_A^-(x - y) &= r \min\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x - y)\} \\
 &\leq r \min\{[-\frac{1}{2}, -\frac{1}{2}], r \max\{V_A^-(x), V_A^-(y)\}\} \\
 &= r \max\{ r \min\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x)\}, r \min\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(y)\}\} \\
 &= r \max\{!V_A^-(x), !V_A^-(y)\}, \text{ for all } x, y \text{ in } R.
 \end{aligned}$$

$$\begin{aligned}
 \text{For every } x, y \text{ in } R, !V_A^-(xy) &= r \min\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(xy)\} \\
 &\leq r \min\{[-\frac{1}{2}, -\frac{1}{2}], r \max\{V_A^-(x), V_A^-(y)\}\} \\
 &= r \max\{ r \min\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x)\}, r \min\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(y)\}\} \\
 &= r \max\{!V_A^-(x), !V_A^-(y)\}, \text{ for all } x, y \text{ in } R.
 \end{aligned}$$

Hence !A is a BVVSR of R.

(iii) For every x, y in R, α in D[0, 1] and β in D[-1, 0],

$$\begin{aligned}
 Q_{(\alpha, \beta)}(V_A)^+(x - y) &= r \min\{\alpha, V_A^+(x - y)\} \\
 &\geq r \min\{\alpha, r \min\{V_A^+(x), V_A^+(y)\}\} \\
 &= r \min\{r \min\{\alpha, V_A^+(x)\}, r \min\{\alpha, V_A^+(y)\}\} \\
 &= r \min\{Q_{(\alpha, \beta)}(V_A)^+(x), Q_{(\alpha, \beta)}(V_A)^+(y)\}, \text{ for all } x, y \text{ in } R.
 \end{aligned}$$

$$\begin{aligned}
 \text{And } Q_{(\alpha, \beta)}(V_A)^+(xy) &= r \min\{\alpha, V_A^+(xy)\} \\
 &\geq r \min\{\alpha, r \min\{V_A^+(x), V_A^+(y)\}\}
 \end{aligned}$$





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$$= r \min \{ r \min \{ \alpha, V_A^+(x) \}, r \min \{ \alpha, V_A^+(y) \} \}$$

$$= r \min \{ Q_{(\alpha, \beta)}(V_A)^+(x), Q_{(\alpha, \beta)}(V_A)^+(y) \}, \text{ for all } x, y \text{ in } R.$$

For every x, y in R, β in $D[-1, 0]$,

$$Q_{(\alpha, \beta)}(V_A)^-(x - y) = r \max \{ \beta, V_A^-(x - y) \}$$

$$\leq r \max \{ \beta, r \max \{ V_A^-(x), V_A^-(y) \} \}$$

$$= r \max \{ r \max \{ \beta, V_A^-(x) \}, r \max \{ \beta, V_A^-(y) \} \}$$

$$= r \max \{ Q_{(\alpha, \beta)}(V_A)^-(x), Q_{(\alpha, \beta)}(V_A)^-(y) \}, \text{ for all } x, y \text{ in } R.$$

For every x, y in R, β in $D[-1, 0]$,

$$Q_{(\alpha, \beta)}(V_A)^-(xy) = r \max \{ \beta, V_A^-(xy) \}$$

$$\leq r \max \{ \beta, r \max \{ V_A^-(x), V_A^-(y) \} \}$$

$$= r \max \{ r \max \{ \beta, V_A^-(x) \}, r \max \{ \beta, V_A^-(y) \} \}$$

$$= r \max \{ Q_{(\alpha, \beta)}(V_A)^-(x), Q_{(\alpha, \beta)}(V_A)^-(y) \}, \text{ for all } x, y \text{ in } R.$$

Hence $Q_{(\alpha, \beta)}(A)$ is a BVVSR of R .

(iv) For every x, y in R, α in $D[0, 1]$ and β in $D[-1, 0]$,

$$P_{(\alpha, \beta)}(V_A)^+(x - y) = r \max \{ \alpha, V_A^+(x - y) \}$$

$$\geq r \max \{ \alpha, r \max \{ V_A^+(x), V_A^+(y) \} \}$$

$$= r \min \{ r \max \{ \alpha, V_A^+(x) \}, r \max \{ \alpha, V_A^+(y) \} \}$$

$$= r \min \{ P_{(\alpha, \beta)}(V_A)^+(x), P_{(\alpha, \beta)}(V_A)^+(y) \}, \text{ for all } x, y \text{ in } R.$$

For every x, y in R, α in $[0, 1]$,

$$P_{(\alpha, \beta)}(V_A)^+(xy) = r \max \{ \alpha, V_A^+(xy) \}$$

$$\geq r \max \{ \alpha, r \min \{ V_A^+(x), V_A^+(y) \} \}$$

$$= r \min \{ r \max \{ \alpha, V_A^+(x) \}, r \max \{ \alpha, V_A^+(y) \} \}$$

$$= r \min \{ P_{(\alpha, \beta)}(V_A)^+(x), P_{(\alpha, \beta)}(V_A)^+(y) \}, \text{ for all } x, y \text{ in } R.$$

For every x, y in R, β in $[-1, 0]$,

$$P_{(\alpha, \beta)}(V_A)^-(x - y) = r \max \{ \beta, V_A^-(x - y) \}$$

$$\leq r \min \{ \beta, r \max \{ V_A^-(x), V_A^-(y) \} \}$$

$$= r \max \{ r \min \{ \beta, V_A^-(x) \}, r \min \{ \beta, V_A^-(y) \} \}$$

$$= r \max \{ P_{(\alpha, \beta)}(V_A)^-(x), P_{(\alpha, \beta)}(V_A)^-(y) \}, \text{ for all } x, y \text{ in } R.$$

For every x, y in R, β in $[-1, 0]$,

$$P_{(\alpha, \beta)}(V_A)^-(xy) = r \min \{ \beta, V_A^-(xy) \}$$

$$\leq r \min \{ \beta, r \max \{ V_A^-(x), V_A^-(y) \} \}$$

$$= r \max \{ r \min \{ \beta, V_A^-(x) \}, r \min \{ \beta, V_A^-(y) \} \}$$

$$= r \max \{ P_{(\alpha, \beta)}(V_A)^-(x), P_{(\alpha, \beta)}(V_A)^-(y) \}, \text{ for all } x, y \text{ in } R.$$





Hence $P_{(\alpha,\beta)}(A)$ is a BVVSR of R.

(v) For every x, y in R, α in $[0, 1]$ and β in $[-1, 0]$,

$$\begin{aligned} G_{(\alpha,\beta)}(V_A)^+(x-y) &= \alpha V_A^+(x-y) \\ &\geq \alpha(r \min\{V_A^+(x), V_A^+(y)\}) \\ &= r \min\{\alpha V_A^+(x), \alpha V_A^+(y)\} \\ &= r \min\{G_{(\alpha,\beta)}(V_A)^+(x), G_{(\alpha,\beta)}(V_A)^+(y)\}, \text{ for all } x, y \text{ in R.} \end{aligned}$$

For every x, y in R, α in $[0, 1]$,

$$\begin{aligned} G_{(\alpha,\beta)}(V_A)^+(xy) &= \alpha V_A^+(xy) \\ &\geq \alpha(r \min\{V_A^+(x), V_A^+(y)\}) \\ &= r \min\{\alpha V_A^+(x), \alpha V_A^+(y)\} \\ &= r \min\{G_{(\alpha,\beta)}(V_A)^+(x), G_{(\alpha,\beta)}(V_A)^+(y)\}, \text{ for all } x, y \text{ in R.} \end{aligned}$$

For every x, y in R, β in $[-1, 0]$,

$$\begin{aligned} G_{(\alpha,\beta)}(V_A)^-(x-y) &= -\beta V_A^-(x-y) \\ &\leq -\beta(r \max\{V_A^-(x), V_A^-(y)\}) \\ &= r \max\{-\beta V_A^-(x), -\beta V_A^-(y)\} \\ &= r \max\{G_{(\alpha,\beta)}(V_A)^-(x), G_{(\alpha,\beta)}(V_A)^-(y)\}, \text{ for all } x, y \text{ in R.} \end{aligned}$$

For every x, y in R, β in $[-1, 0]$,

$$\begin{aligned} G_{(\alpha,\beta)}(V_A)^-(xy) &= -\beta V_A^-(xy) \\ &\leq -\beta(r \max\{V_A^-(x), V_A^-(y)\}) \\ &= r \max\{-\beta V_A^-(x), -\beta V_A^-(y)\} \\ &= r \max\{G_{(\alpha,\beta)}(V_A)^-(x), G_{(\alpha,\beta)}(V_A)^-(y)\}, \text{ for all } x, y \text{ in R.} \end{aligned}$$

Hence $G_{(\alpha,\beta)}(A)$ is a BVVSR of R.

(vi) For every x in R, $?V_A^+(x) = r \min\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x)\} \leq [\frac{1}{2}, \frac{1}{2}]$

and $!V_A^+(x) = r \max\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x)\} \geq [\frac{1}{2}, \frac{1}{2}]$,

so $!(?V_A^+(x)) = ?(!V_A^+(x)) = [\frac{1}{2}, \frac{1}{2}]$.

And $?V_A^-(x) = r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x)\} \geq [-\frac{1}{2}, -\frac{1}{2}]$

and $!V_A^-(x) = r \min\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x)\} \leq [-\frac{1}{2}, -\frac{1}{2}]$,

so $!(?V_A^-(x)) = ?(!V_A^-(x)) = [-\frac{1}{2}, -\frac{1}{2}]$.





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Hence $!(?(A)) = ?(!A) = \langle [\frac{1}{2}, \frac{1}{2}], [-\frac{1}{2}, -\frac{1}{2}] \rangle$ is a constant BVVSR of R.

(vii) For every x in R, α in $D[0, 1]$ and β in $D[-1, 0]$,

$$Q_{(\alpha, \beta)}(V_A)^+(x) = r \min\{\alpha, V_A^+(x)\} \leq \alpha$$

$$\text{and } P_{(\alpha, \beta)}(V_A)^+(x) = r \max\{\alpha, V_A^+(x)\} \geq \alpha,$$

$$\text{so } P_{(\alpha, \beta)}(Q_{(\alpha, \beta)}(V_A)^+(x)) = Q_{(\alpha, \beta)}(P_{(\alpha, \beta)}(V_A)^+(x)) = \alpha.$$

$$\text{And } Q_{(\alpha, \beta)}(V_A)^-(x) = r \max\{\beta, V_A^-(x)\} \geq \beta$$

$$\text{and } P_{(\alpha, \beta)}(V_A)^-(x) = r \min\{\beta, V_A^-(x)\} \leq \beta,$$

$$\text{so } P_{(\alpha, \beta)}(Q_{(\alpha, \beta)}(V_A)^-(x)) = Q_{(\alpha, \beta)}(P_{(\alpha, \beta)}(V_A)^-(x)) = \beta.$$

Hence $P_{\alpha, \beta}(Q_{\alpha, \beta}(A)) = Q_{\alpha, \beta}(P_{\alpha, \beta}(A)) = \langle \alpha, \beta \rangle$ is also a constant BVVSR of R.

Theorem 2.3. If $A = \langle V_A^+, V_A^- \rangle$ and $B = \langle V_B^+, V_B^- \rangle$ are BVVSSs of a ring R, then

$$(i) ?(A \cap B) = ?(A) \cap ?(B);$$

$$(ii) !(A \cap B) = !(A) \cap !(B);$$

$$(iii) P_{\alpha, \beta}(A \cap B) = P_{\alpha, \beta}(A) \cap P_{\alpha, \beta}(B);$$

$$(iv) Q_{\alpha, \beta}(A \cap B) = Q_{\alpha, \beta}(A) \cap Q_{\alpha, \beta}(B);$$

$$(v) G_{\alpha, \beta}(A \cap B) = G_{\alpha, \beta}(A) \cap G_{\alpha, \beta}(B).$$

Proof. (i) For every x in R, $?V_{A \cap B}^+(x) = r \min\{[\frac{1}{2}, \frac{1}{2}], V_{A \cap B}^+(x)\}$

$$= r \min\{[\frac{1}{2}, \frac{1}{2}], r \min\{V_A^+(x), V_B^+(x)\}\}$$

$$= r \min\{r \min\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x)\}, r \min\{[\frac{1}{2}, \frac{1}{2}], V_B^+(x)\}\}$$

$$= r \min\{?V_A^+(x), ?V_B^+(x)\}$$

$$= (?V_A^+ \cap ?V_B^+)(x), \text{ for all } x \text{ in R.}$$

$$\text{And } ?V_{A \cap B}^-(x) = r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_{A \cap B}^-(x)\}$$

$$= r \max\{[-\frac{1}{2}, -\frac{1}{2}], r \max\{V_A^-(x), V_B^-(x)\}\}$$

$$= r \max\{r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x)\}, r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_B^-(x)\}\}$$

$$= r \max\{?V_A^-(x), ?V_B^-(x)\}$$

$$= (?V_A^- \cap ?V_B^-)(x), \text{ for all } x \text{ in R.}$$

Hence $?(A \cap B) = ?(A) \cap ?(B)$.

Similarly, (ii), (iii), (iv) and (v) are proved.





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Theorem 2.4. If $A = \langle V_A^+, V_A^- \rangle$ and $B = \langle V_B^+, V_B^- \rangle$ are BVVSRs of a ring R , then

- (i) $?(A \cap B) = ?(A) \cap ?(B)$ is also a BVVSR of R ;
- (ii) $!(A \cap B) = !(A) \cap !(B)$ is also a BVVSR of R ;
- (iii) $P_{\alpha,\beta}(A \cap B) = P_{\alpha,\beta}(A) \cap P_{\alpha,\beta}(B)$ is also a BVVSR of R ;
- (iv) $Q_{\alpha,\beta}(A \cap B) = Q_{\alpha,\beta}(A) \cap Q_{\alpha,\beta}(B)$ is also a BVVSR of R ;
- (v) $G_{\alpha,\beta}(A \cap B) = G_{\alpha,\beta}(A) \cap G_{\alpha,\beta}(B)$ is also a BVVSR of R .

Proof. The proof follows from the Theorems 2.1, 2.2 and 2.3.

Theorem 2.5. [5] If $A = \langle V_A^+, V_A^- \rangle$ and $B = \langle V_B^+, V_B^- \rangle$ are any two BVVSRs of the rings R_1 and R_2 respectively, then $A \times B = \langle V_{A \times B}^+, V_{A \times B}^- \rangle$ is a BVVSR of $R_1 \times R_2$.

Theorem 2.6. If $A = \langle V_A^+, V_A^- \rangle$ and $B = \langle V_B^+, V_B^- \rangle$ are BVVSRs of the rings R_1 and R_2 respectively, then

- (i) $?(A \times B) = ?(A) \times ?(B)$;
- (ii) $!(A \times B) = !(A) \times !(B)$;
- (iii) $P_{\alpha,\beta}(A \times B) = P_{\alpha,\beta}(A) \times P_{\alpha,\beta}(B)$;
- (iv) $Q_{\alpha,\beta}(A \times B) = Q_{\alpha,\beta}(A) \times Q_{\alpha,\beta}(B)$;
- (v) $G_{\alpha,\beta}(A \times B) = G_{\alpha,\beta}(A) \times G_{\alpha,\beta}(B)$.

Proof. (i) For every (x, y) in $R_1 \times R_2$, $?V_{A \times B}^+(x, y) = r \min\{[\frac{1}{2}, \frac{1}{2}], V_{A \times B}^+(x, y)\}$

$$= r \min\{[\frac{1}{2}, \frac{1}{2}], r \min\{V_A^+(x), V_B^+(y)\}\}$$

$$= r \min\{r \min\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x)\}, r \min\{[\frac{1}{2}, \frac{1}{2}], V_B^+(y)\}\}$$

$$= r \min\{?V_A^+(x), ?V_B^+(y)\}$$

$$= (?V_A^+ \times ?V_B^+)(x, y), \text{ for all } (x, y) \text{ in } R_1 \times R_2.$$

And $?V_{A \times B}^-(x, y) = r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_{A \times B}^-(x, y)\}$

$$= r \max\{[-\frac{1}{2}, -\frac{1}{2}], r \max\{V_A^-(x), V_B^-(y)\}\}$$

$$= r \max\{r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x)\}, r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_B^-(y)\}\}$$

$$= r \max\{?V_A^-(x), ?V_B^-(y)\}$$

$$= (?V_A^- \times ?V_B^-)(x, y), \text{ for all } (x, y) \text{ in } R_1 \times R_2.$$

Hence $?(A \times B) = ?(A) \times ?(B)$.

Similarly, (ii), (iii), (iv) and (v) are proved.

Theorem 2.7. If $A = \langle V_A^+, V_A^- \rangle$ and $B = \langle V_B^+, V_B^- \rangle$ are BVVSRs of the rings R_1 and R_2 respectively, then

- (i) $?(A \times B) = ?(A) \times ?(B)$ is also a BVVSR of $R_1 \times R_2$;
- (ii) $!(A \times B) = !(A) \times !(B)$ is also a BVVSR of $R_1 \times R_2$;





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- (iii) $P_{\alpha,\beta}(A \times B) = P_{\alpha,\beta}(A) \times P_{\alpha,\beta}(B)$ is also a BVVSR of $R_1 \times R_2$;
- (iv) $Q_{\alpha,\beta}(A \times B) = Q_{\alpha,\beta}(A) \times Q_{\alpha,\beta}(B)$ is also a BVVSR of $R_1 \times R_2$;
- (v) $G_{\alpha,\beta}(A \times B) = G_{\alpha,\beta}(A) \times G_{\alpha,\beta}(B)$ is also a BVVSR of $R_1 \times R_2$.

Proof. The proof follows from the Theorems 2.2, 2.5 and 2.6.

Theorem 2.8. [5] Let $A = \langle V_A^+, V_A^- \rangle$ be a BVVSS of a ring R and $V = \langle V_V^+, V_V^- \rangle$ be the strongest bipolar valued vague relation of R . Then A is a BVVSR of R if and only if V is a BVVSR of $R \times R$.

Theorem 2.9. Let $A = \langle V_A^+, V_A^- \rangle$ be a BVVSS of a ring R and $V = \langle V_V^+, V_V^- \rangle$ be the strongest bipolar valued vague relation of R . Then

- (i) $?(V) = ?(A) \times ?(A)$;
- (ii) $!(V) = !(A) \times !(A)$;
- (iii) $P_{\alpha,\beta}(V) = P_{\alpha,\beta}(A) \times P_{\alpha,\beta}(A)$;
- (iv) $Q_{\alpha,\beta}(V) = Q_{\alpha,\beta}(A) \times Q_{\alpha,\beta}(A)$;
- (v) $G_{\alpha,\beta}(V) = G_{\alpha,\beta}(A) \times G_{\alpha,\beta}(A)$.

Proof. (i) For every (x, y) in $R \times R$, $?V_V^+(x, y) = r \min\{[\frac{1}{2}, \frac{1}{2}], V_V^+(x, y)\}$

$$\begin{aligned}
 &= r \min\{[\frac{1}{2}, \frac{1}{2}], r \min\{V_A^+(x), V_A^+(y)\}\} \\
 &= r \min\{ r \min\{[\frac{1}{2}, \frac{1}{2}], V_A^+(x)\}, r \min\{[\frac{1}{2}, \frac{1}{2}], V_A^+(y)\}\} \\
 &= r \min\{?V_A^+(x), ?V_A^+(y)\}
 \end{aligned}$$

$= (?V_A^+ \times ?V_A^+)(x, y)$, for all (x, y) in $R \times R$.

And $?V_V^-(x, y) = r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_V^-(x, y)\}$

$$\begin{aligned}
 &= r \max\{[-\frac{1}{2}, -\frac{1}{2}], r \max\{V_A^-(x), V_A^-(y)\}\} \\
 &= r \max\{ r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(x)\}, r \max\{[-\frac{1}{2}, -\frac{1}{2}], V_A^-(y)\}\} \\
 &= r \max\{?V_A^-(x), ?V_A^-(y)\}
 \end{aligned}$$

$= (?V_A^- \times ?V_A^-)(x, y)$, for all (x, y) in $R \times R$.

Hence $?(V) = ?(A) \times ?(A)$.

Similarly, (ii), (iii), (iv) and (v) are proved.

Theorem 2.10. Let $A = \langle V_A^+, V_A^- \rangle$ be a BVVSR of a ring R and $V = \langle V_V^+, V_V^- \rangle$ be the strongest bipolar valued vague relation of R . Then

- (i) $?(V) = ?(A) \times ?(A)$ is also a BVVSR of $R \times R$;
- (ii) $!(V) = !(A) \times !(A)$ is also a BVVSR of $R \times R$;
- (iii) $P_{\alpha,\beta}(V) = P_{\alpha,\beta}(A) \times P_{\alpha,\beta}(A)$ is also a BVVSR of $R \times R$;





(iv) $Q_{\alpha,\beta}(V) = Q_{\alpha,\beta}(A) \times Q_{\alpha,\beta}(A)$ is also a BVVSR of $R \times R$;

(v) $G_{\alpha,\beta}(V) = G_{\alpha,\beta}(A) \times G_{\alpha,\beta}(A)$ is also a BVVSR of $R \times R$.

Proof. The proof follows from the Theorems 2.2, 2.8 and 2.9.

Theorem 2.11. Let $C = \langle V_C^+, V_C^- \rangle$ be a BVVSR of a ring R . Then the pseudo bipolar valued vague coset $(sC)^p$ is a BVVSR of R , for every $s \in R$ and $p \in P$, where P is a collection of BVVSSs of the ring R .

Proof. Let $a, b \in R$, $(V_{sC}^+)^{V_p^+}(a-b) = V_p^+(s) V_C^+(a-b)$

$$\geq V_p^+(s) r \min\{V_C^+(a), V_C^+(b)\}$$

$$= r \min\{V_p^+(s)V_C^+(a), V_p^+(s)V_C^+(b)\}$$

$$= r \min\{(V_{sC}^+)^{V_p^+}(a), (V_{sC}^+)^{V_p^+}(b)\}, \forall a, b \in R.$$

And $(V_{sC}^+)^{V_p^+}(ab) = V_p^+(s) V_C^+(ab)$

$$\geq V_p^+(s) r \min\{V_C^+(a), V_C^+(b)\}$$

$$= r \min\{V_p^+(s)V_C^+(a), V_p^+(s)V_C^+(b)\}$$

$$= r \min\{(V_{sC}^+)^{V_p^+}(a), (V_{sC}^+)^{V_p^+}(b)\}, \forall a, b \in R.$$

Also $(V_{sC}^-)^{V_p^-}(a-b) = V_p^-(s) V_C^-(a-b)$

$$\leq V_p^-(s) r \max\{V_C^-(a), V_C^-(b)\}$$

$$= r \max\{V_p^-(s)V_C^-(a), V_p^-(s)V_C^-(b)\}$$

$$= r \max\{(V_{sC}^-)^{V_p^-}(a), (V_{sC}^-)^{V_p^-}(b)\}, \forall a, b \in R.$$

And $(V_{sC}^-)^{V_p^-}(ab) = V_p^-(s) V_C^-(ab)$

$$\leq V_p^-(s) r \max\{V_C^-(a), V_C^-(b)\}$$

$$= r \max\{V_p^-(s)V_C^-(a), V_p^-(s)V_C^-(b)\}$$

$$= r \max\{(V_{sC}^-)^{V_p^-}(a), (V_{sC}^-)^{V_p^-}(b)\}, \forall a, b \in R.$$

Hence $(sC)^p$ is a BVVSR of R .

Theorem 2.12. Let C be a BVVSS of a ring R . Then C is a BVVSR of R if and only if each (V_C^+, V_C^-) is a BV-fuzzy subring of R .

Proof. Let $a, b \in R$. Suppose C is a BVVSR of R ,

$$V_C^+(a-b) \geq r \min\{V_C^+(a), V_C^+(b)\}, V_C^+(ab) \geq r \min\{V_C^+(a), V_C^+(b)\},$$

$$\text{and } V_C^-(a-b) \leq r \min\{V_C^-(a), V_C^-(b)\}, V_C^-(ab) \leq r \min\{V_C^-(a), V_C^-(b)\}.$$

Hence each (V_C^+, V_C^-) is BV-fuzzy subring of R .

Conversely, assume that each (V_C^+, V_C^-) is BV-fuzzy subring of R .

As per the definition of BVVSR of R , C is a BVVSR of R .

Theorem 2.13. If $K = \langle V_K^+, V_K^- \rangle$ be a BVVSR of a ring R , then ${}^\circ K = \langle {}^\circ V_K^+, {}^\circ V_K^- \rangle$ is a BVVSR of R .





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Proof. For any $u, v \in R$

$$\begin{aligned} \text{Now } {}^\circ V_K^+(u-v) &= V_K^+(u-v)H(V_K^+) \\ &\geq r \min\{V_K^+(u), V_K^+(v)\}H(V_K^+) \\ &= r \min\{V_K^+(u)H(V_K^+), V_K^+(v)H(V_K^+)\} \\ &= r \min\{{}^\circ V_K^+(u), {}^\circ V_K^+(v)\}, \text{ for all } u, v \in R. \end{aligned}$$

$$\begin{aligned} \text{And } {}^\circ V_K^+(uv) &= V_K^+(uv)H(V_K^+) \\ &\geq r \min\{V_K^+(u), V_K^+(v)\}H(V_K^+) \\ &= r \min\{V_K^+(u)H(V_K^+), V_K^+(v)H(V_K^+)\} \\ &= r \min\{{}^\circ V_K^+(u), {}^\circ V_K^+(v)\}, \text{ for all } u, v \in R. \end{aligned}$$

$$\begin{aligned} \text{Also } {}^\circ V_K^-(u-v) &= -V_K^-(u-v)H(V_K^-) \\ &\leq -r \max\{V_K^-(u), V_K^-(v)\}H(V_K^-) \\ &= r \max\{-V_K^-(u)H(V_K^-), -V_K^-(v)H(V_K^-)\} \\ &= r \max\{{}^\circ V_K^-(u), {}^\circ V_K^-(v)\}, \text{ for all } u, v \in R. \end{aligned}$$

$$\begin{aligned} \text{And } {}^\circ V_K^-(uv) &= -V_K^-(uv)H(V_K^-) \\ &\leq -r \max\{V_K^-(u), V_K^-(v)\}H(V_K^-) \\ &= r \max\{-V_K^-(u)H(V_K^-), -V_K^-(v)H(V_K^-)\} \\ &= r \max\{{}^\circ V_K^-(u), {}^\circ V_K^-(v)\}, \text{ for all } u, v \in R. \end{aligned}$$

Hence ${}^\circ K$ is a BVVSR of R .

Theorem 2.14. If $K = \langle V_K^+, V_K^- \rangle$ be a BVVSR of a ring R , then (i) if $H(V_K^+) < [1]$, then ${}^\circ V_K^+ < V_K^+$; (ii) if $H(V_K^-) > [-1]$, then ${}^\circ V_K^- > V_K^-$; (iii) if $H(V_K^+) < [1]$ and $H(V_K^-) > [-1]$, then ${}^\circ K < K$.

Proof. (i), (ii) and (iii) are trivial.

Theorem 2.15. If $K = \langle V_K^+, V_K^- \rangle$ be a BVVSR of a ring R , then ${}^\Delta K = \langle {}^\Delta V_K^+, {}^\Delta V_K^- \rangle$ is a BVVSR of R .

Proof. For any $u, v \in R$.

$$\begin{aligned} \text{then } {}^\Delta V_K^+(u-v) &= V_K^+(u-v) / H(V_K^+) \\ &\geq r \min\{V_K^+(u), V_K^+(v)\} / H(V_K^+) \\ &= r \min\{V_K^+(u) / H(V_K^+), V_K^+(v) / H(V_K^+)\} \\ &= r \min\{{}^\Delta V_K^+(u), {}^\Delta V_K^+(v)\}, \text{ for all } u, v \in R. \end{aligned}$$

$$\begin{aligned} \text{And } {}^\Delta V_K^+(uv) &= V_K^+(uv) / H(V_K^+) \\ &\geq r \min\{V_K^+(u), V_K^+(v)\} / H(V_K^+) \\ &= r \min\{V_K^+(u) / H(V_K^+), V_K^+(v) / H(V_K^+)\} \\ &= r \min\{{}^\Delta V_K^+(u), {}^\Delta V_K^+(v)\}, \text{ for all } u, v \in R. \end{aligned}$$

$$\begin{aligned} \text{Also } {}^\Delta V_K^-(u-v) &= -V_K^-(u-v) / H(V_K^-) \\ &\leq -r \max\{V_K^-(u), V_K^-(v)\} / H(V_K^-) \\ &= r \max\{-V_K^-(u) / H(V_K^-), -V_K^-(v) / H(V_K^-)\} \end{aligned}$$





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$$= r \max\{\Delta V_K^-(u), \Delta V_K^-(v)\}, \text{ for all } u, v \in R.$$

$$\begin{aligned} \text{And } \Delta V_K^-(uv) &= -V_K^-(uv) / H(V_K^-) \\ &\leq -r \max\{V_K^-(u), V_K^-(v)\} / H(V_K^-) \\ &= r \max\{-V_K^-(u) / H(V_K^-), -V_K^-(v) / H(V_K^-)\} \\ &= r \max\{\Delta V_K^-(u), \Delta V_K^-(v)\}, \forall u, v \in R. \end{aligned}$$

Hence ΔK is a BVVSR of R.

Theorem 2.16. If $K = \langle V_K^+, V_K^- \rangle$ be a BVVSR of a ring R, then (i) if $H(V_K^+) < [1]$, then $\Delta V_K^+ > V_K^+$; (ii) if $H(V_K^-) > [-1]$, then $\Delta V_K^- < V_K^-$; (iii) if $H(V_K^+) < [1]$ and $H(V_K^-) > [-1]$, then $\Delta K > K$; (iv) if $H(V_K^+) < [1]$ and $H(V_K^-) > [-1]$, the ΔK is a normal BVVSR of R.

Proof. (i), (ii), (iii) and (iv) are trivial.

Theorem 2.17. If $K = \langle V_K^+, V_K^- \rangle$ be a normal BVVSR of a ring R, then (i) $\circ K = K$, (ii) $\Delta K = K$.

Proof. It can be easily proved.

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An IoT based ECG Monitoring System and RR Interval based Feature Extraction

Indurekaa S R^{1*}, Suba Rani N², Dencyflora G³ and Balakrishnan M²

¹Assistant Professor, Artificial Intelligence and Data Science, Dr.Mahalingam College of Engineering and Technology, Pollachi, Coimbatore, Tamil Nadu, India.

²Associate Professor, Artificial Intelligence and Data Science, Dr.Mahalingam College of Engineering and Technology, Pollachi, Coimbatore, Tamil Nadu, India.

³Assistant Professor, Computer and Communication Engineering, Sri Eshwar College of Engineering, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

Indurekaa S R

Assistant Professor,
Artificial Intelligence and Data Science,
Dr.Mahalingam College of Engineering and Technology,
Pollachi, Coimbatore, Tamil Nadu, India.
E. Mail : indurekaa@gmail.com



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ABSTRACT

Currently, many people suffer from cardiovascular diseases and one among those diseases is arrhythmia. When a person's heart rate is chaotic or abnormal, arrhythmia occurs. To identify this ailment, there should be consecutive monitoring of Electrocardiogram (ECG) signal irrespective of the location bound to the subject and the physician. The proposed system acquires the ECG data and transmits it to the cloud wirelessly using Wi-Fi technology for continuous ECG signal monitoring using AD8232 ECG Signal conditioning module. Additionally, a feature extraction technique has been created to extract features from the ECG signal of the BioVid Heat pain database for various pain levels, including RMSSD, SDNN, Mean RR, Ratio SR, and slope of linear regression of IBI. On a real-time ECG signal, the same feature extraction algorithm can be used to extract the features. The proposed system helps medical team to treat the subject without being in close vicinity.

Keywords: ECG Signal, Wireless Transmission, Feature Extraction

INTRODUCTION

In recent years, it has been observed that whenever a person is exposed to excessive work, it mostly leads to exhaustion. If this condition prevails for long time and remain unattended, it may lead to cardiovascular diseases.



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During this emergency situation, if the person could not get immediate medical care, the chances of death become high. Therefore a health care system for monitoring the ECG signal wirelessly and the machine learning process to classify ECG signals would be a smart way to diagnose the cardiovascular diseases such as arrhythmia. The proposed method undergoes the implementation of wireless monitoring of ECG signal based on Wi-Fi technology and features are extracted from the BioVid Heat pain database which will be used for high accuracy ECG signal classification. ECG signal monitoring system is portable with wireless transmission capabilities. In this method, ECG signal from the subject is acquired using data acquisition module and microcontroller. The acquired signal is transmitted to IBM Watson IoT cloud server using MQTT protocol and the real time ECG signal is monitored. Features such as mean of RR Interval, Root Mean Square Successive Differences (RMSSD), Standard Deviation of NN intervals (SDNN), Ratio SR, Slope of linear regression of Inter Beat Interval (IBI) are extracted from the ECG signal of BioVid heat pain database for five different conditions such as (BL1, PA1, PA2, PA3 and PA4), which can be further used to perform classification in order to predict arrhythmia. The rest of this paper is organized as follows. Section 2 deals with the related works and databases. Then, the implementation of wireless ECG signal monitoring system and feature extraction from ECG signal of database are given in Section 3. In Section 4, experimental results and discussions are presented. Finally, conclusion is discussed in Section 5.

Related Works and Databases

Related works

A bio-signal acquisition and classification system for diagnosing heart disease has been illustrated in [1] in which ECG signal is acquired and transmitted using Bluetooth for short distances and it is classified at the receiver end. In [2], transmission of biomedical signal is performed using the Bluetooth module which mainly focuses on signal acquisition that takes place after filtering and amplifying the signal. In ECG signal quality assessment method [3], the quality of acquired ECG signals is assessed under resting, ambulatory and physical activity environments using MATLAB. Small wearable sensors capture, process and transmit the ECG signal to the doctor using the Bluetooth module and the abnormalities are observed and diagnosed accordingly [4]. The authors in [5] have taken ECG signal from analog discovery tool and the processed the sampled data of the signal using CC3200 before transmitting to the cloud using Wi-Fi.

Removal of noise and feature extraction of ECG signal is depicted in [6], which undergoes the removal of baseline wandering of ECG signal using butter worth filter and the statistical features are extracted using discrete wavelet analysis. In [7], median filter is used for signal de-noising and statistical feature extraction along with SVM-RBF classification has been performed with 90% efficiency. Different feature extraction methods for analyzing the classification of the ECG signal has been reviewed in [8]. Features are extracted using Discrete Wavelet Transform (DWT), statistical method, time domain and frequency domain methods. In [9], signals are taken from MIT-BIH arrhythmia database in which artifact signals are removed in the preprocessing stage and QRS-complex detection is performed to locate heart beats for segmentation and ECG signal is classified. ECG signal is obtained from MIT-BIH arrhythmia database and classification is done using stacked sparse autoencoder and soft max regression in [10] and accuracy of 99.34% is achieved.

Databases

The ECG signal in BioVid heat pain database has been recorded for 5.5 Seconds long and is digitized at 512Hz. It consists of five different conditions such as BL1, PA1, PA2, PA3 and PA4. BL1 indicates no pain condition and the series of PA indicates the increase in pain level from PA1 to PA4. Each pain and no pain condition consists of 20 recordings and totally 100 recordings are present. The recording for each condition of ECG signal is concatenated and it is plotted. R peaks are located in the plotted ECG signal from which RR Interval (RRI) is obtained. Using RRI, features are extracted using the standard equations.





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Proposed Method

The proposed method involves implementation of wireless ECG signal monitoring system and feature extraction from ECG signal in BioVid Heat pain database.

Implementation of Wireless ECG Monitoring System

The ECG monitoring system consists of several modules as shown in Fig. 1. The initial part of the system consists of three ECG electrodes placed on Right Arm, Left Arm and Left Leg or Right Leg of a human. The corresponding electrode jack is connected to ECG Signal conditioning module (AD8232). The analog output from AD8232 is fed to 12-bit resolution ADC of CC3200 IoT Kit which operates at maximum of 1.46V. The value of ECG signal inferred from AD8232 ranges from 1.65V-2.25V, so the signal value is down converted to 1.46V by designing and implementing a voltage divider circuit. Voltage divider circuit is designed with the specifications as $R_1 = 1K\Omega$, $R_2 = 1K\Omega$, $V_{in} = 1.65V$, $V_{out} = 0.82V$. The output signal from the AD8232 is given to one end of resistor R_1 and common GND is given for the circuit. The output voltage from voltage divider circuit is given to ADC and it is shown in Fig. 2. The digital values are displayed in serial monitor of Energia IDE tool. The CC3200 IoT Kit is configured in Energia IDE utilising the MQTT protocol to send digitised ECG signal readings to IBM Watson Cloud Platform. The SSID, password, baud rate, and IBM IoT foundation link are all defined in the MQTT protocol for a specific network. When a network connection attempt is made, the MAC address and device ID are generated. A Quickstart link and the generated device ID are obtained if the network is connected.

Feature Extraction

Neurokit is a toolbox for biomedical signal processing and it is written in Python. ECG signal in BioVid Heat pain database is processed and R peak detection is done using Neurokit library. RRI is defined as the time interval between two successive R peaks. Using RRI, features are calculated and extracted.

In Feature Extraction method, the following features were extracted.

Mean of RRI - It is the ratio between the sum of RRI and the number of elements of RRI.

RMSSD - It is the square root of the mean of the squares of the successive differences between adjacent NNs.

SDNN - It is a measure of changes in heart rate due to cycles longer than 5 minutes.

Ratio SR - It is the ratio between SDNN and RMSSD.

Slope of linear regression of IBI - It is the slope of regression which is used to test the significance of a linear relationship between range of length of RRI and RRI. The above set of features was calculated using the equation in TABLE I. The algorithm for the extraction of features such as RMSSD, SDNN, Mean RR, Ratio SR and Slope is developed and it is shown in table below.

RESULTS AND DISCUSSIONS

Data Acquisition and Transmission

In Wireless ECG Monitoring System, signal conditioning (AD8232) module is interfaced with CC3200 IoT Kit using the designed voltage divider circuit to acquire ECG signal. The digital values are displayed in Serial Monitor of Energia IDE tool as shown in Fig. 3. The MQTT protocol is used for the transmission of digital values of ECG signal from the serial monitor to cloud server. The HTTP comment which is viewed in serial monitor is copied to the web and by accepting terms and condition of the IBM Watson cloud platform the digital values are plotted in the dashboard as shown in Fig. 4. The transmitted ECG signal using MQTT protocol and TI CC3200 IoT kit is plotted in the dashboard of IoT Platform. Since, the CC3200 IoT Kit uses the 12-bit resolution ADC that returns 12-bits of data per sample. The acquired ECG signal is plotted as Time Versus ADC values. The P wave in the electrocardiogram indicates the depolarization of the atria, the QRS complex represent the depolarization process of the ventricles and T wave represent ventricular repolarization. The RRI is the one in which the interval from the peak of one QRS complex to the peak of next QRS complex is measured. From the RRI, a person's heart rate can be classified as normal and abnormal.





Feature Extraction

ECG signal is plotted for BL1 (no pain) condition as shown in Fig. 5. Similarly, ECG signal is plotted for pain conditions. R peaks are detected using Neurokit toolbox which is written in Python. Using the R peaks, RRI is calculated and plotted. For a single database, the simulation of the developed algorithm calculates RRI values for five different conditions from the R peaks that has been detected using Neurokit toolbox and is plotted as shown in Fig. 6,7,8,9,10. Similarly, RRI values are calculated from the successive differences in time interval between R peaks from 50 databases and it is plotted. The developed algorithm is simulated using Spyder 3.2.5 to extract features such as RMSSD, SDNN, Mean RR, Ratio SR and Slope RR using the calculated RRI values for five different conditions such as BL1, PA1, PA2, PA3 and PA4 and it is tabulated in TABLE III. Similarly, features are extracted from 50 databases that can be further used for classification of ECG signals to predict arrhythmia

CONCLUSION

In this paper, wireless ECG monitoring system is implemented using AD8232 for real time signal acquisition, CC3200 IoT kit for analog to digital conversion and Wi-Fi module of IoT kit for transmission of ECG signal to IBM Watson cloud platform. This portable and reliable system helps the physician to give immediate medical care irrespective of patient's location. Also, R peaks were detected using Neurokit toolbox and features such as RMSSD, SDNN, Mean RR, Ratio SR and slope of linear regression of IBI were extracted from 50 databases using the developed algorithm. R peak detection using Neurokit toolbox and feature extraction algorithm can be further applied on the real time acquired ECG signal to extract the features.

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Table. 1 Features With Their Equation

Features	Equation
Mean	$\sqrt{\frac{\sum_{i=1}^n (RRI_i)}{n}}$
SDNN	$\sqrt{1/(N - 1)* \sum_{i=1}^n (RRI_i - mean(RRI))^2}$
RMSSD	$\sqrt{1/(N - 1)* \sum_{i=1}^{n-1} ((RRI_{i+1} - (RRI)_i)^2)}$
Ratio SR	SDNN/RMSSD
Slope	$\frac{n * (\sum_{j=1} len(RRI)) * \sum_{i=1}^n RRI_i) - ((\sum_{j=1} len(RRI)) * \sum_{i=1}^n RRI_i))}{n * (\sum_{j=1} len(RRI)^2) - (\sum_{j=1} len(RRI))^2}$

Table. 2 Feature Extraction algorithm

No.	Algorithm Steps
1	Import Pandas, Neurokit and Numpy libraries.
2	Load the ECG signal data from the CSV file using the pandas read function.
3	ECG signal is processed and R peaks are detected using Neurokit toolbox in Neurokit2.
4	RRI is calculated in array format from the time interval between two successive R peaks using Numpy library.
5	Features such as SDNN, RMSSD, Ratio SR, Mean RR and Slope are calculated using standard equations along with the parameters: RRI and range of length of RRI.

Table 3. Extracted Features

ID	RMSSD	SDNN	MEAN RR	RATIOSR	SLOPE RR
BL1	84.534	72.142	889	0.853	-0.055
PA1	70.784	61.888	889.6	0.874	-0.155
PA2	92.265	73.551	893.9	0.797	-0.163
PA3	89.688	77.528	879.9	0.864	-0.214
PA4	99.655	86.828	860.35	0.871	-0.466





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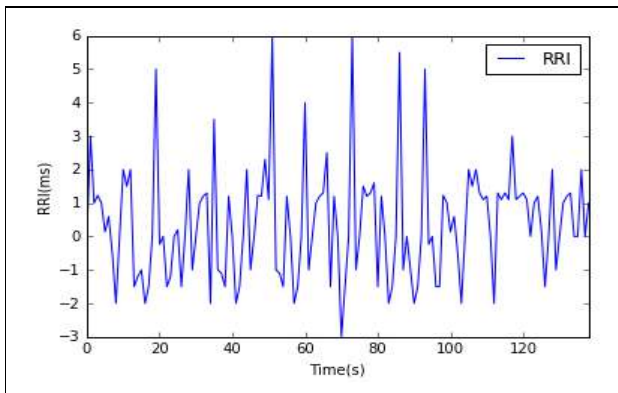


Fig. 7. Plot of RRI for PA1 condition

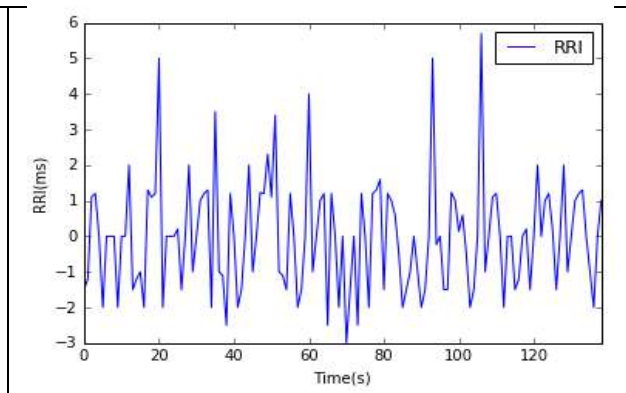


Fig. 8. Plot of RRI for PA2 condition

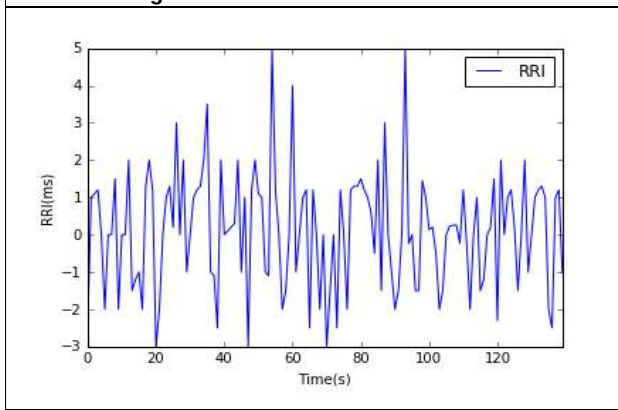


Fig. 9. Plot of RRI for PA3 condition

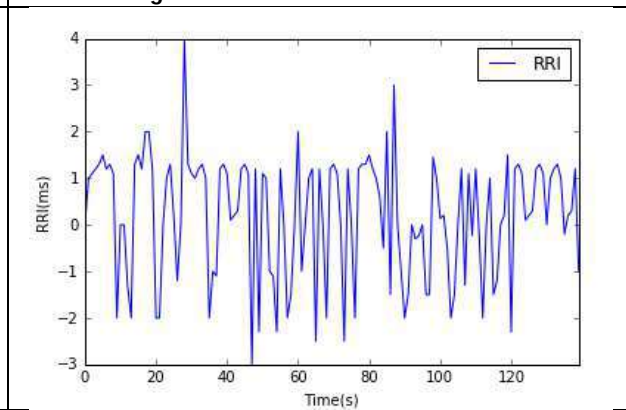


Fig. 10. Plot of RRI for PA4 condition





A Study of Development of COVID-19 Vaccines and Regulatory Challenges during Pandemic Scenario

M.S.L. Divya¹, S. Vasantha Mounika¹, P. Ramya¹, S.N. Swaroopa¹, K. Venkateswara Raju^{2*} and N.L. Prasanthi³

¹Student, Department of Regulatory Affairs, Shri Vishnu College of Pharmacy, Bhimavaram, Andhra Pradesh, India.

²Associate Professor, Department of Regulatory Affairs, Shri Vishnu College of Pharmacy, Bhimavaram, Andhra Pradesh, India.

³Head of the Department, Department of Regulatory Affairs, Shri Vishnu College of Pharmacy, Bhimavaram, Andhra Pradesh, India.

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*Address for Correspondence

K. Venkateswara Raju

Associate Professor,

Department of Regulatory Affairs,

Shri Vishnu College of Pharmacy,

Bhimavaram, Andhra Pradesh, India

E. Mail : venkateswararaju.k@svcp.edu.in



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ABSTRACT

Vaccine development usually takes around 7 years to come to the market after getting necessary regulatory approvals. But recent pandemics like Covid, Ebola, and Swine Flu, have resulted in the collaboration of efforts between the government doing investments in vaccine development, academia, regulatory bodies, and industry. This has shortened the timelines for approval for vaccines. In 2009, H1N1, Swine flu vaccines took 93 days for identifying the vaccine candidate for clinical trials. In 2014, for Ebola vaccine, was deployed while the epidemic was still going on. The Ebola vaccine was developed in 5 years. In the case of Covid (SARS-CoV-2) clinical trials were approved when 2 months after the pandemic onset. Within a time of 9 months about 138, vaccine candidates are being reviewed for approval by EUA. This highly helps in the shortening of vaccine development and necessary approval. In this paper, we focused on the above issues & those related to vaccine platforms like mRNA and DNA vaccines which are novel approaches in vaccine development.

Keywords: Vaccine development, platform technology, COVID-19, Targets, EUA





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INTRODUCTION

As of October 2022, there have been more than 64 million fatalities and more than 600 million documented cases of the virus worldwide. These have detrimental consequences on country and individual economies as well as global public health [1]. A new Coronaviridae virus, SARS-CoV-2 was responsible for the Covid-19 rife. There had never been a human infection with this novel type of Coronavirus. Chinese officials promulgated the incident of the peculiar coronavirus type on January 7 2020. This outbreak of disease brought on by Covid-19 Coronavirus prompted WHO to issue a worldwide health emergency on January 30 2020. After the disease gene sequences were published a few days later, frenzied (R&D) activity started as the world raced to develop a vaccine. On March 11 2020 the WHO designated Covid-19 as pandemic disease. The previous five public health emergencies of global significance were the H1N1 pandemic of 2009, the West African Ebola outbreak from a few years ago, the worldwide Poliovirus outbreak from a few years ago, and the Ebola outbreak from a few years ago. One of the perks of dealing with this specific virus may be seen in the development of a vaccine which retains the position as the main hope in resolving this worldwide crisis. These advantageous factors include everything from initiatives to promote humanitarian solidarity to quicken vaccine research [2,3].

Vaccines What are they? Why Immunization is important?

The ultimate purpose of a shot is to aid in the maturation of the body's defences by utilizing the capacity of the mammalian immune system to ascertain, react to, and retain infectious agent antigens from the target illness or those produced through biotechnology found in the majority of vaccinations. Preservatives, stabilizers, excipients and traces of substances left over from manufacturing are a few examples of extra elements. In particular groups such as neonates, geriatrics and those with compromised resistance, adjuvants are added to lower the amount of vaccine required and to promote the elicitation of an immunological response [4]. The COVID-19 Pandemic has been fought with various drugs to a certain extent. The relevance of the herd effect as an effective measure in fighting the Pandemic, despite the fact that the majority of the treatments have failed to demonstrate viability in combat of COVID-19, has been stressed by scientists [5]. Increasing immunity with vaccinations is a more reliable method of increasing it than contracting it from Covid-19. The vaccine creates an immune response and serves to protect you without being harmful to you. It is thought that having Covid-19 may result in long-term health problems. Even though Covid-19 can cause sickness and death in kids, it isn't desirable to rule out the severity or nature of a person's symptoms. Those who do not manifest symptoms at the time of the first infection might also be at risk for having long-term health issues. It is viable that these side effects may be followed after a mild moderate or severe case of Covid-19 [6]. A vaccine has banished smallpox, human illness kids and parents will soon be able to breathe easy because the case of childhood polio is close to being eliminated thanks to immunizations. Measles levels have been reduced through immunization initiatives. The creation of vaccinations has a unique set of challenges in comparison to the creation of other drugs. Vaccines are inoculated to subjects who are not yet vulnerable to the disease from which they are meant to protect them and for them to function they must meet greater standards than other medications[7,8]. The success or failure of the vaccine will depend on several factors including its effectiveness how quickly it is developed and how many people are insured to get a shot as well as efficacy against other rising variants[9].

SARS-CoV-2: Structure, Prominent Vaccination Targets

It has a genetic makeup that is 30 kb in size and is shaped like a sphere, two thirds of the Sars-CoV-2 genome express the replicase while the remaining three-quarters of the genetic material code for morphological and functional proteins. The four different categories of structural proteins include:

- Spike Protein (S)
- Nucleocapsid Protein (N)
- Membrane Protein (M)
- Envelope Protein (E)



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According to studies, the RNA genomes of Sars-CoV-2 and Sars-CoV share roughly 80 of their similarities, although there are still some notable discrepancies in the genomes of the two viruses as well as Mers-CoV two instances of these alterations are the omission of the 8a protein and the variance in the figure of the amino group that code for the 8b and 3c proteins in Sars-CoV-2 [10]. Since spike protein is the cardinal surface of Covid-19 viruses and they require angiotensin converting substances like Sars-CoV as they are crucial for both adherence and access into target cells, the main goal is to provoke an antibody reaction against them. The host ACE-2 interface is activated by the S1 and S2 subunits of the virus and they are accountable for linking their membranes. To get into the cell, it needs to take control of the cell DNA and then produce progeny to cause further damage and spread the infections to other cells. It's necessary to neutralize the vital functioning of the projecting viral spikes that allow viral entrance with the vaccine-induced manufactured antibodies assisted by the help t cells to stop the infections in their tracks [11,12].

Vaccine Platforms This section describes the five major vaccination platforms, each of which has subtle structural differences, benefits, and drawbacks in terms of immunological activity tolerability and effectiveness. A brief description of three major classic platforms is presented, live-attenuated viral vaccines, combined inactivated virus vaccines, virus-like particle/sub-unit vaccines, followed by next-generation platform vaccines made of mRNA, DNA, Viral vectors.

Traditional Vaccine Platforms This group contains well-known vaccination platform technologies including live attenuated viruses, whole inactivated viruses, proteins and virus-like particles.

Live Attenuated Vaccines are those vaccines that lose their infectious propensity after passing through both human and animal cells. The attenuated virus induced the prominent T cell and B cell-mediated immunity. Toll-like receptors, which include TLR 3, are part of the innate immune system and can be stimulated with live vaccinations. Their effectiveness and safety should be confirmed through more intensive testing. It's possible that there could be a mutation during viral replication that results after the vaccine has been administered. Community cold chain distribution is required [13,14].

Inactivated Vaccines Chemical agent's formaldehyde or propiolactone glutaraldehyde, UV rays diminish the pathogenicity of live viruses in an inactivated vaccine. The causative agent contained in the shot is still latent despite not being able to spread the disease. This lethal virus can nonetheless cause an immunological reaction whensover of a re-exposure. The inactivated version of the morphon makes for a safe vaccine, particularly for those with impaired immune systems. Additionally, these Covid-19 vaccinations required potentially booster doses as they usually demonstrate a weaker immune response than with the live vaccines. As the virus must initially flourish in a lab before being rendered inert creating these inactivated vaccines requires a lot of time. These vaccinations can be freeze-dried and do not need to be distributed in cold chains.^[15,16]

Protein-subunit vaccines They don't have any live virus particle components. They are regarded as secure and less likely to cause unwanted effects. The more effective antigen to stimulate neutralizing antibodies as opposed to the contagion is indeed s protein of Sars-CoV-2. The production procedure for sub-unit vaccines is secure and straightforward because live virus handling isn't necessary. One drawback is that they frequently need potent adjuvants to elicit a robust immunological reaction, and occasionally, these adjuvants might give vaccination recipients an anaphylactic reaction[14,17].

Virus-like particles are empty, genetically dormant viral shells. Presumably they are deemed as prudent, provoke a potent immunological reaction and are challenging to manufacture. They offer a *defensive antigen* insetting of an intact viral particle yet cannot replicate. VLPs perhaps be utilised to create gene transfer therapy vectors and can be employed to enclose medicines, tiny compounds, and nucleic acids enabling targeted release. The lack of a viral genome makes it susceptible to disintegration amid while being more resilient than subunit shots. The integrity of the particle can get compromised by variations in temperature, shear strain, plus chemical modification that lowers the vaccine's immunogenicity. Hence, for VLPs to be stable over time, their design, purification and storage are crucial.



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Next Generation Vaccine Platforms Nucleic acid and Viral vector vaccines are more novel platforms and played an important role in developing COVID-19 Vaccines.

Nucleic Acid Vaccines It is more affordable to create COVID-19 vaccines utilizing nucleic acids. The research on creating vaccines makes extensive use of the antigen that is nucleic acid-coded. Despite the instability of mRNA, plasmid DNA transpired as a possible platform following the failure of the initial clinical investigation. New clinical trials to develop COVID-19 vaccines have been initiated as a result of improvements in vaccine delivery.

DNA-Based Vaccines

It is more affordable to create COVID-19 vaccines utilizing nucleic acids. The research on creating vaccines makes extensive use of the antigen that is nucleic acid-coded. New clinical trials to develop COVID-19 vaccines have been initiated as a result of improvements in vaccine delivery. Local tissue dispersion studies are also required for DNA vaccines utilizing novel delivery techniques, formulations and other adaptations anticipated to have a major impact on cellular uptake, local tissue dispersion studies are also required. As a result, compared to other vaccination platforms, these vaccines may have relatively high development and operations expenses.

RNA-Based Vaccines mRNA coated with lipid of the SARS-CoV-2 expressing S-protein is used in RNA vaccines. These are regarded as safe and incapable of causing disease, although they have not been tested in actual use and can trigger ADE. By in vitro generation from expression vector from a linearized DNA template, the vaccine principle ingredient is created. The final vaccine has the gene of interest's mRNA as well as the regulatory components needed for the gene's translation, such as untranslated regions, a 5' cap, and the poly(A) tail. Due to the platform's ability to copy mRNA intracellularly, a substantial proportion of antigens can be produced from a little vaccine dosage. The size and the proportion of the dosage needed in order are also decreased by this self-replication within the vaccine recipients.

Viral vector vaccines The preparation of these vaccines involves the utilisation of recombinant DNA technology. The bacterium *orviralvectors* contain DNA that encodes a pathogens antigen. The antigen is then expressed in these cells by the bacterial cell or viral vectors. From the bacteria or virus vectors, the antigens are extracted and subsequently purified. Vaccines using viral vectors may replicate or not. Along with the extensive gene transfer procedure, it was also noted that these vaccinations trigger a strong immunological response. These vaccines have a longer half-life and a higher peak level of antigenic protein production than other vaccine types, making them more efficacious.

Replicating The desired gene is genetically altered into an unrelated virus, such as measles or an adenovirus. These have a great ability to stimulate T cell and B cell responses and are thought to be safe.

Non-replicating Genetic engineering is used to alter an unrelated virus, for example, the measles or an adenovirus (containing the dormant gene), to encode the desired gene. These are regarded as secure and call for supplemental doses to produce lasting immunity[18,19].

The Development of Vaccines

The creation of a vaccine necessitates a sophisticated mechanism that involves greater knowledge of recipient and viral interactions with clinical research epidemiology and production needs.^[18] Amid the start of the vaccine advancement phases and the time between the products license or marketing was frequently more than 10 years before Covid-19. Regulatory procedures have been widely categorized by the FDA and EMA and those various consecutive pre-requisites required in those regulatory systems contribute to these protracted durations. Additionally, Conditional Marketing Authorizations by the EMA and Emergency Use Authorizations by the FDA were used to speed up the regulatory process as well as and fast-track designations and rolling data submissions can also be used. For a drug that tries to address a significant unfulfilled medical need like pandemics, necessitates a smaller range of data than standard Marketing Authorization both the EUA and CMA prompt approvals can be requested. However, they still need to exemplify that the boon of having the drug on the market straight away surpasses any potential risks even those linked to vaccines. After receiving a EUA or CMA strict controls are in place, and manufacturers are required to continue collecting as well as reporting placebo-controlled trial data in line with predetermined deadlines[20].



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Only the measles vaccine required the least time to develop and receive authorization for use, roughly 5 years. It will likely be challenging to develop a Covid-19 vaccine within the coming 12 to 24 calendar months albeit with the current understanding the creation of the Covid-19 vaccination intends to reduce such a 10-15-year time frame to 12-24 months. Once the original sequence was released, it was possible to save time by using data from (MERS-CoV & SARS-CoV), pre-tested vaccine candidates instead of beginning with exploratory phases. Preclinical and toxicological evidence from relevant vaccines were used in certain immunisation proposals, while modified manufacturing techniques from vaccine candidates with prior approval were employed in others. This led to the first CVC clinical trial (nct0428346) beginning in March 2020. A shorter timeline was achieved by overlapping the phases of the clinical study in addition to the initial phase trials, phase iii trials were swiftly launched following the interim analysis of data from initial two phases. The US government expedited the development to prepare billions of doses by 2021 and make them available for emergency use by the end of 2020 through operation warp speed. In an attempt to swiftly generate billions of shots, a few companies have started the volume creation of immunizations without even any phase iii trial data as they lined up for. Using Emergency Use Authorization (EUA) one that has subsequently been adopted by several countries just as the UK and the USA can expedite the review procedure. The arduous effort of developing CVCs is finished in a record pace of 12 to 16 months in contrast to conventional vaccine development which takes ten to fifteen years[18]. The purpose of the emergency authorizations is not to stay conditional, but rather to turn into normal authorizations once the necessary information is supplied in a complete dossier in the allotted term. One prerequisite for the granting of a CMA is the ability to provide comprehensive data following clearance. Once a longer-term record is available, the FDA intends for the firm to lodge a Biologics License Application. Currently, AI and certain other computational technologies are being used to accelerate the research on vaccinations against this unique virus. Additionally, a bid to lessen the credible dose and establish the safety and therapeutic window focus is being given first to the enhancement of eliciting an immune response via vaccine adjuvants. At this writing, granted adjuvants for the Covid-19 vaccine are CPG1018, MF59 and AS03[21].

Optimization of approval process for Regulatory Authorities

- Pathways for Emergency use have shown to be essential for the authorization of Covid-19 immunizations in many countries. The FDA and EMA authorities favoured streamlined trial design where crucial phases were completed concurrently but instead of consecutively, letting the sponsors to adopt swift decisions based on new evidence.
- A number of Covid-19-specific rules were also made public in order to bridge and simplify regulatory disclosures. The EMA had a better hold on examining the clinical trial data because they conducted rolling assessments which allowed enterprises to submit inputs generated after filing of CMA. The review period can last up to 20 days as contrary to 70 days formerly.
- The realm of a dossier can be decided on an individual basis before submission, but it must nevertheless show that there is a favourable benefit-risk balance and that it complies with requirements for safety integrity and effectiveness.
- The EMA pandemic task force during Covid-19 was founded to better oversee vaccine research and surveillance. National authorities such as the Paul-Ehrlich Institute introduced rolling assessments for clinical research authorizations, including swift scientific advice protocols. These authorities further authorized the examination of numerous vaccine candidates during the same trial.
- The environmental hazard identification criterion for studies involving transgenics was temporarily reprieved by the European Parliament for the earliest possible start of clinical trials. Sponsors are urged to keep integrating trial data after the EUA has been filed, specific criteria and considerations for granting a EUA were outlined in the FDA's specific guidelines on EUA for Covid-19 vaccines, long-term safety surveillance has been deemed a crucial component by the FDA and EMA.
- In the course of BLA filing and during post-marketing studies the EMA and FDA expressed bids mandating applicants to furnish monthly updates on all pertinent safety and effectiveness data. When seeking a BLA and conducting post-marketing safety testing, candidates were obliged by the FDA and EMA to submit monthly reports containing all pertinent safety and effectiveness data.



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- The EMA and FDA sponsored continuing in-the-moment discussions with manufacturers during the pandemic and also released supplemental Q&A documentation concerning new directives as well as initial design initiatives such as the EMAs PRiorityMEdicines prime programme. The FDA and EMA had not developed product profiles before the pandemic which would have aided in the creation of a Covid-19 vaccine and clarified the overall necessity for immunizations [23,24,25].

Regulatory Affairs Challenges

- Uncoordinated regulatory activities construct barriers to the development of vaccination acceptance for instance, companies who want to enter overseas markets may need to submit many applications for product authorization. Additional trials or animal studies might be needed during this procedure, which would raise the price and delay the time it necessitates to bring the medicine to trade.
- Regulatory agencies in developing countries may not have the resources or the necessary knowledge to keep up with the quick improvements in novel medicines and manufacturing techniques, which creates a tremendous burden on them as a result of the lack of harmonisation.
- An allocation of vaccines and vaccine reluctance may result from the licensure of a medicine that is not believed to be thoroughly examined along with the ICH and the WHO regulators as well as related industries from various regions have collaborated to draft internationally agreed documents so as to harmonize expectations and minimize inconsistent obligations for international registrations[26].
- There is a need for a variety of vaccines for diverse demographics such as infants, toddlers, pregnant women and those with weakened immune systems however, the majority of vaccines currently under establishment are intended towards the healthy community which would be between the ages of 18 and 55. There is a need to define a safe regulatory strategy for giving these immunizations to women expecting to conceive and others with compromised immune systems.
- The regulatory affairs process requires the design of clinical trials, pre-clinical data, clinical data, drug development, approval and launch planning the whole process including the assessment of the deadlines takes a very long period. clinical trial enrolment is extremely challenging and there needs to be a goal to achieve.
- The sponsor of the development project must obtain a patent before committing funds to the program. Patents based on product or composition of matter give the patentee the right to stop others from manufacturing and marketing the drug for uses that are comparable to their own but they also bar the marketing of any unique applications that a third party may find. With exclusivity extensions included in numerous regulatory processes, the patent procedure coexists. On the other hand, so-called "use" patents protect a particular medical usage[27].

Summary information on vaccine products in preclinical development & Clinical development [28]

- **No. of Vaccines in Pre-clinical development:** 198
- **No. of Vaccines in Clinical development:** 171
- **No. of Approved Vaccines:** 44
- **No. of Countries with Approved Vaccines:** 201
- **WHO EUL Vaccines:** 12

AEFI

Adverse Events following Immunization is a term used in the new guidelines to describe a certain unfavourable illness which may arise post vaccination despite the fact that doesn't merely have a definitive link to the use of vaccines.

The primary aspects covered are:

- Methods and strategies for the nations vaccinations to be safe and of high quality.
- AEFI monitoring and vaccinations safety goals
- Updated AEFI categorization recording investigation causation evaluation and reaction procedures
- For the AEFI surveillance system optimum application of vaccination safety surveillance data
- Political and media engagement strategy on the safety of vaccinations





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Classification grouped by Severity and Frequency

1. Common minor AEFIs
2. Severe AEFIs
3. Serious AEFIs

Common minor AEFIs

A vaccine attempts to instil immunity by activating the recipient's body's defences therefore as a component of the immune response local reactivity pyrexia and systemic symptoms are possible additionally certain compounds like adjuvants stabilizers or preservatives may cause responses.

Severe AEFIs

are those which aren't trivial although do not lead to grievous emergency room visits or impairment the word severe is used to express how intense a particular event was as in mild moderate or severe however, the incident itself might not have much medical importance.

Serious AEFIs

will be deemed serious if it causes mortality, necessitates hospitalization, resulting in major disability or incapacity that lasts for an extended period of time, or if it occurs in a cluster (two or more occurrences in one location) with other AEFIs [31]. There seem to be four key approaches for the consent of a vaccine: Acknowledging the firm's indication of interest, Meeting between the manufacturer and WHO before submitting, accepting the vaccine filings for assessment, decisions concerning the assessment's progress and eventual approval. Initially, the Expression of Interest hasn't been accepted it was made apparent in the progress report for the Covaxin case that more details are needed. This essay primarily discusses the immunogenicity of the Indian vaccines, Covaxin and Covishield[32].

Covaxin:

It is an autochthonous, inactivated Covid-19 vaccine from India advanced by a crew of researchers at Bharat biotech and the Indian council of medical research. The Vero cells utilized to make this vaccine are entire-virion inactivated Vero cells. The vaccine's performance had been reported to be 78% ever since the phase III clinical trial's final analysis. The DCGI (Drug Controller General of India) gave the National Institute of Virology (ICMR) consent to perform initial phases of clinical trials of this specific BBV152 vaccine in June 2020. The immunological response in the Phase II study was reported to be stronger than those in the Phase I clinical trial, and BBV152 also demonstrated higher eradication responses in the Phase II trial. Phase III human studies for Covaxin have indeed been approved[33]. These inactivated vaccinations have been utilized for decades to protect people against a number of viral infections, including rabies, influenza, encephalitis, and polio. In a similar vein, BBV152 was also produced utilizing the same tools and techniques. Immuno potentiators, or adjuvants, are mostly added to BBV152 to augment and increase its immunogenicity. It should be stored between 2 and 8 °C. There are two immunization schedules involved.

The vaccine does not have any very harmful adverse effects, but there may be discomfort, generalized pain, swelling at injection site, pyrexia, headache, wooziness, abdominal pain and retching. Clinical trials including the age ranges of around 2 to 18 years were carried out at AIIMS Delhi and Patna (Approved by the DCGI). Immunization may reduce your chance of developing serious infections. In countries including Nepal, Philippines, Iran, and many others, the vaccine was added to the list of urgent needs. Because the adverse effects are moderate in this instance, the individual can opt Covaxin as a safer option who is more prone to side effects. This specific vaccine can be used in place of others and has the ability to reduce the chances of adverse effects such blood clots that are rarely brought on by some other vaccines. Although the vaccine can't completely prevent a specific Covid infection, it can lessen its severity and mortality risks. According to Bharat Biotech, the efficacy of Covaxin's phase III clinical trial was 77.8% effective against COVID-19 symptoms and 93.4% effective against severe symptoms.



**Divya et al.,****Covishield**

Astra Zeneca and The University of Oxford's technology acquisition of SIPL enabled the creation of COVISHIELD. The S glycoprotein of SARS-CoV-2 is encoded by a single recombinant, replication-deficient chimpanzee adenovirus (ChAdOx1) vector, which is used to make the monovalent vaccine Covishield. The S glycoprotein of SARS-CoV-2 has been expressed locally after injection, inducing neutralizing antibodies and cellular immunological responses. After a single standard dose, Covishield is highly immunogenic, with a seroconversion of live virus-neutralizing antibodies >80%, binding antibody levels greater than 97% and after a second dose higher than 99% of both antibodies. Seroconversion for both binding and neutralizing antibodies increased with respect to increase in dose interims between the initial and subsequent shot. Furthermore, if the time between shots was maintained around 4 and 12 weeks, the vaccine's effectiveness improved. People and older adults are deemed to be safe with few deleterious effects, according to safety reports. Immuno compromised folks must be immunized following counselling. To evaluate the safety of vaccines during pregnancy, very little data were available. It isn't advised for those with someone under the age of 18 and those who have confronted a serious response to any vaccine constituent. 24 The Global Advisory committee on vaccine safety GACV examined the most recent data regarding thrombocytopenia potentially rare adverse blood coagulation incident TTS however, it appears that there is very little data accessible.

Covishield provokes the body's defences in opposition to the S-protein of the coronavirus. The immunological stimulation is better as it consists of a single epitope as there is no significant mutation-related alteration in the S protein epitopic complex. Covishield is still widely reliable in anticipation of all mutants of Covid-19 along with the delta strain in India. On the other hand, Covaxin can cause the development of antibodies against several epitopes, most of which resemble COVID-19 infections acquired naturally. However, this vaccination is less effective overall than Covishield. However, the Covishield may not work well if the epitopic structure of spike protein is significantly altered in the future as a result of spontaneous mutation. As a result, combining Covishield and Covaxin shots during vaccination may be more effective than doing it in reverse. A vaccination will work better than others if it's created using the virus' conserved sequence. The efficacy rate of those vaccines won't be lowered even if numerous new varieties or mutant strains are found. However, it still requires additional experimental testing and must meet all requirements for a successful vaccine formulation [19,34,35].

CONCLUSION

Timelines for regulatory approval of vaccine development have shortened. New platforms for vaccine development are emerging. Examples include mRNA, and DNA vaccines ensuring the safety, efficacy, and quality of vaccines developed through new platforms is challenging as it has no previous regulatory experience is available in such cases. Emergency Usage Authorisation for vaccines is approved even 1 or 2 months after the emergence of the pandemic. In cases of vaccines given full authorization, we should keep track of adverse effects and efficacy to address new infections and reduction in mortality and morbidity in non-immunised groups and immunised groups. Using the following steps regulators can incorporate new adaptive models into the toolkit of decision-making and modify the regulatory pathways for usage in emergencies. As in the case of COVID-19 vaccines where multiple vaccine candidates were given EUA. The final candidates that should be rolled out will be recommended on the outcome of evaluations done, and iterations by the complete health authority. In parallel consultation with the regulator with respect to ease of administration of the vaccine, cost, tolerability, relative safety and duration of protection.

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Table 1: Showing Advantages And Disadvantages Of Various Vaccine Platforms

S. No	Vaccine Platform	Immunogen	Advantages	Disadvantages
1	Live-attenuated vaccines	Mutant MERS-CoV and SARS-CoV or recombination with other live attenuated virus	Multiple viral antigens. Elicit strong immune response, long lasting protection. causes reactogenicity. Excellence in induction of T and B cell responses. Site-directed mutagenesis can be tail or made	Safety concerns; requires handling live virus, risk of reversion to a virulent strain, lab or intensive, cold chain required. Not suitable for sensitive population and individuals with weakened immune systems
2	Inactivated vaccines	Chemically or UV inactivated virus	Preserve virus particle structure, relatively simple, rapid development, strong immune response, can be formulated with various adjuvant	Least reactogenicity, requiring multiple dosages and adjuvants, risk of partial inactivation, requires handling live virus, risk of becoming pathogenic, possible cause hypersensitivity and Th2-bias
3	Subunit	Full-length spike, or S1, RDB, nucleocapsid	High safety profile. Non-infectious, consistent production, ease of delivery, robust immune response	Challenging manufacturing, need appropriate adjuvant, stability, cost effectiveness may vary
4	Virus-like particles	RDB, S or co-expressing of S1, M, E	Safety, multimeric antigen display, preserve virus particle structure, simple large-scale construction	Require optimum assembly condition
5	Viral vector	Full-length spike, or S1	Safety, excellence in immune induction, weak immunogenicity and may require the addition of adjuvants	Epitope selection, antigen design, and vehicle development are not straightforward, varies inoculation routes may produce different immune responses, possible TH2 bias
6	DNA	Vector based delivery of a viral gene full-length spike, or S1	Safety, scalability, rapid production, easy design and manipulation, storage at room temperature, cellular and humoral responses, low cost	Efficient delivery system required, poorly immunogenic, purity, pathogenicity due to recombination with wild type virus, requiring repeated administration and the addition of adjuvant
7	RNA	Delivery of modified mRNA full-length spike, or S1	Safety, effectiveness, rapid and inexpensive manufacturing, strong immune capacity, requires low dose	Less stable, low efficiency of delivery, possibly of autoimmune disorders and unwanted immune response, cost repeated administration

Table 2: Showing platforms and no. of. vaccine candidates

S. No	Platform	No. of Candidate Vaccines
1	Protein subunit (PS)	55
2	Viral Vector (non-replicating) (vvr)	22
3	DNA (DNA)	16
4	Inactivated Virus (IV)	22
5	RNA (RNA)	40
6	Viral Vector (replicating) (Vvr)	4
7	Virus like particle (VLP)	6
8	Vvr + Antigen presenting cell	2
9	Live Attenuated Virus (LAV)	2
10	VVnr + Antigen Presenting cell	1
11	Bacterial antigen-spore expression vector (BacAg-spV)	1





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Table 3: Showing data on a list of approved vaccines worldwide

S.No	Name of the Vaccine	No. of Countries where the vaccine got approved	No. of trails carried out
1	Oxford/AstraZeneca: Vaxzevria,	149	70 trails in 33 countries
	Pfizer/BioNTech: Comirnaty		
			92 trails in 30 countries
2	Janssen (Johnson & Johnson): Jcovden	113	26 trails in 25 countries
3	Sinopharm (Beijing): Covilo	93	38 trails in 16 countries
4	Moderna: Spikevax	88	68 trails in 24 countries
5	Gamaleya: Sputnik V	74	25 trails in 8 countries
6	Sinovac: CoronaVac	56	40 trails in 10 countries
7	Serum Institute of India: Covishield (Oxford/AstraZeneca formulation)	49	4 trails in 1 country
8	Novavax: Nuvaxovid	39	21 trails in 14 countries
9	Moderna: Spikevax Bivalent Original/Omicron BA.1	34	2 trails in 2 countries
10	Valneva: VLA2001	33	8 trails in 3 countries
11	Pfizer/BioNTech: Comirnaty Bivalent Original/Omicron BA.1	30	1 trail in 4 countries
12	Gamaleya: Sputnik Light	26	7 trails in 3 countries
13	Bharat Biotech: Covaxin	14	14 trails in 2 countries
14	CanSino: Convidecia	10	14 trails in 6 countries
15	Center for Genetic Engineering and Biotechnology (CIGB): Abdala	6	5 trails in 1 country
16	Serum Institute of India: COVOVAX (Novavax formulation)	5	5 trails in 3 countries
17	Anhui Zhifei Longcom: Zifivax,	4	20 trails in 5 countries
	Instituto Finlay de Vacunas Cuba: Soberana 02,		7 trails in 2 countries
	Vector State Research Center of Virology and Biotechnology: EpiVacCorona		4 trails in 1 country
18	Chumakov Center: KoviVac,	3	3 trails in 1 country
	Medigen: MVC-COV1901,		15 trails in 4 countries
19	Biological E Limited: Corbevax,	2	7 trails in 1 country
	Instituto Finlay de Vacunas Cuba: Soberana Plus,		5 trails in 1 country
	Research Institute for Biological Safety Problems (RIBSP): QazVac,		3 trails in 1 country
	Shenzhen Kangtai Biological Products Co: KCONVAC,		7 trails in 1 country
	Sinopharm (Wuhan): Inactivated (Vero Cells)		9 trails in 7 countries
20	Bagheiat-allah University of Medical Sciences: Noora vaccine,	1	3 trails in 1 country
	Gamaleya: Gam-COVID-Vac,		2 trails in 0 countries
	Gennova Biopharmaceuticals Limited: GEMCOVAC-19,		2 trails in 1 countries
	Health Institutes of Turkey: Turkovac,		8 trails in 1 country
	Medicago: Covifenz,		6 trails in 6 countries
	Moderna: Spikevax Bivalent Original/Omicron BA.4/BA.5,		2 trails in 1 country
	National Vaccine and Serum Institute: Recombinant SARS-CoV-2 Vaccine (CHO Cell),		3 trails in 2 countries
	Organization of Defensive Innovation and Research: FAKHRAVAC (MIVAC),		3 trails in country
	Pfizer/BioNTech: Comirnaty Bivalent Original/Omicron BA.4/BA.5		0 trails in 0 countries
	Razi Vaccine and Serum Research Institute: Razi Cov		5 trails in 1 country
	Pars		
	Shifa Pharmed Industrial Co: COVIran Barekat		6 trails in 1 country
	SK Bioscience Co Ltd:SkyCovione		7 trails in 6 countries
	Takeda: TAK-019 (Novavax formulation)		3 trails in 1 country
	Takeda: TAK-919 (Moderna formulation)		2 trails in 1 country
	Vaxine/CinnaGen Co.: SpikoGen		7 trails in 2 countries
Vector State Research Center of Virology and Biotechnology: Aurora-CoV	2 trails in 1 country		
Zydus Cadila: ZyCoV-D	6 trails in 1 country		





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Table 4: presenting list of WHO EUL Vaccines

S.No	Name of the Vaccine	No. of countries approved	No. of trails carried out	No. of countries where trails were carried	Vaccine Platform
1	Oxford/AstraZeneca: Vaxzevria,	149	70	33	Protein subunit
	Pfizer/BioNTech: Comirnaty		92	30	RNA
2	Janssen (Johnson & Johnson): Jcovden	113	26	25	Non-Replicating Viral Vector
3	Sinopharm (Beijing): Covilo	93	38	16	Inactivated
4	Moderna: Spikevax	88	68	24	RNA
6	Sinovac: CoronaVac	56	40	10	Inactivated
7	Serum Institute of India: Covishield (Oxford/AstraZeneca formulation)	49	4	1	Non-Replicating Viral Vector
8	Novavax: Nuvaxovid	39	21	14	Protein subunit
9	Valneva: VLA2001	33	8	3	Inactivated
10	Bharat Biotech: Covaxin	14	14	2	Inactivated
11	CanSino: Convidecia	10	14	6	Non-Replicating Viral Vector
12	Serum Institute of India: COVOVAX (Novavax formulation)	5	5	3	Protein subunit

Table 5: Showing regulatory update in India during Covid-19 pandemic

S. No	Related to Diagnosis, Prevention, Treatment, and Management of COVID-19.	Notices Related to Regulatory pathway for R&D of drugs, vaccines, clinical trials, and In -Vitro Diagnostics (IVD) kits for the diagnosis of COVID-19	Description of the notice
1		<p>Polymerase chain reaction and RAPID/CLIA/ELISA kits approved for testing of COVID-19</p> <p>Letter regarding manufacturing of oxygen for medical use during COVID</p> <p>Notification S.O. regarding manufacture and stock for sale or distribution of vaccines for COVID-19</p> <p>Advisory notice regarding voluntary registration of personal protective equipment</p>	<p>Two notices (no. X-11026/07/2020-PRO) were issued by CDSCO on March 19, 2020, [1,2] about drugs/vaccines and diagnostic kits for COVID.</p> <p>CDSCO issued an updated list of approved PCR kits, a list of RAPID/CLIA/ELISA kits for COVID-19 on June 8[3] also included name of the firm, type of kit, and country name.</p> <p>CDSCO issued a notice (no. DCGI/MISC/2020/96) on April 7[5] addressing all state/ union territory (UT) drug controllers to ensure the availability and supply & to grant license to manufacture oxygen for medical use within 24 h of receiving application, fees, etc.</p> <p>Ministry of Health and Family Welfare issued a notification (no. S. O. 1511 (E) on May 18, 2020, [6] for lessening the timelines for vaccine development for Covid-19 by allowing applicants to submit the application for manufacturing during the conduct of clinical trial.</p> <p>An advisory notice (no. DCGI/Misc/2020 [119]) was issued by the CDSCO May 22, 2020, [highlighted that all manufacturers of personal protective equipment (PPE) be aware of latest rules governing Medical Device.</p>
2	OFFICE MEMORANDUM REGARDING RAPID RESPONSE REGULATORY FRAMEWORK FOR COVID-19 VACCINE DEVELOPMENT		<p>An office memorandum (no. BT/03/27/2020-PID) was issued by the Ministry of Science and Technology Department of Biotechnology regarding Rapid Response Regulatory Framework for COVID-19 Vaccine development, on May 26, 2020</p> <p>i) Rapid Response Regulatory Framework for fast-track processing of applications relating to recombinant vaccines for COVID-19.</p> <p>ii) a checklist for preclinical toxicity studies, consideration of preclinical data generated outside India, and consideration of data on clinical studies.</p> <p>iii) parallel application for conduct of clinical trials during preclinical studies and abbreviated pathway for COVID-19 vaccine development.</p>





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3	RELATED TO CLINICAL TRIALS DURING THE COVID-19 PANDEMIC	Notice regarding conduct of clinical trials Circular regarding extension of validity of BA/BF study centers	The CDSCO released a notice [9] on Mar 30, 2020 (no. DCGI/MISC/2020 [104]) regarding conduct of clinical trials during the COVID-19 outbreak. It was specified that any communication between sponsor/ethics committee (EC)/investigator regarding the implementation of protocol amendments/deviations/modifications due to the current scenario may be sent via e-mail/any other electronic mode to Indian HA. A circular (no. 7-5/2020/Misc/070) was issued on April 30 by the CDSCO regarding extension of validity of BA/BF study centers based on various representations received from stakeholders.
4	INDIAN COUNCIL OF MEDICAL RESEARCH GUIDELINES FOR ETHICS COMMITTEES DURING COVID-19		The Indian Council of Medical Research (ICMR) has released, on May 6, 2020, [11] National Guidelines for Ethics Committees reviewing Biomedical and Health Research (April 2020) & role of ECs in conducting ethical research during the COVID-19 pandemic.
5	RELATED TO NEW DRUGS, IMPORT/ MANUFACTURING OF DRUGS DURING THE COVID 19 PANDEMIC	Circular regarding procedure for lot release of human vaccine during the COVID pandemic Notice regarding submission of notarized/apostilled documents for import of drugs, medical devices, and in vitro diagnostic kits Letter regarding extension of WHO Good Manufacturing Practice/Certificate of pharmaceutical Products	In order to ensure continued availability of vaccines and essential drug and considering the challenges of logistics and workforce, a circular (no.X 11026/65/2020 BD) was issued by the CDSCO on April 5. Two notices were issued by the CDSCO on April 15 (no. Import/Misc/101/2020-DC) and April 25 (no. 20/Misc/US/2020/DC (60) for drugs and medical devices, respectively, [13,14] which stated that considering the COVID pandemic, an applicant may submit applications for import registration documents once situation normalizes. The CDSCO office issued a notice (no. 7-5/2020/Misc/070) on May 1,[15] addressing all state/UT drug controllers. Considering the COVID outbreak validity of certificates such as WHO Good Manufacturing Practice/Certificate of pharmaceutical Products expiring from March to August 2020 may be extended by 6 months from the date of expiry of certificate.
6	RELATED TO MISCELLANEOUS DURING THE COVID 19 PANDEMIC	Notice regarding the COVID-19 outbreak	The CDSCO office issued a notice (no. DCGI/ MISC/2020/ (99) on March23[16] regarding emergency situation arisen out of the COVID-19 outbreak & mentioned that due to lockdown, permissions/queries/clarifications

Table 6: Showing comparison of characteristics between Covaxin and Covishield

S.NO	Name of the Vaccine	Platform Technology	Vaccine Composition	Dose, Interval, Route of Administration,	Efficacy	Possible Adverse Effects
1	Covaxin	Inactivated Viral Vaccine	Inactivated adenovirus with segments of Coronavirus, Aluminium Hydroxide Gel, L-Histidine, L-Histidine Hydrochloride Monohydrate, Magnesium Chloride Hexahydrate, Polysorbate 80, Ethanol, Sucrose, Sodium Chloride, and Disodium Edetate Dihydrate (EDTA).	0.5ml 4 Weeks Intramuscular (I.M)	78%	Injection site pain, Swelling, Redness, Itching Headache, Fever, body ache, Nausea, Vomiting, Rashes
2	Covishield	Viral Vector Vaccine	inactivated Coronavirus, Aluminum Hydroxide Gel, TLR 7/8 Agonist, 2-Phenoxyethanol and Phosphate Buffered Saline [NKA1].	0.5ml 8-12 Weeks Intramuscular (I.M)	72%	Nausea, Headache, Myalgia, arthralgia, Pyrexia, malaise, fatigue, chills, injection site pain





Divya et al.,

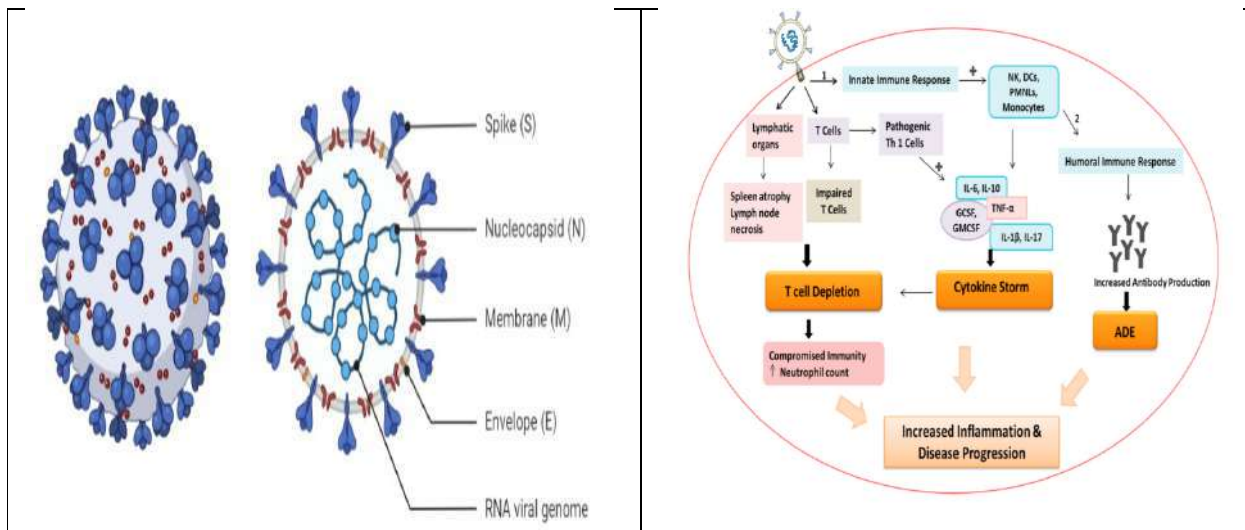


Fig.1: Retrieved from <https://app.biorender.com/biorender-templates>

Fig. 2: Representing Immunopathogenesis of SARS-CoV-2

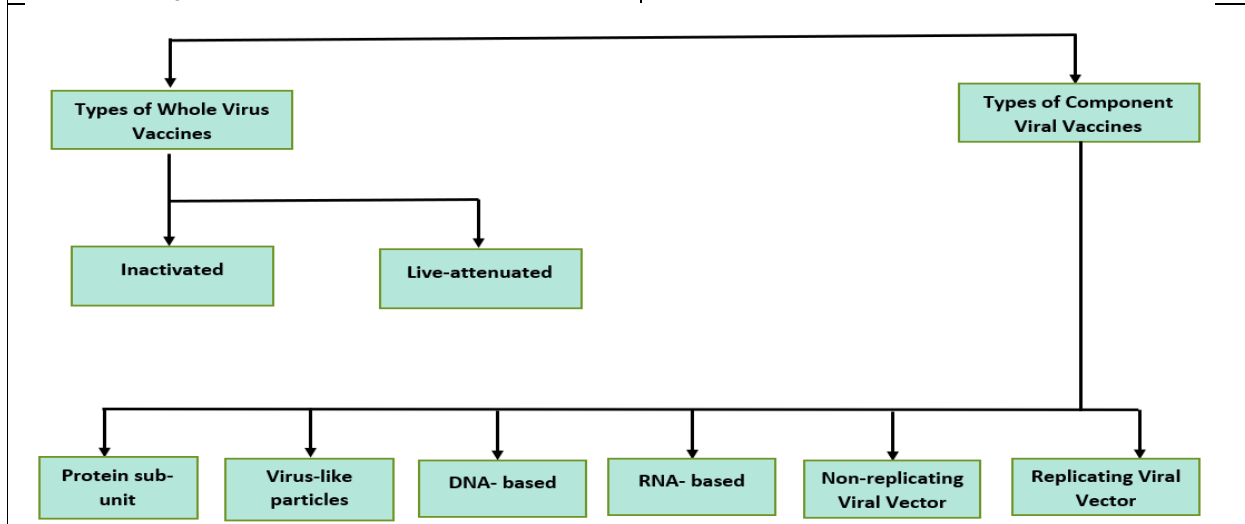


Fig.3: Representation of various vaccine platform technologies

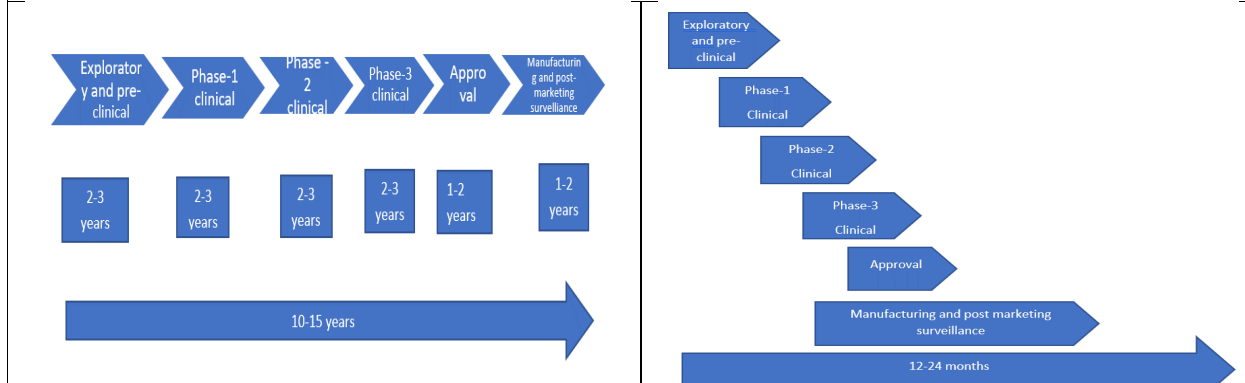


Fig. 4: Standard vaccine development process

Fig. 5: Covid-19 vaccine development process





Divya et al.,

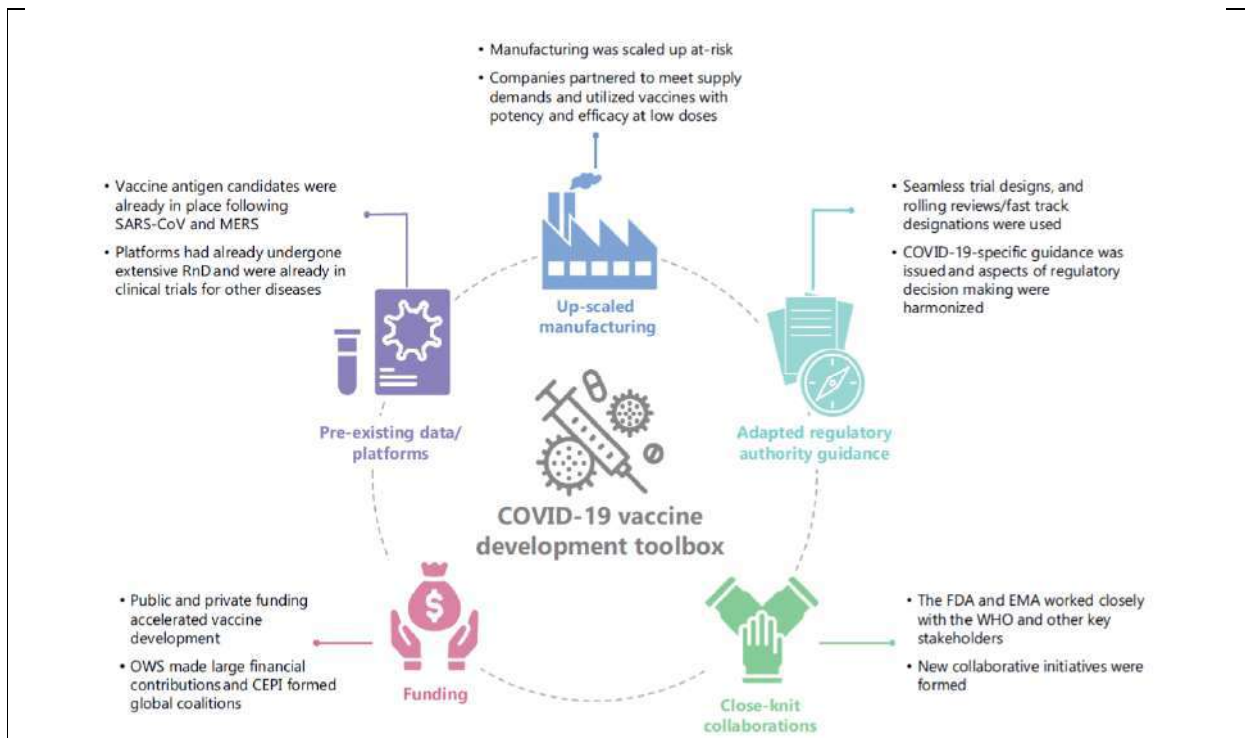


Fig. 6: Crucial elements in facilitating Covid-19 Vaccine development and approval [22]

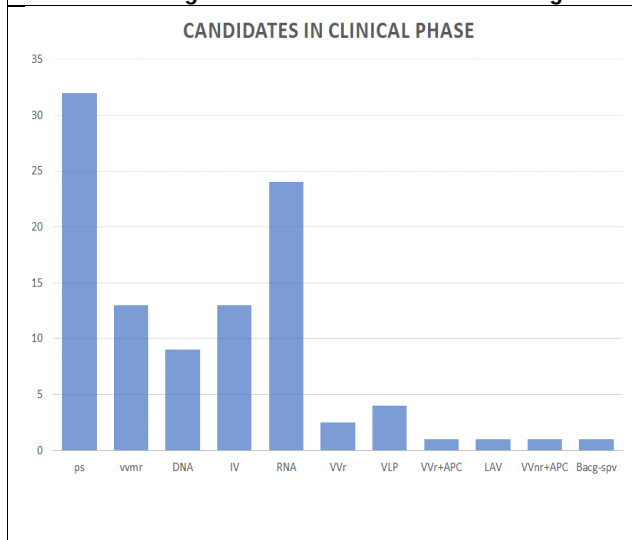


Fig. 7: Graph showing various platforms on the x-axis, no. of vaccine candidates plotted with respect to platforms on the y-axis, it shows that protein sub-unit vaccine candidates are higher in number whereas, VVnr+APC, BacAg-spv in low number in the clinical phase.

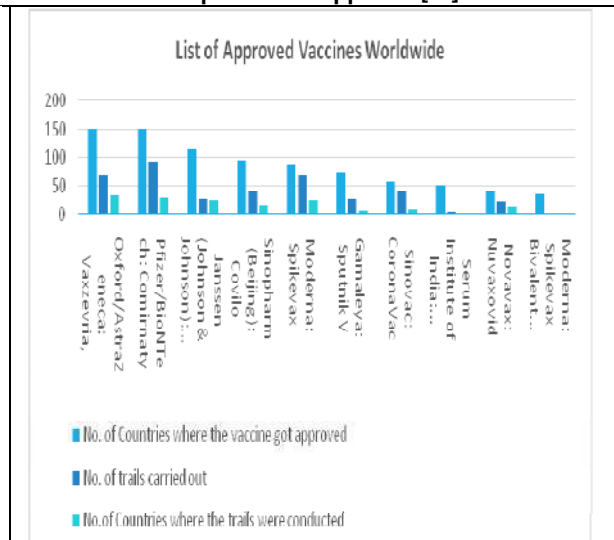


Fig. 8: Showing graph between vaccine candidates on the x-axis got approved in no.of countries on the y-axis





An Exploration of Psychological Trauma in Toni Morrison Novels the Bluest Eye and God Help the Child

Manisha Sharma^{1*} and Yashoda Kumari²

¹Research Scholar, Department of Languages, Manipal University Jaipur, Jaipur, Rajasthan, India

²Assistant Professor, Department of Languages, Manipal University Jaipur, Jaipur, Rajasthan, India.

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*Address for Correspondence

Manisha Sharma

Research Scholar,

Department of Languages,

Manipal University Jaipur,

Jaipur, Rajasthan, India

E.Mail: manisha.budhadhara@gmail.com



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ABSTRACT

Psychological or spiritual wound is mutilate or destruction facing the soul subsequently breathing all the time an exceedingly frightening or poignant event and can outcome in provocation in operate or copying as a general after in event. Xenophobia is a reliance particularly inborn variance amid the copious personage race-related groups dictate cultural or individual procurement, customarily entailing the preposition that unaccompanied race is supercilious and has the liberty to overshadow others. The African-American's existence colored people has been pretentious by xenophobia. These supposed methodology of community-based and intellectual reduction pressurize colored people to perceive subordinates. The novelist Chloe Anthony Wofford (Toni Morrison) acquired as far as influenced universally connected with the issuing of her first novel *The Bluest Eye*. It is the famous work imitating us the terrible repercussion for blacklist personalizing the morals of a white culture specifically renounce them directly and indirectly. This present study pursues to reveal the struggle of blacks and emphasizes on their brutal experiences which affected them physically and mentally. The focus of the current work is to heighten oppression and psychological trauma in the novels of Toni Morrison novels named *The Bluest Eye* and *God Help the Child*, through doctrine of Sigmund Freud.

Keywords: Oppression, Psychological trauma, Racism, Loss of Identity.



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INTRODUCTION

In the beginning of the twentieth century, many African Americans were moving from the rural South to the urban North, afraid of the increasing violence in southern states and holding hopes for a better life and prosperity. That became known as the Great Migration (Buck 926). As a consequence of this migration, in Harlem, New York, a black middle class emerged. According to Marks "at the end of the 1920s there were 164,566 black people living in Harlem, making it the most densely populated black area in the world" (Marks 121). In conjunction with other different social forces, this large African American population would soon make the place the headquarters for an important cultural and artistic movement, which would become known as The New Negro Movement or the Harlem Renaissance (Buck 926).

Langston Hughes, one of the best well-known names of The New Negro Movement, saw the denial of black identity as a sign of racial self-hatred (Bernard 278). The author also announced that he and other young black artists did not plan to keep writing to please the audiences—black or white. What Hughes intended to do in his work was to celebrate the Negro—the good and the bad about it, negative stereotypes and positive views (Bernard 278; 283–284). Carl Van Vecthen, a white African American art enthusiast, also defended that black life should be explored in literary works, but in a different way: he believed that if white audiences wanted to see the exotic in black life, then African Americans should profit from that (Bernard 278–279).

The original name of Morrison is Chloe Anthony Wofford, an African American writer noted for her scanning for grim encounters inside the Black community. Morrison has acknowledged with the awarded for compositions. She ripened inside the American Midwest parentage which owns impassioned intimacy as well as admiration of African morality. Her deep developmental parts of girlhood were Storytelling, songs, and folktales. *The Bluest Eye* (1970) is the introductory work commencement on the subject of an exploited juvenile dark color girl who is captivated by non-black classification charmer and soon desired to be loved one. From start to finish a lot of layers vocalize copious descriptive methodology, the publication apprises with shocking anecdote of dark female juvenile entitled as Pecola Breedlove, who go down in the direction of mental illness posterior emotionally as well as bodily abused on a lot of instances by the whole communal people around her, and especially by her family members. In the celebrated work entitled *God Help the Child* (2015), Toni has narrated about the aftermaths and complications of adolescent ill treatment. It is leading theme of the novels which encounters of African American; in the prejudiced community, her dramatis personae grapples to be met with themselves and their ethical recognition and neglect completely a dark skinned girl who inborn to light-colored mother and father.

OBJECTIVES OF RESEARCH

- To bring out traumatic consequences of Slavery and Colonialism in the novels of Toni Morrison *The Bluest Eye* and *God Help the Child*.
- To reveal the psychological effects of Racism and Oppression in the novels of Toni Morrison *The Bluest Eye* and *God Help the Child*.
- To present excruciation as a Black Woman in the novels of Toni Morrison *The Bluest Eye* and *God Help the Child*.

Primarily, the race-related prejudice set about with the entrance of imperialism. The Westerners chartered political instruction to implement in new population territory which was accomplished by enforcement or supremacy which is termed as expansionism. Walia had mark out the tactical of imperialism:



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Colonialism is accompanied by exploitation, annexation and conquest. Its hegemonic power rests on creating the binary opposition of self/other, white/black, good/evil, superior/inferior, and so on. Thus, a part of the world was able to enjoy supremacy because it convinced the rest of the world about the 'white man's burden' and his 'civilizing machine'.

Previously mentioned, the resistance led to the origination of race-related discrimination between the white color colonists as well as the natives. While the local elites make an effort to recognize themselves with the white colonizers that became more intricate issue, all together the white settlers make use of this state of affairs in exploiting the country.

Voicing of Oppression

The prominent writer Toni Morrison has developed into the spokeswoman of the black people. In her writings she appraises the tales of colored people's exploitation in a white controlling patriarchal society. She is acclaimed with Black-American identification, endeavored light on the difficulties in life span of enslaved, additional people who lives in highly undeveloped as well as disrepair state of affairs in European country.

In novel, *The Bluest Eye* traverses the disaster of the despotism as well as internalized racism. It gives the introduction of the tale of two dark skinned families, Macteers and Breedlove. The Afro-American poor households, among the two Macteer is a slightly finer position, she has migrated in many South American states, in search of career. The novel demonstrates wrongful done to teenage female like Pecola and other black teenage female who has suffered the sinful of race-related and toxic masculinity commanded by the white supremacy. The leading girl of the novel was in her teenage that yearned to be loved and receive aid attention which would go to withdraw all her agony and will live in cozy milieu in her father's house. Pecola's own father brutally raped her as well as her mother ill treated because as we can gauge this ill usage by their parents somewhere or the other remorseless models of supreme ethics. Altogether as a black girl and defenseless, the leading character of the novel suffers a lot. Morrison has affinity towards Pecola and very much aware and responsive of the neglect as well as ill treatment of African community by the supreme power. She digs into the calamity of subjugation of children specifically children with wretched condition prevailing all the way through moreover delve into the suffering of the group targeted by racism, like in internalized racism. We can see that Afro American ready to conceive with the stereotypical thoughts and envisage that Europeans surpasses in beauty, ethics and Intel.

Actually it's a rotation of ill-treatment that is a complex phenomenon that disturbed each and every person who is touched by tyrannical systems, even if they allocate as tyrant or oppressed. The child is abused because young one is inadequate to resist ill-treatment. They are educate so that they could react to malpractice with distinct kinds of invalidate reaction - quietness, self destruction, melancholy, and desire. At the same time the young child gets bigger up in this repressive system, their position frequently shifts and they take it as the role of the oppressor. It is for the most part understandable when we see in the persecution of young ones; however it could be seen in the ill-treatment of communal people based on their cultural identity. Morrison focuses in her book all over hold up a striking likeness with the aim to explain Sigmund Freud's ego, it is a psychoanalyst term described in his book, *The Ego and the ID*. Freud writes, "as a child grows up, the role of father is carried on by teachers and others in authority; their injunctions and prohibitions remain powerful in the ego ideal and continue, in the form of conscience, to exercise the moral censorship" (SF18).

Oppression, according to Ruth (1988: 434-436), can be maintained through the four circles of physical, economic, psychological, and internalized controls. A physical control can be in the form of punishment or threat such as force, intimidation, and beating. An economic to be in controlled can take shape of making the oppressed without power through giving minimum wages, low-level recruitment, or jobless. The mental control can take shape in the form of set up the rules by the mastery regarding the oppressed similarly by customary. The personalize commands solitary in which oppressed one "acknowledge" their weaknesses so that they accept to be in control of oppressor. In *God Help the Child*, Bride feels that she is not loved by her parents. Her parents are divorced because her skin color is different from theirs. Her father accuses her mother of being unfaithful to him. They are both bright skinned, high



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yellow, while Bride is bluish black, or Sudanese black. Bride has been regarded as ruining her parents' happiness. In spite of the fact that Bride is nursed by her mother, she can sense that she is despised and even her mother feels conscience-stricken to have a daughter with black color of skin. Already stated manifests, in addition to, from how her mother wants her to address her.

I told her to call me "Sweetness" instead of 'Mother' or "Mama". It was Safer. Being that black and having what I think are too thick lips calling me "Mama" could confuse people (Morrison.2015:6).

In this quote, Bride's mother wants her to call her Sweetness, instead of Mama. This is like if she does not aspire to be connected with her for the reason that her skin color is black. Her mother's perception is that skin color has echelon. She says that the brighter the color is the towering it is in the gradation; to say nothing of Bride's that is bluish dark. Sweetness' predecessors' undergoes also that of her on racial snobbery so firmly affects her attitudes. Specifically, Sweetness goes through the oppression because she is an offspring of Afro-Americans. Even now, she as well ill-treats her own girl child because Bride possesses darker skin than she does.

*I told her to call me "Sweetness" instead of "Mother" or "Mama." It was safer. Being
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I told her to call me "Sweetness" instead of "Mother" or "Mama." It was safer. Being*

Emphasizing Racism

"Shut up!" Hair uncombed, dresses falling apart, shoes untied and caked with dirt. The end of the world lay in their eyes, and the beginning, and all the waste in between. They were everywhere. They slept six in a bed, all their pee mixing together in the night as they wet their beds each in his own candy-and-potato-chip dream. "Get out," she said, her voice quiet. "You nasty little black bitch. Get out of my house." (Morrison, 90).

So as for the purpose of a better discernment of the narration brought by the famous work, ostensibly crucial to grasp about Black American culture and life. Racial issues are the central subjects of the novella; hence the subject matter of ethnic identity, racial profiling and self-hatred gives rise by the dominion supremacy culture required to be addressed. While observing Morrison's interviews attentively, reading Black American women contents on black feminism as well as perusal what literary proofreaders have to say about *The Bluest Eye* can for sure helps in expanding our understanding of racism, hence these are few of the founts brought into this novel.

In the course of the 1960s—peculiarly in the other half of the decade -, this spirit of racial profiling and bold was collaborated by a lot of Afro American writers. At the time questioned about her purpose for writing the book *The Bluest Eye*, though, she declares that she was not exactly in tune with all of the movement's ideals. As she tells her interviewer:





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“Toni Morrison Talks about Her Motivation for Writing”, most of what was being published by black people was fictional and nonfictional works by men, and it was all “very powerful, aggressive, and revolutionary” (Morrison “Motivation”, Web).

In accordance with the novelist, these segments of fine art had a positive as well as encouraging racially elevated message, and throughout the time she noticed it restorative, it was a little circumspect for her. Initially, she was unconfident regarding the motives for “Black is Beautiful” being screamed so loudly. Apart from this, Morrison anxious that something was going to get leave out. Her leading concern was about the probability of community people overlooking the fact that black had not always been beautiful, and that no one was going to remember

“how hurtful a certain kind of internecine racism is” (Morrison “Motivation”, Web).

In novel *The Bluest Eye* Morrison centre of attention under consideration as it affects blacks as well as their mental mechanism. The book is an emotive depiction of Black Woman’s search for ideal self. It is a novel which is constructed on Morrison’s discussion with a black girl during her childhood. Morrison affirms that her conceptions about why that black girl craves for blue eyes are inspired when the racial beauty of “Black is Beautiful” is retrieved. She vocalizes that,

“it wasn’t that easy of being a little black girl in this country--it was rough. The psychological trick you have to play in order to get through--and nobody said how it felt to be that. . . And I wanted to explore it”. (The Bluest Eye)

The Bluest Eye firmly demonstrates of the opinion of the disheartened black females in the unimportant community that has become silenced. This is actually racial unfairness which is a crystal clear demonstration of Morrison has to do with to describe creatively the insensitivity of the white folk towards black. The novel is about a young girl Pecola who desires to have white skin, blond hair and blue eyes against her dark complexion as:

Each night, without fail, she prayed for blue eyes. Fervently, for a year she had prayed. Although somewhat discouraged, she was not without hope. To have something as wonderful as that happen would take a long, long time. (Morrison, 35)

“Get on wind it, nigger. . . . An’ make it good, nigger, make it good (Morrison, 148).

We could see that racism and emotional abuse has been going hand in hand with Pecola and her father Cholly, and racial discrimination has become a key, by undergoing this trauma they have become stoic.

Morrison introspectively illuminates the sufferings of colored ethnic groups in a white society in the novel *The Bluest Eye*. It reveals *“racism’s damaging effects on the black community at large and on black families”*. Pecola Breedlove perceives the supremacy of oppressor society and prolonged to have the characteristics of white females. Her firm aspiration possesses the bluest eye in the world itself let out the keenness to have even finer quality than white female.

Morrison reflects the novel *God Help the Child*, all through the occurrence in central figure’s life. It begins from the birth delivery of Lula Bride. From the moment of her birth, her mother is disgust by her at the moment that she has skin so black that it makes afraid as well as panics her mother, Sweetness spell out “Midnight black, Sudanese black” (3). Lula Ann is forsaken and ill-treated by the white color people. Lula Ann’s father did not welcomed her and adjudge her as “A Stranger more than that an enemy” (16). Louis declined to have in hands to his daughter, and lay the blame on his wife’s “infidelity” axnd behave towards Lula Ann as an enemy. Both Sweetness and her husband not bring himself to love a child stands at the antithesis of the ideal beauty. The couple argued about their daughter skin color until Sweetness argued that the blackness night is from Louis family, not hers.

“Her color is cross she will always carry”, mother concludes with a deadening lack of subtlety, “But it’s not my fault. It’s not my fault. It’s not my fault. It’s not”. (God Help the Child, 7)



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God Help the Child takes up the classical Morrisonian theme: beauty, violence, racism, American blackness and its ghost of personal and communal trauma, the consumption of bodies'-and black women's body in particular-the lasting injury of rejection, exquisite glory of desire. The novel tells the story of Bride, born Lulla Ann Bridewell, a young dark skinned black woman whose life has been shaped by her body's failure to meet the norms of consumable womanhood. As a "blue black" child she is rejected by "high yellow" mother Sweetness, who refuses to touch for most of her girlhood...Bride's father too vanishes without touching her. (God Help the Child, 13-4)

The novelist Morrison represents a very bold and cogent child as the main protagonist who fights with discouragement, rude awakening and loss of identity. Developed on Bride's sensibility as well as poke into mother's brain, she recollects her connection with a medical student's friend who made acquainted her to his white family. Racially "She vividly rejected and driven by the parents to the train stop" (37). At a later time, Bride had a relationship with Booker, she affirmed about six months into the pleasure of wholesome intercourse, free style songs, challenging books and the companionship of an essay unexacting Bride. She downheartedly reveals that "the fairy tale castle collapsed into the mud and sand on which its vanity was build. And Booker ran away" (God Help the Child, 135). She experienced the loss of the man who became familiar to her sufferings as well as quandary of the prejudice in the country zone. She recalls complaining about the ill-treatment of her mother to her beloved and his reply:

"It's just a color. A genetic trait- not a flaw, not a curse, not a blessing nor a sin" (God Help the Child, 143). He adds "Scientifically there's no such thing a race, Bride, so racism without race is a choice" (God Help the Child, 143).

CONCLUSION

Toni Morrison discloses in her work of piece about the race-related supremacy unsympathetically affected dark color females by way of dispense the harrowing happenings in leading characters. We could see leading characters strenuous effort catastrophe of copious structures of persecution derived from color, race and gender. The novels prove themselves in the world of shabbiness and prejudice. Both these novels reflect racism and the predicament of black women, in a developed territory, from spiritual, interpersonal realistic and ethnical parameters symbolized through many spokesperson.

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Delimitation of Groundwater Potential Zones using Remote Sensing, GIS and AHP Approaches: A Case Study in Bobbili Mandal, Vizianagaram District, Andhra Pradesh, India

K. Swetha¹, M Srinivasa Rao², Mohammad Sohail³ and Gara Raja Rao^{2*}

¹Research Scholar, Department of Geography, College of Sciences, Sri Venkateswara University, Tirupati, Andhra Pradesh, India.

²Assistant Professor, Department of Geology, Andhra University, Visakhapatnam, Andhra Pradesh, India.

³Research Scholar, School of Sciences, Bharatiya Engineering Science and Technology Innovation University, Gorantla, Anantapur, Andhra Pradesh, India.

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*Address for Correspondence

Gara Raja Rao

Assistant Professor,
Department of Geology,
Andhra University, Visakhapatnam,
Andhra Pradesh, India.
E.Mail: rajaraogeo@gmail.com



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ABSTRACT

As a contribution toward the development of an integrated multicriteria methodology to manage groundwater resources, this study aims to optimise drilling site selection in the future while also increasing the likelihood of obtaining water from productive structures, in order to meet the ever-increasing local population's need for water in the Vizianagaram district of Andhra Pradesh, India. The aquifer's shape and hydrodynamic operation are shown on thematic maps created using a geographic information system. Seven variables affecting the distribution of water resources were considered in this research, including geology, geomorphology, slope, soils, landuse/landcover, lineament density, and drainage density. The research identified and classified places based on their hydrogeological potential using the Analytical Hierarchy Process (AHP) model, GIS, and remote sensing. Groundwater potential zones classified into five categories: very poor, poor, moderate, excellent and very good are all included in the study's findings. A total of 42.57 percent of the research is dedicated to industries with favourable prospects. 35.07 percent of the study area is taken up by sectors with intermediate potential, whereas 1.25 percent and 27.13 percent of the study area is taken up by regions with very low and very low incomes. With the use of water level fluctuation data, the research area's groundwater potential map may be verified.

Keywords: Remote Sensing, GIS, Groundwater, Potential Zones, AHP





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INTRODUCTION

Groundwater conservation and improvement rely heavily on geospatial techniques. India's groundwater supplies have been depleted in recent years due to a rise in demand for groundwater for a variety of purposes, including drinking, irrigation, and industrial use (Mall et al. 2006; Siebert et al. 2010). Research shows that (Mall et al. 2006; Siebert et al. 2010). Direct or indirect effects of soil filtration and topography on groundwater flow and occurrence are well-documented. In order for surface water to penetrate into the subsurface, there are a number of factors that must be taken into consideration (Saraf and Choudhury 1998). In 1998, (Saraf and Choudhury 1998), Although the great majority of groundwater is limited to weathered and fractured places, there are limits to the availability of water in hard rocks (Kadam et al., 2012; Alizadeh et al., 2017; Mekuriaw et al., 2017; Gashaw et al., 2018). (Kadam et al., 2012; Alizadeh et al., 2017; Mekuriaw et al., 2017; Gashaw et al., 2018). During the monsoon season, rain in central and southern India may significantly alter groundwater levels in the semi-arid and crystalline aquifers (Zolekar and Bhagat, 2015). (Zolekar and Bhagat, 2015). (Zolekar, 2015). As previously said, groundwater research has become significant not only for locating potential water sources but also for monitoring and conserving this limited but vital resource (Sreedevi P. D et.al. 2005). Researchers (Sreedevi P. D and others, 2005). It is typical to utilise RS or GIS to identify the aquifer's location, groundwater quality, physical characteristics, and other information. Different research from across the globe have demonstrated that AHP may be utilised to address a wide range of socio-economic challenges in decision-making, and the combination of these two methodologies proves to be an effective way to harvest GWP.

It has been reported by Singh and Prakash (2002), Israil (2006), Jha (2010), Krishnamurthy et al. (2000) and others (Singh and Prakash 2002). (Singh and Prakash 2002; Israil et.al. 2006; Jha et al. 2010; Krishnamurthy et al. 2000; Krishnamurthy et al. 2000) It is possible to use AHP to address decision-making challenges when the dimensions are used independently of each other to generate priority scales for the various themed maps (Vaishnavi Mundalik et.al. 2018; Ajaykumar et.al. 2018) One of the findings of Vaishnavi Mundalik (Ajaykumar et al. 2018). There are assertions that AHP not only prioritises traits, but also groups of components that are often needed, according to Saaty (1999). Analytic Hierarchy Process (AHP) enables the ability to investigate alternatives to standard criteria in multi-criteria assessment of an environment (Kanagaraj G et.al. 2019). In the year 2019, Kanagaraj G et al. The primary objective of this research is to contribute to the systematic evaluation of GWP in the GWPZ utilising RS, field studies, GIS, and AHP technology (Ajaykumar et.al. 2017) (Ajaykumar et al. 2017). (Ajaykumar et al. 2017). Geospatial approaches have been more important in the evaluation of GWP in recent years, including mapping and differentiation of groundwater using geographic information, based on the analysis of a specific visible surface. This is why RS and GIS were able to discover GWPZs in the Anantapur area, Andhra Pradesh, India (Rajasekhar and colleagues 2018b) (Rajasekhar et.al 2018a, 2018b). In this study, the primary goal was to analyse the ability of AHP and GIS methodologies to map possible groundwater regions, to offer policymakers and managers with a reference map for hydrogeological research, and to guide the implementation of future points of water.

Study area

The study area (225.32 km²) located in central part of the Vizianagaram district, Andhra Pradesh, India and a semi-arid region, entangling 830 15' 30" to 830 28' 30" and 180 28' 0" to 180 39' 0" and the annual rainfall recorded in around 1086.9 mm, results affected agriculture droughts most parts of the study area. The chronokite, gneiss, and garnet formations pertaining to the hornblende-biotite gneiss, manganous gneiss, and granodiorite having some portions with granulite and laterites in the study area (Fig 1). The region gets a hot and humid temperature throughout the summer months. April through June are the hottest months. The greatest and lowest temperatures, recorded in the area are 40.9°C and 12.8°C respectively. The average annual rainfall of the area is roughly 1086.9 mm. Most of the rainfall is obtained during the southwest monsoon season (June to September). Moderate rainfall is obtained during the north-east monsoon season (October to December).





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METHODOLOGY

Preparation of thematic layers

A geomorphology map developed by the National Remote Sensing Center (NRSC), Hyderabad, is one of the datasets used to construct several thematic maps in ArcGIS for the creation of GWPZ. Lineaments were derived from a September 2020 Landsat 8 satellite image with a 30-meter resolution, which was used to extract land use/cover (LULC) and lineaments. A geological map from the Geological Survey of India (GSI, 2002) was used to prepare the study area base and drainage map, as well as geology, lineament and drainage maps, from which the drainage density and lineament density maps were generated using the GIS line density tool. A Cartosat digital elevation model (5) The FAO globe was used to obtain data on the study area's soils utilising a GIS environment.

Weight factors through AHP

Because of the frequent physiographic characteristics in the present study, the weight factors are supplied in a subjective manner. To create a cartographic database, the various weight components of thematic maps of geology, geomorphology, LULC, DD, LD, soils, and slope are supplied (Kumar and Krishna 2016; Mogaji 2016; Bhunia et al. 2012). For example, (Kumar and Krishna 2016, (Mogaji 2016), and (Bhunias et al. 2012) When it comes to determining the final weight factors/ranks for various GWPZs, this is a major step forwards. Because of the overall physiographic and geographical circumstances of the place and the likely groundwater potential zones in the region, the weight factors are distributed at random. According to experimental limits set on certain ranks or weights, Table 1 exhibits numerous thematic maps, perceivable units, and their weight components at random.

Validation of the GWPZ map

This study's GWPZ map was verified against publicly accessible data on pumping well performance. The average number of pumping wells in each GWPZ should be calculated and compared to one another. It has been shown that wells located in separate GWPZs are more likely to be efficient, which strengthens the evidence.

RESULTS AND DISCUSSION

Geology

The Eastern Ghats Archaean metamorphic band and is made up of Charnockitic rocks, Khondalite, Granitic gneiss and Granites. Due to the lack of field evidence within the plotted region, it is impossible to determine how the khondalite suite and the charnockite suite are related stratigraphically. The charnockite suite of rocks, granite gneisses, and gneissic granite predominate in the region surveyed, with only modest amounts of quartzite, khondalite, and diopside granulite and gneiss present in the landscape. Kayitapalle, north of Chaivealasa, Chintalpet, and Mamidivalasa, have thin laterite cappings. The charnockites and quartzites seem to have derived the laterite through residual weathering. It's possible to see the shift from unaffected charnockites and quartzites to lateritized ones near the contact. When first exposed, the laterite is a dark brownish black with a reddish brown underside. As of 2002, (GSI 2002) (Fig. 3).

Geomorphology

It is possible to have a better understanding of groundwater capacity and groundwater extraction via the use of geomorphological maps, which illustrate the basic landforms and essential geology. These maps are based on the research of GWPZ. As a result of the early availability of Landsat data, satellite imaging has been a common tool for geomorphological mapping. RS is also prepared to offer data on the area's landscapes, composition of the subsoil, and the topographic elevation of that region (Siva et al., 2017). (Siva et al., 2017). Periplain, residual hills, pediment, and structural origins with low and somewhat dissected hills are some of the geomorphic traits currently being researched in the study region (Fig. 4).



**Swetha et al.,****Landuse / Landcover (LULC)**

From the obtained Landsat ETM+ image of the study area, Landuse/landcover analysis was carried out. FCC (False Colour Composite) graphics were made employing the band combinations 7, 4 and 2 to RGB (Red, Green and Blue) channels appropriately. Though images were carefully examined, but it could not be differentiated adequately for recognising the changes because of identical pattern in the photographs. Change of land cover is a requirement accordance to the intensity of natural disasters over such regions. Hence, remote sensing classification technique was utilised to detect the changes quantitatively. Image interpretation elements (shape, size, tone, texture, pattern and association) were crucial for distinguishing the area utilised for various objectives. Major land cover types were classified as agricultural zones, land with extra plants, aquatic bodies and soil/barren land (Fig. 5).

Lineament Density (LD)

Structurally controlled linear or curvilinear traits are termed "lineaments." Using satellite images, it may be detected because of its relatively straight alignments. Lineaments depict the faulting and fracture zones that contribute to increased secondary porosity and permeability. Automatic lineament extraction technique is used to extract the region's lineaments from Landsat 8 ETM+ satellite data. Figure 6 shows the lineament density map that was generated by GIS software utilising line density. According to rigorous evaluation of the data, the data were categorised into five groups: Very low (0.00–0.13), Low (0.03–0.10 km/km²), Moderate (0.10–0.18 km/km²), and High (0.18–0.27 km/km²). Lineament density is ranked according to the proximity of lineaments. The groundwater potential weakens as one moves away from the lineaments, as has been shown. Courses with a high density are given more weight, whereas classes with a low density are given less weight.

Drainage Density (DD)

Drainage density has a significant impact on both the supply of groundwater and the polluting of that water. Lithology is critical to the drainage system because it provides information on the rate of infiltration. Permeability is inversely proportional to the drainage density. As a result, it is a critical factor in determining the groundwater potential zone. The entire length of all rivers in a drainage basin is divided by the drainage basin's area to calculate drainage density. The region's groundwater potential is harmed by the low penetration rates caused by dense drainage systems. As a result, more groundwater potential is generated by areas with lower drainage densities. For the first time in history, the drainage density was reclassified and categorised as Very low (0.00–0.09 km/km²), Low (0.1–0.22 km/km²), Moderate (0.2–0.35 km/km²), High (0.35–0.50 km/km²), and Very high (0.50–0.98 km/km²) (Fig 7). This is seen in Figure 7. High weight is given to low density areas and low weight is given to high density areas when determining groundwater potential zonation.

Soils

It is the kind of soil that determines how much water can infiltrate into the subsurface formations and therefore how much groundwater is recharged. The rate of infiltration may be estimated using soil texture and hydraulic factors. It's shown in Figure 8: a soil map of the region studied. Based on a methodology devised by the Food and Agriculture Organization (FAO), we have established the soil classes in the basin (FAO). The bottom portion of the black cotton soil has the lowest infiltration and, as a result, has a lower priority than the loamy soil, which has a higher level of infiltration.

Slope

An important feature of the landscape is slope, which tells us how steep the earth is at any given point. To better understand the geological and geodynamic processes at a regional scale, Slope is essential. Runoff and infiltration are greatly affected by the slope of the ground. Recharge from precipitation is reduced on steeper slopes, since rainwater rushes downward quickly. As a result, it is unable to penetrate and recharge the saturated zone. The research area's slope map is shown in Figure 9. A new classification system was used, dividing the slope values into five categories: flat (0–3), moderate (3–10), medium (10–15), severe (15–35), and very steep (>35). Flat and gentle slopes may be accommodated by the heavy weight. Steep and very steep grades are made possible because to the light weight of the low-impact materials used in construction.



**Swetha et al.,****Groundwater Potential Zones (GWPZ)**

It is essential to include geology, geomorphology, DD, LD, LULC, slope and soils into the RS and GIS to determine the groundwater potential zones (GWPZs). Hydrogeological habitats and topographic conditions limit groundwater occurrence and exploration for a variety of reasons (P.D.Sreedevi et.al 2001). A study by (P.D.Sreevai et al. 2001) GWPZ used ArcGIS to combine eight different theme maps in the study area. Because not all parameters have the same impact on detecting the presence of groundwater and movement, the multi-criteria evaluation based on GIS and AHP is utilised to calculate the percentages of classes and weights and ranks for thematic maps (Saaty, 1980). According to (Saaty, 1980). It is less than 0.10 for the degree of consistency coefficient (CR), which ranges from 0.01-0.09. Saaty (1980) argues that a pair-wise comparison is acceptable for each thematic map. GWPZs are calculated by comparing the significant thematic maps used in the present study with the matrix for comparing them (Table 1). Lastly, a connection is made between the geographical analysis and all the thematic maps, based on a pair-wise comparison on ranks and weights for each class in the underlying layer. Thematic maps are used to create the GWPZ map, which is then reclassified into poor, moderate, excellent, and very good categories (Fig. 10). According to the statistics, 20.43 km² (9.07 percent), 79.03 km² (35.07 percent), 95.91 km² (42.57 percent), and 2713 km² (12.04 percent) of the region are categorised as excellent GWP, moderate GWP, and low GWP, respectively. Loamy soils with low geomorphic classes and high DD are more common in the study area, as seen on the GWPZ map

CONCLUSION

In India's arid and semi-arid regions, overuse of groundwater due to population growth, urbanisation, industry, and inadequate recharge is posing a serious threat to the country's groundwater supply. The present study made use of RS data, conventional maps, and ArcGIS-linked groundwater depth data to identify GWPZ. Finally, the GWPZ map's well-yield data authentication was declared adequate. The region under investigation is semi-arid by nature and accounts for a little percentage of the world's massive GWP. These five classifications are: very poor, low, moderate and high potentials. Most of the area has a moderate to good GWP, with the majority of it concentrated in the middle. As a result, the north-western quadrant has a substantial groundwater supply. Due to its steep topography, the south-western and south-eastern part has little promise. There are, however, numerous areas in the research zone's centre that show substantial promise. The findings show that there are five distinct levels of performance: low, moderate, good, and exceptional (Fig. 10). The tenth figure is shown here. According to the statistics, 20.43 km² (9.07 percent), 79.03 km² (35.07 percent), 95.91 km² (42.57 percent), and 2713 km² (12.04 percent) of the region are categorised as excellent GWP, moderate GWP, and low GWP, respectively. Loamy soils with low geomorphic classes and high DD are more common in the study area, as seen on the GWPZ map. GWP is affected by the cultivated land area and water bodies and settlements in these areas because of the moderate rainfall and modest slope. In order to carry out an artificial groundwater recharge plan, planners, policymakers, academics, and technicians may use the study's GWP map to pinpoint the best locations. There's a chance it can help with the creation of effective groundwater extraction strategies for the research region. General planning and environmental assessment goals may both benefit from the methods used in this study. Groundwater extraction techniques in the research region may be developed to ensure the long-term viability of this critical resource. The approaches used in this study may also be used in general planning and environmental evaluations.

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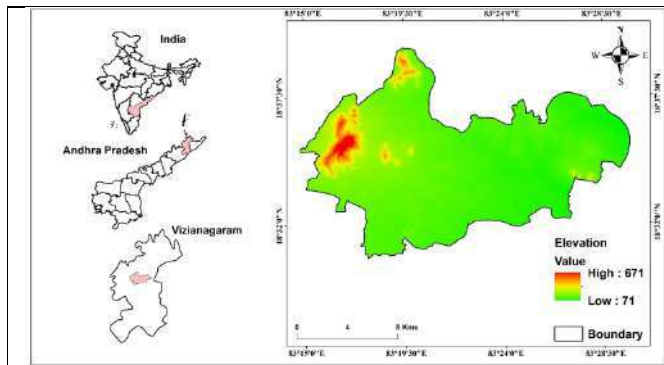


Figure 1. Location Map: Bobbili Mandal, Vizianagaram District, Andhra Pradesh

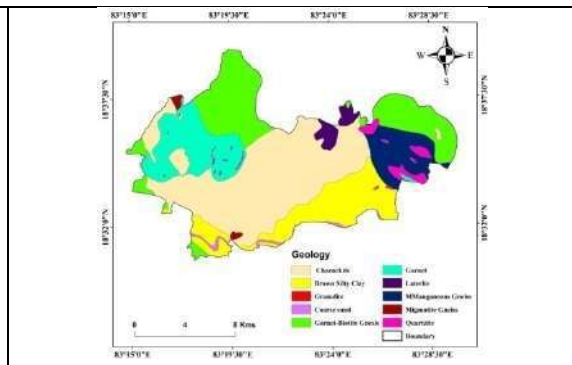


Figure 3. Geology of the study area

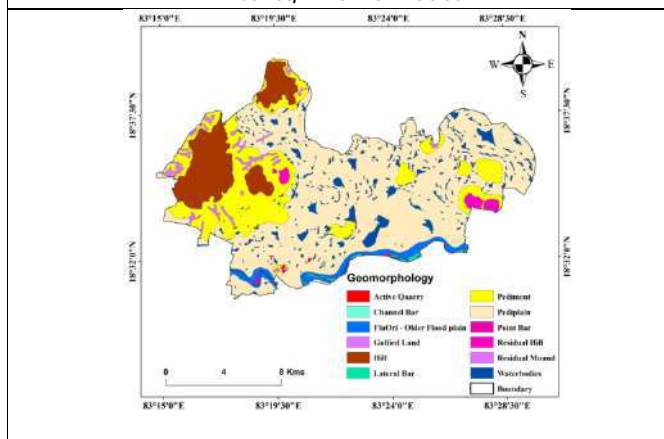


Figure 4. Geomorphology map of the study area

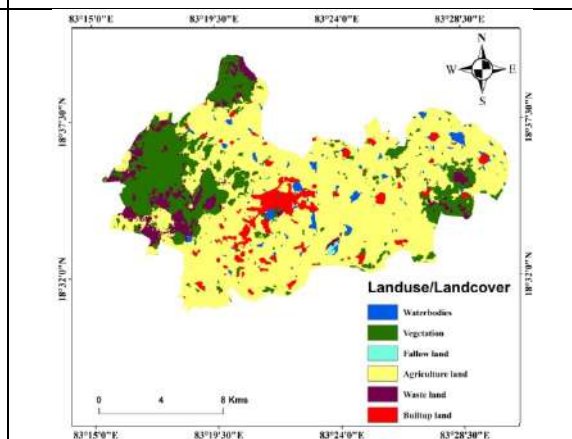


Figure 5. Landuse / landcover map of the study area

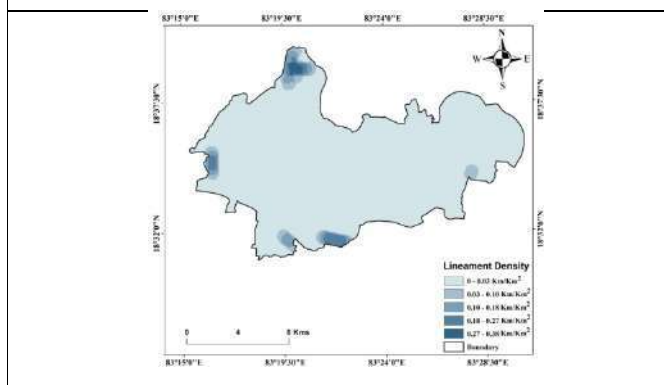


Figure 6. Lineament density map of the study area

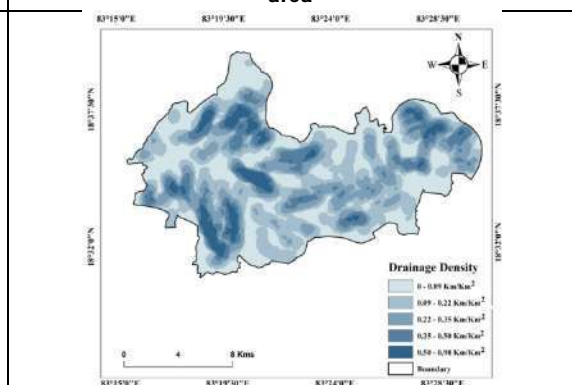


Figure 7. Drainage density of the study area





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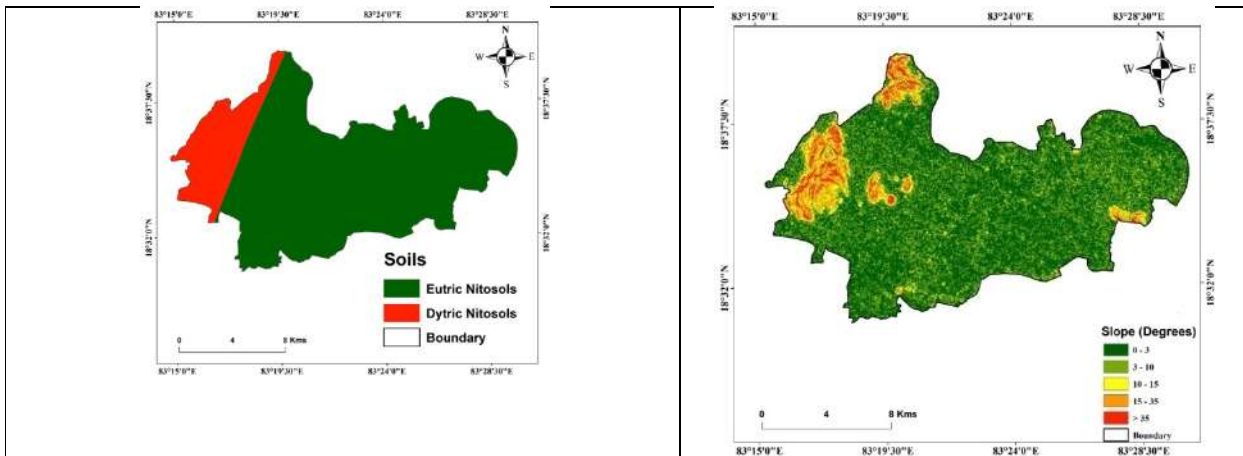


Figure 8. Soil map of the study area

Figure 9. Slope map of the study area

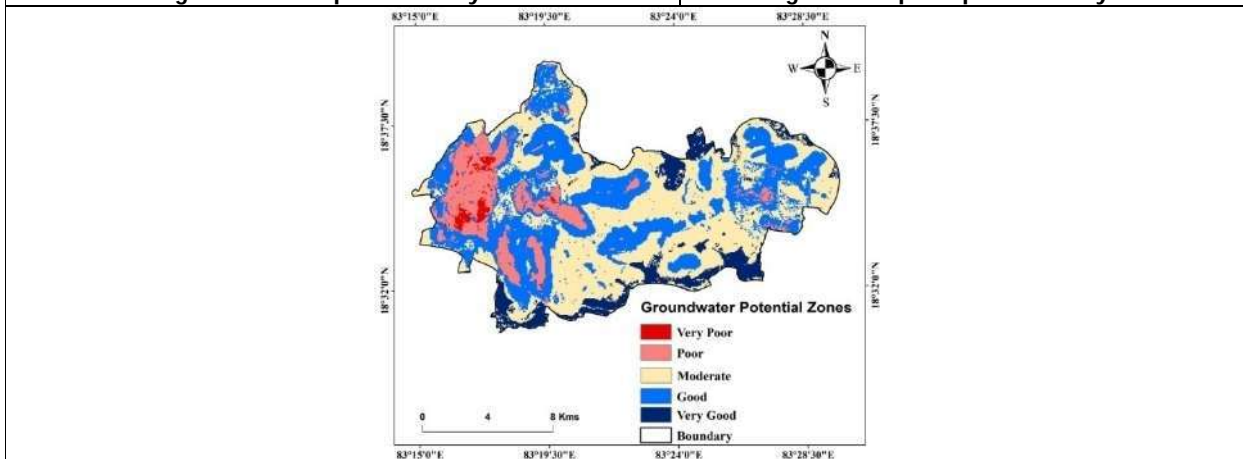


Figure 10. Groundwater Potential Zones map of the study area





Analysis of Fuzzy Logic Controller (FLC) based Hybrid Energy System Fed Microgrid

M.Kondalu^{1*} and T.Umamaheswari²

¹Professor, Department of EEE, Malla Reddy Engineering College (Autonomous), Hyderabad, Telangana, India.

²Assistant Professor, Department of EEE, Malla Reddy Engineering College (Autonomous), Hyderabad, Telangana, India.

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*Address for Correspondence

M.Kondalu,

Professor,

Department of EEE,

Malla Reddy Engineering College (Autonomous),

Hyderabad, Telangana, India.



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ABSTRACT

This paper proposes a fuzzy logic controller (FLC) based hybrid energy system fed microgrid. Generally, most of the researchers consider PI controllers for controlling the proposed system but tuning the gain values of PI is difficult due that getting more errors and adding extra passive elements for compensating frequency fluctuations. In this project, we propose FLC with a model predictive control (MPC) Controlling three-level bidirectional DC/DC converters for grid connections to a HESS in a DC microgrid to begin, a mathematical model of a HESS with a battery and ultra-capacitor (UC) is created, and the neutral point voltage imbalance of a three- level converter is addressed by examining the converter 39;s operating modes. Second, an MPC approach for calculating steady-state reference values in the outer layer and dynamic rolling optimization in the inner layer is proposed for grid-connected converter control. The outside layer guarantees voltage regulation and creates a current predictive model, while the inner layer uses model predictive current control to make the current follow the predicted value, eliminating system current ripple. To realize the high-and low-frequency power allocation for a HESS, this cascaded architecture features two separate controllers and is devoid of filters. As a result, it enables two types of energy storage devices to separately regulate voltage and realizes battery and UC power allocation. Finally, simulation results are designed in MATLAB SIMULINK environment. And obtained results are proof that the proposed system is better than the conventional system.

Keywords: Hybrid energy system; Model predictive control, fuzzy controller.





INTRODUCTION

In order to achieve voltage controller and power apportionment amid battery then UC, this study proposes a two-dimensional MPC approach for grid integration of a HESS's DC/DC translators. The MPC approach suggested in this research has the following primary improvements over the earlier control strategies: 1) The suggested control approach may accomplish quicker DC-link voltage refurbishment then necessary power apportionment among UC and battery when compared to the earlier work in [1]. 2) Filters are not required for the low- and high-frequency power allocations to be realized using this HESS control approach. A high charge/discharge rate in battery contain and avoided with suggested outside voltage stability and gradient regulator. 3) When the program's constant power frequency shifts, the MPC approach performs better dynamically than the PI control technique. This solution has a shorter processing time and a cheaper computing cost when compared to other MPC methods with more complicated models. The PI controller in [2] can command the sensor and UC's charging and disconnecting currents, but it must model the physical network and have access to its governing equations in order to build and fine-tune the control settings. Additionally, the PI control test's function would suffer when the operating point varied and it was unable to preserve optimal controller popular real-time. To provide primary indicator balancing between the cell and UC, Standard [3] suggested an enhanced switching device (EDD) composed of a simulated resistance sag controller and a VCD regulator. However, when the load is regularly replaced, the voltage of the DC MG based on the droop control will oscillate significantly, and voltage drop caused by the reactance will further damage the reliability of a DC link voltage. An algorithm has a significant computational cost and uses a lot of matrices. A wider resonance range is generated by dynamic switching of frequency, necessitating more powerful sorting [4]. A CCS-MPC by the specified duty cycle is what the solution suggested in [6] refers to. The current ripple can be decreased by using a time-varying ratio. Based on the model-predictive PCA determine by a best switch configuration under the assumption of computing the minimal power output error. They also calculate charging and discharging currents of the battery over its entire state of charge. Describes the design of a thrice-level bidirectional DC/DC converter.

DESIGN OF A TEST SYSTEM WITH FIGURES

Topology of the HESS

Fig.1 [7] depicts of a hybrid stowage grid-connected converter's structure. The battery fuels the UC's ability to control its voltage, and the UC uses its thrice-level DC/DC convertor to control of a load demand. On the bus side, those are few different sorts of an input signal standards: full bus voltage (V_{dc}) and half bus voltage ($V_{dc}/2$). The input voltage can be chosen based on the current circumstances. This architecture can successfully lower the battery voltage on each switch and the inductor power ripples, which suppress the higher voltage DC bus power oscillations.

As shown in Fig.1 V_{bat} and r represent the voltage and resistance values of the battery, respectively; V_{uc} , r_{uc} , and i_{uc} represent the voltage, resistance, and current of the UC, respectively; $L1$ and $L2$ are used to control the battery and the UC's current, while i_{L1} and i_{L2} are the equivalent inductor currents. C_{uc} stands for UC capacitance. The DC bus voltage is V_{dc} ; two similar capacitors, $C1$ and $C2$, are represented by their relative voltages, V_{c1} and V_{c2} , as well as by switches SA_i (i ranging from 1 to 4), $SB1$, and $SB2$ [8].

Battery and UC Mathematical Model

A continuous voltage source and a continuous internal resistor are connected trendy series to make up the battery model. This is how the output voltage is expressed:

$$V_{bat} = E - i_{bat}r \quad (1)$$

when I_{bat} is the battery current and E is the potential of the constant voltage source. Due to its high-power density, UC can reduce MG high-frequency power variations [20]. It can decrease the battery's high-power load and increase the battery's lifespan [9]. Aimed at DC-MG schemes, UC cannisterstay easily signifiedthru an ideal series resistor and





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capacitor. This straightforward model is capable of capturing a charging and discharging features of UC [22]. The following diagram illustrates the UC's output voltage:

$$V_{uc} = V_c + i_{uc}\gamma_{uc} \quad (2)$$

when V_c is the optimal voltage for a capacitor.

Procedure for NPVB

In reality of a voltage levels those two capacitors of a DC bus side whitethorn vary greatly. It will cause oscillations in neutral point voltage (NPV), sometimes referred to as "middle position stream," which will raise the demand on the reservoir and trigger. To balance V_{c1} and V_{c2} , switching on and off must be done in a balanced manner [19]: When $V_{dc} = 2 V_{uc}$ then the input voltage on the bus side equals the entire DC bus voltage V_{dc} , capacitors C1 and C2 are connected to the system. Once $i_{L1} > 0$, SA1 and SA4 function in buck mode, and when $i_{L1} = 0$, SA2 and SA3 operate in boost mode, respectively, neither of which will result in a neutral point current. Only C1 or C2 are connected to the system when $V_{uc}/V_{dc} = 2$, resulting in anNPC. In order to effectively balance V_{c1} and V_{c2} , an NPV balancing technique must be used. The input voltage on the bus cross is currently $V_{dc}=2$. The system still functions in buck or boost method, and the capacitors are either charged or discharged, depending on the value of i_{L1} . Whether C1 is connected to the system via SA1 and SA3 or C2 is connected to the system depends on the values of V_{c1} and V_{c2} . Identify whether C2 is connected to the system via SA2 and SA4 versus C1 being connected via SA1 and SA3. The charge controller has two components that work together to regulate the voltage in a UC, bus voltage of the DC MG: if a battery powers in UC, the UC powers the DC bus [9]. Individually component has few control strands: an internal current zone and an outer voltage control plane. Calculating the extrapolative worth of the inductor current required toward stabilize the voltage is the goal of outer voltage stability. The purpose of inner current control is to ensure that the real current follows the extrapolative worth generated by external regulation in order to achieve the goals of outer layer constant forecasted value computation and inner layer dynamic moving utilization.

Control of the outer voltage

For example, battery voltages control. In a change in the UC voltage V_{uc} container straight affect the variation in current IUC once there is a discrepancy between the rated reference voltage $V_{uc\ ref}$ and the UC real voltage V_{uc} . The convertor arranged the battery lateral runs in boost mode once the battery is exhausted and the UC is charged, and it runs in buck mode when the battery is charged and the UC is discharged. KCL states that the converter's signal is applied in Fig. 2 as $i_{in} = i_{L1} - i_{uc}$. The below steps can be taken to obtain the current reference, i_{L2ref} :

$$i_{L2ref} = i_{in} \times \frac{V_{uc}}{V_{bat}} \quad (3)$$

The anticipated current, $i_{L2}(k + 1)$, is calculated using both sample voltage and current. This current acts as the reference current for the internal current regulation (i_{L2ref}). Following that, the duty cycle, or d_{bat} , is calculated using the MPCC approach. The schematic for the battery-side control method is shown in Fig. 3.

Create a Battery Gradient Device

The charge is not suitable for frequent charging and draining, so the reaction of the current i_{L2} should be as gradual as possible. The outside voltage control incorporates a battery current slope limiter that permits a slower changing rate of the estimated current controller, i_{L2ref} . $i_{L2ref}(k)$ and $i_{L2ref}(k+1)$ are characterized as derived for the inductor L2 at the k th and subsequent instants of each sampling time T_s , respectively. The four output of neural network correspond to a fault for every one of the 3 phases and 1 output is ground line. Thus, all outputs is either 0 or 1 suggesting a yes or no fault on the line (A, B, C or G, where A, B and C represents 3 phases of transmission line network and G indicates ground) [1]. Therefore, each of different faults be represented accordingly by the various possible permutations. The proposed neural network is able to precisely differentiate ten feasible kind of faults. The table 1 shows the truth value describing faults and efficient operation for each of faults.





SIMULATION AND RESULTS

For creating MPC, the MPC Tool cabinet offers roles, an app, Simulink wedges. The tool cabinet facilitates the proposal of implicit, explicit, adaptive, and gain-scheduled MPCs for linear glitches. You can use single- and multi-stage nonlinear MPC to resolve nonlinear problems. You can use a custom resolution in addition to the deployable optimization solvers that are provided by the toolbox. Run closed-loop simulations in MATLAB and Simulink to assess controller performance shown in the fig 4. Developers can also utilise the principles and features provided to get started with autonomous driving technologies like lane keep assist, path scheduling, path following, and adaptive cruise control straight away.

Step load changes

Fig.4 Only with the suggested MPC approach a bus voltage overshoot stands near 0.8% of a settling period be situated approximately 0.002, the overshoot is approximately 3.5%, along with settling duration remains approximately 0.0025 at 0.4 s through step load. Fig. 4(a) Simulation results using MPC method. (b) Simulation results using PI method. Difference between a PI controller technique and a suggested MPC technique. According to Fig. 4.(b), the bus voltage overshoot with the proposed MPC technique is approximately 0.8%, about settling time is 0.002 s along a step load at 0.2 s; the overshoot approximately 3.5%, the settling duration is approximately 0.0025 s and 0.4 s. Those dynamic performances of a system under the suggested MPC technique is better, as can be observed from the examination of the two methods. The normal operating point of the device will alter, changing the PI controller's ideal settings. As a result, A PI regulator technique can't always preserve optimal controller. To ensure optimum control, the suggested MPC approach can react in real-time in accordance with changes in the state variables.

Change controller parameters

This curve of $iL2ref$ and the subsequent charging and discharging rates of the battery are both directly impacted by the controller parameter i . Fig.4 shows that as I grows from 0.01 A to 0.02 A and finally to 0.05 A, the characteristics of a battery power retort become earlier and quicker. At $\Delta I = 0.05$ This device's power level when the actuator is engaged. The variable δi is altered. (c) 0.01, (d) 0.02 and (e) 0.05 As a summary and primary- or secondary-order filters canister remains deleted, the scheme wants to assign high- and low-frequency power variations. To accomplish by same effect of power distribution, a cut-off frequency canister remain modulated indirectly and flexibly thru changing value of the constraints δi .

UC short circuit (SC) fault

The retort of a bus, UC voltages below the suggested MPC approach is seen while taking into account the SC defect of the UC in the HESS. If a UC experiences a SC fault under typical operating conditions on $t = 0.3$ s, and fault is resolved in 0.05 s. Fig. 5 displays changes to the DC bus, UC voltage (b). According to the simulation results shown in Fig. 5(b), at $t = 0.3$ s, UC's SC defect causes a sharp drop in both the UC and bus voltages. The issue is fixed within 0.05 seconds. The UC starts to get recharged as the grid's voltage starts to increase. The above figure illustrates that the UC takes a while to attain its initial steady state due to its enormous capacity. The findings demonstrate of scheme meticulous thru suggested MPC technique container immobile be returned to a default functioning mode once the UC short-circuit problem has been repaired.

Photovoltaic Power Fluctuations

This primer is 1000, and at $t = 0.5$ s and $t = 1$ s, individually, 100 and 50 DC lots are introduced in corresponding. At time $t = 0$, the variable PV power is also added. The PV device's power rating is 952 W, and its lowest terminal voltage is 0, as shown in Fig.6. Fig 6 compares the anticipated MPC approach with the PI controller technique and displays the effects of loads and PV power variations on a voltage of a DC bus and UC. According to Fig. 6(a-b), voltage variations in the system meticulous by a PI regulator are higher and voltage constancy is visibly inferior than the system meticulous thru the MPC regulator when $t = 1-1.5$ s.



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(a) The voltage of capacitors C1 and C2. (b) Inductor L1 reference current i_{L1ref} and actual current i_{L1As} can be shown, the thrice-level convertor in Figure. 7's proposed MPC approach can guarantee NPV balance (a). In Fig. 7, low current ripples are obtained, and the real current closely matches the reference current (b).

Comparison with LPF method Stagecapacity change

In a UC and battery reactions to power in the HESS are exposed in Figure 7. The output power of energy storage technologies is limited. The load is connected in 0.4 seconds, and as can be seen in Fig.7 (a) and (b), the UC responds right away to offer instantaneous power recompense while battery output influence grows gradually toward provide steady-state power. Power sags are lessened by the energy storage devices working together. Both strategies, as shown in Fig.8 (a) and (b), can reduce the number of battery cycles when there are significant high-frequency power fluctuations during the first couple of seconds. It will enhance the pressure of the UC and make it more capable of bearing energy at low frequencies. Overall, the two strategies can produce the same control performance. The suggested approach without LPF optimizes the operational state of the energy storage device and simplifies the controller architecture.

CONCLUSION

Under this Paper recommend an MG-fed FLC-based hybrid energy system. The majority of researchers typically think about using PI controllers to control the proposed systems, but fine-tuning the gain values of these controllers is challenging because they produce more error and require more passive components to compensate for frequency changes. In this paper suggest using FLC with an MPC to operate thrice-level simultaneous DC/DC translators in a DC MG for grid integration with a HESS. After a two-stage enhancing architecture, a battery container prevents larger voltage level variations in a similar grid voltage level. Unlike the control scheme, the MPC controller does not require a time-consuming phase of parameter modifications in order to account for many random variables at every sampling interval. The MPC method, which is based on a constant switching frequency, also achieves rapid and accurate voltage and current regulation with reduced ripple. Eventually, the control scheme is simplified while battery performance is extended, and power fluctuations may be distributed without the need for filters.

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Table.1: Values of Various Faults

Fault Types	Phase A	Phase B	Phase C	Ground
AG	1	0	0	1
BG	0	1	0	1
CG	0	0	1	1
AB	1	1	0	0
BC	0	1	1	0
CA	1	0	1	0
ABC	1	1	1	0
No Fault	0	0	0	0

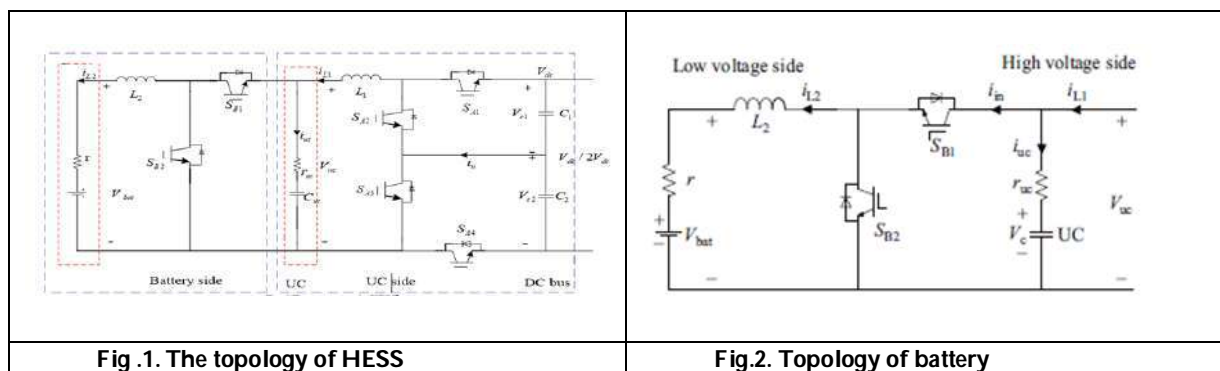


Fig. 1. The topology of HESS

Fig.2. Topology of battery

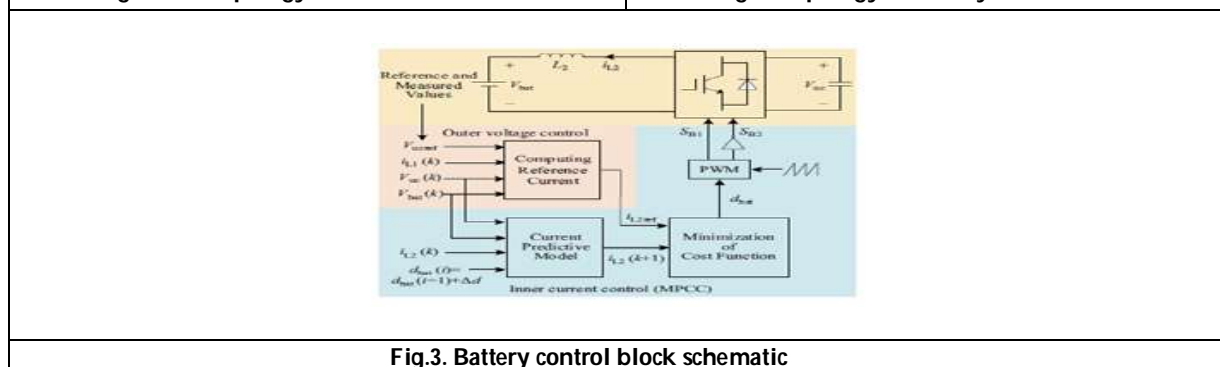


Fig.3. Battery control block schematic





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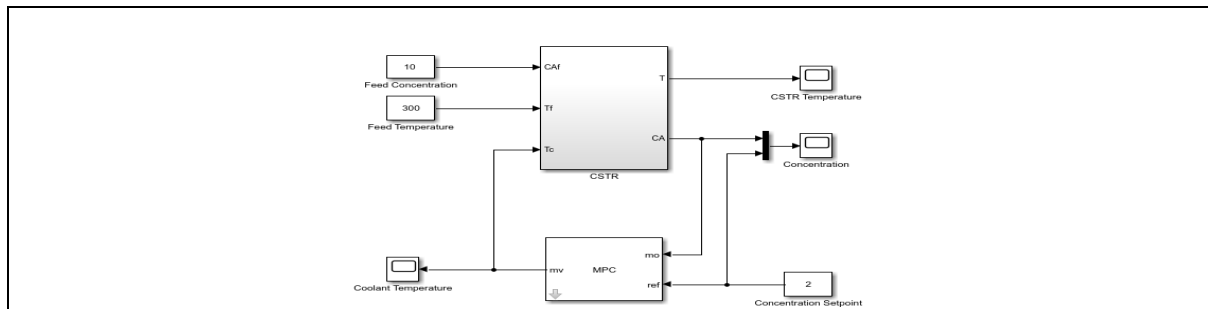


Fig.4 Schematic Simulink diagram

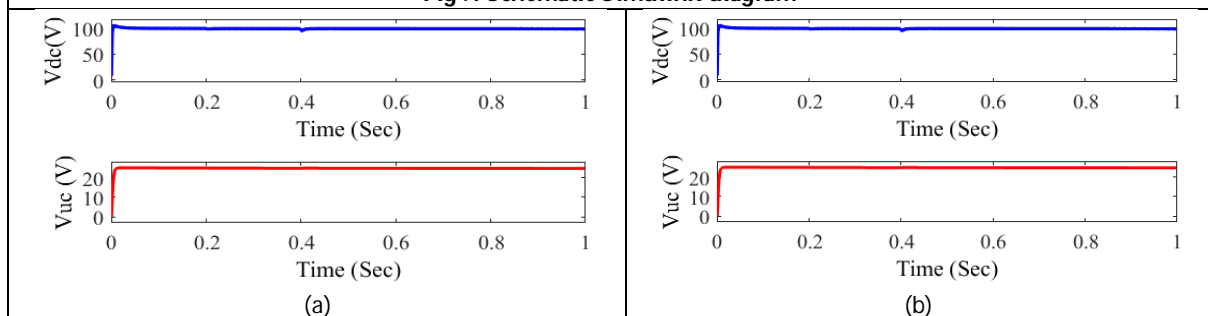
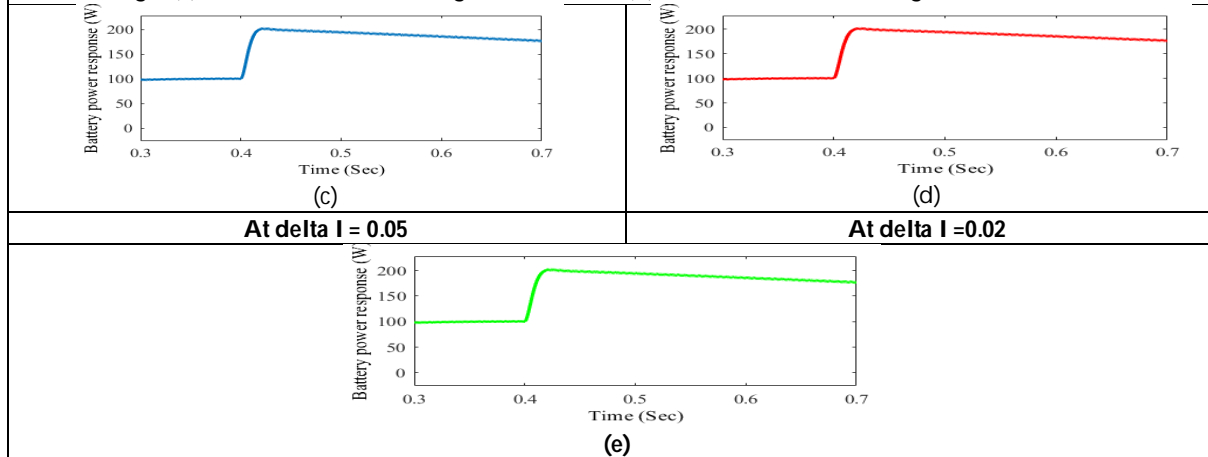


Fig. 4(a) Simulation results using MPC method. (b) Simulation results using PI method.



At delta I = 0.05 At delta I =0.02 At delta I = 0.01
 Fig. 5. This device's power level when the actuator is engaged. The variable δi is altered. (c) 0.01, (d) 00.02 and (e) 0.05

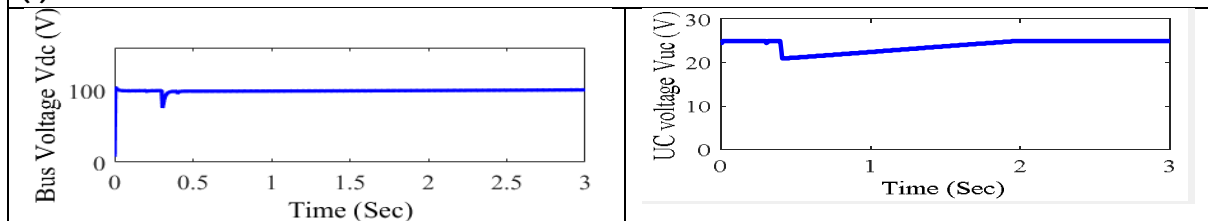


Fig. 5.(a) SC of UC in case of voltage response.

Fig. 5.(b) UC voltage





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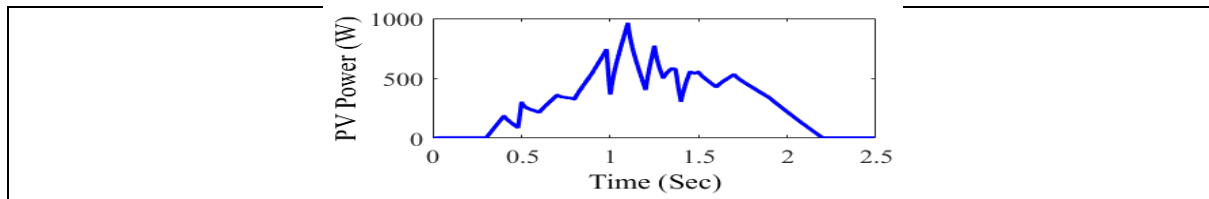


Fig. 6. PV module output power

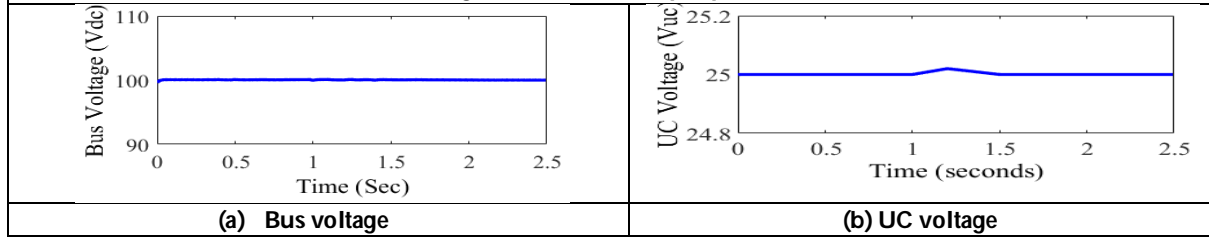


Fig. 7 Using MPC controller (a) Bus voltage, (b) UC voltage

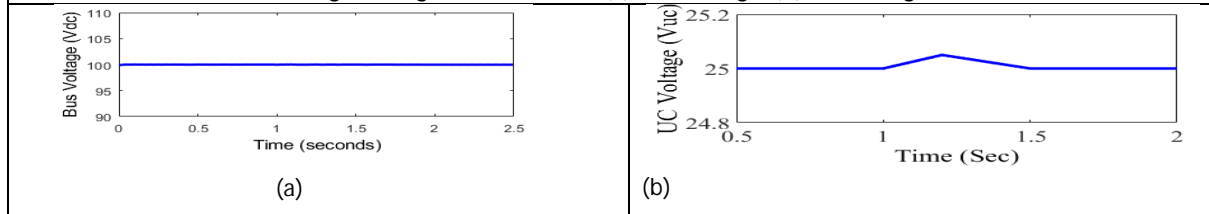


Fig. 8 (b) demonstrates that the highest voltage fluctuation with the MPC controller is 0.02 V, while by the PI Regulator, it is 0.05 V.

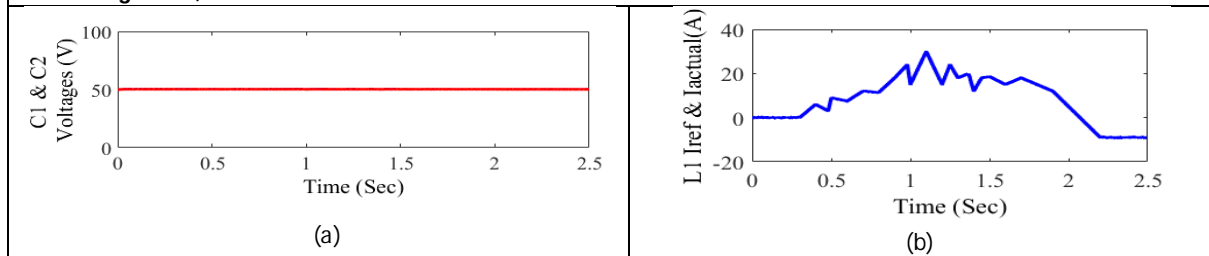


Fig. 9 The efficiency of the suggested MPC technique

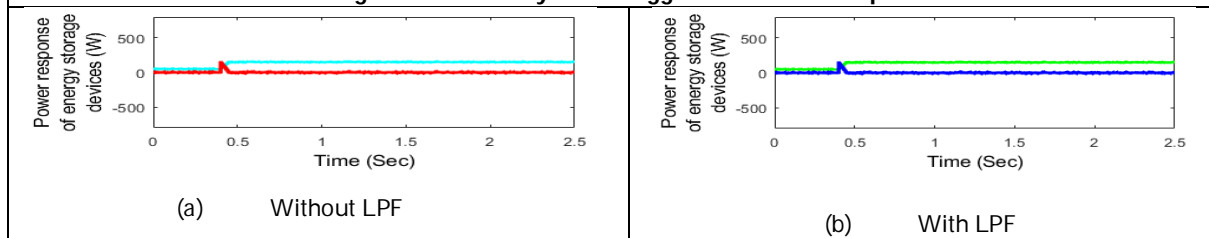


Fig 10. Photo voltaic power fluctuations.





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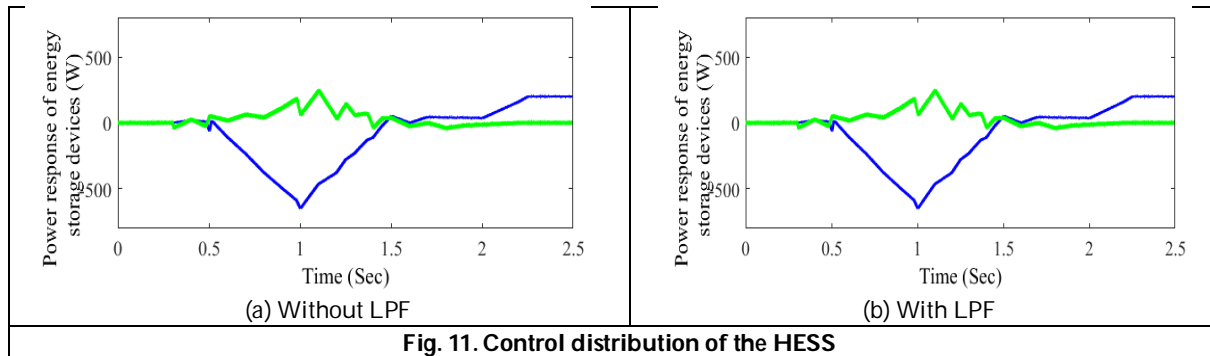


Fig. 11. Control distribution of the HESS





Study of COVID 19 Applications Related to India

Rohit Goswami^{1*}, Govind Verma² and Shikha Goswami²

¹Research Scholar, Human Resource (H.R.), Indira Gandhi National Open University, Chandigarh, India

²Assistant Professor, Department of Information Technology, College of Technology, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

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*Address for Correspondence

Rohit Goswami

Research Scholar,
Human Resource (H.R.),
Indira Gandhi National Open University,
Chandigarh, India
E. Mail: rohgoswa@ignou.ac.in



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ABSTRACT

Indians are growing increasingly frightened and making significant changes to their way of life habits as a result of the country's rapidly rising number of positive COVID-19 cases. The first steps in battling the pandemic are being taken by spreading knowledge and practicing mindfulness. The knowledge on practicing excessive cleanliness in regular daily practice has been made possible by this mindfulness and is being enthusiastically embraced. The Indian government released an app called "Arogya Setu" to carefully arm the population with awareness and knowledge regarding the Covid. These applications related to the corona virus inform the users of the number of new cases, recovered cases, and expired cases. They also instruct the users on the importance of social removal, hand washing, and the wearing of a veil in public places etc. The application fulfillment levels are the main focus of the present review. Applications of Covid-19 and its impact on client behavior. Additionally, the focus examines how customer satisfaction affects their mindset. 300 users of these programmes participated in the review using purposive testing, which was used to gauge interest. The connection and relapse analysis revealed that these applications have a significant impact on the clients' fulfillment and disposition. In this approach, the applications have been developed to raise awareness of the problems and educate the users about adhering to the government-issued warnings about the dangers of being influenced by the Covid. The satisfaction has a significant favorable impact on the client's perspective of the pandemic.

Keywords: CORONAVIRUS, COVID-19, COVID, Arogya setu, Clinliness, applications, mindset, achievement, clinical applications, veil, Coronakavach, maha kavach, Cova Punjab, Government of India, Covid safe, Corona Warn, Stop COVID-19, Corona 100M, Covid 19- DXB, StopCovid France, Immuni, NZ Covid tracer



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INTRODUCTION

According to BBC, whole world is encountering the huge dare in opposition to COVID-19 which is proclaimed as the third omnipresent conflict. The contamination is observed as extraordinarily contagious and some courses of action have been laid to control the expansion of COVID. Reports appear as an essential aspect for accomplishing the ascendancy [15] and the “Indian government” is embracing swift duration to retain individual’s cautions and grant the details on contemporary situations, which assist in keeping away from insanity and apprehension among the individuals. One of a like pursuit launched by the government of India is the announcement of open-source COVID-19 applications that authorize individuals to make an effort for self-analysis tests to examine the occurrence that they possess side effects of COVID and educate individual regarding how to stay sheltered in the absence of getting adulterated. The prime implementation of launching these kinds of applications against someone’s portable is to produce “Arrangement of after contact state and analysis” Additional segment of this application is up gradation where the number clients, recovered cases. Furthermore, about expired cases are considered and reports are published by the government is inculcated. In this way, for which causes the carefulness is important? Corona virus hold as a asymptotic ailment which known as showing no symptoms of contamination while they really infected and also the escalation chances are very high. This type application gives carefulness regarding disease either by reviving recording from experts or clinical experts make carefulness between the general inhabitants, as per the assessable reports, as of September 2020, the count of applications approachable at Google play store is 2.96 million applications [2] beginning at 2013, the number of applications on Google play store.

Was around 1,000,000 and the number of expansions of uses in store has grown quickly. These reviews expose the way that the client’s dependability for applications is introducing daily. An application with huge number of downloads, assessments and surveys like WhatsApp, Facebook, Instagram and Myntra & so on have absolutely inserted in the existence of individual. The interest to generate more interactive and creative applications to deal the matters and demand of individuals is enlarging persistence with the evolution of mobile phones it has displaced other objects like personal computers, TVs and workstations by which data can be conquered and correspondence can be carried on. In the recent ages where transposition is welcomed by the people for better way of life. Observation of data is a pivotal piece of work today for an individual to reinvigorate to the new and existing scheme absenteeism of the data will cause absenteeism of carefulness among the individual. Therefore, development of COVID-19 associated applications deliberated to spread through the information on the actuality of the pandemics and spread awareness through campaign by the means of applications presented the give facts and figures about latest information to the clients with absolute recondition and providing awareness. For the awareness basic requirement is the data. The COVID- 19 associated applications -Arogya setu, allows the patients to circulate the constructive spirit of the area to various users to stay careful. It is a segment of consistency these applications permit to publish the carefulness.

AROGYA SETU AND COVID RELATED APPLICATIONS

The foremost application which was launched in India was Arogya setu. The state Government all over India launched Covid-19 coupled applications that marked as it were the pandemic agreement associated with different states. These applications have a large number of users with high appraisals as the Google play store for interfaces / frameworks like Android and IOS these applications are directly compatible. These authorized to send alert messages to the users about the nearest COVID-19 cases. Also, it allows condition checks of the client’s relatives near to visited to him/her. Application also provides replies to the clients who have asked information about the electronic-pass. The applications focus on permitting the patients to update the data and alert their adjoining clients for the purpose of remaining safe. Later covid-19 connected applications throw light on how to help the fight, charm of exercise and yoga, recognize the client & why wearing the shield/masks is important etc.



**Rohit Goswami et al.,****A GLOBAL VIEW OF COVID-19**

The mandatory target of covid related applications is “Automated contact trackdown” some of the applications introduced and used in the different countries are the following.

1. Australia: App Covid Safe
2. Germany: Corona-Warn-App
3. Croatia: Stop COVID-19
4. South Korea: Corona 100M
5. Dubai: Covid19 - DXB
6. France: StopCovid France
7. Italian: Immuni
8. New Zealand: NZ Covid tracer

By the use of these applications the people who were covid positive can make other people around them. Alert regarding the contamination. These applications are authorized in their individual countries are absolutely important and easy to use (with a simple user interface) and to acknowledge the occurrence of an infected person is somewhere near to them. Nevertheless, globally the literacy is also an important topic to this literacy is also an important topic to these applications is a virtuous of susceptibility [20]. The fundamental independence activists investigate if there will be actual threat that this kind of survey shell will begin this widespread/pandemic. The query which occurs majorly is about the advanced security of these kinds of applications. These kinds of applications operate on two dissimilar ways i.e. the included way and the distributed way. In the countries such as China, Covid-19 linked application is generated based on condensed mode. Vast methods of communication of company grant sanction to government experts to accompany the growth of the clients' strenuous particulars accumulation authorize Chinese experts to accompany spot of the infected people imbue their vitality. Inhabitant of Conventional nation does not address on their safety and authorized survey to be carried above them to average the mount of the contamination. In countries such as India, Germany etc., Covid-19 related applications depends on distributed way. Meanwhile in the impartial nations Covid-19 associated applications depends on distributed way. Government survey of the subsequent people development is disappointing and insecure. One matter of question that must be taken into attention with these Covid-19 applications is information security and information insurance. The trouble with these Covid-19 applications is mindfulness and clinical information. The client finds it difficult to detect their own data as well as clinical data. So, securing the data is the issue presently with Covid-19 applications.

LITERATURE SURVEY

Currently, the public as a whole is heavily reliant on e-Health. Web-based administrations are available. In the clinical consideration sector, Instant Health is arguably the most reputable and well-regarded provider of Electronic Medical Records (EMR) and clinical attention control systems (Liu Weilong Yanshan College Shandong University of Finance and economics Jinan, China Liu Yuhang, 2018). It provides clinical targets with thinking trodden and nearby server jogged replies to work on their key approaches as clinical, financial, beneficial, and control strategies. Cognos's provides the executive's framework at the most affordable price for the medical sector. You only pay per client each month, which can be as little as \$150 per month and you are free to add creative strength percentages. Without incurring exorbitant costs (adding a part can cost as little as \$20 each month). The clinical master expects to receive an email from an information-based clinical decision emotionally supportive networks (CDSS) ([3] MUHAMMAD NAZRUL ISLAM 1) in view of virtual telemedicine that analyses the illness. However, email is undoubtedly not as intuitively as it might get after some deferral and data is submitted in the exact structure. Sensors collect patient information, a clinical server examines it, and the patient's mobile phone or PDA receives general feedback. For the purpose of gathering general data, this framework involves the use of body sensors, and it is also set up in a standard



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manner. Types of Chat bots a Chabot is a computer software that uses automatic responses for text, pictures, connections, video, and other media. Rule-Based chat bots and AI-Based chat bots are the two different types of chat bots. The process of building chat bots using rules or circumstances is known as rule-based approach. Its foundation is the Design and Implementation of a Web-Based Real-Time Chat Interfacing Server ([4]. Diotra Henriyan #1) The Chabot won't understand a client who asks several questions without specifying any criteria. As a result, the discussion application is not a good fit for this kind of Chabot. The strategy that is built on the human capacity to learn independently and gather convincing evidence is known as simulated intelligence-based methodology, also known as goal-based methodology. Consequently, to separate the mix of discussion, including objective, setting, and element, the Chabot is produced using regular language handling (NLP) and informational indexes that are change discoursed. Several cutting-edge tools, such as IBM Watson, Api.ai or Dialog flow, and Wit.ai, can be used with this paradigm.

Execution

In the modern era, application improvement has become a crucial corporate requirement (Luna et al. 2019). In this instance, Medi assist Edge Simplifying the diagnostic process and enhancing patient-doctor communication ([2] Amiya Kumar Tripathy^{1*}, 2010) Planning the application to have a simple, clear, reliable, and effective UI that empower Easy access to tools and options is a crucial aspect of achieving client satisfaction. Customers feel strained by an excessive number of commercials, pop-ups, or errors, which leads them to uninstall programmes. Literature has noted that the textual tones, styles, and symbols used in the varied applications do have an impact on the personalities of the users. This analysis determines whether Covid-19-related applications are convenient to use.

REVIEW OF THE LITERATURE AND HYPOTHESES FORMULATION

Contentment

In the modern day, application enhancement is now a crucial company requirement (Liu Weilong Yanshan College Shandong University of Finance and Economics Jinan. 2018 China Liu Yuhang) Fundamental considerations for achieving customer satisfaction include designing an application with a simple, clear, effective, and efficient user interface that enables quick access to devices and options. Customers feel burdened by the sheer volume of Commercials, pop-ups, or an error, which leads them to uninstall programmes. Studies have found that the textual tones, styles, and symbols used in the various programmes do have an impact on the personalities of the users. This review evaluates how satisfying it is to use Covid-19-related applications.

Mentality

This focus mainly focuses on what the release of these Covid-19-related applications entails for the clients' thinking. Mentality is defined by the Oxford Word Reference as "establishing a perspective." Mentality is the way a person behaves or approaches situations from their point of view. We now live in a time that is utterly dependent on invention, so people can easily find homes to live in and purchase necessities like food, clothing, and food with the click of a button. Applications that are flexible play a crucial role in meeting people's needs, from the most basic to the most extravagant. Utilization of Covid-19-related software, such as "Aarogya Setu," "Coronavirus Care Tamil Nadu," and other applications launched by several Indian regions, has received a large number of visitors, reaching lakhs of customers. The use of flexible applications has become deeply ingrained in people's way of life. Clients evaluate and review any data or content posted on portable applications, which leads to a rapid increase in client application usage.

However, among the citizens of the nation, the difficulties, dread, and unease of contracting the sickness are perpetually growing. The review is highly needed in this circumstance because it helps with mindfulness and provides knowledge on staying safe. Tamil Nadu is the second-most severely damaged state, behind Maharashtra, according to the measurements updated in



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Aarogya Setu. The Coimbatore region will be in the "orange zone" as of August 2020, according to Covid-19 Care Tamil Nadu. Together, these perspectives consider the need for the review. Additionally, if these data are impacted by Covid-19-related applications should be taken care of.

Satisfaction with mobile apps and user attitudes

The industry for mobile applications has seen remarkable growth and is becoming as a well-known tool among industry professionals due to its ability to connect users directly with just a single click. It's a fundamental tool that's used for a variety of activities, including shopping, watching videos, and gathering data. According to an analysis, portable applications have an impact on the client's fulfillment and mindset. Essentially, research has shown that the fulfillment gained from using a portable application can influence the client's behavior, promoting trust, responsibility, and dependability. The current review reveals, in light of the aforementioned writing, that Covid-19-related applications do have an effect on customers' attitudes regarding the epidemic by raising fulfillment. These apps include instructions from medical professionals on what and how patients should follow in order to remain sensible. These programmes offer a one-stop shop for daily reports and information that clients are required to know. On the other hand, it should be noted that customers do install Covid-19-related applications in their mobile devices in order to obtain information. The goal of receiving data is to learn something. The clients' mindset will be affected by learning about how serious the situation is, and these applications will then advise them to follow the instructions to protect themselves during pandemics.

GRADE, VALIDITY, AND RELIABILITY

Instrumentation

There were two components to the survey. The first part gathered respondents' finer demographic details (e.g.: sexual orientation; recurrence of use of the Coronavirus related applications). The second component of the study collected data on customer satisfaction and customer behavior using structured surveys, as discussed below; Clients' fulfillment scale: 18-things scale was copied from Paragon and colleagues. "The messages offered me wonderful ideas," "the presence of the message plate was sufficient," and "The messages given by the programme were innovative" are a few of the rememberable questions for the poll assessing clients' satisfaction. The scale's Cronbach's alpha was 0.92. Three items with low normalized loadings were eliminated, bringing the final number of items down to 16. The scale's overall dependability received an adequate score of 0.93. The normal difference removed (AVE) test, which scored 0.65 and is higher than the required value of 0.50, was used to determine the concurrent legitimacy. Clients' disposition scale: The nine-point scale was adapted from Alahdal et al. Model phrases include "Remain at home helps to lessen the spread of the virus," "Associating with loved ones can help with

Limiting the spread of the infection," and "Quit travelling between metropolitan regions can handle the spread of the sickness." Given that the scale's Cronbach's alpha was 0.91, its dependability was assured. Low normalized loadings were absent. The combined legitimacy score was 0.45, while the composite dependability score was 0.94. The concurrent legitimacy of the scale is declared to be acknowledged when composite dependability is assumed to be greater than 0.60 but combined legitimacy is less than 0.50 but close to 0.50. Therefore, the assessment will take into account AVE's 0.45 value. The estimates were made using a 5-point Likert scale (1-Strongly Disagree, 5-Strongly Agree).

Calculating the sample size

This review employs a non-likelihood inspection technique that is purposefully or critically tested. For the review, respondents who live less than one kilometer from control zones were taken into account. Because they should be aware of these Covid-19-related applications that would help them follow successful cases in their neighborhood, it was decided to select respondents who reside close to the affected areas. According to reports released in April 2020, eight areas in the Coimbatore region were designated as regulation zones (rundown of these limited regions was procured from The Hindu paper, 2020). We visited the control zones' neighboring neighborhoods and counted the number of families we could find within a kilometer.



**Rohit Goswami et al.,****COMPARATIVE AND INTERPRETATIVE****Analyses of surveys****Basic information**

Male volunteers made up 65.8 percent of the survey participants, while female volunteers made up 32.9%. Similarly, it can be seen that 72.4 percent of the population was between the ages of 19 and 30, and the remaining 27.6 percent were above 30. When asked if they had contracted COVID, 68.4% of respondents replied no, while 21.6% admitted to having done so.

Information about the application

The survey included the following questions regarding covid awareness: People were asked about their awareness of foods that raise immunity. Because Covid is considered as less damaging against those with good immune systems. 39.5 percent of respondents stated they were unaware of such food items, while 60.5% of respondents indicated that they were. When asked if they had any trouble locating covid-specialized hospitals and testing labs in their city, 53.9 percent of the volunteers responded that they were unaware of these resources, while 46.1% stated they were aware of them. People in your neighborhood use face masks and practice social distancing, another question, to which 59.2 percent responded "no" and 40.8 percent "yes." If people thought that increasing knowledge could stop COVID 19 was the subject of a different survey. The spread cannot be stopped, according to 30.3% of respondents, while it can be, according to 69.7%.

The question, "What do you think COVID related health awareness may be conveyed through which medium most successfully," was put to the populace. In response, volunteers stated that the best method of raising awareness is through a mobile application, followed by television and then newspapers. Do you feel physically safe when visiting a doctor in these times? was another query. In response to this inquiry, 69.7% of respondents answered that they indeed feel insecure, while 29.3% disagreed. The following query was: Would you prefer an integrated platform that offers features like (real-time data on COVID cases, vaccination center information, COVID awareness information, and online medical consultation)? 88.2 percent of respondents indicated their agreement with the statement, while 11.8% disagreed.

At the conclusion of the survey, participants were invited to offer their recommendations for features they would want to see added to covid-related applications. Several ideas included:

- Covid instances should be analyzed in real time per hour. Additionally, we can observe that fake data is not integrated in any way.
- Details regarding vaccine availability.
- Discussion forum or Q&A on COVID.
- Certain elements, including interactive data, aid in understanding

Analysis of existing apps user ratings

This section will analyze user ratings and the size of the application in MB of various applications available on the Google Play or Apple App Store. We looked into a total of 4 applications from the Google Play Store and the Apple App Store that use the Covid Awareness Model. Table 1 reveals that all of these applications have ratings of at least 3 and less than 3 MB also these are having more than 1 lakh downloads on both the app store and the play store, indicating that people are generally accepting them. To fulfill the goal of raising awareness and putting an end to COVID, we discovered that significant adjustment or revisions are still needed by looking through the comments section for user feedback.





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Trend Analysis: Popularity of Applications

In this Section we will analyze the trends found on Google. It will give number of a particular keywords related to a particular COVID application searched. Thus, it is associated with popularity and adequacy of the application. Figure 1 will give the Google trend for corona check in 4 Indian Applications.

AFFECTATIONS ON SOCIETY AND PRACTICE

Countries all around the world are in a true sense being forced to gradually loosen the lockdowns to shield their economies from collapsing as the fight against Covid continues around the world with increasing examples of people who have been affected by it. The new adage is to endure the COVID-19 infection until an antibody is discovered. Without breaking a sweat, the COVID-19 pandemic's increasing rushes of danger and constant dread arrive during lockdown. The awareness of the situation and the abundance of information on the infection provided by reliable sources. Source is becoming more and more important. The cutting-edge platform, in particular the Covid- identified applications, is playing a significant role in the distribution of information. These are the finest readily available options for straightforward data transmission, to both the general public as well as front-runners, even though additional research should be done on the effectiveness of individual applications. Applications related to Covid-19 can set up a system for conducting online physical examinations at no cost to users. This would ensure security and let doctors and patients save a ton of time. Second, folks can be provided with internet arrangements at no cost to obtain government- started medical care apps for other severe ailments including sickness, jungle fever, tuberculosis, and so forth.

Third, these applications should feature live chat features that would enable users to ask medical professionals questions during the epidemic and receive responses. They would be directed to continue being useful in this manner. False information about COVID-19 is widely distributed, so it's important that administration oversee these applications to ensure that no incorrect information is disseminated through them. Furthermore, these COVID-19-related applications errors, breakdowns, and incorrect upgrades may endanger their users' safety far more than they intended to benefit them. In contrast to western countries, where applications are primarily focused on data dissemination with less emphasis on contact following and manifestations checking due to the fear of information breach and widespread fraud, applications developed in India are typically centered around contact following or side effects checking. As a result, more Indian application developers may concentrate on enhancing the security and safety of client information collected by clients.

RESTRICTIONS AND ADDITIONAL RESEARCH

Like all research, our focus has several limitations, including the small sample size of 76 respondents and the possibility of future research with a larger sample size. Future research studies may take into account similar investigations using various groups, such as games, web-based business installment frameworks, or interactive media enlightening apps. Further research should concentrate on whether these applications reach a large portion of the Indian population. The question of whether people in rural areas of the country are aware of Covid-19-related applications and job openings must be answered.

CONCLUSION

As India is very largely populated country so, the Management regarding spread, control and vaccination is challenging itself. The mobile application discussed here provided to convenient way to handle this challenge. For example, Arogya setup application which is launched by government of India. This application is installed in 100 million mobiles in just 40 days and also it has reached to above 210 million in number in recent times. Arogya set u provides may features such as:

1. Contact Tracking.
2. Syndrome mapping and self-assessment.





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3. User status: tell the risk of getting Covid-19 for the user.
4. Self-Assess: helps the user to identify Covid-19 symptoms and their risk profile.
5. E-pass integration: if applied for E-pass it will be available.
6. See recent contact options: Allow the user to assess the risk level of their Bluetooth contact.
7. It also facilitates about scheduling of COVID vaccination.
8. Provide certification after vaccination.

The mobile app is convenient and reachable among various types of users also these applications require less space to install. In this respect the applications which are discussed above also help in order to ensure their wellbeing, people have become extremely cautious about the locations they visit, the people they meet and greet, the food they eat, and, yes, even the things they touch. This was revealed through talks with the general public during information gathering.

They moreover accepted to be wearing veils, washing hands, also, preserving social separation to stop becoming tainted. Most people agree that it is useful, although being curious about the assumption that these applications are illuminating. Despite all the inventive advancements made to educate people about the significance of the situation, strangely, the number of instances is still growing at a steady rate. The numbers are still on the verge of increasing despite strict lockdown guidelines and teaching wellbeing measures through all possible correspondence.

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Table 1. Analysis of existing apps user ratings

Name of App	Play Store rating	App Size (MB)	App store rating	App Size (MB)
Arogya setu	3.9	4.1	4.4	21.6
Corona Kavach	3	3.8	3.5	12.7
Maha Kavach	3.9	2.4	N/A	N/A
Cova Punjab	3.8	8.3	3.5	31.5





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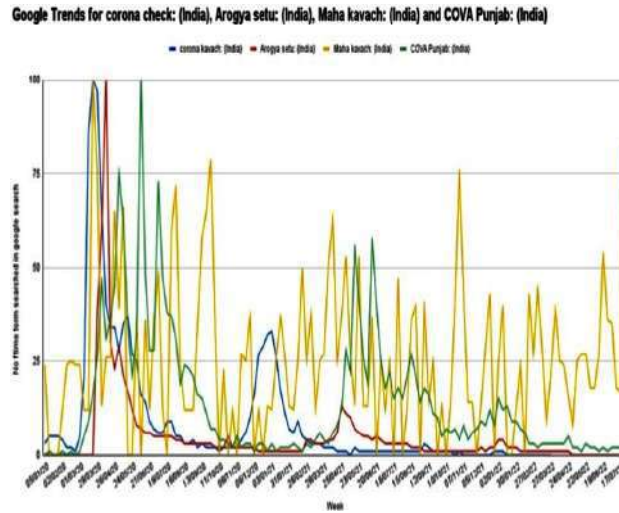


Figure 1: Google trend for corona check in 4 Indian Applications





Some Resultant of Feebly Closed Sets in Kasaj Topological Spaces

P.Sathishmohan^{1*}, E.Prakash¹, K.S.Viplavanjali² and K.Rajalakshmi³

¹Assistant Professor, Department of Mathematics, Kongunadu Arts and Science College (Autonomous), Coimbatore, Tamil Nadu, India.

²Research Scholar, Department of Mathematics, Kongunadu Arts and Science College (Autonomous), Coimbatore, Tamil Nadu, India.

³Assistant Professor, Department of Science and Humanities, Sri Krishna College of Engineering and Technology, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

P.Sathishmohan

Assistant Professor,

Department of Mathematics,

Kongunadu Arts and Science College (Autonomous),

Coimbatore, Tamil Nadu, India

E. Mail :



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ABSTRACT

This paper considers feebly generalized semi closed sets and feebly semi generalized closed sets in Kasaj topological space are denoted as KS_{fgs} -closed set and KS_{fsg} -closed set, we scrutinize the relationship between the above sets and some of the sets in Kasaj topological space and also analyzed characterization.

Keywords: Kasaj Topological space, Kasaj feebly generalized semi closed sets, Kasaj feebly semi generalized closed sets.

AMS Subject Classifications: 54A05, 54B05, 54B99.

INTRODUCTION

The theory of Kasaj topology proposed by [6] Kashyap.G.Rachchh and Sajeed.I.Ghanchi in 2020 is a partial extension of Micro Topological Space initiated by [3] Chandrasekar which an extension of Nano Topological Spaces is introduced by [2] Lellis Thivagar, and Carmel Richard. In 1970, [1] Levine originate the class of generalized closed set. In 1978, [4] Maheshwari and U.Tapi introduced the concept of feebly open set, in topological space. Also [5] Dalal Ibraheem introduced the concept of feebly generalized closed sets in general topological spaces. [7] Kashyap G. Rachchh and Sajeed introduced Kasaj generalized closed sets in Kasaj topological spaces. In 2022, [8] Prakash et.al introduced the

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concept On Kasaj Generalized Semi and Semi Generalized Closed Sets in Kasaj Topological Space. The study of generalized closed sets and feebly closed sets has found considerable interested among general topologists. In this Paper, the notion of Kasaj feebly generalized semi closed sets and Kasaj feebly semi generalized closed sets introduced by comparing the Kasaj feebly semi closure of a set with the Kasaj sets. Also several characterizations are discussed and studied.

NOTATIONS: In this paper work, we use these ensuing symbols

- (i) $KS_{fg} \rightarrow$ Kasaj feebly generalized
- (ii) $KS_{fgs} \rightarrow$ Kasaj feebly generalized semi
- (iii) $KS_{fsg} \rightarrow$ Kasaj feebly semi generalized
- (iv) $KS_{fscl} \rightarrow$ Kasaj feebly semi closure
- (v) $KS_{fsint} \rightarrow$ Kasaj feebly semi interior
- (vi) $KS_{fgs-nbhd} \rightarrow$ Kasaj feebly generalized semi neighborhood
- (vii) $KS_{fsg-nbhd} \rightarrow$ Kasaj feebly semi generalized neighborhood

PRELIMINARIES

Definition 2.1 [6] Let $(U, \tau_R(X))$ be a nano topological space. Then Kasaj topology is defined by $KS_R(X) = \{(K \cap S) \cup (K' \cap S') : K, K' \in \tau_R(X), \text{ fixed } S, S' \notin \tau_R(X), S \cup S' = U\}$ The Kasaj topology $KS_R(X)$ satisfies the following postulates:

- (i) $U, \phi \in KS_R(X)$
 - (ii) The union of elements of any subcollection of $KS_R(X)$ is in $KS_R(X)$
 - (iii) The intersection of any finite subcollection of elements of $KS_R(X)$ is in $KS_R(X)$
- Then $(U, \tau_R(X), KS_R(X))$ is called Kasaj Topological Spaces and the members of $KS_R(X)$ are called Kasaj open (KS-open)set (KS-open) and the complement of a Kasaj-open set is called a Kasaj-closed (KS-closed)set.

Definition 2.2 [6] For any two subsets P, Q of U in a Kasaj topological space $(U, \tau_R(X), KS_R(X))$

- (i) P is a Kasaj -closed set iff $KS_{cl}(P) = P$
- (ii) P is a Kasaj -open set iff $KS_{int}(P) = P$
- (iii) $KS_{cl}(P) = [KS_{int}(P)]^c$
- (iv) $KS_{int}(P) = [KS_{cl}(P)]^c$
- (v) KS-Semi-closed, if $KS_{int}(KS_{cl}(P)) \subseteq P$.
- (vi) KS- α -closed, if $KS_{cl}(KS_{int}(KS_{cl}(P))) \subseteq P$.

Definition 2.3 [8] A subset P of U in $(U, \tau_R(X), KS_R(X))$ is called a Kasaj generalized semi closed set (briefly KS_{gs} -closed), if $KS_{scl}(P) \subseteq V$ whenever $P \subseteq V$ and V is Kasaj-open set in $KS_R(X)$.

Definition 2.4 [8] A subset P of U in $(U, \tau_R(X), KS_R(X))$ is called a Kasaj semi generalized closed set (briefly KS_{sg} -closed), if $KS_{scl}(P) \subseteq V$ whenever $P \subseteq V$ and V is Kasaj semi-open set in $KS_R(X)$.

Definition 2.5 [7] A subset P of U in $(U, \tau_R(X), KS_R(X))$ is called a Kasaj generalized closed set (briefly KS_g -closed), if $KS_{cl}(P) \subseteq V$ whenever $P \subseteq V$ and V is Kasaj-open set in $KS_R(X)$.

Definition 2.6 [9] Let $(U, \tau_R(X), KS_R(X))$ be a Kasaj topological space and let x be a point of U . A subset P of U is called KS-semi-neighbourhood of U their occur a KS-semi-open set F such that for $x \in F \subseteq P$.

Definition 2.7 [10] A subset P of U in $(U, \tau_R(X), KS_R(X))$ is called

- (i) KS-feebly closed set, if $KS_{sint}(KS_{cl}(P)) \subseteq P$.
- (ii) KS-feebly semi-closed set, if $KS_{sint}(KS_{scl}(P)) \subseteq P$.





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Definition 2.8 [10] A subset P of U in $(U, \tau_R(X), K_S_R(X))$ is called *KS-feebly generalized closed set*, if $KS_{fcl}(P) \subseteq V$ whenever $P \subseteq V$ and V is *KS-feebly open set* in U . It is denoted as KS_{fg} -closed set. The complement of KS_{fg} -closed set is KS_{fg} -open set in U .

Definition 2.9 [10] The *Kasaj feebly closure* and the *Kasaj feebly interior* of a set P is denoted by $KS_{fcl}(P)$ and $KS_{fint}(P)$, respectively.

It is defined by $KS_{fcl}(P) = \cap \{Q : P \subset Q, Q \text{ is KS-feebly closed}\}$ and $KS_{fint}(P) = \cup \{Q : Q \subset P, Q \text{ is KS-feebly open}\}$

Definition 2.10 [10] The *Kasaj feebly generalized closure* and the *Kasaj feebly generalized interior* of a set P is denoted by $KS_{fgcl}(P)$ and $KS_{fgint}(P)$, respectively.

It is defined by $KS_{fgcl}(P) = \cap \{Q : P \subset Q, Q \text{ is KS-feebly generalized closed}\}$ and $KS_{fgint}(P) = \cup \{Q : Q \subset P, Q \text{ is KS-feebly generalized open}\}$

$KS_{fgs}(KS_{fsg})$ -CLOSED SETS

The main work of this paper is to initiate and scrutinize KS_{fgs} and KS_{fsg} closed sets in Kasaj topological spaces.

Definition 3.1 A subset P of U in $(U, \tau_R(X), K_S_R(X))$ is called *KS-feebly generalized semi closed set*, if $KS_{fcl}(P) \subseteq V$ whenever $P \subseteq V$ and V is *KS-feebly open set* in U . It is denoted as KS_{fgs} -closed set. The complement of KS_{fgs} -closed set is KS_{fgs} -open set in U .

Definition 3.2 A subset P of U in $(U, \tau_R(X), K_S_R(X))$ is called *KS-feebly semi generalized closed set*, if $KS_{fcl}(P) \subseteq V$ whenever $P \subseteq V$ and V is *KS-feebly semi open set* in U . It is denoted as KS_{fsg} -closed set. The complement of KS_{fsg} -closed set is KS_{fsg} -open set in U .

Definition 3.3 The *Kasaj feebly generalized semi closure* and the *Kasaj feebly generalized semi interior* of a set P is denoted by $KS_{fsgcl}(P)$ and $KS_{fsgint}(P)$, respectively.

It is defined by $KS_{fsgcl}(P) = \cap \{Q : P \subset Q, Q \text{ is KS-feebly generalized semi closed}\}$ and $KS_{fsgint}(P) = \cup \{Q : Q \subset P, Q \text{ is KS-feebly generalized semi open}\}$

Definition 3.4 The *Kasaj feebly semi generalized closure* and the *Kasaj feebly semi generalized interior* of a set P is denoted by $KS_{fsgcl}(P)$ and $KS_{fsgint}(P)$, respectively.

It is defined by $KS_{fsgcl}(P) = \cap \{Q : P \subset Q, Q \text{ is KS-feebly semi generalized closed}\}$ and $KS_{fsgint}(P) = \cup \{Q : Q \subset P, Q \text{ is KS-feebly semi generalized open}\}$

Lemma 3.5 Let P be subsets of $(U, \tau_R(X), K_S_R(X))$ in Kasaj topological spaces. Then

- (i) $KS_{sint}(KS_{scl}(P)) \subseteq KS_{scl}(P)$.
- (ii) $KS_{sint}(KS_{scl}(P)) \subseteq KS_{acl}(P)$.
- (iii) $KS_{sint}(KS_{fsgcl}(P)) \subseteq KS_{cl}(P)$.
- (iv) $KS_{sint}(KS_{fsgcl}(P)) \subseteq KS_{scl}(P)$.
- (v) $KS_{sint}(KS_{fsgcl}(P)) \subseteq KS_{acl}(P)$.

Proof:

- (i) Let $u \in KS_{sint}(KS_{scl}(P))$
 $\Leftrightarrow \cap \{G : G \text{ is KS-semi open}, G \subseteq KS_{scl}(P)\}$
 $\Leftrightarrow KS_{scl}(P)$ is KS-semi neighborhood of u .
 \Leftrightarrow there exists an KS-semi open set G such that $u \in G \subseteq KS_{scl}(P)$
 $\Leftrightarrow u \in KS_{scl}(P)$. Since $KS_{scl} \subseteq KS_{scl}$
 \Leftrightarrow Therefore $u \in KS_{scl}(P)$.

- (ii) Let $u \in KS_{sint}(KS_{scl}(P))$





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$\Leftrightarrow \cap\{G:G \text{ is KS-semi open, } G \subseteq KS_{scl}(P)\}$
 $\Leftrightarrow KS_{scl}(P)$ is KS-semi neighborhood of u .
 \Leftrightarrow there exists an KS-semi open set G such that $u \in G \subseteq KS_{scl}(P)$
 $\Leftrightarrow u \in KS_{scl}(P)$. Since $KS_{scl} \subseteq KS_{acl}$
 \Leftrightarrow Therefore $u \in KS_{acl}(P)$.

(iii) Let $u \in KS_{fscl}(P)$
 $\Leftrightarrow \cap\{F:F \text{ is KS-feebly semi closed and } F \supseteq P\}$
 $\Leftrightarrow KS_{fscl}(P)$ is KS-feebly semi closed set, since it is intersection of KS-feebly semi closed set.
 $\Leftrightarrow KS_{fscl}(P) \subseteq P$.
 $\Leftrightarrow F$ is any KS-feebly semi closed set containing P , then $KS_{fscl}(P) \subseteq F$.
 $\Leftrightarrow KS_{fscl}(P)$ is the smallest KS-feebly semi closed set containing P , by lemma 3.7(ii) in [10].
 $\Leftrightarrow u \in KS_{cl}(P)$.

(iv) Let $u \in KS_{fscl}(P)$
 $\Leftrightarrow \cap\{F:F \text{ is KS-feebly semi closed and } F \supseteq P\}$
 $\Leftrightarrow KS_{fscl}(P)$ is KS-feebly semi closed set, since it is intersection of KS-feebly semi closed set.
 $\Leftrightarrow KS_{fscl}(P) \subseteq P$.
 $\Leftrightarrow F$ is any KS-feebly semi closed set containing P , then $KS_{fscl}(P) \subseteq F$.
 $\Leftrightarrow KS_{fscl}(P)$ is the smallest KS-feebly semi closed set containing P , by lemma 3.5(i).
 $\Leftrightarrow u \in KS_{scl}(P)$.

(v) Let $u \in KS_{fscl}(P)$
 $\Leftrightarrow \cap\{F:F \text{ is KS-feebly semi closed and } F \supseteq P\}$
 $\Leftrightarrow KS_{fscl}(P)$ is KS-feebly semi closed set, since it is intersection of KS-feebly semi closed set.
 $\Leftrightarrow KS_{fscl}(P) \subseteq P$.
 $\Leftrightarrow F$ is any KS-feebly semi closed set containing P , then $KS_{fscl}(P) \subseteq F$.
 $\Leftrightarrow KS_{fscl}(P)$ is the smallest KS-feebly semi closed set containing P , by lemma 3.5(ii).
 $\Leftrightarrow u \in KS_{acl}(P)$.

Lemma 3.6 Let P be subset of $(U, \tau_R(X), KS_R(X))$ in Kasaj topological space then $KS_{fscl}(P) \subseteq KS_{scl}(P)$.

Proof: Let $u \in KS_{fscl}(P)$

$\Leftrightarrow \cap\{F:F \text{ is KS-feebly semi closed and } F \supseteq P\}$
 $\Leftrightarrow KS_{fscl}(P)$ is KS-feebly semi closed set, since it is intersection of KS-feebly semi closed set
 $\Leftrightarrow KS_{fscl}(P) \subseteq P$
 $\Leftrightarrow F$ is any KS-feebly semi closed set containing P , then $KS_{fscl}(P) \subseteq F$
 $\Leftrightarrow KS_{fscl}(P)$ is the smallest KS-feebly semi closed set containing P
 $\Leftrightarrow u \in KS_{scl}(P)$.

Theorem 3.7 The following conditions of $(U, \tau_R(X), KS_R(X))$ in Kasaj topological space satisfies the combination of Kasaj feebly sets are:

- (i) Every KS-closed set is KS_{fgs} -closed.
- (ii) Every KS-closed set is KS_{fsg} -closed.
- (iii) Every KS-semi closed set is KS_{fgs} -closed.
- (iv) Every KS-semi closed set is KS_{fsg} -closed.
- (v) Every KS- α closed set is KS_{fgs} -closed.
- (vi) Every KS- α closed set is KS_{fsg} -closed.





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Proof:

(i) Let $P \subseteq V$, where P be a KS-closed set in V. If $P \subseteq V$ and V is a KS-feeblly open in U. We know that P is KS-closed set, $KS_{cl}(P) = P$. Since by [10] Lemma 3.7(i). $KS_{fscl}(P) \subseteq KS_{cl}(P) = P \subseteq V$. Therefore $KS_{fscl}(P) \subseteq V$. Hence P is KS_{fgs} -closed set.

(ii) Let $P \subseteq V$, where P be a KS-closed set in V. If $P \subseteq V$ and V is a KS-feeblly semi open in U. We know that P is KS-closed set, $KS_{cl}(P) = P$. Since by [10] Lemma 3.7(i). $KS_{fscl}(P) \subseteq KS_{cl}(P) = P \subseteq V$. Therefore $KS_{fscl}(P) \subseteq V$. Hence P is KS_{fsg} -closed set.

(iii) Let $P \subseteq V$, where P be a KS-semi closed set in V. If $P \subseteq V$ and V is a KS-feeblly open in U. We know that P is KS-semi closed set, $KS_{scl}(P) = P$. Since by Lemma 3.5(iv) $KS_{fscl}(P) \subseteq KS_{scl}(P) = P \subseteq V$. Therefore $KS_{fscl}(P) \subseteq V$. Hence P is KS_{fgs} -closed set.

(iv) Let $P \subseteq V$, where P be a KS-semi closed set in V. If $P \subseteq V$ and V is a KS-feeblly semi open in U. We know that P is KS-semi closed set, $KS_{scl}(P) = P$. Since by Lemma 3.5(iv) $KS_{fscl}(P) \subseteq KS_{scl}(P) = P \subseteq V$. Therefore $KS_{fscl}(P) \subseteq V$. Hence P is KS_{fsg} -closed set.

(v) Let $P \subseteq V$, where P be a KS- α closed set in V. If $P \subseteq V$ and V is a KS-feeblly open in U. We know that P is KS- α closed set, $KS_{acl}(P) = P$. Since by Lemma 3.5(v) $KS_{fscl}(P) \subseteq KS_{acl}(P) = P \subseteq V$. Therefore $KS_{fscl}(P) \subseteq V$. Hence P is KS_{fgs} -closed set.

(vi) Let $P \subseteq V$, where P be a KS- α closed set in V. If $P \subseteq V$ and V is a KS-feeblly semi open in U. We know that P is KS- α closed set, $KS_{acl}(P) = P$. Since by Lemma 3.5(v) $KS_{fscl}(P) \subseteq KS_{acl}(P) = P \subseteq V$. Therefore $KS_{fscl}(P) \subseteq V$. Hence P is KS_{fsg} -closed set.

The reverse of the implications need not be true as seen from the subsequent exemplar.

Exemplar 3.8 Let $U = \{a,b,c,d,e\}$ with $U/R = \{\{c,d\},\{b,e\},\{a\}\}$ and $X = \{a,b\} \subseteq U$.

Then $\tau_R(X) = \{\phi, U, \{a\}, \{a, b, e\}, \{b, e\}\}$. If we consider $S = \{e\}$ $S' = \{a,b,c,d\}$

$KS_R(X) = \{\phi, \{a\}, \{b\}, \{e\}, \{a,b\}, \{a,e\}, \{b,e\}, \{a,b,e\}, \{a,b,c,d\}, U\}$.

Then KS_{fgs} and KS_{fsg} -closed set =

$\{\phi, \{a\}, \{b\}, \{c\}, \{d\}, \{e\}, \{a,c\}, \{a,d\}, \{a,e\}, \{b,c\}, \{b,d\}, \{b,e\}, \{c,d\}, \{c,e\}, \{d,e\}, \{a,c,d\}, \{a,c,e\}, \{a,d,e\}, \{b,c,d\}, \{b,c,e\}, \{b,d,e\}, \{c,d,e\}, \{a,c,d,e\}, \{b,c,d,e\}, U\} \notin$ KS-closed set, KS-semi closed and KS- α closed.

Remark 3.9 KS_g -closed set is independent of KS_{fgs} -closed set and KS_{fsg} -closed set it is shown by following exemplar.

Exemplar 3.10 Let $U = \{a,b,c,d,e\}$ with $U/R = \{\{c,d\},\{b,e\},\{a\}\}$ and $X = \{a,e\} \subseteq U$.

Then $\tau_R(X) = \{\phi, U, \{a\}, \{a, b, e\}, \{b, e\}\}$. If we consider $S = \{a,e\}$ $S' = \{b,c,d\}$

$KS_R(X) = \{\phi, \{a\}, \{b\}, \{a,b\}, \{a,e\}, \{a,b,e\}, \{b,c,d\}, \{a,b,c,d\}, U\}$. Then the subset $\{a,b,c,e\}$ is KS_g -closed but not $KS_{fgs}(KS_{fsg})$ -closed and the subset $\{a\}$ is $KS_{fgs}(KS_{fsg})$ -closed but not KS_g -closed.

Remark 3.11 $KS_{fscl}(P) = KS_{fscl}(Q) \not\Rightarrow P = Q$.

Exemplar 3.12 Let $U = \{a,b,c,d,e\}$ with $U/R = \{\{a,c\},\{d,e\},\{b\}\}$ and $X = \{b,d\} \subseteq U$.

Then $\tau_R(X) = \{\phi, U, \{b\}, \{b, d, e\}, \{d, e\}\}$. If we consider $S = \{b,d\}$ $S' = \{a,c,e\}$

$KS_R(X) = \{\phi, \{b\}, \{d\}, \{e\}, \{b,d\}, \{b,e\}, \{d,e\}, \{a,c,e\}, \{b,d,e\}, \{a,b,c,e\}, \{a,c,d,e\}, U\}$ be the Kasaj topological space on U. Let $P = \{a,e\}$ and $Q = \{c,e\}$ be two subsets. Then $KS_{fscl}(P) = KS_{fscl}(Q) = \{a,c,e\}$ but $P \neq Q$.





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Remark 3.13 $KS_{f_{scl}}(P) \not\subseteq P$.

Exemplar 3.14 Let $U = \{a,b,c,d,e\}$ with $U/R = \{\{a,d\},\{c,e\},\{b\}\}$ and $X = \{b,d\} \subseteq U$.

Then $\tau_R(X) = \{\phi, U, \{b\}, \{a, b, d\}, \{a, d\}\}$. If we consider $S = \{a,d\}$ $S' = \{b,c,e\}$

$KS_R(X) = \{\phi, \{b\}, \{a,d\}, \{a,b,d\}, \{b,c,e\}, U\}$ be the Kasaj topological space on U. Let $P = \{b,c\}$. Then $KS_{f_{scl}}(P) = \{b, c, e\} \not\subseteq P$.

Theorem 3.15 If P and Q are $KS_{f_{gs}}$ -closed sets. Then $P \cup Q$ is $KS_{f_{gs}}$ -closed sets.

Proof: Let V be any KS-open set containing $P \cup Q$, then for every KS-open set V , we have $KS_{f_{scl}}(P) \subseteq V$ and $KS_{f_{scl}}(Q) \subseteq V$. Since $KS_{f_{scl}}(P \cup Q) = KS_{f_{scl}}(P) \cup KS_{f_{scl}}(Q)$. We have $KS_{f_{scl}}(P \cup Q) \subseteq V$ for every KS-open set V . Which implies $P \cup Q$ is $KS_{f_{gs}}$ -closed sets.

Theorem 3.16 If P and Q are $KS_{f_{sg}}$ -closed sets. Then $P \cup Q$ is $KS_{f_{sg}}$ -closed sets.

Proof: Let V be any KS-semi open set containing $P \cup Q$, then for every KS-semi open set V , we have $KS_{f_{scl}}(P) \subseteq V$ and $KS_{f_{scl}}(Q) \subseteq V$. Since $KS_{f_{scl}}(P \cup Q) = KS_{f_{scl}}(P) \cup KS_{f_{scl}}(Q)$. We have $KS_{f_{scl}}(P \cup Q) \subseteq V$ for every KS-semi open set V . Which implies $P \cup Q$ is $KS_{f_{sg}}$ -closed sets.

Remark 3.17 If P and Q are $KS_{f_{gs}}(KS_{f_{sg}})$ -closed subsets of Kasaj topological space U , then $P \cap Q$ is not $KS_{f_{gs}}(KS_{f_{sg}})$ closed in U as given by the subsequent exemplar.

Exemplar 3.18 Let $U = \{a,b,c,d,e\}$ with $U/R = \{\{a,e\},\{b,d\},\{c\}\}$ and $X = \{b,c\} \subseteq U$.

Then $\tau_R(X) = \{\phi, U, \{c\}, \{b, c, d\}, \{b, d\}\}$. If we consider $S = \{c,d\}$ $S' = \{a,b,e\}$

$KS_R(X) = \{\phi, \{b\}, \{c\}, \{d\}, \{b,d\}, \{b,c\}, \{c,d\}, \{a,b,e\}, \{b,c,d\}, \{a,b,c,e\}, \{a,b,d,e\}, U\}$ be the Kasaj topological space on U. Let $P = \{a,b,d,e\}$ and $Q = \{b,c,d,e\}$. Since U is only KS-open(KS-semi open) containing each of P and Q. $KS_{f_{scl}}(P) \subseteq V$ for each KS-open(KS-semi open) $V \supseteq P$ and $KS_{f_{scl}}(Q) \subseteq V$ whenever V is KS-open(KS-semi open) and $V \supseteq Q$. Therefore, P and Q are $KS_{f_{gs}}(KS_{f_{sg}})$ in U. Then $P = \{a,b,d,e\}$, $Q = \{b,c,d,e\}$ are $KS_{f_{gs}}(KS_{f_{sg}})$ -closed sets in U, but $P \cap Q = \{b,d,e\}$ which is not a $KS_{f_{gs}}(KS_{f_{sg}})$ -closed sets. Since $KS_{f_{scl}}(P \cap Q) = U$. But $\{b,d,e\}$ is a KS-open(KS-semi open) sets containing $P \cap Q$ and $KS_{f_{scl}}(P \cap Q) \not\subseteq \{b, d, e\}$.

Theorem 3.19 Let $(U, \tau_R(X), KS_R(X))$ be a Kasaj topological space and $P \subseteq U$. Then P is $KS_{f_{gs}}$ -closed set in U if and only if $KS_{f_{scl}}(P)/P$ contains no non empty KS-semi closed set.

Proof: Let P be $KS_{f_{gs}}$ -closed and F be any KS-semi closed set contained in $KS_{f_{scl}}(P)/P$. Then $F \subseteq KS_{f_{scl}}(P)/P$. Thus $P \subseteq F^c$, where F^c is KS-semi open. Since P is $KS_{f_{gs}}$ -closed. We have $KS_{f_{scl}}(P) \subseteq F^c$. Hence $F \subseteq [KS_{f_{scl}}(P)]^c$. But $F \subseteq KS_{f_{scl}}(P)$. Therefore $F \subseteq KS_{f_{scl}}(P) \cap [KS_{f_{scl}}(P)]^c$. That is, $F = \phi$.

Conversely assume that P is a set such that $KS_{f_{scl}}(P)/P$ has no non empty KS-semi closed set. Let G be a KS-semi open set containing P. Then $KS_{f_{scl}}(P) \cap G^c$ is KS-semi closed subset of $KS_{f_{scl}}(P)/P$. Therefore $KS_{f_{scl}}(P) \cap G^c = \phi$. Thus $KS_{f_{scl}} \subseteq G$ and P is $KS_{f_{gs}}$ -closed.

Theorem 3.20 Let $P \subseteq U$. Then $KS_{f_{gs}}-int(P) = \cup\{H:H \text{ is } KS_{f_{gs}}\text{-open, } H \subseteq P\}$.

Proof: Suppose $u \in KS_{f_{gs}}-int(P)$

\Leftrightarrow P is neighborhood of u.

\Leftrightarrow there exists a $KS_{f_{gs}}$ -open set H, such that $u \in H \subseteq P$

$\Leftrightarrow u \in \cup\{H:H \text{ is } KS_{f_{gs}}\text{-open, } H \subseteq P\}$

Hence $KS_{f_{gs}}-int(P) = \cup\{H:H \text{ is } KS_{f_{gs}}\text{-open, } H \subseteq P\}$.

Theorem 3.21 Let $(U, \tau_R(X), KS_R(X))$ be a Kasaj topological space and $P \subseteq U$. Then

(i) $KS_{f_{gs}}-int(P)$ is $KS_{f_{gs}}$ -open in U.

(ii) $KS_{f_{gs}}-int(P)$ is the biggest $KS_{f_{gs}}$ -open set contained in P.

(iii) P is $KS_{f_{gs}}$ -open iff $KS_{f_{gs}}-int(P) = P$.





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Proof:

(i) Let u be any arbitrary point of $KS_{f_{gs}}\text{-int}(P)$. Then u is a KS-feebly generalized semi interior point of P . Hence by definition, P is $KS_{f_{gs}}\text{-nbhd}$ of u . Then there exist $KS_{f_{gs}}\text{-open}$ set H such $u \in H \subseteq P$. Since H is $KS_{f_{gs}}\text{-open}$, it is $KS_{f_{gs}}\text{-nbhd}$ of each of its points and so P is also $KS_{f_{gs}}\text{-nbhd}$ of each point of H . It follows that every point of H is KS-feebly generalized semi interior point of P so that $H \subseteq KS_{f_{gs}}\text{-int}(P)$. Thus it is shown that to each $u \in KS_{f_{gs}}\text{-int}(P)$, there exists a KS-feebly generalized semi open set H such that $u \in H \subseteq KS_{f_{gs}}\text{-int}(P)$. Hence $KS_{f_{gs}}\text{-int}(P)$ is $KS_{f_{gs}}\text{-nbhd}$ of each of its points and consequently $KS_{f_{gs}}\text{-int}(P)$ is $KS_{f_{gs}}\text{-open}$ set in U .

(ii) Let H be any subset of P and let $u \in P$ so that $u \in H \subseteq P$. Since H is $KS_{f_{gs}}\text{-open}$, P is $KS_{f_{gs}}\text{-nbhd}$ of u and consequently u is KS-feebly generalized semi interior point of P . Hence $u \in KS_{f_{gs}}\text{-int}(P)$. Thus we have shown that $u \in H$ that implies $u \in KS_{f_{gs}}\text{-int}(P)$ and so $H \subseteq KS_{f_{gs}}\text{-int}(P) \subseteq P$. Hence $KS_{f_{gs}}\text{-int}(P)$ contains every KS-feebly generalized semi open subset of P and it is therefore the largest KS-feebly generalized semi open subset of P .

(iii) Let $P = KS_{f_{gs}}\text{-int}(P)$, by(i) $KS_{f_{gs}}\text{-int}(P)$ is a $KS_{f_{gs}}\text{-open}$ set and therefore P is also $KS_{f_{gs}}\text{-open}$. Conversely P be $KS_{f_{gs}}\text{-open}$. Then P is absolutely identical with the largest $KS_{f_{gs}}\text{-open}$ subset of P . But by(ii), $KS_{f_{gs}}\text{-int}(P)$ is the biggest KS-feebly generalized semi open subset of P . Hence $P = KS_{f_{gs}}\text{-int}(P)$.

Theorem 3.22 For any two subsets P and Q of $(U, \tau_R(X), KS_R(X))$ in Kasaj topological space

- (i) If $P \subseteq Q$, then $KS_{f_{gs}}\text{-int}(P) \subseteq KS_{f_{gs}}\text{-int}(Q)$.
- (ii) $KS_{f_{gs}}\text{-int}(P \cap Q) = KS_{f_{gs}}\text{-int}(P) \cap KS_{f_{gs}}\text{-int}(Q)$.
- (iii) $KS_{f_{gs}}\text{-int}(P) \cup KS_{f_{gs}}\text{-int}(Q) \subseteq KS_{f_{gs}}\text{-int}(P \cup Q)$.
- (iv) $KS_{f_{gs}}\text{-int}(U) = U$.
- (v) $KS_{f_{gs}}\text{-int}(\phi) = \phi$

Proof:

(i) Let P and Q be subsets of U such that $P \subseteq Q$. Let $u \in KS_{f_{gs}}\text{-int}(P)$. Then there exists KS-feebly generalized semi open set F such that $u \in F \subseteq P$ and hence $u \in KS_{f_{gs}}\text{-int}(Q)$. Hence $KS_{f_{gs}}\text{-int}(P) \subseteq KS_{f_{gs}}\text{-int}(Q)$.

(ii) We know that $P \cap Q \subseteq P$ and $P \cap Q \subseteq Q$. We have by(i) $KS_{f_{gs}}\text{-int}(P \cap Q) \subseteq KS_{f_{gs}}\text{-int}(P)$ and $KS_{f_{gs}}\text{-int}(P \cap Q) \subseteq KS_{f_{gs}}\text{-int}(Q)$. This implies that $KS_{f_{gs}}\text{-int}(P \cap Q) = KS_{f_{gs}}\text{-int}(P) \cap KS_{f_{gs}}\text{-int}(Q)$ —————(1) Again, let $u \in KS_{f_{gs}}\text{-int}(P) \cap KS_{f_{gs}}\text{-int}(Q)$. Then $u \in KS_{f_{gs}}\text{-int}(P)$ and $u \in KS_{f_{gs}}\text{-int}(Q)$. Then there exists KS-feebly generalized semi open sets F and H such that $u \in F \subseteq P$ and $u \in H \subseteq Q$. $F \cap H$ is KS-feebly generalized semi open set such that $u \in (F \cap H) \subseteq (P \cap Q)$. Hence $u \in KS_{f_{gs}}\text{-int}(P \cap Q)$. Thus $u \in KS_{f_{gs}}\text{-int}(P) \cap KS_{f_{gs}}\text{-int}(Q)$ implies that $u \in KS_{f_{gs}}\text{-int}(P \cap Q)$. Therefore $KS_{f_{gs}}\text{-int}(P) \cap KS_{f_{gs}}\text{-int}(Q) \subseteq KS_{f_{gs}}\text{-int}(P \cap Q)$ —————(2). From (1) and (2), it follows that $KS_{f_{gs}}\text{-int}(P \cap Q) = KS_{f_{gs}}\text{-int}(P) \cap KS_{f_{gs}}\text{-int}(Q)$. The proofs of (iii),(iv),(v) are obvious.

Theorem 3.23 Let $(U, \tau_R(X), KS_R(X))$ be a Kasaj topological space and let $P \subseteq U$ Then

- (i) $KS_{f_{gs}}\text{-int}(P) = (KS_{f_{gs}}\text{-cl}(P^c))^c$.
- (ii) $KS_{f_{gs}}\text{-cl}(P^c) = (KS_{f_{gs}}\text{-int}(P))^c$.
- (iii) $KS_{f_{gs}}\text{-cl}(P) = (KS_{f_{gs}}\text{-int}(P))^c$.

Proof:

(i) Obvious.

(ii) Taking complements in (i), $(KS_{f_{gs}}\text{-int}(P))^c = (KS_{f_{gs}}\text{-cl}(P^c))^c = KS_{f_{gs}}\text{-cl}(P^c)$. Taking complements again, $((KS_{f_{gs}}\text{-int}(P))^c)^c = (KS_{f_{gs}}\text{-cl}(P^c))^c$. That is, $KS_{f_{gs}}\text{-int}(P) = (KS_{f_{gs}}\text{-cl}(P^c))^c$. Since $(S^c)^c = S$ for any set S .

(iii) By(ii) $KS_{f_{gs}}\text{-cl}(P^c) = (KS_{f_{gs}}\text{-int}(P))^c$. Replacing P by P^c in this, we get $KS_{f_{gs}}\text{-cl}(P^c)^c = (KS_{f_{gs}}\text{-int}(P^c))^c$. Hence $KS_{f_{gs}}\text{-cl}(P) = (KS_{f_{gs}}\text{-int}(P^c))^c$.





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Theorem 3.24 Let $(U, \tau_R(X), KS_R(X))$ be a Kasaj topological space and $P \subseteq U$. Then P is KS_{fsg} -closed set in U if and only if $KS_{fsc}(P)/P$ contains no non empty KS -semi closed set.

Proof: Let P be KS_{fsg} -closed and F be any KS -semi closed set contained in $KS_{fsc}(P)/P$. Then $F \subseteq KS_{fsc}(P)/P$. Thus $P \subseteq F^c$, where F^c is KS -semi open. Since P is KS_{fsg} -closed. We have $KS_{fsc}(P) \subseteq F^c$. Hence $F \subseteq [KS_{fsc}(P)]^c$. But $F \subseteq KS_{fsc}(P)$. Therefore $F \subseteq KS_{fsc}(P) \cap [KS_{fsc}(P)]^c$. That is, $F = \phi$.

Conversely assume that P is a set such that $KS_{fsc}(P)/P$ has no non empty KS -semi closed set. Let G be a KS -semi open set containing P . Then $KS_{fsc}(P) \cap G^c$ is KS -semi closed subset of $KS_{fsc}(P)/P$. Therefore $KS_{fsc}(P) \cap G^c = \phi$. Thus $KS_{fsc} \subseteq G$ and P is KS_{fsg} -closed.

Theorem 3.25 Let $P \subseteq U$. Then $KS_{fsg}\text{-int}(P) = \cup\{H:H \text{ is } KS_{fsg}\text{-open}, H \subseteq P\}$.

Proof: Suppose $u \in KS_{fsg}\text{-int}(P)$

$\Leftrightarrow P$ is neighborhood of u .

\Leftrightarrow there exists a KS_{fsg} -open set H , such that $u \in H \subseteq P$

$\Leftrightarrow u \in \cup\{H:H \text{ is } KS_{fsg}\text{-open}, H \subseteq P\}$

Hence $KS_{fsg}\text{-int}(P) = \cup\{H:H \text{ is } KS_{fsg}\text{-open}, H \subseteq P\}$.

Theorem 3.26 Let $(U, \tau_R(X), KS_R(X))$ be a Kasaj topological space and $P \subseteq U$. Then

(i) $KS_{fsg}\text{-int}(P)$ is KS_{fsg} -open in U .

(ii) $KS_{fsg}\text{-int}(P)$ is the biggest KS_{fsg} -open set contained in P .

(iii) P is KS_{fsg} -open iff $KS_{fsg}\text{-int}(P) = P$.

Proof:

(i) Let u be any arbitrary point of $KS_{fsg}\text{-int}(P)$. Then u is a KS -feebly semi generalized interior point of P . Hence by definition, P is KS_{fsg} -nbhd of u . Then there exist KS_{fsg} -open set H such $u \in H \subseteq P$. Since H is KS_{fsg} -open, it is KS_{fsg} -nbhd of each of its points and so P is also KS_{fsg} -nbhd of each point of H . It follows that every point of H is KS -feebly semi generalized interior point of P so that $H \subseteq KS_{fsg}\text{-int}(P)$. Thus it is shown that to each $u \in KS_{fsg}\text{-int}(P)$, there exists a KS -feebly generalized semi open set H such that $u \in H \subseteq KS_{fsg}\text{-int}(P)$. Hence $KS_{fsg}\text{-int}(P)$ is KS_{fsg} -nbhd of each of its points and consequently $KS_{fsg}\text{-int}(P)$ is KS_{fsg} -open set in U .

(ii) Let H be any subset of P and let $u \in P$ so that $u \in H \subseteq P$. Since H is KS_{fsg} -open, P is KS_{fsg} -nbhd of u and consequently u is KS -feebly semi generalized interior point of P . Hence $u \in KS_{fsg}\text{-int}(P)$. Thus we have shown that $u \in H$ that implies $u \in KS_{fsg}\text{-int}(P)$ and so $H \subseteq KS_{fsg}\text{-int}(P) \subseteq P$. Hence $KS_{fsg}\text{-int}(P)$ contains every KS -feebly semi generalized open subset of P and it is therefore the largest KS -feebly generalized semi open subset of P .

(iii) Let $P = KS_{fsg}\text{-int}(P)$, by (i) $KS_{fsg}\text{-int}(P)$ is a KS_{fsg} -open set and therefore P is also KS_{fsg} -open. Conversely P be KS_{fsg} -open. Then P is absolutely identical with the largest KS_{fsg} -open subset of P . But by (ii), $KS_{fsg}\text{-int}(P)$ is the biggest KS -feebly semi generalized open subset of P . Hence $P = KS_{fsg}\text{-int}(P)$.

Theorem 3.27 For any two subsets P and Q of $(U, \tau_R(X), KS_R(X))$ in Kasaj topological space

(i) If $P \subseteq Q$, then $KS_{fsg}\text{-int}(P) \subseteq KS_{fsg}\text{-int}(Q)$.

(ii) $KS_{fsg}\text{-int}(P \cap Q) = KS_{fsg}\text{-int}(P) \cap KS_{fsg}\text{-int}(Q)$.

(iii) $KS_{fsg}\text{-int}(P) \cup KS_{fsg}\text{-int}(Q) \subseteq KS_{fsg}\text{-int}(P \cup Q)$.

(iv) $KS_{fsg}\text{-int}(U) = U$.

(v) $KS_{fsg}\text{-int}(\phi) = \phi$

Proof:

(i) Let P and Q be subsets of U such that $P \subseteq Q$. Let $u \in KS_{fsg}\text{-int}(P)$. Then there exists KS -feebly semi generalized open set F such that $u \in F \subseteq P$ and hence $u \in KS_{fsg}\text{-int}(Q)$. Hence $KS_{fsg}\text{-int}(P) \subseteq KS_{fsg}\text{-int}(Q)$.





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(ii) We know that $P \cap Q \subseteq P$ and $P \cap Q \subseteq Q$. We have by (i) $KS_{fsg}\text{-int}(P \cap Q) \subseteq KS_{fsg}\text{-int}(P)$ and $KS_{fsg}\text{-int}(P \cap Q) \subseteq KS_{fsg}\text{-int}(Q)$. This implies that $KS_{fsg}\text{-int}(P \cap Q) = KS_{fsg}\text{-int}(P) \cap KS_{fsg}\text{-int}(Q)$ —(1) Again, let $u \in KS_{fsg}\text{-int}(P) \cap KS_{fsg}\text{-int}(Q)$. Then $u \in KS_{fsg}\text{-int}(P)$ and $u \in KS_{fsg}\text{-int}(Q)$. Then there exists KS-feebly semi generalized open sets F and H such that $u \in F \subseteq P$ and $u \in F \subseteq Q$. $F \cap H$ is KS-feebly semi generalized open set such that $u \in (F \cap H) \subseteq (P \cap Q)$. Hence $u \in KS_{fsg}\text{-int}(P \cap Q)$. Thus $u \in KS_{fsg}\text{-int}(P) \cap KS_{fsg}\text{-int}(Q)$ implies that $u \in KS_{fsg}\text{-int}(P \cap Q)$. Therefore $KS_{fsg}\text{-int}(P) \cap KS_{fsg}\text{-int}(Q) \subseteq KS_{fsg}\text{-int}(P \cap Q)$ —(2). From (1) and (2), it follows that $KS_{fsg}\text{-int}(P \cap Q) = KS_{fsg}\text{-int}(P) \cap KS_{fsg}\text{-int}(Q)$. The proofs of (iii),(iv),(v) are obvious.

Theorem 3.28 Let $(U, \tau_R(X), KS_R(X))$ be a Kasaj topological space and let $P \subseteq U$ Then

$$(i) KS_{fsg}\text{-int}(P) = (KS_{fsg}\text{-cl}(P^c))^c.$$

$$(ii) KS_{fsg}\text{-cl}(P^c) = (KS_{fsg}\text{-int}(P))^c.$$

$$(iii) KS_{fsg}\text{-cl}(P) = (KS_{fsg}\text{-int}(P))^c.$$

Proof:

(i) Obvious.

(ii) Taking complements in (i), $(KS_{fsg}\text{-int}(P))^c = (KS_{fsg}\text{-cl}(P^c))^c = KS_{fsg}\text{-cl}(P^c)$. Taking complements again, $((KS_{fsg}\text{-int}(P))^c)^c = (KS_{fsg}\text{-cl}(P^c))^c$. That is, $KS_{fsg}\text{-int}(P) = (KS_{fsg}\text{-cl}(P^c))^c$. Since $(S^c)^c = S$ for any set S .

(iii) By (ii) $KS_{fsg}\text{-cl}(P^c) = (KS_{fsg}\text{-int}(P))^c$. Replacing P by P^c in this, we get $KS_{fsg}\text{-cl}(P^c)^c = (KS_{fsg}\text{-int}(P^c))^c$. Hence $KS_{fsg}\text{-cl}(P) = (KS_{fsg}\text{-int}(P^c))^c$.

CONCLUSION

The concept of Kasaj feebly generalized semi closed sets and Kasaj feebly semi generalized closed sets has its own importance in the study of Kasaj topological space. We have derived some characterizations in terms of Kasaj feebly generalized semi closure, Kasaj feebly semi generalized closure, Kasaj feebly generalized semi interior, Kasaj feebly semi generalized interior and compared the Kasaj feebly semi closure of a set with the Kasaj sets and proved some results. We have also discussed and studied its properties. This work in future, can be extended to get more results.

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Graphene Oxide as an Adsorption Matrix for the Immobilization of Carboxyl Esterase from *Aeromonas caviae* MTCC 7725

Sujatha.R^{1*}, Deepika Jothinathan² and Gautam Pennathur³

¹Assistant Professor, Department of Biotechnology, SRM Arts and Science College, Kattankulathur, Chennai and Anna University, Centre for Biotechnology, Guindy, Tamil Nadu, India.

²Assistant Professor, Department of Biotechnology SRM Arts and Science College, Kattankulathur, Chennai, Tamil Nadu, India.

³Professor, Centre for Biotechnology, Anna University, Chennai-25, Tamil Nadu, India

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*Address for Correspondence

Sujatha.R

Associate Professor,
Department of Biotechnology,
SRM Arts and Science College,
Kattankulathur, Chennai and Anna University,
Centre for Biotechnology, Guindy, Tamil Nadu, India.
E. Mail: sujatha.raghu@gmail.com



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ABSTRACT

An in-house isolated esterase enzyme was immobilized on graphene oxide. The morphology of the adsorbed enzyme was analysed using SEM, AFM and Zeta potential analysis showed a positive shift in the surface charge of the GO on immobilization. The activity of the enzyme-GO conjugate was studied at different pH, temperature and its stability in organic solvents. The enzyme-Go conjugate showed enhanced stability under varying temperatures for four hours. The kinetic parameters were also determined for the enzyme-GO conjugates as well as for the free enzyme. The stability of the enzyme-GO conjugates increased several folds in hydrophobic solvents. The enzyme-GO conjugates had over 90% of their activity at the end of forty days. Esterification reaction showed that the adsorbed enzymes had a higher percentage of conversion when compared to the free enzymes. Our results showed that graphene oxide is an ideal matrix for enzyme immobilization and is a promising candidate for large-scale bio-transformations.

Keywords: Adsorption, Graphene Oxide, Esterase, Gas chromatography, Zeta potential

INTRODUCTION

Enzymes enhance the kinetics of complex biochemical reactions. Naturally occurring enzymes perform moderately because of their inability to withstand harsh operational conditions [1]. Enzymes immobilization is done on various

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support materials to overcome the limitations of their native equivalents. The prosthetic groups, functional groups, molecular mass and enzyme purity affect enzyme interaction with the support material [2]. The chemical composition, functional groups, pore size and stability of the matrix also influence the binding affinity [3]. The suitable method of immobilization is chosen by assessing the above- stated factors. The enzyme and the supporting material may form one or many bonds such as covalent, ionic, hydrophobic and hydrogen bonds. Enzymes can also be immobilized by the formation of Cross linked Enzyme Aggregates (CLEAs) using a cross linker such as glutaraldehyde. Enzymes can also be immobilized by entrapment or by forming microcapsules and liposomes [3,4]. There are various applications for immobilized enzymes. For example, lipase from *Candida rugosa* was immobilized on magnetic composites functionalized with ionic liquids. It was used for interesterification reactions to produce trans-free plastic fats [5]. In another study, lipase immobilized on functionalized magnetic nanoparticles was used for transesterification of soybean oil for the production of biodiesel [6].

The simplest technique for immobilization is adsorption; the enzyme binds to the support material non-covalently. The support materials range from organic materials such as graphene oxide, chitin, chitosan, cellulose and alginate and inorganic materials such as silica, titanium, and hydroxyapatite [7]. Graphene oxide (GO) shows immense potential as an adsorption matrix. The atomically flat surface with multiple functional groups like epoxy, carbonyl, and hydroxyl groups provide several reaction sites for linking small molecules, proteins and peptides. The thermostability of cold-adapted esterase from *Pseudomonas mandelii* was enhanced by immobilization on graphene oxide [8]. Alkaline protease immobilized on GO enhanced the hydrolysis of waste activated sludge [9]. An in-house partially purified esterase enzyme isolated from *Aeromonas caviae* (MTCC 7725) was immobilized using graphene oxide. The morphology of the enzyme-GO conjugate was studied using SEM, AFM and zeta potential analysis. The biochemical properties were studied by subjecting the conjugates at different pH, temperatures, and various organic solvents. The synthesis of ethyl salicylate was performed using the enzyme-GO conjugate as a biocatalyst.

MATERIALS AND METHODS

Materials used

4-nitrophenyl valerate were purchased from Sigma Aldrich, India. *Aeromonas caviae* (MTCC 7725) was procured from MTCC, CSIR- IMTECH, Chandigarh, India. All other reagents used were of analytical grade and purchased from SRL, India and HI Media Labs, India. Graphene oxide was a kind gift from the Chemical Engineering department, Anna University, Chennai.

Immobilization of Esterase

An extracellular esterase from *Aeromonas caviae* (MTCC7725) was isolated by the methods described by Elizabeth and Nicolet [10]. A 1mg/ml solution of GO was prepared in 10 mM Tris HCl pH-7.2. 60U of carboxylesterase (AC Est) was added to the GO/ Tris HCl solution. The GO-enzyme mixture was incubated at 25°C overnight in an orbital shaker at 120 rpm. The mixture was centrifuged and the supernatant was used to determine the loading efficiency and immobilization yield [11]. All the experiments were performed in triplicates.

Biophysical Characterization of the Enzyme-GO Conjugates

Zeta potential analysis was done using a Malvern Zetasizer nano ZS system (Malvern Co.UK). Fourier Transform infrared (FT-IR) spectra of the enzyme- GO conjugate was recorded using a Jasco FT/IR-4000 over a range of 4000cm⁻¹- 400cm⁻¹ [12]. The morphology of the bio conjugate was studied using Scanning Electron Microscopy (SEM) on a Hitachi S-3400 N at 15kV. The samples were mounted on metal grids using carbon tape and were sputter coated with gold. Atomic Force Microscopy (AFM) was performed in non-contact mode for the immobilized enzymes using a Park XE100. The images were obtained at a 1.2Hz scan rate. The area was scanned (25 μm²) with a pixel resolution of 256 X 256. The samples were scanned by silicon etched tips with a typical resonance frequency of 310Hz and amplitude of 20.8nm. The images were analysed with XEI software for roughness and Z-scale characterization.



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Esterase Assay

The assay was performed by the method explained previously by Degrassi *et al.*, [13]. A 50 mM stock solution of the substrate (4-Nitrophenol Valerate for AC Est) was prepared in acetonitrile. A reaction mixture was prepared; containing 50mM Tris-HCl, pH 7.2, and 100 μ l of enzyme solution and 4 μ l of the substrate. The mixture was incubated at 37°C for 10 min. The activity was determined by measuring the liberated nitro phenol against an enzyme-free blank at 410 nm using Bio-Rad Model 680 ELISA reader. The amount of protein in the enzyme was calculated using the Lowry method [14]. Bovine serum albumin was used as the protein standard to plot the calibration curve.

Effect of pH on Activity

The effect of pH was observed by carrying out the assay at various pH conditions (5-10). The different buffers used in the reaction mixture were sodium acetate buffer (pH 3.0-5.0), sodium phosphate buffer (pH 6.0-7.5), tris-HCl buffer (pH 7.0-9.0), and glycine-NaOH buffer (pH 9.0-10.0). All experiments were performed in triplicates and the results are given as mean \pm standard error.

Effect of Temperature on Activity

The thermal stability was studied by incubating the samples at different temperatures (20-50°C). Samples were drawn at an interval of 1 hour for 4 hours and the residual activity of the immobilized enzyme was compared to that of the free enzyme. All experiments were performed in triplicates and the results are given as mean \pm standard error.

Effects of Organic Solvents

The stability of the immobilized enzymes was studied by incubating it with 25% (v/v) of various organic solvents at 30°C for 4 hours in an orbital shaker. Aliquots were drawn from the samples every hour to carry out esterase assay. The relative activity was determined in different organic solvents of the immobilized enzymes. The enzyme incubated with buffer was taken as control. All experiments were performed in triplicates and the results are given as mean \pm standard error.

Kinetic Studies

The kinetic parameters were determined by varying the substrate concentrations (from 0.4 - 4 mM). 4-NPV was used for GO/AC Est. The K_M and V_{MAX} were determined by the Lineweaver-Burk method.

Esterification

The esterification reaction of the free and immobilized enzymes at a concentration of 60 Units was performed using salicylic acid (1M) in ethanol (1M w/v) to synthesize ethyl salicylate [15]. Isooctane (2, 2,4 trimethyl pentane) was the solvent medium. 60U of and A.C. Est respectively were taken as control samples. The esterification was carried out in screw-capped vials that were incubated at 30°C and 120rpm. A simple titration was performed to monitor the progress of the reaction. The sample was titrated with 1N NaOH for the left-over salicylic acid present in the reaction mixture. Phenolphthalein was used as an indicator.

RESULTS AND DISCUSSION

Loading Efficiency and Immobilization Yield

The loading efficiency and the immobilization yield were calculated according to the method of Pena- Montes *et al.* [11]. The loading efficiency of GO/A.C. Est was found to be 69%. The immobilization yield of the GO/A.C. Est bio-conjugates was 70%, respectively. The high surface-to-volume ratio of GO could have resulted in the increase in immobilization yield and loading efficiency [16]. A structural change in the immobilized enzyme could have increased the accessibility of the substrate to the active site, leading to a higher immobilization yield. The GO surface being hydrophilic offers multiple sites (carbonyl, epoxy and hydroxyl groups) for enzyme interaction [7]. Knezevic *et*



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al. immobilized *C. rugosa* lipase on unmodified Eupcaergit-C. They achieved a loading efficiency of 53% and an immobilization yield of 21% [17].

Zeta Potential Analysis

Zeta potential analysis is a technique used in the characterization of stability of colloidal dispersions. It measures the effective surface charge associated with the material and shows the strength of the interaction between the matrix and the enzyme immobilized [12]. The zeta potential measurements were performed at neutral pH. The zeta potential of GO was measured to be -28.2 as shown in Table 1. The zeta potential of GO/A.C. Est was found to be -22.5. This positive shift showed a significant change in the surface charge of GO, because of immobilization. A shift of +21mV was observed for *R. oryzae* lipase immobilized on GO [18]. The Zeta potential analysis of GO and GO/A.C Est were analysed to test the surface change of the matrix and the immobilized enzymes.

SEM Analysis

The SEM images of GO showed multiple aggregated GO platelets. The platelets had a wrinkled and folded surface morphology because of oxidation. The GO flakes showed a large surface area and an edge width of 135 nm. Sobon *et al.*; observed a similar morphology for oxidized graphite [18]. The SEM images of enzyme immobilized GO platelets, as shown in Figure 1, revealed a smooth surface devoid of wrinkles showing enzyme immobilization [19]. SEM images of GO (A) shows aggregated platelets with wrinkled morphology. GO/A.C Est shows a smooth morphology owing to enzyme adsorption.

AFM Analysis

The immobilized enzymes and GO were analysed to determine the thickness of the GO sheets. The uniformity of the sample was confirmed by scanning different locations. The morphology of the GO platelets was not distinct, since no surfactants were added to prevent agglomeration. Figure 2 shows the AFM analysis of GO (A), GO/A.C. EST (B) GO showed a peak-to-valley distance of 120 nm. The immobilized enzyme on GO showed a smooth, mound-like appearance and a significant increase in the peak-to-valley distance was observed in GO/A.C. Est (500nm). The increased distance showed the loading of the enzymes on the GO surface. The roughness value of GO was 59.7µm and the GO/Ac Est showed a roughness value of 18.7µm. This showed that on immobilization, the surface of GO had become smooth. Asmat *et al.*, (2017) observed a similar change in surface roughness between Ag/GO and ANL immobilized PANI/Ag/GO. Orrego and Valencia (2009) performed similar analyses on plain and lipase immobilized chitosan thin films. Their group observed an overall change in the surface of chitosan films immobilized with lipase and a difference in the Z scale [20]. AFM analysis of the plain GO shows a rough morphology (A). GO/A.C Est (B) shows mound like appearance showing enzyme adsorption. In adsorbed enzymes the z scale value has increased compared to the plain GO matrix.

Effect of pH and Temperature on Activity and Stability

The effect of pH on the activity of GO immobilized enzymes was found at a range of pH 5-10 in figure 3. The GO /AC Est had an optimum activity at pH 7 similar to the free enzyme [21, 22]. A shift in the optimum pH was observed for β-galactosidase after immobilization on a mixed-matrix membrane [23]. The immobilized enzymes showed a high range of relative activity between pH 6-8. This could be because of the microenvironment provided by the GO matrix [24]. The residual activity of the GO- enzyme conjugates was calculated from pH 5-10. Enzymes are optimally active at a distinct temperature range. Immobilization of enzymes by adsorption enhances its activity and stability over a broad range of temperature. The temperature activity profiles of GO/A.C. Est showed that the conjugate had > 80% of activity at 20-50°C [1,3]. The effect of temperature on the stability of the GO/A.C. Est conjugate was studied for four hours. GO/A.C. Est retained > 80- 90% activity at both 20°C and 30°C at the end of 4 hours, as shown in Figure 5. At 40°C, GO/A.C. Est showed 46% activity at the end of the 4th hour. The residual activity at the end of 2 hours at 50°C for GO/A.C. Est was 50% and 25% as shown in figure 4. At the end of four hours GO/A.C. Est showed 15% residual activity. Thermal stability analyses showed that immobilization improved catalytic activity over a 4 hour incubation period. Similar results were observed by Hermanova *et al.*, (2015)



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observed increased thermal stability for a *C.rugosa* lipase immobilized on graphene oxide [25]. Zhang *et al.*, (2014) observed that *P.camemberti* lipase immobilized on graphene oxide showed better stability for a period of 2 hours [24].

Determination of Kinetic Parameters

The Michaelis–Menten constant, K_m and V_{max} were calculated using Lineweaver–Burk plot. V_{max} is defined as the highest rate of reaction possible when the enzyme is saturated with substrate. K_m is the substrate concentration at which the reaction velocity, (v) is half the maximum reaction rate possible. The lower K_m value of a catalyst shows its increased affinity towards a substrate. As shown in Table 3, the K_m values of the GO-enzyme complex decreased significantly compared to that of the free enzyme. The K_m value for the A.C. Est (free enzyme) was 0.11mM. The GO/A.C. Est showed K_m values of 0.08. PLE (free enzyme) showed a K_m value of 0.4mM on immobilization, this decreased to 0.158 mM. This showed that the adsorbed enzyme had increased the affinity of the enzyme towards its substrates. This shows that the immobilized enzymes are suitable for industrial applications. Lee *et al.*, reported a similar drop in K_m values when a cold-adapted esterase was immobilized on GO [8]. The Lineweaver-burk plot was used for calculating the K_m and V_{max} values of the free and immobilized enzymes. The A.C. EST (free enzyme) had V_{max} values of 10.41 Units/mg. The immobilized conjugates showed a V_{max} of 10.22 units/mg (GO/A.C. Est). These differences in maximum reaction rates could be because of steric effects, diffusional limitations, and lower accessibility to the active site [26].

Stability of the Immobilized Enzymes in Various Organic Solvents

Enzymes tend to denature in the presence of organic solvents [1]. Lipases and esterases catalyse synthesis reactions in organic media efficiently as long as there are enough water molecules which maintain their active site confirmation. The activity of the enzymes increased in solvents with log P values (>1) when compared with hydrophilic solvents. PLE was found to be stable in most of the organic solvents (methanol: 109 %, ethanol: 109 %, propanol: 102. % n-Octane: 103%, n-decane: 99 %, n-undecane 102 %). Lopez *et al.* 2010 tested the efficacy of Porcine Liver Esterase in near anhydrous conditions and found that at hydrations of 3 (± 2) catalysis could occur in organic solvents [28]. The immobilized GO/A.C esterase showed a relative activity of 112%, 111% and 106% relative activity in n-octane, Isooctane, and n-decane, respectively as shown in Table 4. Dave *et al.*(2006) used *C.rugosa* lipase immobilized on the polyvinyl alcohol-boric acid complex for esterification reaction and reported that solvents with higher log P values gave a high yield of esterification when compared to solvents with lower log P values. A similar pattern was observed in alkaline protease isolated from *Aeromonas caviae* AU0425. The robust activity of the immobilized enzyme in the isooctane medium was the reason to perform an esterification reaction in the latter [29].

Operational stability

Immobilized enzymes are stored for a longer duration and can be used multiple times. The storage stability experiment showed that GO/A.C. esterase conjugates retained 97% activity respectively, even after 40 days. These results showed that the enzyme–GO complex is highly stable and can be used for industrial purposes. Kishore *et al.*, (2012) had found that β -galactosidase immobilized on functionalized graphene oxide showed high stability (94%) when stored at 4 °C for 4 months [30]. The activity of the immobilized enzyme reduced after each cycle. The activity of the first cycle was taken as 100% [31]. After the fourth cycle, it was found that GO/A.C. EST the residual activity was 24% as shown in figure 5. The loss of activity is because of the detachment of the enzyme from GO thus disrupting the non-covalent interactions. Repeated washing steps after each cycle could have contributed to the loss of enzyme activity. The immobilized enzymes were used for four reaction cycles. Esterase assay was performed at every step to determine the residual activity.

Esterification

The stability studies carried out in various organic solvents allowed us to choose the right medium for esterification [32]. The activity enhanced (>100%) for both the enzyme conjugates in 2, 2, 4 trimethyl pentane (isooctane). Therefore, the esterification of ethanol and salicylic acid was done in an isooctane medium. The percentage of conversion by the free and immobilized enzyme was calculated. Table 5 shows the extent of esterification by the free



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and immobilized catalysts. It was observed that the immobilized conjugates at the end of 12 hours showed a higher rate of conversion. GO/A.C. Est showed 70% conversion; greater than the free enzymes (22%-GO/A.C. Est). Lau *et al.*; showed enhanced esterification of lauric acid and oleyl alcohol with lipase immobilized chitosan beads (Lau. Choong Hey and Kun-Lin (2016) reported that lipase immobilized on biphasic alginate beads was used for the esterification of butanol and butyric acid and reported an esterification yield of 6.32%.

CONCLUSION

Enzyme immobilization by adsorption on pristine graphene oxide is a simple and efficient method of immobilization. The high surface-to-volume ratio, multiple sites for enzyme attachment, had resulted in high loading efficiency and immobilization yield. Raman and Zeta potential analysis confirmed that the adsorption was successful. The GO/A.C. Est showed improved stability over a wide range of pH and temperature conditions. The enzyme conjugate displayed improved thermal stability even after four hours of incubation. The conjugates showed high solvent stability in n-undecane, n-decane, and isooctane. This property was exploited for the synthesis of ethyl salicylate from ethanol and salicylic acid in isooctane. The rate of esterification using the GO-enzyme conjugate doubled when compared to that of the free enzyme. This study highlights the importance of adsorption as a straightforward, rapid and economical immobilization technique for applications at an industrial level.

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Table 1: Zeta potential Analyses

Material used	Zeta Potential (mV)
GO	-28.2
GO/ AC Est	-22.5

Table 3: Kinetic Parameters for free and immobilized conjugates

Catalyst used	K _m (mM)	V _{max} (µM/ml/min)
Free enzyme- A.C. Est	0.36	10.41
GO/A.C. Est	0.12	10.22

Table 4: Stability of Immobilized enzymes in various organic solvents Note-Conjugates incubated in buffer was taken as Control with 100% activity

Organic Solvents (25% V/V)	log p value	Residual activity of GO/A.C Est
Ethanol	-0.58	50
Methanol	-0.85	54.6
Propanol	0.28	26.0
Isooctane	4.373	111.1
Octane	4.783	112
n-Decane	5.802	105.80
Undecane	6.312	92.30

Table 5: Percentage conversion of free enzymes and adsorbed enzymes into esters

Conjugate used	Percentage of conversion
Free enzyme PLE	40%
Immobilized GO/PLE	75%
Free enzyme A.C. Est	22%
Immobilized A.C. Est	70%

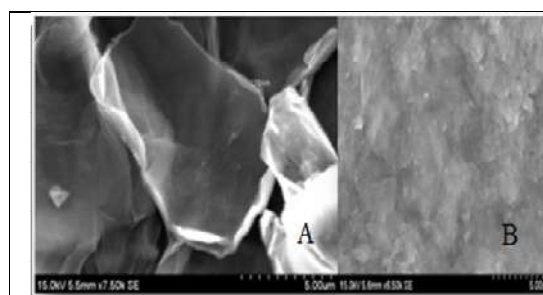


Figure 1: SEM Analysis A-Graphene oxide B- GO/A.C. Est C-GO/PLE

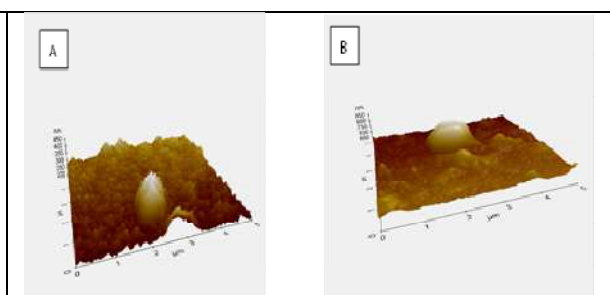
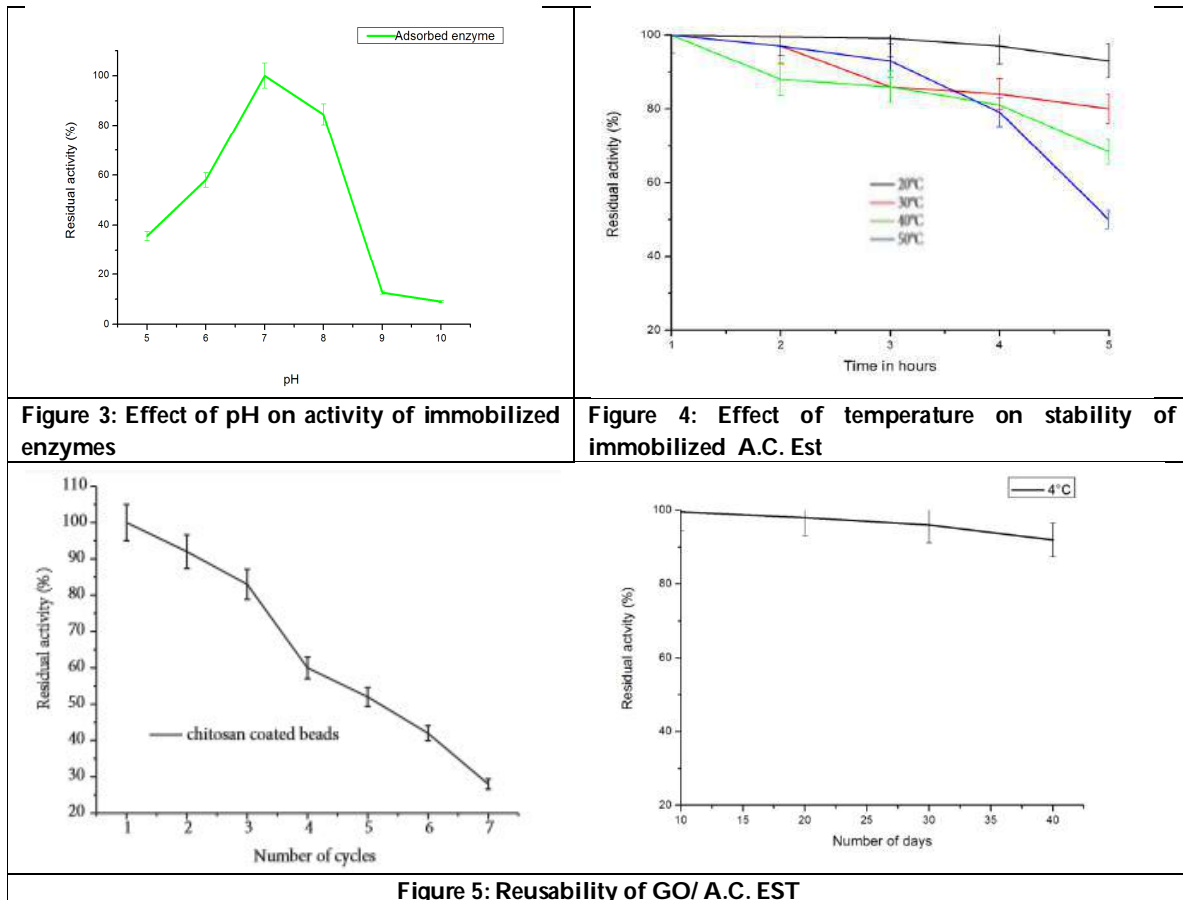


Figure 2: AFM analysis A. Graphene oxide, B. GO/A.C. Est





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In vitro* and *In silico* Studies of Antifungal Activity Evaluation of Methanolic Extract of Leaves and Latex of *Euphorbia antiquorum

Annadurai Gowtham¹, R.Kalaivani², Chilamakuru Naresh Babu³, Onamala Varalaksmi¹, H Rajamohamed⁴ and Akkiraju Sudheer^{5*}

¹Department of Pharmacology, Raghavendra Institute of Pharmaceutical Education and Research (RIPER)-Autonomous, Anantapur, Andhra Pradesh, India-515721.

²Associate Professor, Department of Pharmacy Practice, Thanthai Roever College of Pharmacy Rover Campus, Perambalur-621212, Tamil Nadu, India.

³Assistant Professor, Department of Pharmaceutical Chemistry, Raghavendra Institute of Pharmaceutical Education and Research (RIPER)-Autonomous, Anantapur, Andhra Pradesh, India-515721.

⁴Assistant Professor, Department of Pharmacy Practice, Thanthai Roever College of Pharmacy Rover Campus, Perambalur-621212, Tamil Nadu, India.

⁵Associate Professor, Department of Pharmacology, Raghavendra Institute of Pharmaceutical Education and Research (RIPER)-Autonomous, Anantapur, Andhra Pradesh, India-515721.

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***Address for Correspondence**

Akkiraju Sudheer

Associate Professor,

Department of Pharmacology,

Raghavendra Institute of Pharmaceutical Education and Research (RIPER)-Autonomous,

Anantapur, Andhra Pradesh, India-515721.

E. Mail : sudeerlegend@gmail.com



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ABSTRACT

The current research was aimed at phytochemical evaluation, and comparing the antifungal spectrum of the methanolic extract of leaves and latex of *Euphorbia antiquorum* and *In silico* studies of chemical constituents of *Euphorbia antiquorum*. Methanolic extract of leaves and latex of *Euphorbia antiquorum* tested against pathogenic strains of fungi like *Candida albicans* and *Aspergillus flavus* by disc diffusion method. Further the chemical constituents of EA were docked against *Candida albicans* sterol 14-alpha demethylase (CYP51) (Chain A; PDB code: 5TZ1) and Crystal structure of *Aspergillus flavus* FAD glucose dehydrogenase (Chain A; PDB code: 4YNT) and *In silico* ADMET studies by Swiss ADME and ADMET Lab 2.0. The best antifungal activity against *Candida albicans* and *Aspergillus flavus* was found in a methanolic extract of EA leaves at 20, 40, and 60mg/ml with the following area of inhibition in diameters of 11, 13.5, 13.5mm and 11.25, 11.75, 12.50mm respectively. The methanolic extract of the latex presented an area of inhibition in diameter of 10.6, 11.3 and 12.1mm against *Candida albicans* and 11, 11.75, and 11.75mm against *Aspergillus flavus* at same concentrations. The methanolic extract of leaves has better





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antifungal activity when compared to the methanolic extract of latex of EA and standard drug (fluconazole). The docking study reveals that the compound cameliol C exhibited a better docking score (-11.728) against *Candida albicans* sterol 14- α demethylase when compared with fluconazole (-4.940). In case of docking with *Aspergillus flavus* FAD glucose dehydrogenase the compound cameliol C exhibited a better docking score (-6.676) compared with fluconazole (-5.971). *In silico* ADMET studies of chemical constituents of EA showed synthetic acceptability, lead likeness, and toxicity profile and the compound cameliol C has only skin sensitization and hepatotoxicity. Methanolic extract of leaves and latex of *Euphorbia antiquorum* exhibited significant antifungal activity.

Keywords: *Euphorbia antiquorum*, Leaf, Latex, Antifungal activity, Molecular docking, ADMET studies.

INTRODUCTION

Infections caused by various microorganisms are treated with medicinal plants. According to the World Health Organization, 80% of people around the world employ different plant fractions and their active ingredients as traditional remedies [1-5]. The chemical components of plants or phytochemical components, which are naturally found in several plants are effective therapeutically [6,7]. Plants include a variety of secondary metabolites flavonoids, alkaloids, tannins, saponins, phenols, and glycosides with different biological activities like antioxidant, anti-inflammatory, anti-cancer, and antibacterial effects, etc. [9] In a growing number of people with impaired immune systems, fungal infections have become widespread and are recognized as significant public health issues [8]. *Candida* species are the primary opportunistic fungal infections globally, causing considerable morbidity and death in the population. Fungal infections are also often associated with the species of *Aspergillus*, and *Cryptococcus* [9,10]. Throughout the entirety of its life cycle, this polymorphic fungus grows on mammalian hosts and alternates between various single-celled yeast and multicellular mycelial forms [11]. *Candida albicans* is a common commensal of the human microbiome that takes the form of yeast that inhabits the skin, mouth, gastrointestinal system, and female reproductive tract of healthy people [12,13]. However, *Candida albicans* lifestyle shifts from commensal to pathogenic in weak hosts, notably in immunocompromised or severely sick individuals or those who acquired microbial dysbiosis. A transition in cell type between benign yeast and invasive, such as hyphal morphology, causes diseases ranging from superficial ones that are relatively simple to treat like athlete's foot, and oral thrush, and fatal systemic infections like disseminated (deep-seated) candidiasis and particularly candidemia [8,14]. Everywhere on the planet, *Aspergillus flavus*, an opportunistic pathogen that has been identified from insects, birds, animals, plants, and extensively dispersed soil-borne molds, may be found. Due to the abundance of airborne conidia produced, it has a high reproductive rate [15,16]. Due to the worrying increase of microbe resistance against commonly used synthetic antimicrobial drugs, medicinal plants have been explored extensively over the past several decades for the goal of preventing and treating a variety of infectious disorders [17-19].

Folk medicine uses the *Euphorbia antiquorum* L. (Euphorbiaceae) plant for a variety of medicinal purposes, including the treatment or management of a wide range of illness like inflammation, arthritis, wounds, stomachaches, antioxidant activity, cutaneous infections, diabetes, and purgative. In the village shrubberies of Ceylon and India's tropical and warm temperate regions, it is common. [20] It appears to be a large bush or sapling. The plant's caustic juice has medicinal uses for things like rheumatism, dropsy, gout, neuropathy, deafness, coughing, etc. Warts and other skin illnesses are commonly treated using the juice that oozes from the branches. Triterpenoids and flavonoids have been found in early phytochemical analyses of EA. Isolated plant chemicals from this species include euphol, antiquol A, euphorbol, isohelianol, and cameliol. [21] Ingenol 3-angelate, one of the active ingredients in EA, is also used as a traditional medicine to cure a variety of ailments, such as catarrh, asthma, skin cancer, warts, corns, and waxy growths [22]. Natural plant latex *Euphorbia antiquorum* contains Antiquol C, abeo-8 α , 9 β , 10 α -eupha-5,24-dien-3 β -ol (antiquol B), and 24-methyltirucalla-8,24(24(1)). The tumor promoter 12-O-tetradecanoylphorbol-



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13-acetate(TPA)activated the Epstein-Barr virus early antigen (EBV-EA), while -dien-3beta-ol (euphorbol), lemmaphylla-7,21 -dien-3beta-ol, isohelianol, and camelliol C demonstrated substantial inhibitory effects on EBV-EA activation.[23] The current research was aimed at phytochemical evaluation and comparing the antifungal spectrum of the methanolic extract of leaves and latex of *Euphorbia antiquorum* against pathogenic strains of fungi like *Candida albicans* and *Aspergillus flavus* by the disc diffusion method.

When a powerful medicine reaches the target spot in sufficient quantity and for a duration that allows for normal biological function in the body, it is effective. The compound structures predicted for various parameters, docking scores, and interactions during drug discovery and development pilot the selection of which compounds to consider and evaluate for activity studies to identify an active molecule with low toxicity [24]. The failure rate in the discovery of clinical phases is significantly decreased by this early evaluation of molecular docking [25] and ADMET investigations of the drugs. Glide Schrodinger software was used for molecular docking studies to determine the best fit compound in the active site of *Candida albicans* sterol 14-alpha demethylase (CYP51) crystal structure in combination with a potential antifungal drug candidate based on tetrazole (Chain A; PDB code: 5TZ1)[27] and of *Aspergillus flavus* FAD glucose dehydrogenase (Chain A; PDB code: 4YNT).[28] The identified phytochemical constituents of *Euphorbia antiquorum* ADME and toxicological properties were calculated by using the Swiss ADME web application and ADMETLab2.0 prediction. These *insilico* models have been proposed as a viable alternative to experimental methods.

MATERIALS AND METHODS

Plant Collection, Authentication, and Preparation

Fresh leaves and latex of *Euphorbia antiquorum* were collected from keerikalmedu, Trichy, and authenticated by assistant professor, Dr.P.Jaishankar, Department of Horticulture, Thanthai Roever Institute of Agriculture and Rural Development, Perambalur. These plants' freshly harvested leaves were then properly cleaned with distilled water to get rid of any dirt and dust. The leaves were minced. Following a two-week drying period at room temperature in the shade dry, the material was ground into a powder using a mixer [29]. Finally, the powder and latex were subjected to extraction.

Methanolic Extraction of Leaves

The powdered fresh leaves of *Euphorbia antiquorum*, were exposed to methanol solvent for extraction of phytochemical constituents by cold maceration in a narrow-mouthed bottle for 7 days at room temperature. The resultant mixture was filtered and evaporated in the autoclave, where the temperature was kept between 55 to 65°C. The resulting dried crude extract was utilized to examine phytochemical constituents and the antifungal properties further.

Methanolic Extraction of Latex

The fresh latex *Euphorbia antiquorum* was collected and it is centrifuged at 4000rpm per minute. 1ml of latex is added with 9ml of methanol and it is subjected to centrifuging at 4000rpm per minute for about 10 minutes at room temperature. Then the supernatant liquid obtained after centrifugation is collected, stored in a glass vessel, and used for further studies.

Phytochemical Evaluation

The phytochemical assessment of the plant is carried out by analyzing several class chemicals using accepted techniques. The chemicals utilized were all of the analytical grades. [30-34]





Test for Carbohydrate

Molisch test: To the 2ml of the test solution, a few drops of alcohol-alpha naphthol solution were added before adding the 1ml of conc. sulfuric acid along the test tube's side. The development of violet coloured ring at the junction indicates the presence of carbohydrates.

Fehling's test: When Fehling solutions A and B are combined in equal parts and heated with a little amount of sample solution, the presence of reducing sugar was indicated by a brick-red precipitate formation.

Xanthidrol test: Treated 2ml of the test solution with 3ml of Xanthidrol solution, the red color formation indicates the presence of deoxy sugar.

Raymond's test: To 2ml of the test solution add 2-3 drops of ethanol, 0.1ml of dinitrobenzene, and 2-3 drops of 20% sodium hydroxide. The appearance of a violet color indicates the presence of the methylene group.

Test for Glycoside

Keller killiani test: To the 2 ml of the test solution add 3 ml of glacial acetic acid, and 1 drop of 5% ferric chloride solution. By the test tube's side, carefully pour in 0.5ml conc. sulfuric acid. Cardiac glycosides can be detected by the blue colour formation in the acetic acid layer.

Legal's test: Take 2 ml of the solution, add 1 ml of pyridine, sodium nitroprusside solution, and sodium hydroxide solution (to make it alkaline). Glycosides are visible as a pink to deep red color.

Bomtrager's test: To the sample, add 5-10 ml of dilute HCl, boil for 10 min on a water bath, and filter. Extract the filtrate with CCl₄ or benzene with an equal amount of ammonia solution and shake well. The appearance of pink to red color in the ammonical layer indicates the presence of anthraquinone moiety.

Test for Saponins

Foam test: Distilled water was used to dilute the extract, which was then agitated for 15 minutes in a graduated cylinder. The development of a layer of foam is a sign that saponins are present.

Test for flavonoids:

Shinoda test: (Test for reduction of magnesium chloride) When strong hydrochloric acid and a few pieces of magnesium ribbon are added to the test solution drop by drop, a rosy crimson color indicates the presence of flavonoids after a short period.

Libermann-Burchard test: Conc. sulfuric acid was added to the side of the test tube after boiling and chilling the extracted material with a few drops of acetic anhydride. A brown ring forms at the junction of the two layers, the top layer becomes green indicating the presence of sterols, and deep red pigments indicate the presence of triterpenoids.

Salkowski's test: Treat 2ml of the extract in chloroform with a few drops of conc. sulfuric acid occasionally shaking the mixture. When a red color appears in the lower layer, triterpenoids are present.

Test for Tannins

Ferric chloride test: To the 2ml of extract add 2ml of 5% ferric chloride solution, and the development of bluish green color indicates the presence of tannins.

Lead acetate test: Take 2ml of extract, and add a few drops of 10% lead acetate solution. The formation of a precipitate indicates the presence of tannins.

Collection of Fungi Isolates

Fungal cultures such as *Candida albicans*, and *Aspergillus flavus* were obtained from the Eumic analytical Lab and Research Institute, Tiruchirappalli. Fungal strains were maintained on Nutrient agar slants (Hi media) at 4°C.

Culture Plate Preparation

Culture plates were prepared by mixing 3.9g of potato dextrose agar media (PDA - Himedia) in 100 ml of water, autoclaved, and pouring 20 ml into each plate. Clinical strains *Aspergillus flavus* and *Candida albicans* were cultured in nutrient broth for 18hrs by applying over the PDA plates using a sterile cotton swab. Then wells were made in solidified plates by using a cork borer of 0.6 mm diameter.



**Annadurai Gowtham et al.,****In vitro Antifungal Activity**

Using human pathogenic fungal isolates of *Candida albicans* and *Aspergillus flavus*, the methanolic extract of *Euphorbia antiquorum* leaves and latex was tested for antifungal activities at concentrations 20, 40, and 60mg/ml. The extract's potential sensitivity to the two tested bacteria was discovered, and assessed by measuring the area of fungal growth inhibition around the well in millimeters. The zone of inhibition, the effectiveness was compared with the standard fluconazole.

In silico Studies**Virtual screening (molecular docking): [35-37]**

Molecular docking studies were performed to know the binding interaction and docking score by Schrödinger software (Version 2020_1)

Ligand preparation

The chemical constituents of the EA 2D structure were acquired in SDF format from the PubChem database. These all ligands are imported into the maestro workspace and subjected to Ligprep to convert 2D structure into 3D, to generate possible states, necessary ionization (Neutralize), and chirality with minimized energy by force field OPLS4.

Macromolecule (Protein) Preparation

To reduce the energy of the protein for docking investigations, the protein preparation wizard in maestro was used. By using the code 5TZ1, the protein structure was imported (it uses PDB online database to import the protein). After that, the protein underwent preprocessing by having bond ordering assigned, the hydrogen added, disulfide bonds made, etc. Chain A was chosen on the review and alter tab, and chain B was deleted since they are unique. Water molecules that had not interacted with either the ligand or the protein were likewise eliminated, but the co-crystal ligand VT1 (Oteseconazole), and protoporphyrin ix containing Fe (HEM) was left in its original form. Additionally, the chosen protein chain was optimized in the refine tab before being minimized. The preferred and forbidden values of ψ and ϕ are shown by the Ramachandran plot (2D) in **Fig.1**. The ψ and ϕ which stand for the residues (amino acids) in a peptide are used to depict the torsional angles on the Ramachandran plot. Similar to this, the protein 4YNT was also imported, optimized, and minimized; it only has chain A with 571 amino acid residues. The proteins 4YNT not have any co-crystal, hence performed sitemap analysis to identify the top one active site among the five identified sites.

Receptor Grid Generation

In the 5TZ1 protein, the grid box was generated by choosing any one atom from the co-crystal ligand VT1 molecule on the workspace. As a result, a grid box with the X, Y, and Z coordinates 70.73, 66.24, and 4.39 was created for docking. In the case of the 4YNT protein, the grid box was created in sitemap 1 with the X, Y, and Z coordinates 27.54, 38.45, and 49.94 respectively.

Ligand Docking

In ligand docking, the glide grid and ligprep outmaegz zip files were imported from the working directory. The write XP descriptor information option was then chosen in the settings to dock the ligands in the active site of the protein. The virtual screening results were indexed from least binding energy to highest, and the binding interactions are shown in Table No.1 and 2.

ADMET Studies

In order to filter out structures that lacked drug-like characteristics and choose viable drug candidates, molecular descriptors were derived based on the virtual screening of massive collections of molecules with SwissADME and ADMETLab2.0. In SwissADME, the parameters like molecular weight (MW), logP, molar refractivity (MR), topological polar surface area (TPSA), hydrogen bond donor (HBD), hydrogen bond acceptor (HBA), rotatable bond (RB), GI absorption, blood-brain barrier (BBB) permeant, log Kp cm/s, logs, cytochrome p450 enzyme inhibition, lead



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likeness, and synthetic accessibility were calculated by giving the molecule SMILES notation. In ADMETLab2.0 additionally to the SwissADME parameters, toxicity parameters were predicted like skin sensitization, carcinogenicity, genotoxicity, HERG channel inhibition, respiratory toxicity, hepatotoxicity, and drug-induced liver toxicity. These predicted values from Swiss ADME and ADMETLab2.0 were compared with the standard drug values to know the drug-like character of the chemical constituents of EA.

RESULTS AND DISCUSSION

Phytochemical Screening

The findings of screening for preliminary phytochemicals for different chemical components of leaves and latex methanolic extract of *Euphorbia antiquorum* are shown in Table No.1

Antifungal Activity

The area of inhibition in triplicate of different concentrations of methanolic extract of leaves, latex, and standard drug (fluconazole) against *Candida albicans* and *Aspergillus flavus* are shown in Table No.2 and Fig.2 The methanolic extract of leaves of *Euphorbia antiquorum* showed the diameter of the area of inhibition 11, 13.5, and 13.5 mm at the concentration of 20, 40, and 60mg/ml against *Candida albicans*. Similarly showed the diameter of the area of inhibition was 11.25, 11.75, and 12.5mm at the concentration of 20, 40, and 60mg/ml against *Aspergillus flavus*. The methanolic extract of latex of *Euphorbia antiquorum* showed the diameter of the area of inhibition 10.6, 11.3, and 12.1mm at the concentration of 20, 40, and 60mg/ml against *Candida albicans*. Similarly showed the diameter of the area of inhibition was 10.6, 11.3, and 12.1mm at the concentration of 20, 40, and 60mg/ml against *Aspergillus flavus*. The standard drug fluconazole showed the area of inhibition 8, 9, and 11mm at the concentration of 20, 40, and 60mg/ml against *Candida albicans*. Similarly showed the diameter of the area of inhibition was 8, 10, and 12mm at the concentration of 20, 40, and 60mg/ml against *Aspergillus flavus*. The methanolic extract of leaves and latex of *Euphorbia antiquorum* have a better area of inhibition against both *Candida albicans* and *Aspergillus flavus* when compared to the standard fluconazole. Among the leaves and latex extracts, the leaves extract showed excellent antifungal activity than latex extract against both *Candida albicans* and *Aspergillus flavus*. The comparative antifungal data was shown in the Fig.3

Molecular Docking Studies

To identify the best fit chemical constituents with the highest docking scores and interactions, the downloaded structures from PubChem database were subjected to *insilico* molecular docking studies by Schrödinger Glide (version 2020_1). To determine the antifungal efficacy, all of the proposed compounds were docked to the *Candida Albicans* sterol 14-alpha demethylase (CYP51) crystal structure in combination with a potential antifungal drug candidate based on tetrazole (Chain A; PDB code: 5TZ1) and crystal structure of *Aspergillus flavus* FAD glucose dehydrogenase (Chain A; PDB 4YNT) along with standard drugs like Fluconazole, ketoconazole itraconazole. The docking score, glide energy, and binding interactions were shown in Table No.3 and 4. The more negative values of the glide docking score represent tighter binders.

From the docking results against sterol 14-alpha demethylase(Chain A; PDB code: 5TZ1), the active ligands camelliolC (-11.728), isohelanol (-9.651), tirucalla-7,24-dien-3beta-ol (-9.410), antiquoIC (-8.779), camelliol A (-6.998) and lemmaphylla-7,21-dienol- (-4.866) showed better docking score and interactions when compared with co-crystal oteseconazole (-10.024) and standard drugs Itraconazole (-10.214), ketoconazole (-6.262), and fluconazole (-4.940). The two-dimensional (2D) interactions of the active ligands and standards are represented in Fig.4

In the same way from the docking results on with crystal structure of *Aspergillus flavus* FAD glucose dehydrogenase (Chain A; PDB 4YNT), the active compounds camelliol C (-6.676), ingenol-3-angelate (-4.973), camelliol A (-3.754), euphorbol (-3.294) showed better docking score and interactions when compared with standard drugs such as fluconazole (-5.971), ketoconazole (-4.690), itraconazole (-3.624). The two-dimensional (2D) interactions of the active ligands and standards are represented in Fig.5





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ADMET Studies

The chemical constituents ADMET parameters were predicted by SwissADME online database and ADMETLab2.0 and are represented in Table No.5 and 6. From the ADME results it is clear that all the chemical constituents of EA not comply with Lipinski's rule of 5 (Most of the compounds have $\log P > 5$) except the compound Ingenol-3-angelate. Due to $\log P > 5$ these compounds have less GI absorption and bioavailability. All the compounds are poorly water soluble with logs values between -7.64 to -10.04, except the compound ingenol-3-angelate having logs -3.49. Skin permeability $\log K_p$ is low to all the compounds (-1.85 to 2.86) when compared with standard drugs fluconazole (-7.92) and ketoconazole (-6.46) except Ingenol-3-angelate (-7.52). The chemical constituent doesn't have any inhibitory action on cytochrome P450 – 1A2, 2C19, 2C9, 2D6 and 3A4 enzymes except the compound cameliol C and Ingenol-3-angelate, they inhibit the enzyme 1A2 and 3A4 respectively. The toxic studies of all the compounds from ADMETLab2.0 the compounds have mild moderate and high toxicity.

CONCLUSION

According to an *in vitro* investigation, the methanolic extract of *Euphorbia antiquorum* leaves and latex has antifungal activity. When compared to methanolic extracts of latex and conventional medication (Fluconazole), the methanolic extract of leaves from *Euphorbia antiquorum* exhibits greater antifungal action based on an area of inhibition. The *in silico* studies also showed that the chemical constituents of EA cameliol C exhibited a better docking score (-11.728) against *Candida albicans* sterol 14- α demethylase (CYP51) crystal structure in combination with a potential antifungal drug candidate based on tetrazole (Chain A; PDB code: 5TZ1) than fluconazole (-4.940). Similarly, the cameliol C exhibited a better docking score (-6.676) against the Crystal structure of *Aspergillus flavus* FAD glucose dehydrogenase (Chain A; PDB 4YNT) when compared with fluconazole (-5.971) standard drug. The rest of the compounds also have better docking scores when compared to standard drugs. This study helps further in the synthesis and *in vivo* animal studies for the development of potent antifungal natural agent with good ADME and less toxicity.

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Table 1: Phytochemical screening of the extracts of leaves and latex of *Euphorbia antiquorum*

S.No	Phytochemical constituent	Presence/Absence	
		Leaf	Latex
1	Carbohydrates	+	+
2	Reducing sugar	+	+
3	Phenolic compounds	+	+
4	Saponins	-	-
5	Flavonoids	+	+
6	Terpenoids	+	+
7	Tannins	+	+
8	Steroids	-	-
9	Oil	-	-

Note: + Present – Absent

Table 2: Antifungal activity results from the methanolic extract of leaves and latex of *Euphorbia antiquorum*

S.No	Concentration (mg/ml)	Antifungal activity (area of inhibition in mm)					
		<i>Aspergillus flavus</i>			<i>Candida albicans</i>		
		Extract	Latex	Fluconazole	Extract	Latex	Fluconazole
1	20	11.25	11	8	11	10.6	8
2	40	11.75	11.75	10	13.5	11.3	9
3	60	12.50	11.75	12	13.5	12.1	11





Table 3: Chemical constituent's docking scores and interactions with 5TZ1_Aprotein

Chemical constituents	Docking score	Glide energy	H-bond interactions	Hydrophobic interactions
Camelliol C	-11.728	-45.665	----	TYR118,HIE277,HEM 601
Itraconazole	-10.214	-81.550	----	TYR118,HIE277,HEM 601
Oteseconazole	-10.024	-61.090		
Isohelianol-	-9.651	-13.023	----	----
Tirucalla-7,24-dien-3beta-ol	-9.410	-18.087	----	----
AntiquolC	-8.779	-27.050	----	----
Camelliol	-6.998	-27.247	----	----
Ketoconazole	-6.262	-57.727	LYS90	----
Fluconazole	-4.940	-39.821	----	TYR118,HIE277,HEM 601
Lemmaphylla-7,21-dienol	-4.866	-24.746	----	TYR118,HIE277,HEM 601

Table 4: Chemical constituent's docking scores and interactions with 4YNT_Aprotein

Chemical constituents	Docking score	Glide energy	H-bond interactions
Camelliol C	-6.676	-31.746	ALA 277
Fluconazole	-5.971	-37.802	THR89,THR15,ALA27
Ingenol-3-angelate	-4.973	-30.369	TYR199, TYR53,ALA50
Ketoconazole	-4.690	-64.943	ASN93,ALA235,SER16
Camelliol A	-3.754	-32.266	----
Itraconazole	-3.624	-66.689	TYR199
Euphorbol	-3.294	-27.420	----
Tirucalla-7,24-dien-3beta-ol	-2.857	-24.945	TYR199,GLY94
Lemmaphylla-7,21-dienol	-2.722	-27.996	----
AntiquolC	-2.569	-27.129	TYR199,GLY94
Euphol	-0.601	-34.329	PRO404

Table 5:ADME properties of compounds by Swiss ADME

Compound Name	MW	Log P	MR	TPSA	HBA	HBD	RB	GI absorption and BBB Permeant	Log Kp cm	Log S	CYP Inhibition					Synthetic accessibility
											1A2	2C19	2C9	2D6	3A4	
Isoheliano I	428.73	5.4	139.42	20.23	1	1	7	Low/No	-2.04	-8.14	No	No	No	No	No	5.79
Euphol	426.72	5.09	137.04	20.23	1	1	4	Low/No	-2.58	-7.83	No	No	No	No	No	6.07
Antiquol A	574.88	6.12	178.06	46.53	3	1	8	Low/No	-1.85	-10.0	No	No	No	No	No	6.73
Euphorbol	440.74	5.24	141.85	20.23	1	1	5	Low/No	-2.29	-8.19	No	No	No	No	No	6.19





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Camelliol A	426.72	5.49	138.94	20.23	1	1	6	Low/No	-2.86	-7.45	No	No	No	No	5.97
Ingenol-3-angelate	430.53	2.34	116.9	104.06	6	3	4	High/No	-7.52	-3.49	No	No	No	Yes	6.49
Tirucalla-7,24-dien-3beta-ol	426.72	5.04	137.04	20.23	1	1	4	Low/No	-2.36	-8.02	No	No	No	No	6.15
Lemmaphylla-7,21-dienol	426.72	5.1	136.78	20.23	1	1	3	Low/No	-2.26	-8.18	No	No	No	No	6.04
Antiquol c	424.70	5.09	136.57	20.23	1	1	4	Low/No	-2.77	-7.64	No	No	No	No	6.36
Camelliol c	426.72	5.46	142.74	20.23	1	1	12	Low/No	-1.99	-7.82	Yes	No	No	No	5.64
Fluconazole	306.27	0.41	70.71	81.65	7	1	5	High/No	-7.92	-1.63	No	Yes	No	No	2.45
ketoconazole	531.43	3.96	144.44	69.06	5	0	8	High/Yes	-6.46	-5.51	No	Yes	Yes	Yes	4.45

Table 6: Toxicity properties of compounds by ADMETLab2.0

Compound Name	Skin sensitization	Carcinogenicity	Genotoxicity	HERG channel inhibition	Respiratory toxicity	Hepato toxicity	Drug induced liver toxicity
Isohelianol	---	---	---	---	--	--	---
Euphol	--	---	---	---	++	-	---
Antiquol A	+++	---	---	++	++	-	---
Euphorbol	---	---	---	---	+	---	---
Camelliol A	--	---	---	---	---	--	---
Ingenol-3-angelate	+	---	---	---	+++	+	--
Tirucalla-7,24-dien-3beta-ol	---	---	---	---	+++	-	---
Lemmaphylla-7,21-dienol	---	---	---	---	+++	-	---
Antiquol c	+++	---	---	++	+++	---	---
Camelliol c	+++	---	---	---	---	+++	---
Fluconazole	+++	+++	++	---	++	+++	+++
Ketoconazole	+++	-	+++	++	---	++	+++

Note: + indicates Plausible; - indicated Equivocal; +/- = mild; ++/-- = moderate; +++/-- = high





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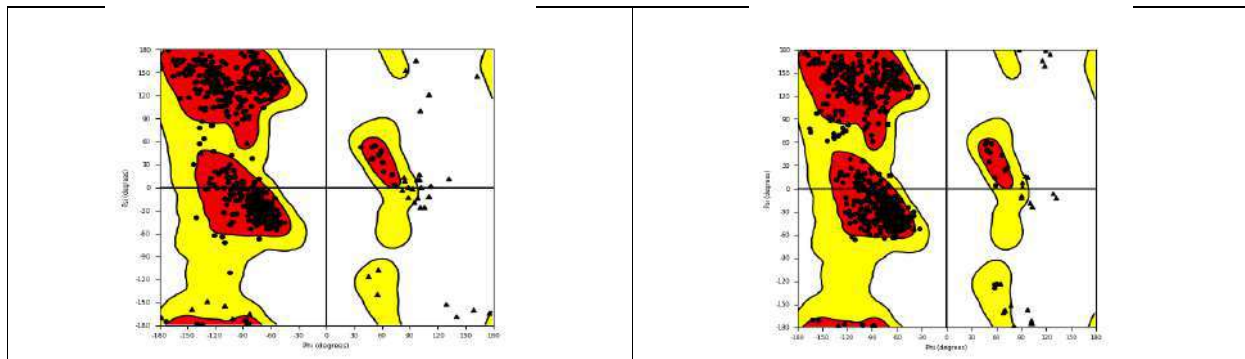


Fig.1 Ramachandran plot of protein 5TZ1 and 4YNT (Red-Favoured region; Yellow -Allowed region; White-Disallowed region)

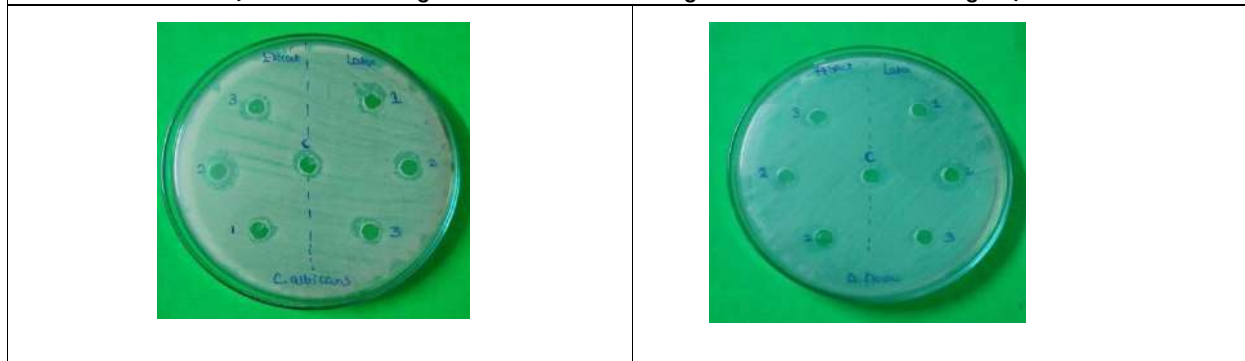


Fig.2 Antifungal activity of the extract and latex of *Euphorbia antiquorum* against *Candida albicans* and *Aspergillus flavus*

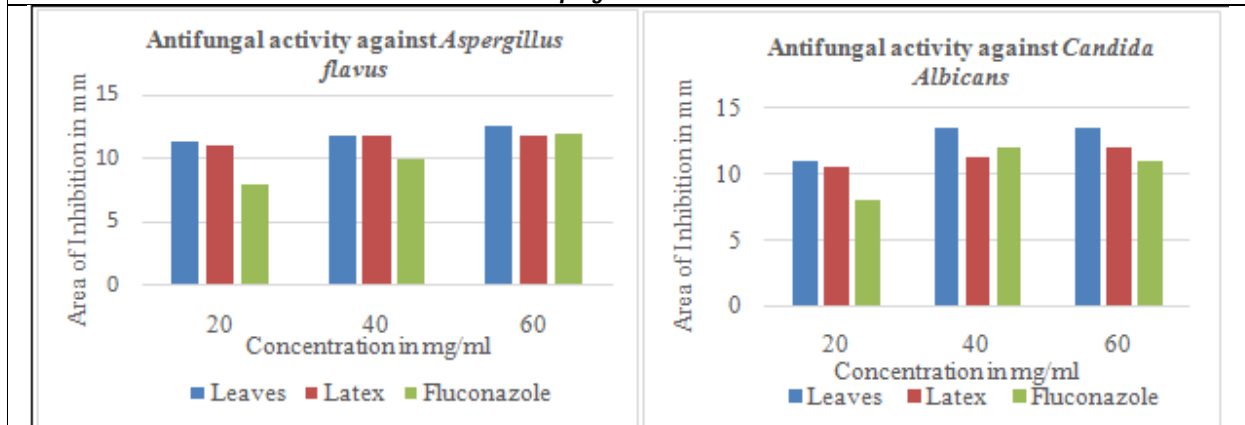


Fig.3. Comparative data of antifungal activity of extract of leaves, latex, and fluconazole against *Aspergillus flavus*, and *Candida albicans*.



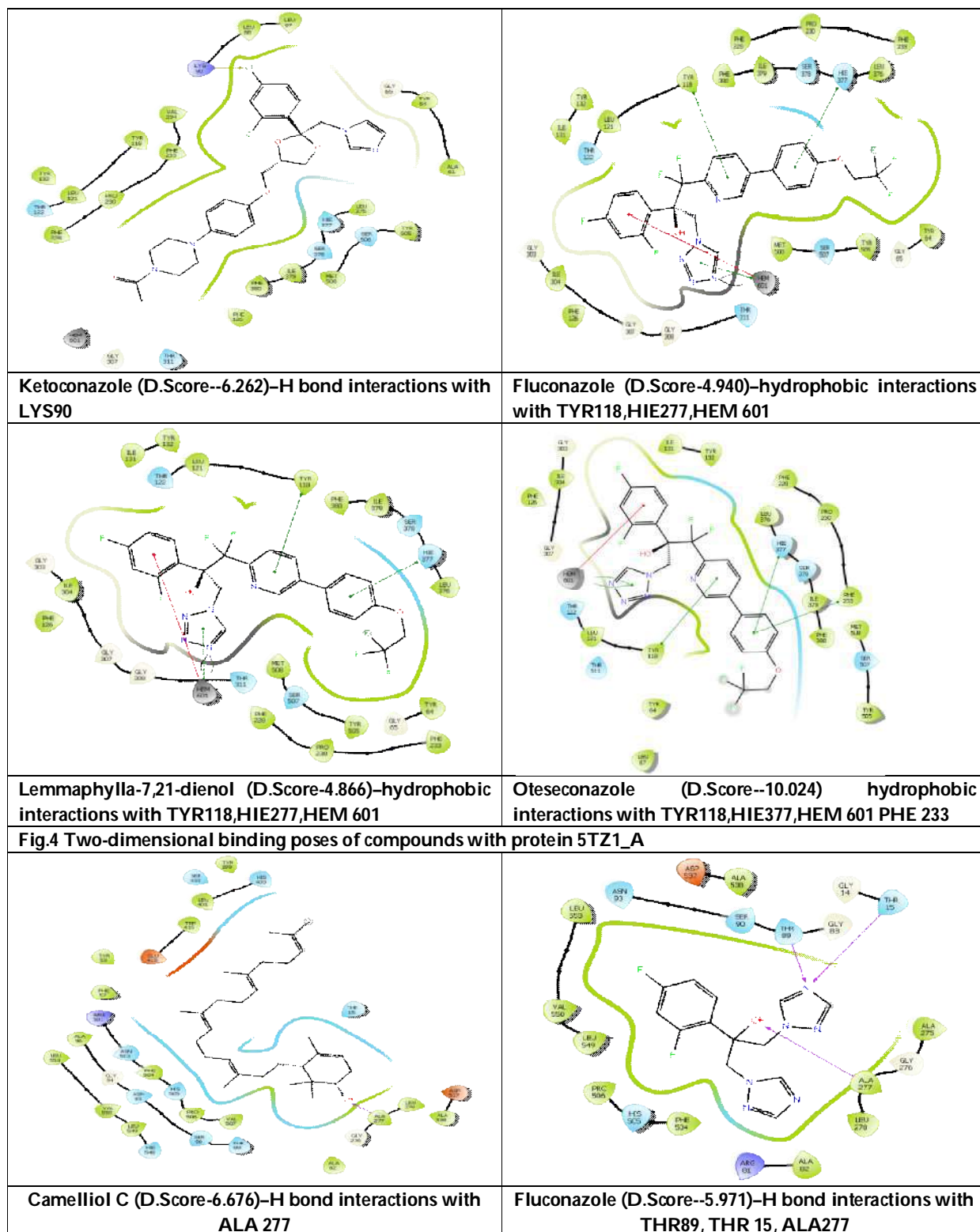


<p>CamelliolC (D.Score-11.728)–hydrophobic interactions with TYR118,HIE277,HEM 601</p>	<p>Itraconazole(D.Score-10.214)–hydrophobic interactions with TYR118,HIE277,HEM 601</p>
<p>Isohelianol (D.Score-9.651) with protein 5TZ1</p>	<p>Tirucalla-7,24-dien-3beta-ol (D.Score-9.410) with protein 5TZ1</p>
<p>AntiquolC (D.Score-8.779) with protein 5TZ1</p>	<p>Camelliol A (D.Score-6.998) with protein 5TZ1</p>





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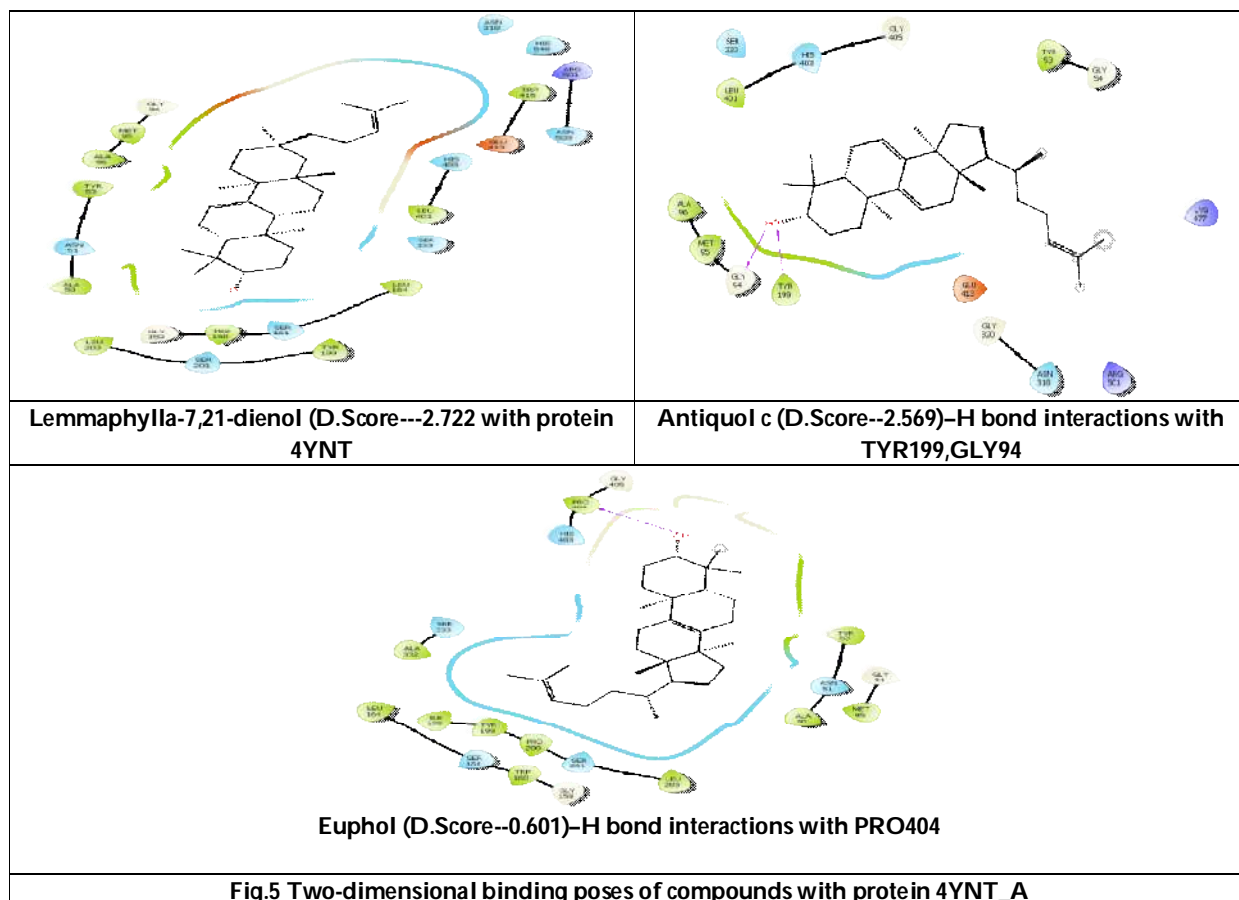


<p>Ingenol-3-angelate (D.Score--4.973)–H bond interactions with TYR199, TYR53, ALA50</p>	<p>Ketoconazole (D.Score--4.690)–H bond interactions with ASN93, ALA235, SER16</p>
<p>Camelliol A (D.Score--3.754) with protein 4YNT</p>	<p>Itraconazole (D.Score--3.624)–H bond interactions with TYR199</p>
<p>Euphorbol (D.Score--3.294) with protein 4YNT</p>	<p>Tirucalla-7, 24-dien-3beta-ol (D.Score--2.857)–H bond interactions with TYR199, GLY94</p>





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Decoding the Search of Identity through Sartorial Strategies in Sylvia Plath's Poetry

Tanuja Yadav*

Associate Professor, Department of Languages, Literatures and Cultural Studies, Manipal University Jaipur, Jaipur, Rajasthan, India.

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*Address for Correspondence

Tanuja Yadav

Associate Professor,
Department of Languages,
Literatures and Cultural Studies,
Manipal University Jaipur,
Jaipur, Rajasthan, India



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ABSTRACT

The search for identity has played an important role in the life of human being and the literature has helped the writers to expose the feeling of alienation of oneself amongst the others. The writings have unveiled the different concept and ideas taken forth by the writers to express their search for identity. No doubt the very nature of such a struggle is a complicated business under any circumstances. A human identity defies finding and keeping. One's identity is a mixture of external and internal factors, an inchoate element always in the process to becoming to define a being as fixedly as possible in a world of flux. But in spite of the essentially inchoate nature of it as a developing element, it must also be granted that a central cohering thread runs through the whole process of development. Figuratively speaking the search for identity may be described as an attempt to find this connecting thread and by holding on to it, arrive at the end of the quest. Did Plath ever find this thread, this life-line, and by its guidance did she ever arrive at the end of the search? An attempt will be made in this paper to find an answer to that question through a study of the special key imagery of clothes that she has in her poems.

Keywords: Identity, Clothes, Existence, Experience, Self

INTRODUCTION

One of the main, recurring themes in Sylvia Plath's works is her search for identity. The search further extends into an existential level with her anxiety to find her meaningful identity as an individual human being. There was cause for confusion in her mind at the personal level regarding her identity because of her traumatic experience of finding herself fatherless at the early age of nine. Later in her life her temporary loss of sanity aggravated this loss and sense

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of emptiness and confusion. Her crossing the waters and settling down in a new country after her marriage to an Englishman further complicated this awareness of rootlessness and confusion. Although the marriage itself and the choice of English for a home appeared to be good omens for a wholesome personal and artistic existence for Plath, all the promise of such hope was soon shattered by the final breaking up of the marriage and a re-surfacing in her mind of a fatally ingrained sense of alienation and loneliness in her adopted country. At an existential level, her struggle was to face the problems confronting an ambitious woman in a society dominated by men, and to meet the challenges of a poet and artist who is caught up in a world of materialism and social success and fame. She had to strive hard to find and keep her individual identity in the face of these odds. The persona of the writer, which is always extraordinarily striking, is constantly placed before us in a number of stylized postures and attitudes. The differences in such self-dramatizations are emphatically presented through the visual effects of clothes. The series of images involve this persona in a kind of stage show where the ego is displayed in a revolving change of modes, personalities and roles. References to dressed, hairstyles, accessories, jewelry, mirrors, etc., cumulatively used to present this dynamic quest of the poet-persona to discover her identity.

The subject of dress is often seriously regarded by sociologists as a visible source of knowledge for determining the social and artistic temper of a particular society. Man's and woman's dress is an expression of the creative impulses, sometimes of the wearer himself and the other times of the designer's. Quite often it can be as self-expressive as a painting or architecture. Not merely sociologists, but even psychologists may find the subject of dress and undress an indispensable, supportive source of information to gauge the inner urges of their patients. Conceptions of beauty, sex, personality, are represented in a visible dimension in the matter of dress, and one's inner nature and identity are thus made manifest to the outside world through one's dress. Next to one's body one's dress is of importance in the business of living and being so close to oneself, next to one's own skin, it engages one's innermost feeling without fail. Lacking a more insightful way of judging a person's inner nature the next best measurement to understand this deeper self in its external expression is through clothes. The outer self reflects or manifests the inner self. It cannot be denied that clothing and costuming of women, specially, has been a matter of social significance throughout the ages in all cultures. Susan Gubar points out the crucial symbolic role costuming played in the lives of some of the female modernists, in the 19th century. Mary walker, a doctor, was one of the first woman to discuss the social, political and medical questions of the woman's clothing in her two books, *Hit* and *Unmasked*. She herself discarded the claustrophobic clothing imposed by Victorian society and wore the divided skirt, "bloomers", as a liberated woman. One can safely say that the rhetoric of clothes has turned out to be of even greater importance to the modern woman, after her liberation, in order to define herself.

At present time, a good part of our judgement of Sylvia Plath must be based on a study of her first novel, *The Bell Jar*, some slender volume of her poems, and a volume of letters published by her mother in 1976 under the title, *Sylvie Plath: Letters Home*. The Letters serve as a magic mirror, drawing out the innermost, inexpressible moods and feelings of writer herself. But placed besides her own novel and poems The Letters ones again conceal as much as they reveal of what must be her full identity. It is to her works that one must return in order to understand the struggle and the triumph or failure of this writer to find and define herself. In her novel, *The Bell Jar* the very first suggestion of her heroine's feeling of undermined identity is indirectly referred to in terms of clothing. Esther says: "I knew something was wrong with me that summer, because all I could think about was the Rosenberg and how stupid I'd been to buy all those uncomfortable, expensive clothes, hanging limp as fish in my closet" (TBJ 1). Further develops the picture of feeling of confusion by references to her outward appearance. She was to the envy of all collage girls because she was ".....tripping about in those same size seven patent leather shoes I'd bought in Bloomingdale's one lunch hour with a black patent leather belt and black patent leather pocket-book to match" (TBJ 2). The height of this heady phase of glamour is reached when ".....skimpy, imitation silver-lamé bodice stuck on to a big, fat cloud of white tulle, "she drinks martinis on starlit roofs in the company of all-American youths. (TBJ 2). But the crash comes as dramatically as that of the Rosenbergs and soon she was losing control of herself. But even after the crack-up she hangs on to remnants of the make-up kit that the Mademoiselle office had given them that summer, "..... fitted out for a person with brown eyes and brown hair.....completed with mascara, eye shadow, lipsticks, and.....a gilt box with a mirror on one side" (TBJ 3). That indicates Esther's instinctive attempt to cling to



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her normal identity, her worldly self, through her possession of these objects of dress and make-up from a former gay life. The bourgeois nature of Esther Greenwood is also suggested by her rather resentful comparison of herself with her well-dressed companions. She admires Doreen and envies her for her peach pink silk and lace dressing gown. She herself has to make do with starched "...cotton summer nighties and terry cloth robe that doubled as peach robe..." (TBJ 4). As in the case of Doreen, even in regard to her boss, Jay Cee, Esther's feelings are expressed through her reactions to her clothes, her appearance. She finds her to be in "...strict office suit and luncheon –duty hat" (TBJ 5). She likes her a great deal from the first. Jay Cee becomes the model for a successful career woman that Esther secretly wants herself to be. Esther's admiration for Doreen also continuous with her increasing admiration for Doreen's daring way of dress and behavior. Indeed, Doreen gradually appears to become a bolder side of Esther herself. To a party that they both attend Doreen wear white and she herself wear a black shantung sheath, under which she could wear no bra. She identifies with Doreen to such an extent that she declares: "Everything she said was like a secret voice speaking straight out of my own bones" (TBJ 6). Throughout the novel, Esther tries to keep on top form and tries to learn about whatever might help her to be herself, to be successful as a woman. She sets the goal high for herself and in many situations she is frustrated about her own feelings, especially in situations which involve her with young man like Buddy and Irwin.

These swings between ambition and depression are vividly expressed in terms of clothing and unclothing. In one instance, she returns to the hotel from a party where she feels frustrated and standing alone on the balcony in the middle of the night lets fly all her clothes, one by one, over the spires of Manhattan. That was her last day in New York and her short term on the editorial staff of Mademoiselle had ended. The next morning she had to return to her suburban existence. In her gesture of throwing away a particular set of clothes, Esther seems to be symbolizing the destruction of one typical identity, that of the glamour girl she had attempted to be. This is also reflective of self – destructiveness. At the same time, it is this self-destructiveness that releases her and reveals her naked self. It makes way for a remodeling of herself. Throughout the novel, there is, of course, the confusion in the writer-heroine persona's identity. In the novel itself she is changing into Elly or Betsy or Esther variously and writing in the first person narrator's voice Plath deliberately maintains this theme of the double or the multiple personality. Rapid changes in life's situations require that there be equally rapid changes in one's adaptability. But on the other hand, this capacity for rapid change carried to the extreme may itself be the cause of disintegration. Multiple roles may lead to neuroses, rather than be a cure for it. Associated with the occasions for dressing and make-up, there are innumerable references to mirrors in Plath's novel and poems. The face in the mirror always looks like somebody else's for Esther, like a sick Indian once and another time like an old Chinese woman. On the verge of cutting her wrists to commit suicide Esther says: " I moved in front of the medicine cabinet. If I looked in the mirror while I did it, it would be like watching somebody else, in a book or a play. But the person in the mirror was paralyzed and too stupid to do a thing" (TBJ 121). The mirror is known to be a much used, richly complex symbol in the poetry of all cultures. It is, first of all, a fascinating object that not only reflects reality but also transforms it quite often. As a symbol, the mirror has magical properties of revealing not merely the surrounding world, but it might also transport into its surface reality the unseen and unknown background.

In folk and fairy tale it is not uncommon for a witch or a step-mother to use a mirror as a medium for seeking such unseen events of the past or the future. Most obviously as its main function the mirror reflects oneself. The reflector might also be something other than a mercury-coated glass. In Romantic poetry especially the image of the poet gazing on his own reflection in a pool or lake is a constantly used image evocative of symbolic meaning. He contemplates his own importance in the universe through this gazing at his own reflection. For mere surface gazing the poet takes himself to the depths of contemplation about his own psyche and inner impulses. In this way, the lake and pool are symbol and deeper reflectors than the surface coated mirror. The self is thus seen to be a complex evolvment of a number of deeply refracted images. The reflection itself might act as an externalized presentation of one's own psyche, or it might equally strongly signify the idea of the other. What one faces is the other, the necessary object in the outside world that one learns to confront from one's earlier stage of growth.

Associated with the dress and make-up is the aspect of the hair and hairstyles contributing distinctively to one's personality or identity. Hair, the crowning of the women's appearance, especially, has always been regarded as a





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symbol of sexuality and fertility and strength. The colour of the hair or length of the hair or the cut and make-up of it is taken as an indication of the person's inner nature and character. Long hair spells bondage just as short cut hair announces freedom and liberation for the woman. Examples like the ensnaring long hair of Rapunzel in the fairy tale, the snaky locks of Medusa in mythology and the golden net of Browning's *Porphyria* or Tennyson's *Lady of Shalott* are familiar instances where the woman's hair plays a significant part in the action. Hair is also suggestive of mystery, a sinister potency, an evil force. Plath's imagery abounds in significant references to hair in the *Bell Jar* and in her poems.

In one instance, the first man that Esther goes out with in New York is Constantin. He fails to seduce her as she had expected, and under cover of a fall of hair on her face she contemplates him secretly and wonders at this attractive man lying on the bed beside her. Constantin, although he does not touch her that night, while gazing at her the next morning suddenly wonders at her hair and runs his fingers through it from the roots to the tips. "A little electric shock flared through me and I sat quite still," Esther says. But Constantin brings her down to earth brutally by commenting: "Ah, I know what it is, you've just washed it." (TBJ, p.70). Esther's constant fear that she is too homely compared to her glamorous friend Doreen, who had white hair like cotton candy, is confirmed by the world, alas! All her roused expectations for herself are crushed. At another point when Buddy Willard and she are lying on the bed side by side and talking about sex for the first time during their acquaintance, a similar situation as with Constantin occurs. Esther sits cross-legged on the bed and asks for a comb. When she got it she says: "I began to comb my hair down over my face so Buddy couldn't see it." And then she asks him if he's had an affair with anyone, and continues: "I kept rhythmically combing the hair down over the side of my face nearest to Buddy, and I could feel the little electric filament clinging to my hot cheeks and I wanted to shout..." (TBJ, p.70). Even on this occasion Esther is disappointed in her expectations and she "froze up." She merely continues to comb her hair mechanically. Both sexual encounters turn out to be failures for Esther.

On many other occasions in the *Bell Jar*, Esther's, and many times other characters' being well or ill is indicated by the condition of the hair, as being "fats and greasy," or as "hair that was shaved off and sprouted in bristly chicken feather tufts all over the head," or as "Trusty hair knotted up in a school marmish bun." Esther uses the description of the hair to indicate psychic moods. With differing personae and changing voices Plath uses the imagery of clothes with varied effects in her poems. A poem like the "Applicant" depends entirely on the imagery of clothes to suggest the mood of self-alienation. The metaphors, depending on the different turns of phrase, obliquely refer to society as a hospital, a toyshop, or a graveyard. The individual himself is bound to be a misfit in such a background:

The body itself is all broken down and patched up:

...

A glass eye, false teeth or a crutch
A brace or a hook
Rubber breasts or rubber crotch,
Stitches to show something's missing?

...

I notice you are stark naked
How about this suit –
Black and stiff but not a bad fit

...

Believe me, they'll bury you in it.

The same kind of imagery to suggest loss of self and identity is kept up in the "Tulips" also. Her identity changes as soon as she hands her day clothes to the nurse and dons the hospital dress. Even in her poem "Getting There" the difference between being well and ill is suggested through her act of dressing:

The body of this woman
Charred skirt and deathmask





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....

And I stepping from this skin
of old bandages, boredoms, old faces.

Similar imagery is worked out in her long poem "Three Women" in which there is a complex, intricate detailing of the poet's feelings as woman and mother, through the different voices and masks of three women. Besides many images of the body and clothes the poem makes references to the mirror as an object deflecting or reflecting one's identity:

How slowly she superimposes her neat self
On the inferno of African Oranges, the heel-hung pigs.
She is deferring to reality
It is 1. It is 1.

And later in the poem she observes:
The mirror gives me back a woman without deformity
The nurse gives me back my clothes, and an identity.

Little adhesive tapes with their names written on them marked the clothes of Esther in the Bell Jar and of these personae in the poems when they were confined in hospitals, thus fixing or unfixing their identities as they went in and out of these clothes. The illness and nervous breakdown that Plath herself had suffered naturally led her to an acute awareness of her body and its parts and its workings. With remarkable ironic distance she views the workings of her own mind and body through these acts of clothing and unclothing herself.

Contrasting with this is the strip tease in "Lady Lazazus" shocking the spectators, defying death itself to reduce her body to ashes.

"Fever 103 shows the female persona as being alienated and lost in the thralldom of love and sex:

Love, love the low smokes roll
From me like Isadora's scarves. I'm in a fright
One scarf will catch and anchor in the wheel.

.....

(My selves dissolving, old whore petticoats --)

By such violent and flamboyant rhetoric regarding her clothes the poet appears to evoke in the reader a shock of recognition of her innermost, inexpressible self. The clothes themselves serve as metaphors to emphasize this shock of recognition as well as to actualize it.

Poems like "Totem" and "Edge" go beyond the subject of self-alienation of the poet personally and extend into comments on the existential alienation of man from the universe, from life itself. Once again Plath draws inspiration from the images of clothes in these poems. She declares:

There is no terminus, only suitcases
Out of which the same self unfolds like a suit
Bald and shiny, with pockets of wishes,
Notions and tickets, short circuits and folding mirrors
"Totem". Ariel, p.77

She observes about the dead woman in "Edge" :

.....

Flows in the scrolls of her toga.
her bare Feet seen to be saying
We have come so far, it is over.

In the poem "The Other" the split personality is seen:

Cold glass, how you insert yourself
Between myself and myself



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By all these example sit can be seen how Plath again and again indicates the connection between mystery of the self and the paraphernalia of dress, especially as it relates to female persona which we find in all her works. Juxtaposing her novel, *The Bell Jar* and her poems with her own letters and biographical accounts given by her friends, one can better understand the lifelong struggle Sylvie underwent to find herself. The personae in her writings appear to be close images of her everyday self that her friends saw. For Sylvia her outward clothes served as a mask. They effectively concealed her inner being but at the same time gave her the boldness to express what was in her heart fearlessly in her poetry. This was a subversive method of laying bare her deepest feelings her conscious as well as her subconscious urges frankly in her poetry. It is well known that a mask can be used as a carapace for defence just as it can be used as a device for exposure of the self. Plath fully makes use of this ambivalent nature in the art of dressing to play out the drama of the self in her works.

A woman gives attention to her clothes with the prerogative of an artist. Her sense of beauty, form, and aesthetic values are indicated in this attention, Plath the artist was quite aware of this. Just as her characters and personas play out their roles in different garments, Plath plays out her moods through the medium of words, stitching them into poems or fiction. She tries to make and remake and fix her identity as completely as she can by clothing her thoughts, or unclothing them, in these succession of poems and novel, *The Bell Jar*, which are mostly about herself. An over-dependence on the matter of clothes, the emphasized attention given to it, especially on the part of a women, indicates a vulnerability, suggestion of her wish to please the other sex. The vulnerability shows itself at its worst in the spirit of competitiveness that is set up for such a woman in a man's world. Esther's several confrontations with man in *The Bell Jar* come to mind in this context. Her relationships with Marco, Constantin, Irwin, and above all Buddy Willard are all abrasive and they end in a disastrous way, Even in poems like "Daddy" and "For Fatherless Son," the persona of the woman is left behind, alone. In her personal life, for Plath, there was the failure of her relationship with her father, and later her husband Ted Hughes. Then, spite of all the razzmatazz of her changing clothes and playing different roles in this game of identity-hunt and survival, did Plath finally lose? Both as artist and woman?

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Role and Impact of Structured Exercise Interventions on Hepatic Triglycerides for Non Alcoholic Fatty Liver Disease (NAFLD) Patients - A Scoping Review

Sedhunivas.R¹ and Sridevi.S^{2*}

¹M.P.T. Cardiopulmonary Sciences, Assistant Professor, Garden City University, Bangalore, Karnataka, India.

²M.P.T. Cardiopulmonary Sciences, Associate Professor, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamil Nadu, India.

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*Address for Correspondence

Sridevi.S,

M.P.T. Cardiopulmonary Sciences,

Associate Professor,

Sri Ramachandra Institute of Higher Education and Research,

Chennai, Tamil Nadu, India.

Email: devibsmoorthy@sriramachandra.edu.in



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ABSTRACT

Exercise prescription in Non-alcoholic fatty liver disease patients gains the topmost importance, provided already there is existing absence of effectiveness of pharmacotherapy drugs in treatment of NAFLD. Exercising daily can improve the exercise capacity of the individual and can reduce the progression of NAFLD disease into NASH and cirrhosis. Understanding the available various exercise protocols and its effectiveness devised for NAFLD patients will help in future progression of exercise protocols and can lead to advancement in protocols and also it will benefit the patients. To investigate on impact in hepatic triglycerides levels as a result of various structured exercise interventions prescribed as a treatment for NAFLD patients. A scoping review was conducted using PubMed, Hepatology journals, Google scholar database during the time period of (2013-2020) and 20 literature evidences related to the topic were found and further analysed. A total of 20 Randomized control trial articles were included in the review ,which studied on effectiveness and impact of exercise interventions on liver enzymes .we could found 10 articles focusing on aerobic protocols and 5 articles focusing on resistance exercises and 5 literature evidences focusing on both aerobic and resistance protocols. Aerobic form of exercise is found to be more beneficial when compared to other structured exercise intervention in lowering the triglycerides values among NAFLD patients.

Keywords: Exercise interventions, Non-alcoholic fatty liver disease, triglycerides, impact





INTRODUCTION

Liver is a major organ which is responsible for lipid homeostasis and it functions by specifically designed biochemical cellular pathways. Hepatocytes of liver maintains the hepatic metabolism, which metabolism of triglycerides also. Though liver metabolises huge quantities of fatty acids daily, but it stores only relatively small quantities of triglycerides less than 5%. NAFLD presents with excessive storage of triglycerides and appears to be most common chronic liver disease [1]. Hepatic steatosis occurs as the mismatch between the production and export of triglycerides and the triglycerides production occurs from fatty acids of mainly from three sources like non-esterified fatty acids (NEFAs), TG-rich lipoproteins, very low-density lipoprotein (VLDL), and chylomicrons [2]. Pathological process occurring in NAFLD is more or less similar to alcoholic fatty liver disease, provided in latter is the absence of alcohol consumption[3]. Non-alcoholic fatty liver disease (NAFLD) noted to be found on higher rates as a result of obesity and sedentary life style all over the world and deteriorating changes impacting in the liver and denotable biochemical and histological changes are noted to be have more impact in elderly than in youth[4]. The epidemiology of NAFLD is about around 20% to 30% of adult common population and impacts of 70% to 90% of population with obesity and diabetes in westernized countries[5]

Common characteristic finding in obesity is the raised liver triglyceride (IHTGs) levels and it subsequently raises the risk of cardiovascular disorders and metabolic syndrome also. Treatment programs focusing on metabolism activation and its improvement are shown with decreasing level of triglycerides and exercise training are proved to be the prime and sole treatment for NAFLD patients in the lacunae of pharmacology treatment, which is also approved by American Association for the Study of Liver Diseases and Association of American Gastroenterology[6]. Various studies have highlighted the influence of exercise and diet control on IHTG where the medical treatment doesn't show any improvement on hepatic fats[7]. Though many studies have evaluated the effectiveness of exercise interventions on liver enzymes, and blood lipid on NAFLD patients and proper awareness on importance of triglycerides and documentation on relation between exercise interventions and triglycerides level in NAFLD patients remains unclear. Thus this scoping review study aims to investigate and determine the effectiveness of structured exercise intervention on triglycerides on NAFLD patients.

MATERIALS AND METHODS

Eligibility criteria

Articles are collected from the time period of year 2013-2020. Only the topic relevant randomised controlled trials (RCT's) were included from the available worldwide evidences. Guidelines, literature review, systematic review, consensus statement, conference statements are excluded in the study English was used as the search language.

Information source

Evidences were gathered by performed a customized search strategy. The systematic advanced search was performed in PubMed and Google scholar from the time period of 2013 -2020.

Search

The scoping review was conducted from June 2021 to September 2021 using the above mentioned database search strategies and following are the search terms used in varied combinations such as : "non alcoholic fatty liver disease" , "exercise protocols" , "liver enzymes", "hepatic triglycerides" , "randomised controlled trials" , "aerobic" , "resistance" , "effectiveness". The Boolean logic (AND, OR & NOT) was employed to generate different combination of search strings

Selection of source of evidences

We could identify around 168 articles in the database search conducted and 142 articles were excluded due to various reasons like animal trials and not focusing on concept of exercise for NAFLD patients, other reviews and



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thus only 20 relevant RCT articles were found eligible and they were retrieved as a full text .it comprised of 18 international articles and 2 Indian articles. On further division, we could find 10 articles focusing on aerobic protocols and 5resistance exercise protocols and 5 of them were combined both aerobic and exercise protocols. The collected articles were also reviewed by the co-investigator (guide). Informed consent weren't obtained since the review usually doesn't involve human population. This scoping review also followed the guidance of PRISMA guidelines checklist for scoping reviews and thus eligibility criteria was developed using PCC method of framework (Participant, Concept, Context)

Participants

To be a part of this review, the available RCT's are needed to focus on various structured exercise interventions prescribed for NAFLD patients

Concept

This review was mainly focused on different types of exercise protocol provided as a part of treatment for NAFLD patients in varied forms of prescription. We wanted to focus only on RCTs available, since we wanted also to find the significant effectiveness of various structured protocols available. Though NAFLD is increasing its prevalence worldwide, very few RCTs were published, thus it shows less awareness and interest among the researchers

Context

This review wasn't intended to evaluate a particular geographic affected population, rather it was intended to study various exercise protocols available worldwide and in particular evaluating the effectiveness on hepatic triglycerides on NAFLD patients which is increased drastically among affected worldwide population

Search strategy

Specific search strategy used was as follows: (((((hepatic triglyceride) OR (intrahepatic triglyceride)) AND (Non alcoholic fatty liver disease)) AND (Randomised controlled trials)) AND (exercise protocol) AND (effectiveness)). Following the completion of search, the references in the papers were selected, and also reviewed to include additional articles that were not found in the original electronic search

Focused question

The scoping review question mainly focused was : What are the available evidences in form of RCT's showing the effectiveness on hepatic triglycerides by providing exercise as intervention to NAFLD patients?

Data extraction

After the initial screening process of the obtained articles and identifying the key factor present in the studies and the next step is to extract more data to produce the results. In the process of detailed review on each of the articles. we found that the exercise protocols consisted mainly of aerobic focused and also more focused in combination of aerobic and resistance exercise protocols than purely resistance training based.

Data items

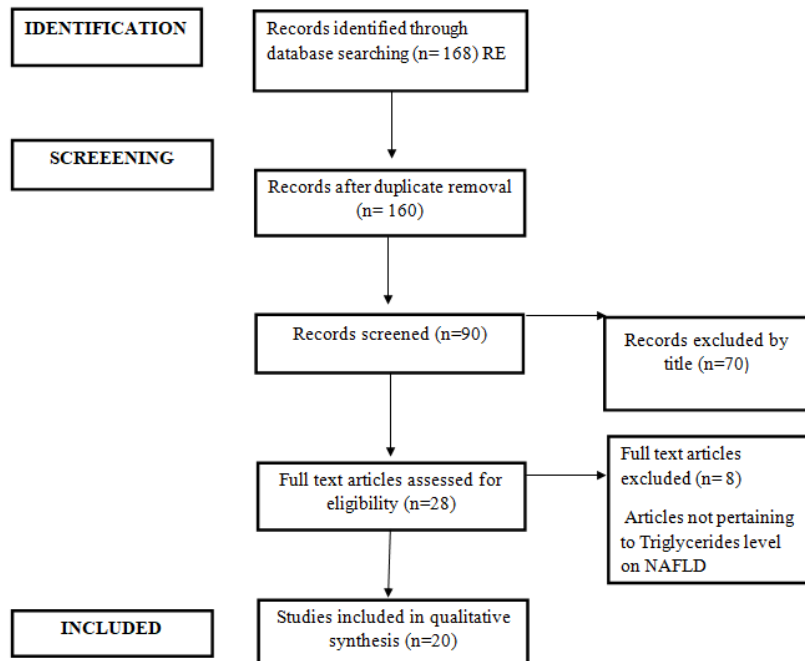
Data were independently obtained from available eligible RCT's by one author. The characteristics chosen were about(title, author and year of publication, number of samples, study duration, type of exercise intervention along with extracted FITT protocol and pre and post hepatic triglyceride level (P VALUE) ,remarks/conclusion) split into based on type of exercise protocol.





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Prisma Chart



PRISMA Flow chart for inclusion for review

Summary of Review

RESULTS

Selection of sources of evidence

Through a database search we could identify 168 articles in total, among them 148 of them were excluded after the screening of title and irrelevant articles pertaining to this study . we included only 20 Randomised controlled trials, out of which there were only 2 Indian articles and 18 rest of them were international articles collected from various parts of globe done on NAFLD patients from the time period of 2013-2020.The international articles are obtained from Iran (2),USA (3) ,United kingdom (3), Japan (4), Egypt (2) ,China(2), Italy(1), Israel(1), India(2).

Characteristics of sources of evidences

The studies which were included are based on NAFLD and focusing on exercise protocols and determining its effectiveness on the increased triglycerides levels which is often the root cause for NAFLD disease and progression. All these studies exhibited a varied outcome measures like blood lipid profile and spectroscopy but focused on triglycerides levels.

Results of individual source of evidence

On analysing the effectiveness of exercise protocols, we decided to look for significances of P value of Pre and post triglycerides levels on those studies. Based on this analysis we found that a total of only 7 articles out of 20 articles showed its effectiveness in reducing the triglycerides level on NAFLD patients. In depth analysis showed a varied results , 6 aerobic protocols out of 10 were found to be effective ,whereas the only 1 protocol was effective in combined intervention and none of articles focusing on resistance showed its effectiveness on triglycerides levels. Among aerobic protocols, Gholami *et al*, Kate hallsworth *et al*, Oh *et al*, Abdel basset *et al* and Preethamnath *et al*



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could find a beneficial effect of aerobic exercises on triglycerides levels. Studies focusing on resistance only interventions done by Kritidamor *et al* , Zelbersagi *et al*, A Takahashi *et al*, Shelly Keating *et al* could find only a negative result on triglycerides level where the triglycerides level fail to drop significantly as expected. In combined exercise interventions of aerobic and resistance exercise protocols, only Bacchi *et al* could find a significant improvement in triglycerides level when exercises are performed for 4 months consisting of treadmill and ergometer training and gym based resistance training and other authors Shojaemoradie *et al*, Oh S *et al*, Browsers *et al*, Mohammed ebrahim *et al* could only find a negative impact on triglycerides level.

DISCUSSION

This scoping review was conducted with the primary aim of finding out the effective best exercise intervention which is suitable for NAFLD patients that can also lower the triglycerides level which is found to be elevated in patients. Outcome measures used to find out the triglycerides levels varied in some of the obtained studies like biochemical test analysis mainly through lipid profile by obtaining the blood samples and few of the studies non-invasive methods like indirect fat analysis through H-MRS spectroscopy. On final analysis we could find that 6 out of 10 aerobic interventions were effective and only 1 of 5 combined exercise interventions were effective and but interestingly none of 5 resistance exercise interventions were found to be effective. We could understand the maximum effect on triglycerides obtained as a result of aerobic exercises due to the given fact it maximises the calorie expenditure better than other exercise interventions. This is in correlation with fact that aerobic exercise is proven to improve blood lipids and indicators mainly triglycerides. This form of exercise mainly controls and lowers the triglycerides in these sedentary patients with characteristic hypertriglyceridemia and other elevated lipid profile. A research indicates lipoprotein lipase is an important component required in the formation of HDL and this is influenced by aerobic exercise. Recent studies done on elderly people indicate that physical activity has a positive effect on lipid profile (mainly on HDL-cholesterol and triglycerides and even on body composition parameters)(8) So in this study, we analysed about the effectiveness of exercise intervention and found that aerobic exercise is more beneficial compared to other resistance and combined interventions in improving the triglycerides parameters in NAFLD patients.

Limitations

This scoping review had several limitations among which, we focused only on RCT's in order to obtain p values so that effectiveness of exercise intervention could be analysed effectively and thus we couldn't consider other reviews and other type of studies. Due to lack of awareness of physiotherapy in hepatology field, which is evident by the lacunae present in exercise protocols, we could analyse only a lesser number of studies in the given study time period.

CONCLUSION

This scoping review concludes that, aerobic form of exercise is found to be more beneficial when compared to other structured exercise intervention in lowering the triglycerides values among NAFLD patients.

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Conflict of interest

Authors state no conflict of interest.

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Table.1: Aerobic Only Intervention

Available Evidences	Type of exercise Intervention	(P VALUE<0.05)	Remarks/Conclusion
Gholami <i>et al</i> ,2013,RCT	Aerobic	0.002	Medical therapy along with exercise is more beneficial for patients with NAFLD and reduction in Triglycerides is more significant in aerobic group.
Haus <i>et al</i> ,2013,RCT	Aerobic	0.06	Short term exercise improves hepatic lipid composition but not specifically hepatic triglyceride content
Kate hallsworth <i>et al</i> ,2015,RCT	Aerobic HIIT	0.032	HIIT reduces liver fat and improves body composition and also triglycerides level effectively
Shelly keatingz,2015,RCT	Aerobic Low to moderate, high volume	0.34	All exercise regimes were equally effective on liver fat but not specifically on triglycerides level
	High intensity ,low volume	0.46	
	Low to moderate intensity, low volume	0.35	
Oh s <i>et al</i> 2015,RCT	Aerobic	0.01	Moderate vigorous physical activity is beneficial combined with diet for NAFLD and also for triglycerides level





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Cuthbertson 2016, RCT	Aerobic	0.123	Exercise training reduced liver fats and improved cardiorespiratory fitness but not on triglycerides level
Scheng <i>et al</i> ,2017,RCT	Aerobic Aerobic + diet	0.766 0.590	Aerobic exs and diet shows better results but not triglycerides level
Abdelbasset <i>et al</i> ,2019,RCT	Aerobic HIIT	0.01	HIIT is beneficial effect on intrahepatic triglycerides, visceral lipids, and QOL
Abdelbasset <i>et al</i> 2020,RCT	Aerobic HIIT group MICT group	0.01 0.01	Both exercise training are equally effective in making an impact on triglycerides level
Preetamnath <i>et al</i> 2020,RCT	Aerobic Moderate intensity group Low intensity group	0.013 0.303	Moderate intensity exercises improves hepatic steatosis and also the triglycerides levels

Table.2: Resistance Only Intervention

Article-author,type, Year	Type Of Exercise intervention	(P VALUE<0.05)	Remarks/Conclusion
Kirti damor,2013,RCT	Progressive resistance	0.18	Progressive resistance exercise improved hepatic fat and subcutaneous fat , has negative impact on triglycerides level
Zelbersagi <i>et al</i> ,2014,RCT	Resistance	0.086	Resistance training improved hepatic fat content but not much effective on triglycerides level
A.Takahashi <i>et al</i> ,2015,RCT	Resistance	0.565	Resistance exercise improves liver enzymes, but not blood lipids and triglycerides level
A.takahashi, 2016,RCT	Resistance	0.479	Resistance training is effective in reducing ALT in patients ,has negative impact on triglycerides level
Shelly keating,2016,RCT	Resistance	0.42	Progressive resistance training is not effective on specifically lowering triglycerides levels

Table.3: Combined Aerobic And Resistance Exercise Intervention:

Article-Author, Type, Year	Type Of Exercise Intervention	(P VALUE<0.05)	Remarks / Conclusion
Bacchi <i>et al</i> ,2013,RCT	Aerobic and Resistance	0.036	Both aerobic and resistance training are equally effective in improving triglyceride content
Shojaemoradie <i>et al</i> ,2016,RCT	Aerobic and Resistance	0.457	Aerobic exercise reduced the liver fat, increased vo2 max, reduction in VLDL and not significant on triglycerides level
Oh S <i>et al</i> ,2017 ,RCT	Aerobic and Resistance	0.326	HIAT was improving hepatic stiffness, MICT was improving hepatic fat content but not significant in triglyceride level improvement
Browers <i>et al</i> ,2017, RCT	Aerobic and resistance	0.729	Exercise training reduces intrahepatic lipid content in both the groups Not significant in triglycerides
Mohammed ebrahim <i>et al</i> , 2019,RCT	Aerobic and resistance	8.178	Aerobic is more effective than resistance in blood lipid profile improvement but has no significant difference in reduction of Triglycerides among three groups





What Sparks Customer Loyalty? Analysing the Catalysts of Customer Loyalty and Their Impact

P.Rajini¹ and R.Bhuvaneshwaran^{2*}

¹Assistant Professor and Head, Department of Commerce, Tagore College of Arts and Science Chrompet, Chennai-44, Tamil Nadu, India.

²Assistant Professor, PG and Research Department of Commerce, Thiruthangal Nadar College Selavayal, Chennai -51, Tamil Nadu, India.

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*Address for Correspondence

R.Bhuvaneshwaran

Assistant Professor,
PG and Research Department of Commerce,
Thiruthangal Nadar College Selavayal,
Chennai -51, Tamil Nadu, India.
E.Mail: drbhuvaneshcom@gmail.com



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ABSTRACT

Purpose – The automobile sector, the main condition for protecting the subscriber base is to win customer loyalty, a key necessity for the maintenance of a brand's life in the long term. To achieve this aim, customer satisfaction and trust must be measured and "Perceived Value" needs to be identified. In this connection, this paper's aim is to measure the effects of Commitment, Customer Satisfaction, Perceived Value, Service Quality, Service Recovery and Trust on customer loyalty. **Design/ methodology/ approach** – The data set covered 340 Nissan car users in Chennai. The data were analyzed by correlation and regression analysis to test the hypotheses. **Findings** – The findings of this study show that the Service Recovery is the most important factor to extract loyalty followed by Perceived value, Trust, Service Quality, Customer Satisfaction and Commitment. Therefore, these factors play a crucial role and act as catalysts in winning customer loyalty. **Originality/value** – With respect to the findings, Service recovery has more importance than Perceived value, Trust, Service Quality, Customer Satisfaction and Commitment in engendering loyalty. Service recovery is critical because it allows businesses to satisfy consumer expectations and avoid churning. It's an opportunity for the company to save and develop a client connection. So, the effect of service recovery on loyalty becomes greater than the effect of other factors. Therefore, any car manufacturer who wishes to preserve its existing subscriber base should concentrate on Service Recovery.

Keywords: Commitment, Customer satisfaction, perceived value, Service Quality, Service Recovery, Trust, Customer Loyalty



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INTRODUCTION

Companies are now attempting to utilise the intangible character of services and the large human contact involved there to combat competitive pressures and acquire a competitive advantage in the market. Because of the competitive advantage it provides, customer loyalty has been incorporated in many organisations' strategic objectives. Due to the stronger human participation in services compared to products, the role of client loyalty takes on greater significance. The inherent character of services, as well as their intangible and perishable nature, increases the potential for error during service delivery and emphasises the importance of human interactions in commercial transactions. Customer loyalty has garnered a lot of marketing attention recently (Wu and Ai, 2016), and its ramifications for modern firms cannot be emphasised. In fact, client loyalty is viewed as a long-term asset and a significant business consequence (Kandampully et al., 2015). (Ali et al., 2016; Kim et al., 2016). Because of its importance in generating long-term competitive advantages, having loyal consumers is an essential choice for many businesses (Wu and Ai, 2016). As a crucial criterion for market success, marketing practitioners are also encouraged to cultivate loyal clients towards their firms (Kandampully et al., Globalized marketplaces and the free flow of information have resulted in increasing customer expectations and strong competition. In today's corporate world, productivity, quality, and customer happiness are buzzwords that necessitate significant efforts on the part of the corporation. Furthermore, in order to achieve the essential business goals of survival and growth, companies are seeking for long-term solutions to attract and keep customers. Customer loyalty and value are important factors in ensuring a company's competitive edge because it is less expensive to retain existing customers than to attract new ones.

Saturated marketplaces encourage businesses to refocus on customer loyalty in order to keep their existing clients (Kim et al., 2016). In competitive markets, loyal clients are valued by various service providers (Ali et al., 2016; El-Adly and Eid, 2016; Wu and Ai, 2016), since they would advocate their favoured items to other customers (Kim et al., 2016). Customer loyalty results in a variety of financial benefits (Murali et al., 2016), including price premiums (Kim et al., 2016), cost reductions (Murali et al., 2016), and increased sales income. In order to succeed and survive in the market, any company must first understand and meet the expectations of its customers. Customers have now become the main focus of practically all firms, and they deserve to be treated as such. Companies are finding it increasingly challenging to keep customers while remaining profitable, due to rising expectations, increased rivalry, and the quick entrance of new business models and forms. In recent years, the economic environment's instability has contributed to corporate loyalty difficulties. According to Abu-Alhaja et al., (2018), establishing and retaining client loyalty and value has become a critical activity for businesses that have recognised its importance.

Due to its growing importance for worldwide firms, studying customer loyalty is an important research endeavour (Haryanto et al., 2016). Several loyalty models have been proposed by marketing scholars to improve client loyalty. According to a recent review of the literature, marketing experts have looked into consumer loyalty from several angles and factors (e.g., Cassidy and Wymer, 2016; El-Adly and Eid, 2016; Jiang and Zhang, 2016; Rubio et al., 2016; Campón-Cerro et al., 2016). Understanding consumer loyalty from other viewpoints, on the other hand, has received scant attention (i.e., cultural and religious factors).

Literature review and Hypotheses

According to Bharatwaj et al. (1993), businesses should consider customer loyalty as a source of competitive advantage. Customer relationship management, according to Reichheld and Sasser (1990), Sheth and Parvatiyar (1995), is based on the notions of customer loyalty and corporate performance. Customer loyalty has drawn attention from both the corporate and academic realms, according to Oliver (1999) and Reichheld (2001). "Customer loyalty is a complicated, multidimensional notion," according to Majumdar (2005). As a result, it becomes critical to investigate the literature's conceptual domain of customer loyalty for a clear understanding of its concept, classification, and antecedents in order to provide a solid foundation for future research.



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Repeat purchases, self-stated retention, price insensitivity, resistance to counter persuasion, and recommendation to others are all characteristics of loyalty, according to Jaishankar, Arnold, and Kristy (2000). The desire to share positive word-of-mouth about a service provider and repeat purchase behaviour are the most common markers of customer loyalty, according to Dwyer, Schurr, and Oh (1987); Fornell (1992). Oliver (1999); Knox and Walker (2001); Tsauro et al., (2002) have made attempts to gain a better grasp of the process of creating client loyalty. According to Palmer et al. (2000), Knox and Walker (2001), and Rowley (2005), the development of customer loyalty occurs in stages, and clients at different stages require different techniques.

Commitment

Nissan wants to be a part of the future mobility society; hence it wants to evolve as a brand. The foundation of the future mobility that we envision is "zero emissions" (the eradication of CO₂ emissions from new Nissan vehicles) and "zero fatalities" (the elimination of almost all fatal traffic incidents involving Nissan vehicles). Nissan's sustainability strategy, "Nissan Sustainability 2022," was developed in 2018 to help the company lead in creating new business value through innovation. It reaffirms our commitment to contribute to a more sustainable society through three areas of activity: environmental, social, and governance.

Commitment and Its Influence

Two sorts of commitment are distinguished: emotional and continuous commitment (calculative commitment). Affective commitment is defined as the desire to keep a connection going, and it is built on loyalty and affinity (Gundlach et al.1995). Continuance commitment is more rational, with an emphasis on termination or switching costs (Kumar, 1996). Morgan and Hunt (1994) claimed that comprehending customer-company interactions required dedication. According to research, there may be a link between commitment and the length of a relationship. Verhoef (2003) discovered that commitment had a favourable influence on client retention, and other research have identified a link between commitment and consumer loyalty.

According to Jacoby and Kyner (1973), commitment is an important tool for separating loyalty from repeating purchasing behaviour. According to Dwyer et al. (1987); Morgan and Hunt (1994); Gundlach et al. (1995), commitment is a useful construct for analysing client loyalty and forecasting future purchase frequency. Committed partners, according to Anderson and Weitz (1992), are willing to invest in valuable assets special to an exchange in order to demonstrate that they can be counted on to perform critical responsibilities in the future. Commitment, according to Achrol (1991), is a necessary component of effective long-term relationships. Affective commitment is defined as the desire to keep a connection going, and it is built on loyalty and affinity (Gundlach et al.1995). The assumption being that commitment most probably impacts customer loyalty leads to the following hypothesis to be tested.

H₁. Customer loyalty is significantly affected by Commitment. Service Quality

According to Grönroos (1983), service quality is divided into two parts: technical quality (what is delivered) and functional quality (how it is delivered). Early research, according to Parasuraman, Zeithaml, and Berry (1988), projected service quality as an attitude influenced by the gap between customers' expectations for a service to be obtained and perceptions of the service being received. Ranaweera and Neely (2003) also found that perceived service quality and customer retention have a straight linear connection. The relationship between service quality and client loyalty was accepted by Simon, Seigyoung, and Karen (2005). The assumption being that Service Quality most probably impacts customer loyalty leads to the following hypothesis to be tested.

H₂. Customer loyalty is significantly affected by Service Quality. Service Recovery

"Mistakes are an unavoidable component of every human endeavour, and so also of service delivery," according to Boshoff (1997). Service failure was defined by Duffy et al. (2006) as an actual or perceived service breakdown in terms of outcome or process. Service recovery, according to Gronroos (1988), is the response a service provider gives in the event of a service breakdown.



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Miller, Craighead, & Karwan (2000); Smith & Bolton (2002) examined service recovery literature and discovered that it demonstrates how customer happiness and loyalty are influenced by the settlement of customer problems. Customers' perceptions of a firm's consistency in executing service recovery when failures occur, according to Swanson and Kelley (2001), influence their behavioural intentions positively. Customer loyalty is influenced by effectively managed service recovery, according to Robbins and Miller (2004). Emotions, according to Izard (1977), are the major motivators of behaviour. The assumption being that Service Recovery most probably impacts customer loyalty leads to the following hypothesis to be tested.

H3. Customer loyalty is significantly affected by Service Recovery Perceived value

In this study, the term "value" refers to a consumer's preference judgement (Gan et al., 2005). Perceived value, according to Cronin et al. (2000) and Zeithaml (1988b), is the customer's total appraisal of a product's utility based on perceptions of what is received and supplied. Customer value is defined by Sweeney and Soutar (2001) and Woodruff (1997) as a customer's perception of and evaluation of product attributes, attribute performance, and consequences in terms of the customer's goals and purposes. Value, according to Stonewall (1992), is a result of product characteristics, quality concerns, delivery, service, and price. Value, according to Stonewall (1992), is a result of product characteristics, quality concerns, delivery, service, and price. He also stated that "value is a perspective, a view, or understanding made up of quantitative components" and that "value is always defined by the consumer, in his or her own words, timing and testaments." Perceived value is a broad measure of a customer's satisfaction with a service. According to Rust and Oliver (1994), value can be defined as an overall assessment of a service consuming experience, which can be encounter specific or a more long-term worldwide assessment. Ackar and D'Incau (2002) found that value perception differed depending on the usage situation.

A consumer's judgement of the ratio of perceived advantages to perceived costs is commonly regarded to be a component of perceived value V.A. Zeithaml(1988). Perceived value, according to Bolton and Drew (1991), is a "richer measure of customers' total judgement of a service than perceived service quality." Perceived value is a function of a 'get' component (the benefits a buyer obtains from a seller's providing) and a 'give' component (the buyer's monetary and non-monetary costs of acquiring the offering), according to Parasuraman and Grewal (2000). The 'receive' component of our study was information, system, and product/service quality, whereas the 'give' component was money spent.

Prior research specifically modelled perceived performance or quality as a direct antecedent of value, which drove repurchase intent. In addition, findings from previous studies corroborated the basic idea that perceived value influenced customer loyalty W.B. Dodds, K.B. Monroe, D. Grewal, (1991), G.B. Voss, A. Parasuraman, D. Grewal (1998), D. Grewal, K.B. Monroe, R. Krishnan (1998). Customers would be more likely to migrate to competing businesses in order to boost perceived value, according to Anderson and Srinivasan, which would contribute to a decrease in loyalty. The assumption being that Perceived value most probably impacts customer loyalty leads to the following hypothesis to be tested.

H4. Customer loyalty is significantly affected by Perceived value Trust

According to Anderson and Narus (1990), in order to build confidence, one party must think that a third party would take activities that benefit the first party. As a result, a buyer must regard quality as favourable in order to trust a brand. According to Doney and Cannon (1997), trust is a calculative process based on a party's ability to continue meeting its responsibilities and an estimate of the cost-benefits of staying in the partnership. As a result, the client should not only notice favourable results, but also think that they will continue in the future. Morgan and Hunt (1994), Moorman et al. (1993), and Sharma (2003) have all identified trust as a key aspect in relationship commitment and thus consumer loyalty (see, for example, Fournier, 1998; Gundlach et al., 1995). It appears that if one partner trusts the other, the other is more likely to generate positive behavioural intentions. Customers are more likely to establish good buying intentions towards brands when they trust them (Lau and Lee, 1999).

In this context, trust works to protect relationship investments by cooperating with exchange partners, resists appealing short-term alternatives in favour of the expected long-term benefits of staying with existing partners, and



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views potentially high-risk actions as prudent because partners are unlikely to act opportunistically (Morgan and Hunt, 1994). As a result, a fourth research hypothesis may be established, which is compatible with previous research investigations (for example, Chaudhuri and Holbrook, 2002; Lau and Lee, 1999; Sirdeshmukh et al., 2002). In the ongoing economic interaction between customers and electronic sellers, Gefen et al. stated that this definition was based on the separation of trust and actual behavioural intents (e.g., repeat buy intentions). Bearden and Teel (1983); Cronin and Taylor (1992); Oliver et al. (1997); Selnes (1998) discovered a direct link between trust and loyalty, but Doney and Cannon (1997) considered trust to be the most important antecedent of repurchase intentions. Trust was determined to be a significant aspect in loyalty formation by Lim et al. (1997), Garbarino and Johnson (1999), Chaudhuri and Holbrook (2001), Singh and Sirdeshmukh (2000), and Sirdeshmukh et al. (2002).

Foster and Cadogan (2000) found that trust is a prerequisite for attitudinal loyalty in the workplace. Trust is required for patronage behaviour, according to Pavlou (2003). When it comes to building long-term connections between service providers and customers, Ranaweera and Prabhu (2003) argued that trust is likely to result in client retention. The assumption being that trust most probably impacts customer loyalty leads to the following hypothesis to be tested.

H₅. Customer loyalty is significantly affected by trust Customer satisfaction

According to the IS success model of DeLone and McLean (2003), user/customer satisfaction is the determinant of net benefit or individual effect (i.e. customer loyalty). In the view of R.L. Oliver(1980),R.A. Westbrook and R.P. Oliver (1991), consumer satisfaction was thought to influence prior experience-based learning and to explain crucial post-purchase behaviours like complaining, word of mouth, repurchase intent, and product usage. A consumer's post-purchase appraisal and affective response to the total product or service experience is defined as satisfaction (R.L. Oliver, 1980). According to A. Eggert and W. Ulaga (2002), it was thought to be a good predictor of things like repurchase intentions, word-of-mouth referrals, and loyalty.

Customer satisfaction is a result of a customer's pre-purchase assessment of expected performance to perceived actual performance and cost (Churchill and Surprenant, 1982). According to marketing research, client happiness operates in two ways: transaction-specific and overall satisfaction (Yi, 1991). Customer satisfaction as an appraisal made following a specific purchase occasion is the transaction-specific idea. The customer's overall satisfaction rating of the brand is based on all interactions and experiences (Johnson and Fornell, 1991). Overall satisfaction is actually a consequence of all previous transaction-specific satisfactions (Jones and Suh, 2000).Cumulative customer satisfaction is an assessment of a product or service based on the whole purchase and consumption experience across time. Unlike transaction-specific satisfaction, which might provide diagnostic information about a specific product or service encounter, overall satisfaction is a more fundamental reflection of a company's past, current, and future success (Anderson et al., 1994).

Customer happiness, on the other hand, lessens sensitivity to price by lowering price elasticity (Garvin, 1988; Anderson, 1996) and minimises customer attrition from short-term swings in service quality (Fornell, 1992; Brady and Robertson, 2001; Oh, 1999; Eklof and Cassel, 2001; Hackl et al., 2000; Edvardsson et al., 2000; Brady and Robertson, 2001). In this scenario, it is reasonable to believe that consumer happiness and loyalty have a positive relationship. Customers will not have a favourable opinion toward the service provider compared to other choices available, according to Palmer (1998), unless they are satisfied. Many other research has indicated that customer satisfaction affects loyalty (Gronholdt et al., 2000; Kristensen et al., 2000; Gerpott et al., 2001; Sharma, 2003; Bruhn and Grund, 2000). The assumption being that Customer satisfaction most probably impacts customer loyalty leads to the following hypothesis to be tested.

H₅. Customer loyalty is significantly affected by Customer satisfaction

The above presented literature clearly states that customer loyalty formation is dependent on the following variables. Commitment, Service Quality, Service Recovery, Perceived value, Trust and Customer satisfaction. Customer loyalty, thus formed can be assessed through the following functional relationship:





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Customer Loyalty = f (Commitment, Service Quality, Service Recovery, Perceived value, Trust, Customer satisfaction)

The relationship illustrated above can be used to build a loyalty measurement scale. Testing the relationship between customer loyalty and its antecedents across industries and cultural contexts would be fascinating. Discovering the relative weights of these antecedents in the process of customer loyalty development can provide considerable insight for loyalty strategists, allowing them to focus on the components in order of relative importance and develop an effective loyalty programme for their company. Furthermore, the interaction between distinct antecedents of customer loyalty and their moderating impact on one another must be investigated in order to gain a better understanding of their respective roles in the construction of customer loyalty.

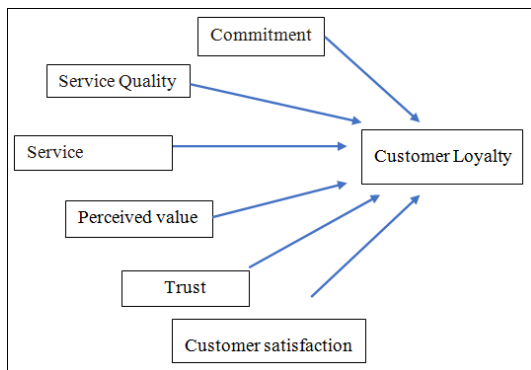
Research objectives

Primary objective of this research is to study the relationships of 6 factors affecting customer loyalty of Nissan cars. More specifically: To examine the impact of Commitment, Service Quality, Service Recovery, Perceived value, Trust and Customer satisfaction on customer loyalty of Nissan cars users.

Research Method

A quantitative research approach was utilized in this study with the well-structured survey questionnaire to test the model. The quantitative approach was applied to assess the relationship between Commitment, Corporate Image, Customer satisfaction, Emotions, Habit, Perceived value, Service Quality, Service Recovery, Switching Cost, Trust and customer loyalty. It also measures the relationship between the above variables and customer loyalty through regression and correlation analyses.

Research / Hypothesized Model



Sampling Design and Sample Size

This study primarily utilized convenience sampling with 340 questionnaires and were distributed equally to the customers. The use of convenience was done because of the accessibility of the respondents and the proximity to the researcher.

Research Instrument

In this study, the survey questionnaire is divided into two parts. Part 1 consists of the demographic profile of the respondents such as respondents' age, gender, education and experience. However, Part 2 comprises the customers' perceptions on Commitment, Service Quality, Service Recovery, Perceived value, Trust, Customer satisfaction and Customer Loyalty. Five Likert-type scales were utilized to address the questions in Part 2 to determine the extent of responses with numerical equivalent and interpretation (Jalagat et al., 2017): 1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, and 5 = *strongly agree*.



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The data collected from the sample were analysed using descriptive statistics, SPSS Version 22. The respondents' profiles such as age, gender, education and experience were analysed using the frequency and other numerical descriptive statistics. In dealing with the relationship between the 7 variables, the correlation coefficient was used. Finally, regression analysis was applied to determine the relationship between the study variables.

Research Validity and Reliability

To test the validity, the questionnaire was examined for content from a pool of experts to ascertain that all components that should be measured will be considered, and pretesting has been done to make sure that the questionnaire attends to the degree of fairness and accuracy. While determining whether the instrument is reliable, Cronbach's alpha was used to measure the total number of 30 items distributed to Commitment, Service Quality, Service Recovery, Perceived value, Trust, Customer satisfaction and customer loyalty, and the result shows 0.939, which is beyond the 0.70, as the considered acceptable reliability (Nunnally, 1978). Hence, the instrument is highly reliable.

Data Analysis and Interpretation

This section presents the data analysis and interpretation of the data collected. It shows the statistical tools to be used such as the frequencies and tables, weighted mean standard deviation, correlation, and regression analyses.

Demographic Profile of the Respondents

Table 1 depicts the classification of respondents according to age. Most of respondents or 53% ($N = 181$) belong to age group of 25 to 35 years, whereas 27.1% ($N = 92$) are aged 35 to 45 years. About 19.7% of the respondents are within 45 years of age, this can be interpreted as Nissan cars have gained more interest in the age group 25 to 35 years old. The data imply that more respondents who participated in the survey are male with 64.4% (219 out of 340), whereas females comprised only 35.6% (121 out of 340).

From table 1, we find that Trust is having highest average (3.8765) followed by Perceived Value (3.852) and Service Quality (3.85) and so on. The reliability test results show that all the variables have Cronbach's alpha value greater than the recommended threshold of 0.65 and above for going ahead with the analysis. Also, we can see that the values of Kurtosis ranged between (-0.07 to 1.323). Higher Kurtosis belong to Trust (1.323), and the lowest Kurtosis for Perceived Value (0.04). Additionally, the highest skewness value for Trust (-0.67), and the lowest for Service Quality (-0.143). It could be concluded that the adapted concepts fulfil the requirement of univariate normality, because the values of skewness and kurtosis lie between ± 3.5 . (Hair et al, 1998).

Correlation and Regression Analysis

The statistical tools, namely, the correlation and regression analyses, were utilized in this study to test the hypothetical assumptions among the seven variables: Commitment, Service Quality, Service Recovery, Perceived value, Trust, Customer satisfaction and customer loyalty. Regression analysis, however, was used to determine the relationship between service quality dimensions and customer satisfaction.

Table 2 depicts the correlation analysis between the variables. From the result, it is clearly shown that there is a positive relationship between the variables, namely, Commitment, Service Quality, Service Recovery, Perceived value, Trust, Customer satisfaction and customer loyalty, at $p < .01$ level of significance. Specifically, there is a very strong positive relationship between Service Recovery and customer loyalty with $r = 0.921$ at $p < .01$.

Also, there is a strong positive relationship between Perceived Value and customer loyalty with $r = 0.835$, between Trust and Customer Loyalty with $r = 0.834$. Moreover, there is a high positive relationship between Service Quality and Customer Loyalty with $r = 0.777$ whereas there is a moderate positive relationship between Commitment and customer loyalty ($r = 0.638$) and between Commitment and Customer Loyalty ($r = 0.556$).





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Since p – value is less than 0.01, all the hypotheses H_1 , H_2 , H_3 , H_4 , H_5 and H_6 were accepted. Hence Commitment, Service Quality, Service Recovery, Perceived value, Customer satisfaction, and Trust have significant impact on Customer Loyalty. This implies that these seven variables should be continuously emphasized by the respondent banks in their operation because of their significance to the possible growth of Islamic banking in the country. These results were also consistent with previous studies that affirmed the relationship between the study variables and Customer Loyalty.

Regression Analysis of Customer Loyalty and distinct antecedents of Customer Loyalty

A regression analysis with **Customer Loyalty** as dependent variable and distinct antecedents of Customer Loyalty Independent Variables like Commitment, Service Quality, Service Recovery, Perceived value, Trust, Customer satisfaction have been attempted and discussed as follows:

Dependent variable	: Customer Loyalty(Y)
Independent variables	: 1. Commitment (X₁) 2. Service Quality(X₂) 3. Service Recovery(X₃) 4. Perceived value(X₄) 5. Trust (X₅) 6. Customer satisfaction(X₆)
Multiple R value	:0.973
R Square value	: 0.946
F value	: 979.028
P value	: 0.000**

The multiple correlation coefficient is 0.973 measures the degree of relationship between the actual values and the predicted values of the Customer Loyalty. Because the predicted values are obtained as a linear combination of Commitment (X_1), Service Quality (X_2), Service Recovery (X_3), Perceived value, (X_4), Trust, (X_5), and Customer satisfaction (X_6), the coefficient value of 0.973 indicates that the relationship between Customer Loyalty and the six independent variables is very strong and positive. The Coefficient of Determination R-square measures the goodness-of-fit of the estimated Sample Regression Plane (SRP) in terms of the proportion of the variation in the dependent variables explained by the fitted sample regression equation. Thus, the value of R square is 0.946 simply means that about 94.6% of the variation in Customer Loyalty is explained by the estimated SRP that uses Commitment, Service Quality, Service Recovery, Perceived value, Trust, and Customer satisfaction (as the independent variables and R square value is significant at 1% level).

The multiple regression equation is

$$Y = -0.415 + 0.05X_1 + 0.104X_2 + 0.489X_3 + 0.244X_4 + 0.17X_5 + 0.052X_6$$

Here the coefficient of X_1 is 0.05 represents the partial effect of Commitment on Customer Loyalty, holding the other variables as constant. The estimated positive sign implies that such effect is positive that Customer Loyalty would increase by 0.05 for every firm increase in Commitment and this coefficient value is significant at 5% level. The coefficient of X_2 is 0.104 represents the partial effect of Service Quality on Overall Customer Loyalty, holding the other variables as constant. The estimated positive sign implies that such effect is positive that Customer Loyalty would increase by 0.146 for every firm increase in Service Quality and this coefficient value is not significant at 1% level.

The coefficient of X_3 is 0.489 represents the partial effect of Service Recovery on Customer Loyalty, holding the other variables as constant. The estimated positive sign implies that such effect is positive that Customer Loyalty would increase by 0.489 for every firm increase in Service Recovery and this coefficient value is significant at 1% level. The coefficient of X_4 is 0.244 represents the partial effect of Perceived value on Customer Loyalty, holding the other



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variables as constant. The estimated positive sign implies that such effect is positive that Customer Loyalty would increase by 0.244 for every firm increase in Perceived value and this coefficient value is not significant at 1% level. Here the coefficient of X_5 is 0.17 represents the partial effect of Trust on Customer Loyalty, holding the other variables as constant. The estimated positive sign implies that such effect is positive that Customer Loyalty would increase by 0.17 for every firm increase in Trust and this coefficient value is significant at 1% level. The coefficient of X_6 is 0.052 represents the partial effect of Customer satisfaction on Customer Loyalty, holding the other variables as constant. The estimated positive sign implies that such effect is positive that Customer Loyalty would increase by 0.052 for every firm increase in Customer satisfaction and this coefficient value is significant at 1% level. Based on standardized coefficient, Service Recovery (0.471) is the most important factor to extract Customer Loyalty, followed by Perceived value(0.308), Trust(0.15), Service Quality(0.088) Customer Satisfaction (0.059) and Commitment(0.045).

According to the first hypothesis, Commitment affects Customer Loyalty meaningfully. Using table 3, it can be inferred that influence of Commitment is significant on Customer Loyalty ($\beta=0.05$, $p<0.05$). According to the second hypothesis, Service Quality has significant impact on Customer Loyalty. From the results we can infer that, Service Quality has noteworthy influence on Customer Loyalty ($\beta=0.104$, $p<0.01$). Similarly, the third, fourth, fifth, sixth hypotheses state that consequences of Service Quality, Service Recovery, Perceived Value, Trust and Customer Satisfaction have a positive impact on decision-making process. According to the theoretical expectations, we can infer from the results that those factors have substantial influence on Customer Loyalty.

CONCLUSIONS AND FUTURE RESEARCH

Because of its consequences and importance, studying client loyalty will always be essential to marketing scholars and practitioners. Because local and worldwide markets are so competitive, practitioners are increasingly focusing on client loyalty formation and enhancement. Scholars are also encouraged to develop appropriate loyalty models in order to efficiently create and enhance customer loyalty to certain businesses. In this regard, researchers should look into client motivation elements while studying loyalty behaviour. Customers' motives are vital to understand since their acceptance is tied to their experience, which is linked to their motivations (Shin, 2009).

For marketing scholars and practitioners, studying client loyalty from a motivational standpoint is an important research avenue. For example, Heo and Lee (2016) advise researchers to look into other antecedents of loyalty, such as student motivation. Religion's motivational approach through religious orientation is also an important research issue. To deliver dependable and effective marketing strategies, this study finds that investigating the origins and repercussions of client loyalty is highly recommended. Because of their favourable effects on businesses, marketing experts should investigate the repercussions of customer loyalty (i.e. profitability, share of wallet, desire to spend more, and word of mouth). In order to gain a better understanding of customer loyalty, it's also a good idea to incorporate pertinent mediating and moderating aspects into loyalty models. Due to changing technologies, surroundings, and lifestyles, studying and understanding customer loyalty is critical in today's dynamic environment. This can aid marketers in building trustworthy strategies and methods. According to this study, there are six types of loyalty antecedents that should be considered: Service Quality, Service Recovery, Perceived Value, Trust and Customer Satisfaction. Customer satisfaction, trust, perceived value, and perceived service quality are primary determinants of loyalty; In conclusion, this study has looked at a variety of loyalty antecedents, but there is still a need to understand customer loyalty from many angles. Customer loyalty is a self-reinforcing system in which a company constantly provides higher value in order to attract and retain high-quality customers. Customers who are loyal not only repurchase enterprise products and services to save on advertising and publicity costs, but also promote the products or services to their family and friends. Customer loyalty is one of the most critical factors in ensuring that a company's profits remain stable and that it maintains its market competitiveness. In this study, we examined the data from the questionnaire as well as the size of the Nissan Corporation, with the goal of assisting Nissan in achieving better marketing implementation by exploring how to boost customer loyalty.





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	Mean	Std. Deviation	Skewness	Kurtosis	Reliability	Number of items
Commitment	3.849	0.52541	-0.162	0.301	0.684	3
Service Quality	3.85	0.48786	0.143	0.162	0.663	6
Service Recovery	3.82	0.5584	-0.473	1.05	0.753	5
Perceived Value	3.852	0.73494	-0.394	0.04	0.85	3
Trust	3.8765	0.51276	-0.67	1.323	0.667	5
Customer Satisfaction	3.7696	0.66286	-0.166	-0.07	0.761	3
Customer Loyalty	3.8424	0.58059	-0.418	0.616	0.727	5

		CT	SQ	SR	PV	TR	CS	CL
Commitment	Pearson Correlation	1	.365**	.728**	.345**	.485**	.659**	.638**
	P value		.000	.000	.000	.000	.000	.000
Service Quality	Pearson Correlation	.365**	1	.648**	.823**	.659**	.247**	.777**
	P value	.000		.000	.000	.000	.000	.000
Service Recovery	Pearson Correlation	.728**	.648**	1	.669**	.764**	.679**	.921**
	P value	.000	.000		.000	.000	.000	.000
Perceived Value	Pearson Correlation	.345**	.823**	.669**	1	.730**	.247**	.835**
	P value	.000	.000	.000		.000	.000	.000
Trust	Pearson Correlation	.485**	.659**	.764**	.730**	1	.329**	.834**
	P value	.000	.000	.000	.000		.000	.000
Customer Satisfaction	Pearson Correlation	.659**	.247**	.679**	.247**	.329**	1	.556**
	P value	.000	.000	.000	.000	.000		.000
Customer Loyalty	Pearson Correlation	.638**	.777**	.921**	.835**	.834**	.556**	1
	P value	.000	.000	.000	.000	.000	.000	
	N	340	340	340	340	340	340	340

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3 Regression Analysis of Customer Loyalty and antecedents of Customer Loyalty

Variables	Unstandardized co-efficient	SE of B	Standardized co-efficient	t value	P value
Constant	-0.415	0.079		-5.269	0.000**
Commitment	0.05	0.022	0.045	2.278	0.023*
Service Quality	0.104	0.028	0.088	3.79	0.000**
Service Recovery	0.489	0.034	0.471	14.393	0.000**
Perceived Value	0.244	0.02	0.308	12.144	0.000**





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Trust	0.17	0.026	0.15	6.525	0.000**
Customer Satisfaction	0.052	0.018	0.059	2.915	0.004**

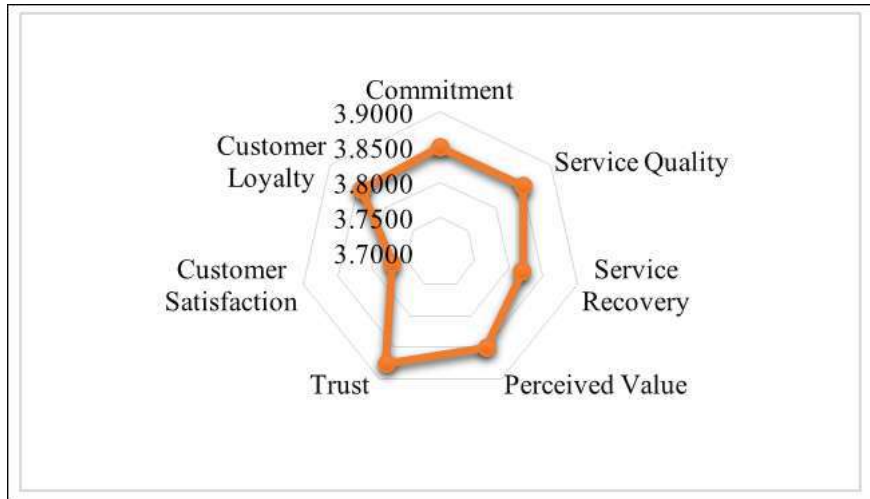


Figure 1. Radar chart showing the average of study variables





HPTLC Analysis and Data Interpretation of Phenolic Compounds of Various Aerial Parts of *Putranjiva roxburghii* Wall. using rTLC an Open source Online Software: A Gateway to Metabolomics

Mamatha Shivalingegowda^{1*} and Manjunath Kiragandur²

¹Research Scholar, Department of Microbiology, Biotechnology and Food Technology, Jnana Bharathi Campus, Bangalore University, Bengaluru, Karnataka, India.

²Professor, Department of Microbiology, Biotechnology and Food Technology, Jnana Bharathi Campus, Bangalore University, Bengaluru, Karnataka, India.

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*Address for Correspondence

Mamatha Shivalingegowda
Research Scholar,
Department of Microbiology,
Biotechnology and Food Technology,
Jnana Bharathi Campus, Bangalore University,
Bengaluru, Karnataka, India.
E.Mail: mamathas@bub.ernet.in



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ABSTRACT

Scientific research in the omics era is fast progressing, and testing of newly developed software tools and creating a pool of databases to enhance dry lab predictive analytical work is gaining momentum. High-performance thin-layer chromatography (HPTLC) is an efficient and reliable analytical tool for phytochemical separation studies. Since the data obtained without an MS interface was rudimentary much of the work with HPTLC has not found much importance in industry and research. The MS interface is expensive, so identifying a software tool, rTLC for the image pre-processing and analysis based on the image obtained during an HPTLC analysis is a tangible alternative. The proper use and generation of a library of images and training the software will allow the software to compare multiple fingerprint data and create a one-stop solution for detecting adulterants in food, pharma, and beauty industries using herbal extracts. *Putranjiva roxburghii* Wall is a tree found in the Western ghats that has recorded bioactive properties like antimicrobial, antioxidant, anti-inflammatory and anticancer. The identification of bioactive active ingredients from this plant has yet to be explored. In this regard, the aerial parts of this plant were subjected to preliminary phytochemical profiling. The methanolic extracts of the various aerial parts were estimated for the phenolic content using the Folin Ciocalteu method and extracts were used to generate a phenolics fingerprint using HPTLC. The results revealed that the highest concentration of phenolics was in leaf methanolic extract 353.14±3.00 mg GAE/g. The HPTLC analysis revealed a higher relatedness between the fruit and pulp secondary metabolites and indicated that UV 254nm is a better visualization parameter for the phenolic fingerprint of the aerial parts of *Putranjiva roxburghii*. The current study has exploited a new tool for the data analysis and interpretation of HPTLC



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data. This can have extensive applications in quality control of herbal products for simultaneous analysis of multiple products.

Keywords: High-Performance Thin layer Chromatography, phenolics, metabolomics, rTLC

INTRODUCTION

Natural product research has gained renewed importance due to changing trends in medicinal science. Modern medicine has become an integrated approach inculcating alternate therapeutic systems and mainstream allopathic treatment. The current trend in medicine involves a synergy of synthetic and natural pharmaceuticals. At times like these, exploratory work on natural products' bioactive components involves the study of plant secondary metabolites. The HPTLC (High-pressure Thin Layer chromatography) analysis is a critical tool in this line of work. Though it is one of the easy-to-use and reliable sources, its applications have been limited owing to the cumbersome data interpretation. HPTLC is a powerful separation technique where multiple samples can be processed simultaneously. *Putranjiva roxburghii* wall is a tropical tree belonging to the Euphorbiaceae family. *Putranjiva* is a medicinal plant exploited for its important fertility enhancement property[1]. Many herbal products in commercial markets do have the leaf, bark and seeds of this tree being used as their principal components. The seed oil of this plant has been used as a potent antifungal agent against *Fusarium*[2] and in seed storage[3]. Extracts from this plant have shown antimicrobial, anti-helminthic, and anti-inflammatory activities[4]. Since this plant finds ample medicinal applications and is a plant whose phytochemical profile is not very well established, in this study, for the first time, the HPTLC fingerprints of the leaf, bark, fruit, pulp, and seed methanolic extracts have been generated and the patterns are clustered and analyzed. Gallic acid is the standard for quantitatively estimating phenolics and fingerprint generation. The methanolic extract is selected for this experiment as the composition and yield of Phyto-compounds in the methanolic extract is high and promising [5].

The HPTLC fingerprints are used for the identification of the impurities in herbal products used in Ayurvedic drugs, this serves as a source of authentication[6]. The data interpreted based on R_f and the peak area are limited due to the non-availability of standard databases for HPTLC profiles. The same tool integrated with Mass spectroscopy helps identify separate bioactive organic compounds [7]. A new approach to understanding the chromatogram can revolutionize this analytical technique. The image generated on HPTLC analysis is subjected to image-to-data conversion using pixel intensities. An R-based software tool rTLC, processes this data. rTLC is a valuable data interpretation tool freely available on GitHub. It is a user-friendly tool that allows uploading the batch data and the image file as a .jpg, or .png file. Post this, the chromatogram dimensions need to be specified. The software then compares the pixel intensities and the color saturation of grey, blue, red, and green colors to generate numerical signal data. This data is further processed using the R package to generate a heat map and cluster map. These indicate the patterns of these secondary metabolites present in the various aerial parts of *Putranjiva roxburghii*. In this study, the leaf, bark, fruit, pulp, and seed samples were subjected to Soxhlet extraction, and preliminary phenolic content estimation was performed using spectrophotometric estimation.[8]. The methanolic extracts of the aerial parts are spotted on chromatograms along with standard compounds to understand the distribution pattern of phenolics in the samples at UV light of 254 and 366nm. The prevalence of the standard in the samples and the comparison of the phytochemical distribution pattern are assessed using rTLC[9]. The cluster dendrogram and the heat map are generated and the peak data is analyzed. This study provides an alternate way into HPTLC fingerprint analysis, this tool supported by the software can be an excellent tool in comparing samples of plants from various geographic distributions and mapping a fingerprint pattern that is prevalent to one plant species. The documentation of this data would allow researchers to investigate the presence of principle components in the herbal formulations and products and check if label claims are authentic. HPTLC can be explored as an effective tool in Ayurvedic and other herbal drug authentication tools. Similar works have been explored to study the various components of honey



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generated from different floral components. This study is a comparative analysis of the quantity of phenolic compounds found in the aerial parts and the fingerprint they generate.

METHODS**Chemicals and Reagents**

Gallic acid and HPLC grade methanol, toluene, acetone and formic acid were procured from Sigma Aldrich, India. FolinCiocalteu reagent, methanol, sodium carbonate and ferric chloride were procured from S.D Fine Chem Limited, India. All chemicals and solvents used for estimation were analytical grade and the HPTLC solvents were HPLC grade.

Plant extract preparation

Putranjiva roxburghii wall plant parts were collected from Sagar taluk, Shivamogga district from their natural habitat (14°07'22.2" N 75°01'06.4E), in November 2018. The sample was authenticated by Dr. K T Prasanna, Professor and Head Curator, Mahatma Gandhi Botanical Garden (accession number UASB 5275), University of Agricultural Sciences, Gandhi Krishi Vigyana Kendra, Bangalore where a voucher specimen was deposited. The material was sorted and the healthy parts were collected in aseptic bags. The leaf, bark, fruit, pulp and seeds were separated and dried in shade for one week. Post drying the samples were grinded using a mechanical blender, coarse powder 50g was taken in a thimble and subjected to hot Soxhlet methanolic extraction at 70° C. The extraction was done for many cycles till a completely colourless solvent is obtained. The solvent extract was subjected to rotary evaporation under vacuum at 55° C till it concentrates, the completely dry sample is refrigerated until further use.

Estimation of total phenolic content

The total phenolic content for individual extracts were determined using Folin -Ciocalteu (FC) method [8]. Briefly 1ml of extracts (20-100µg/mL) was allowed to react with 1mL of FC reagent (10% w/v). After 5 min, 2ml of sodium carbonate (75%) was added with constant mixing. The setup was incubated at room temperature (28°C) for 10 min. Post incubation the absorbance of the extracts against a blank (no extract only methanol) was measured at 765nm. Phenolic content was expressed as mg gallic acid equivalent per gram of dry extract [10].

High performance thin layer chromatographic fingerprint generation for phenolics.

The dry extracts (1mg/mL) are reconstituted with HPLC grade methanol, the samples are subjected to centrifugation and the supernatant was filtered. The extracts were spotted on 10*10 Silica gel 60 F 254 TLC plates as stationary phase using CAMAG® Linomat 5 (CAMAG, Switzerland). The development and visualization were performed using CAMAG® HPTLC system consisting of an automated sampler, TLC scanner 4 and TLC visualizer. The mobile phase used was toluene, acetone and formic acid (4.5:4.6:1). The data processing acquisition and visualization were achieved using Win CATS software. The chromatographic conditions were as follows: tank is 100X 100mm, 20min saturation, Chromatogram application of 2 µL in methanol, at a speed of 150nl/s dosage speed and 0.20µl per dosage volume were spotted.

Image processing and Data Analysis

Post-acquisition of data using win CATS the result of the peak data and RF is generated as a PDF result sheet. The preliminary data from this did not reveal any substance names hence the image generated was subjected to rTLC software to better interpret the results generated.

RESULT AND DISCUSSION**Percentage yield of various extracts.**

Methanolic extracts for all the aerial parts were used in the study, as methanol is considered to be the solvent with the highest efficacy of extracting bioactive phytochemicals [11]. The dry extracts after rotary vacuum evaporation



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and the weight of the plant material used are used to determine the percentage yield of the sample; % yield= (weight of dry extract/ weight of powdered sample used) * 100. The *Putranjiva roxburghii* bark sample resulted in the highest yield at 20.12 ±0.22 % and the seed was lowest yield at 6.08 ± 0.08%(Figure 1).

Total phenolic content of aerial parts of *Putranjiva roxburghii*.

Plant phenolics are important phytochemicals having good antioxidant properties. Gallic acid usually used as a standard phenolic compound has reported antimicrobial, antioxidant and anti-cancer properties [12]. The phenolic content of the *Putranjiva* aerial parts are measured using the Folin-Ciocalteu reagent [8]. The results were derived from the calibration curve of gallic acid (20-100 µg/ml) of $y = 0.0174x - 0.03$; $R^2 = 0.9958$. The total phenolic content of the extracts are expressed as gallic acids equivalents per gram dry weight. The figure 2 indicates a comparative chart of TPC showing leaf extract having highest phenolic content. The tabulation of the TPC calculated from the standard linear regression plot of gallic acid is also represented in the image.

HPTLC Preliminary Data Obtained using WINCATS software

Figure 3. a. The chromatogram as visualised under white light before derivatization; b. chromatogram post derivatization with alcoholic ferric chloride. c. chromatogram under 254nm UV light. d. chromatogram visualised under 366nm UV light. The visualization of the developed chromatogram indicates the banding pattern of the fingerprint generated. Here the lane 1-6 are indicated as leaf, bark, fruit, gallic acid, pulp and seed. The white light is not very conducive for the visualization of the separated phenolic compounds. The visualization under UV at both 254 and 366 short and long UV ranges generate a well-defined banding pattern from which the Rf data is generated. The number of bands generated, Rf and peak area details of the same are indicated in table 1.

The number of bands, Rf and peak area of the phenolic compounds in the aerial parts of *Putranjiva roxburghii* leaf, bark, fruit, pulp and seed as visualised under UV light for the HPTLC chromatograms. The banding pattern and the peak area analysis revealed that at UV 254nm there was better visibility of the separated phytochemicals. Since the standard compound gallic acid was also visible at that wavelength of light the further analysis was conducted for this particular visualisation method only. The data represented in table 1 indicates that the maximum separated phenolics are present in the leaf extract owing to the richness of the variety of the phenolics, it may be deduced that the leaves may have higher medicinal values when compared to the other aerial parts. In bioactive property or individual component study pulp and fruit needs to be worked on as there are lesser compounds so easier will be the separation of individual components. One HPTLC analysis has paved a way into designing the work flow in pharmaceutical explorations from this plant.

The preliminary peak data analysis from an HPTLC chromatogram gives us knowledge about the prominent sharp peaks obtained using a densitometric analysis of the chromatogram and also the area of the peaks indicates the abundance of the distribution of that particular phytochemical. Lane 4 on the chromatogram consisted of Gallic acid and its most prominent area peak at Rf 0.595 indicates the closeness of the obtained Rf to previously published data on gallic acid [13], [14]. From this data we can also comment on the gallic acid likeness in the samples of pulp and seed. Since we do not have a MS interphase identification of compounds is difficult, but this fingerprint will illustrate a pattern of the phenolic composition in the aerial parts.

Image to signal processing

The open-source software rTLC is a user-friendly tool to analyse HPTLC and TLC data. Here the software requires only the batch data and the image files. The image intensity in pixels is converted to signals which is used to perform predictive statistical analysis. The image has to be specified for processing data then the software uses green, red, grey and blue scale of intensity analysis to generate the track peaks. From this the similar phytochemicals based on banding pattern in HPTLC can be grouped together for any explorative study. The clustering based on the banding pattern of the various lanes indicate that the lane 3 (fruit) and 5 (pulp) are more closely related to gallic acid presence. The other three lanes 1 (leaf), 2 (bark) and 6 (seed) are outliers with the bark and seed being more related to each other. This indicates that the distribution of phytochemicals across the various aerial parts is related with the fruit



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and pulp bearing most relatedness. This tool can be highly valuable when we have to compare across more number of samples at one time. If we compare the Rf peak data also we can see that the peaks pattern in fruit and pulp seem most similar and have Rf values that are close to each other. As per Dinakaran *et al.*, the standard compounds gave the following values in HPTLC analysis, Gallic acid -0.51, Quercetin- 0.68 , Rutin- 0.12 and Kaempferol- 0.71[13]. In the current study the prominent peak in gallic acid was at 0.595 indicating similarity with reported Rf from previous report [14]. The three Rf's 0.758,0.752 and 0.765 can be closer to kaempferol or similar derivatives.

CONCLUSION

Changing paradigms in modern medicine, has seen a revolution in the way people all over the world are accepting traditional medicinal practices. The Corona pandemic witnessed a high market demand for herbal health enhancing nutraceuticals. *Putranjiva roxburghii* is one such medicinal plant which has multiple reported bioactivity[15]–[17]. The advancements in the systematic production protocols and quality control parameters have seen an inclusion of herbal extracts and drugs in international pharmacopeia. The next generation medicines, nutraceuticals and beauty products will see a surge in usage of medicinal plants in their products. Since the authentication for the presence of mentioned plants will be a major challenge in the quality control of such herbal products, HPTLC will serve as a powerful and extremely easy to use tool where we can generate and document data and compare the herbal products to check label claims. The Ayurvedic sector has witnessed an irregularity in quality supply owing to adulterations which can be avoided with the help of such analytical techniques.

All previous studies of HPTLC have only been able to compare the phytochemical compounds with standards and give a comparative data[13], [18]. In the current study we have compared the peak intensities and generated a clustering and indicted the metabolic relatedness of the aerial parts of a plant as well as the standard gallic acid used. The rTLC tool is a well written R based tool which has packages for the analysis of HPTLC data[9]. If all HPTLC performance results can be pooled into a database and used to train rTLC we can also identify the compounds separated on the chromatograms. Predictive statistical analysis offers a different perspective for chromatographic data analysis. One single HPTLC chromatogram has rich data generation more statistical analysis can further be performed on the data set generated which can revolutionize natural product research.

The current study is a reporting of the preliminary analysis and more statistical and analytical comparisons of the secondary metabolites is the future scope of this work. A library of the fingerprint data of the various aerial parts of *Putranjiva roxburghii* phenolics is generated for the first time and since the leaves, bark and seeds are used in many herbal drugs this data can be used for the authentication purposes. The quantitative estimation revealed that the leaves of the *Putranjiva* has highest phenolic content when compared to the other aerial parts. In conclusion the phenolic content estimation and the fingerprint generation in this work is going to serve as a benchmark for authenticity verification and metabolomics studies of the various plant parts. *Putranjiva* aerial parts were isolated from a native habitat in this study, and this also makes way for the comparative exploration of metabolite richness in native species when compared to commercially reared plant species.

CONFLICT OF INTEREST

There is no conflict of interests in the current work.

AUTHOR CONTRIBUTIONS

MK has conceptualized and proof read the work, MS has planned and executed the experimental.



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Table 1: HPTLC chromatogram data of *Putranjiva roxburghii* aerial parts.

Sample	UV at 254nm			UV at 366nm		
	No. of bands	Rf	Peak area %	No. of bands	Rf	Peak area %
Leaf extract	10	0.023,0.081,0.131, 0.181,0.353,0.640, 0.692,0.750,0.768, 0.974	0.14,5.95,16.32, 15.59,5.58,16.75, 2.13,7.39,13.31, 16.84	04	0.737,0.777 0.892,0.990	2.76,19.68 11.07,66.48
Bark extract	07	0.037,0.155,0.194 0.348,0.556,0.765, 0.966	0.52,3.39,2.23, 30.05,18.01,30.97, 14.83	03	0.774,0.932 0.989	68.32,24.09 7.59
Fruit extract	06	0.011, 0.076,0.179 0.345,0.758,0.984	0.80,3.23,6.87 4.84,55.17,29.10	03	0.777,0.834 0.987	54.68,15.73 29.59
Gallic acid	03	0.595, 0.765, 0.964	61.79,13.30, 24.91	-	-	-
Pulp extract	03	0.082, 0.181, 0.752	6.16, 28.98, 64.86	04	0.761,0.779 0.934,0.989	8.59, 22.10 16.27,53.04
Seed extract	07	0.087, 0.195,0.347 0.660,0.718,0.760, 0.950	1.12, 3.50,3.22, 31.59,16.29,35.56, 8.72	03	0.782,0.835 0.931	63.10,30.28 6.63

Table 2: The Rf values of the fruit, pulp, and gallic acid for comparison

Sl.No	Rf of Fruit extract	Rf of Pulp extract	Rf of Gallic acid
1.	0.011	0.082	0.595
2.	0.076	0.181	0.765
3.	0.179	0.752	0.963
4.	0.345		
5.	0.758		
6.	0.984		

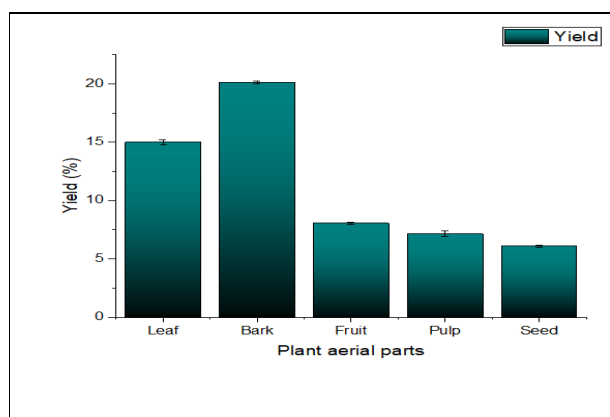


Fig1: Comparison of the percentage yield of the methanolic extracts of the aerial parts of *Putranjiva roxburghii* Wall.

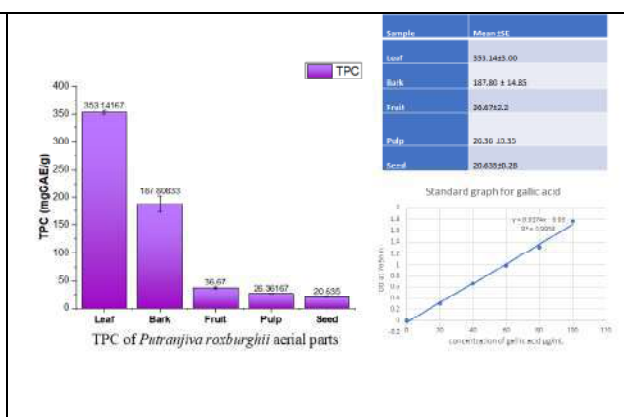


Fig 2: Estimation of the Total Phenolic Content(TPC) in the aerial parts of *Putranjiva roxburghii* Wall





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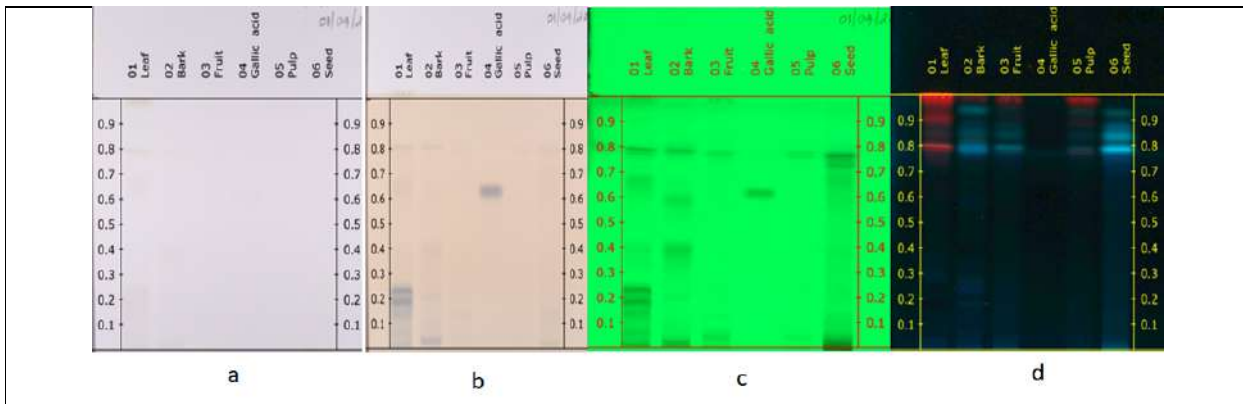


Fig 3: The HPTLC chromatograms of the phenolic compounds using toluene: acetone: formic acid (4.5:4.6:1).

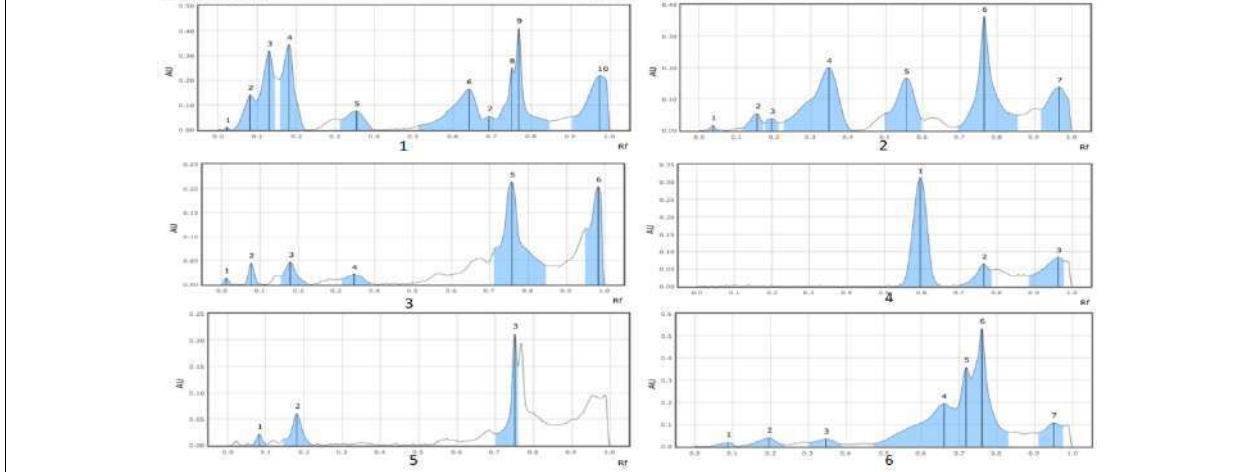


Fig 4: The HPTLC peak data of phenolics of aerial parts of *Putranjiva roxburghii* at 254nm.

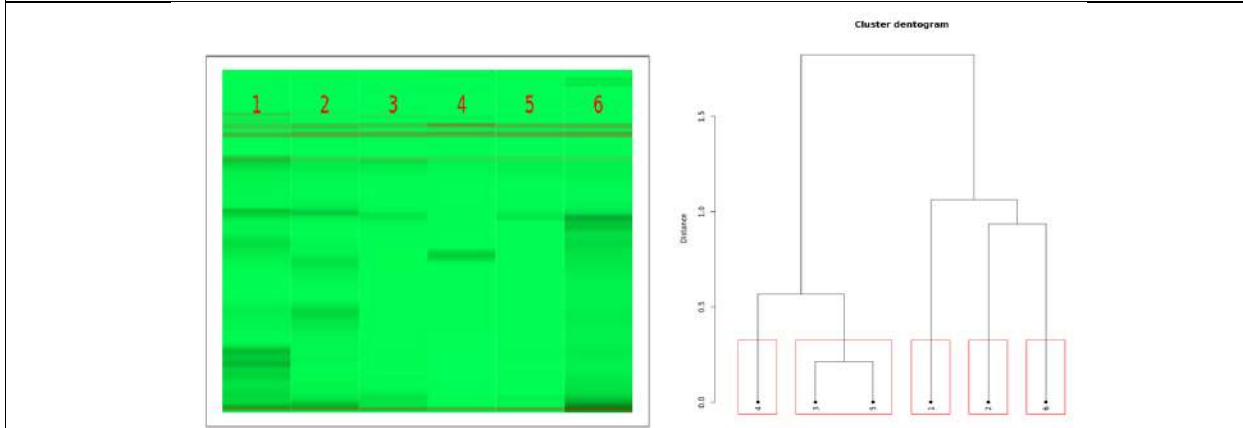


Fig.5. HPTLC of the Methanolic extracts of the aerial parts of *Putranjiva roxburghii* using rTLC. a. Chromatogram comparison of the various lanes spotted, 1=leaf extract;2= bark extract ;3= fruit extract; 4= gallic acid; 5= pulp extract; 6= seed extract. b. The dendrogram indicating the metabolic relatedness of the samples spotted based on the banding patterns.





Family Business Leadership: A Thematic Analysis on Scientific Approaches

Nataraj R.T^{1*} and Mousumi Sengupta²

¹Research Scholar, Department of Management Studies, SDM RCMS, A Recognised Research Centre of University of Mysore, SDM Institute for Management Development (SDMIMD), Mysore, Karnataka, India.

²Professor, OB and HRM, Department of Management studies, SDM Institute for Management Development (SDMIMD), SDM RCMS, A Recognised Research Centre of University of Mysore, Mysore, Karnataka, India.

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*Address for Correspondence

Nataraj R.T,

Research Scholar,

Department of Management Studies,

SDM RCMS, A Recognised Research Centre of University of Mysore,

SDM Institute for Management Development (SDMIMD),

Mysore, Karnataka, India.



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ABSTRACT

Many studies have documented the importance and contribution of family businesses to the economy in terms of job creation and tax revenue. Scholarly papers on the family business shed light on the challenges and issues that family-owned enterprises face, such as leadership succession, conflict management, and succession planning. The purpose of this article is to provide an overview of theoretical models for leadership succession in family businesses and discuss scientific approach to leadership that can be adopted to ensure the long-term success of a family business. This article seeks to provide information on the leadership problems that family businesses confront, as well as a brief overview of the various leadership styles used in family businesses. The elements affecting leadership succession from one generation to the next are discussed in this article. The paper suggests a few possible areas for future research on family business leadership.

Keywords: Family-owned business, Family Firms. Leadership, Leadership skills, Succession Planning, Conflict.





INTRODUCTION

Family Business

Today's world economy recognises family-owned firms as significant and unique businesses. TATA, TVS, and Kirloskar, among others, are examples of family-owned businesses. But how to know if a company is owned by a family? In answering these questions, there are numerous definitions proposed. Three of the most representative are:

1. "A business in which two or more extended family members influence the direction of the business" (Davis and Tagiuri 1985);
2. "A system that includes the business, the family, the founder, and such linking organisations as the board of directors" (Beckhard and Dyer 1983); and
3. "A business governed and/or managed to intend to shape and pursue the vision of the business held by a dominant coalition controlled by members of the same family in a manner that is potentially sustainable across generations of the family" (Chua *et al.* 1999).

Family businesses, like any other type of business, encounter numerous hurdles. The replacement of the Chief Executive Officer (CEO) or management with another is one of the most challenging problems a family business encounters (Handler 1994). Because most such enterprises remain in the family, and families do stay in their businesses, this replacement frequently occurs between generations of family members (Barnes and Hershon 1991). Because hereditary succession is so important to a family business's longevity, it must be handled properly (Barnes and Hershon 1991). The question is how to ensure that it is effective. Certain cultural configurations in family businesses, according to Dyer (1986), tend to establish the conditions that assist the transition's success and secure the firm's long-term existence. Furthermore, it is common for business leaders to establish and change such structures (Dyer 1988). The role of these leaders in achieving a smooth transition has been thoroughly researched. Many studies have highlighted what family business executives should and should not do to ensure a successful transition (Longenecker and Schoen 1991; Handler 1989). However, no study has yet identified which family-business CEOs might act in this manner.

Leadership in Family Business

Planning for succession is one of the hallmarks of excellent leadership. A firm is doomed if it is intimately attached to one key individual and has not been planned for survival beyond that individual's involvement. True leaders understand the need of establishing a system that secures the company's success after they leave the business. While this is true in any organisation, it is especially critical in privately held businesses, where succession might refer to either management or ownership changes or both. When the family element is added to it, it's clear that strong leadership is required to secure the company's long-term success. Dyer released a study in 1986 that has now become a classic in the field of family business research. Dyer's research sheds light on the many styles of leadership found in family enterprises. He classified approximately 40 family enterprises into four cultures after studying them. Dyer's description of each culture depicts a distinct style of administration. Even though he did not name the behaviour as leadership, the titles he chose for two of the four cultures – participatory and laissez-faire – are often used to describe leadership styles. Furthermore, Dyer adequately depicts family management behaviour to infer the sort of leadership in each culture. To gain a better understanding of the importance of leadership in family businesses and to develop a deeper understanding of leadership in family businesses, more research on leadership styles, challenges in leadership succession, the role of the leader in succession planning, and conflict management has been conducted in this study.

Objectives of The Study

The purpose of this article is to examine the evolution of theoretical models of leadership and scientific approaches to leadership succession in family-owned businesses. This article aims to look at some of the most important leadership difficulties and issues that family businesses encounter. In addition, different leadership styles that are common in family businesses are investigated. An attempt has been made to comprehend the distinctiveness of family business





leadership from non-family business. This thematic analysis focuses on identifying the gap in existing literature and opportunities for future studies in family business leadership.

METHODOLOGY

The study began with the identification of relevant journal articles through an appropriate selection method, keeping the quality of the journals and thesis in mind, to gain a better grasp of the subject of family business leadership. The procedure for selecting, grouping, and reviewing material is as follows:

1. The selection procedure was aimed at reducing the enormous number of family business publications to a reasonable number of studies while keeping the article's relevance and time constraints in mind. The published papers surrounding the core issues of family business and leadership within family business were searched in the literature available through the end of 2022.
2. Google is used to find relevant material from reputable sites such as Emerald Insight, Google Scholar, Science Direct, and Pro Quest. A manual keyword search was undertaken in each article (as an Adobe PDF).
3. After filtering the search results, papers discussing the key phrases were gathered for further study. Following that, significant papers about family business leadership were separated and qualitatively analysed to determine the present state of research on family business leadership. The outcomes of the attempt to identify the gaps in current literatures are presented in the following sections.

Theoretical Models for Leadership Succession

Most representative theoretical models for leadership succession in family businesses are discussed below.

1. **The Three-Circle Model of Family Business:** The three circles of family, ownership, and management that intersect in a family business are described by Tagiuri and Davis' (1996) model. The process of succession planning entails locating and controlling the intersections of these circles. The concept underlines how crucial it is to match family values with organisational goals and managerial skills.
2. **The Resource-Based View of the Firm:** According to this theoretical framework, which Barney (1991) established, businesses can attain long-term competitive advantage by utilising their distinctive resources and competencies. This approach contends that the family's social and human capital can be used to gain a competitive edge in the context of family business succession. Planning for the family's particular resources and skills should take priority in the succession process.
3. **The Stakeholder Theory of the Firm:** According to Freeman's (1984) theoretical framework, businesses must take into account the interests of all stakeholders, not only shareholders. This model advises family members to take into account the interests of all stakeholders, such as employees, clients, and the larger community, while planning the succession of a family firm. Planning for succession should concentrate on building a long-lasting company that balances the interests of all stakeholders.

These theoretical models can provide a useful framework for family businesses to approach leadership succession. By considering the unique dynamics of family businesses and leveraging the family's resources and capabilities, family businesses can ensure a successful transition of leadership and create a sustainable business for future generations.

Scientific Approach to Family Business Leadership

Scientific leaders guide and inspire by influencing knowledge with their thinking and ideas. Scientific leaders create new technologies, undertake research and writing, teaching and so on. Their ideas tend to be well thought-through, supported by data and analysis, and logical. These people develop structure and frameworks that help others solve problems. To ensure the long-term success of a family business, a scientific approach to leadership should be adopted. This approach should incorporate the following elements:

1. **Strategic planning:** Family businesses need to create a long-term strategy that describes their aims and objectives. To make sure that the firm stays on course, this plan should be constantly evaluated and modified (Basco, R., 2018).





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2. **Professional development:** To guarantee that family members who are active in the business have the abilities and information essential to make wise business decisions, they should undergo training and professional development (Chrisman, J. J., Chua, J. H., & Steier, L. P., 2020).
3. **Governance structures:** Family enterprises should set up clear governance structures that define decision-making procedures as well as family member roles and obligations. To make sure that these structures continue to function effectively, regular reviews and updates should be conducted (Craig, J. B., Moores, K., & Moores, A., 2014).
4. **Conflict resolution:** For the purpose of settling disputes that emerge between family members, family enterprises should develop explicit procedures. The best interests of the business should come first in these procedures, which should be impartial and fair (Gómez-Mejía, L. R., Cruz, C., Berrone, P., & De Castro, J., 2011).
5. **Succession planning:** A succession plan that specifies how the company will be handed on to the following generation should be created by family firms. To make sure that this strategy remains relevant, it needs to be frequently reviewed and modified (De Massis, A., Frattini, F., Pizzurno, E., & Cassia, L., 2021).

In conclusion, family firms play a crucial role in the global economy, but they also provide special leadership problems. A scientific approach to leadership that combines strategic planning, professional development, governance frameworks, conflict resolution, and succession planning should be used to address these issues. By using this strategy, family businesses may guarantee the longevity of their operations and safeguard their legacy for next generations.

Review of Literature on Leadership In Family Business

This section presents the review of literatures pertaining to family business leadership and discusses the topic from different dimensions like distinctiveness from non-family business, succession planning, various leadership styles, developing next generation leadership, founder's centrality, conflict within family business.

Leadership in Family Business and Non-family Business

One of the strong features or benefits of family enterprises over non-family firms, according to Tagiuri and Davis (1996), is the prevalence of common beliefs, values, and visions. This advantage enables family businesses to have a distinct identity and a strong sense of accomplishment in the purpose they intend to pursue, as well as to focus their efforts on what they do best, establishing competitive competencies (Ibrahim & Ellis, 1994). This could be the difference between a family firm and a non-family business when it comes to developing leadership skills. Manuel Carlos Vallejo (2009) researched to see whether there are variations in leadership between family and non-family organisations that use transformational leadership, as well as the potential benefits of transformational leadership for enterprises. They concluded that leadership in family businesses is more transformational than in non-family businesses. According to Aldrich and Cliff (2003), attempts have been undertaken to study the leaders' leadership styles as well as their relationships with other family and non-family members.

Leadership Succession

One of the most critical variables in the sustainability and longevity of family-owned and operated businesses is succession planning. Succession is more than just passing the executive position from one generation to the next; it also encompasses the company's leadership structure and the type of generational shift the family business is undergoing. Controlling owner, sibling partnership, and cousin consortium are examples of ownership arrangements that evolve with the family's generational phases (Lansberg, 1999). Leadership succession has traditionally been viewed as an intra-family process that must be meticulously planned and implemented to enable a seamless and advantageous transition to the next generation (e.g., Cabrera-Suarez *et al.*, 2001). However, because of the Covid-19 health and economic consequences, a large number of senior family business leaders have died or will leave the company sooner than expected, either intentionally or inadvertently, due to a deteriorating environment that will necessitate new perspectives and stamina. Current demographic difficulties are increasing family business members' awareness of mortality, which has significant consequences for the management of succession, which is more likely to occur in an unexpected, quick, and unplanned manner. Families in business must also explore alternatives to intra-family successions, such as external succession, business growth, or business shutdown, as a



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result of the upheaval. As a result, researchers De Massis, A. V. & Rondi, E. (2020) believe that family business research should complement the view of succession as a planned process by looking into the mechanics and ramifications of rapid generational succession, as well as more varied types of succession.

Leadership Styles and Developing Next Generation Leadership

Aronoff and Ward (1992) discussed the value of developing leadership skills in future successors. Its objective was to assist founders in preparing successors who would not only continue their legacy but also revitalise the long-term objectives of the family firm. They noticed that because most family firms find it difficult to produce new leadership, it appears to be a low priority in most of them to develop future leaders. Business owners usually fail to adequately prepare their children for the work even when they intend to pass their company on to them.

One of the keys to a successful business transfer from one generation to the next is preparing potential successors. Aronoff and Ward did not address the founder's explanations on why potential successors were not properly prepared (1992). It may be considered that the founders have what is required to manage a successful firm because they have established they have these talents through the expansion of their businesses. What therefore makes it so difficult for many family business leaders to choose or even pass on their knowledge, expertise, and business savvy to their chosen successors? One location to search for a solution to this issue is the founder's style of leadership.

Succession planning may be simpler for founders who use particular leadership philosophies than for others. If this is the case, founders might learn about these leadership philosophies, which would put them at ease when it comes to succession planning. Sorenson (2000) looked into how the leadership philosophies of family company owners affected the prosperity of both the business and the family. Sorenson (2000) based his leadership styles on Dyer's (1986) study of family business cultures. Participative, autocratic, laissez-faire/mission, expert, and referent were the five leadership styles.

- Autocratic leaders have complete control over all essential information and decision-making authority, and they are averse to sharing their power.
- Participative leaders are focused on the group and build trusting relationships. Status and power aren't as essential to them as they formerly were. Leaders who value the opinion of family and nonfamily staff and consistently evaluate them were found to have a good performance on both family and business dimensions.
- Laissez-faire/mission leaders have a high level of trust in their people, share authority, make decisions jointly, and achieve goals as a team. Employee commitment was boosted by laissez-faire/mission leadership.
- Expert leaders are promoted to positions of leadership because they are experts in a certain field or possess a specific competence.
- Referent leaders are charismatic leaders with a desire to please people and a great regard for them. Referent leadership had a favourable impact on employee satisfaction and family results.

However, no definitive findings were found in this study on the influence of different leadership styles on performance in family or business dimensions, indicating that more research is needed. Why do founders use diverse leadership styles? Research on personality features and beliefs on the proper power gap between family and non-family members may shed light on why they do. Furthermore, a better knowledge of founders' long-term objectives in terms of family and business performance may impact their management and leadership styles, as well as any observable differences in these styles over time. The stage of life that an individual, family, and business are in may have an impact on the founders' observed leadership style. Donata Mussolino and Andrea Calabro's (2013) research shows how predecessors' paternalistic leadership styles influence successors' attitudes, subjective norms, and perceived behavioural control in family businesses, as well as the extent to which these factors influence a successor's perceptions of the quality of the succession process. Hsi-Mei Chung and Shu-Ting Chan (2012) claim that their findings show that the ownership structure of the affiliate firm increases the chance of family leadership being used. Family leadership has a beneficial effect on business performance when it comes to direct family ownership but has no effect on the negative association between pyramidal ownership and business performance.



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Marques (2007) studied seven leaders and their traits to better understand the necessary characteristics of a successful leader in an organisation. Marques encouraged students to consider three questions when analysing each leader:

- How do the leader, the follower, and the situation relate to one another?
- What are the positive and negative characteristics of each leader?
- What distinguishes each of the leaders?

The leadership-trait paradigm, the leader-behaviour paradigm, and situational leadership theories are among the hypotheses examined in the study. Although each leader had varying amounts of attributes, they all shared features like confidence, hard work, empathy, risk-taking ability, communication, strategic thinking, intelligence, and determination. Even though all of the attributes were discovered to be identical, Marques identified one trait that indicated the level of success of each leader: passion. All of the other characteristics were impacted by passion, which distinguished exceptional leaders from the rest. This learning may be adopted by family businesses, and passion may be identified as a significant aspect in the succession of family business leadership.

Rahael (2012) investigated the influence of “internal family social capital in the interactions between the two Co-CEOs” in a family-owned and operated business. He concentrated on two primary theories of shared leadership: dyadic interactions and shared leadership. Rahael discovered that the family foundations' level of values and cohesiveness contributes to its success. Eleni T. Stavrou (2003) looked into the personality types of leaders and how they affect family business succession. The authors put Dyers' cultural framework and Jungian personality notions to the test in a study of family enterprises in Cyprus. As a result, they uncover certain common features of leader personality and business culture concerning transition success, which could serve as the foundation for future research. DeNoble *et al.* (2007) interviewed top family business executives to learn about the abilities and tools needed to succeed as a leader. Many ineffable traits, such as perseverance and dedication, were mentioned by the leaders. In the development of a family business, factors such as self-efficacy, business structure, and degree of education were crucial. Leaders, on the other hand, emphasised the importance of passion, perseverance, and other life-experience attributes. The incorrect people may be chosen to head a family business if they lack specific abilities and attributes.

Founders' Centricity

Family business literature acknowledges the significance of founders. The majority of family business owners desire to maintain family control once they retire (e.g., Astrachan, Allen *et al.*, 2002). Due to their anchoring function within the organisation, lengthy tenures, and crucial roles in their families and businesses, organisational leaders have been viewed as having a significant impact on the culture, values, and performance of their enterprises (Collins & Porras, 1996; Kelly, Athanassiou, & Crittenden, 2000). Various research has revealed that there are various sorts of founders, such as parallel, serial, and novices (Alsos & Kolvereid, 1998). The parallel founders are methodical in their operations, performing one action at a time in sequential order. These entrepreneurs wait until their businesses have a good chance of succeeding before investing a lot of money and dedicating themselves to full-time labour (Alsos & Kolvereid, 1998). Serial entrepreneurs, on the other hand, put in more work during the startup phase than parallel entrepreneurs. In comparison to parallel or beginner founders, they also dedicate more time as full-time employees from the start of a business and seek financial support earlier. Parallel founders, on the other hand, are known to be more successful than serial owners and to attract more finance (Alsos & Kolvereid, 1998). Finally, inexperienced business founders begin the same way as their more experienced counterparts when it comes to business gestation. While inexperienced founders commit more time to the start-up phase, they devote more work to the final stages of the gestation process. Unlike parallel and serial founders, beginner founders work alone and only hire personnel when needed. However, when compared to parallel founders and serial founders, they are less likely to launch a firm (Alsos & Kolvereid, 1998).



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Family businesses confront several hurdles, regardless of the type of founder. Important hurdles are listed below

- A. Family businesses led by founders may be overly reliant on the founders' management and leadership. If the founders die, the company can quickly become non-functional if the successors are unable to carry on with the firm. If there is a lack of preparedness before moving firm ownership and management to new generations, the same difficulty is expected (Bamford, Bruton & Hinson, 2006).
- B. Due to a lack of managerial skills, personnel management skills, and risk management capabilities, business family founders frequently encounter significant issues when their enterprises reach unmanageable levels of growth (Kansikas & Kuhmonen, 2008).
- C. The leadership styles and personal traits of the founders might have an impact on succession planning and management (Alvarez, Sintas & Gonzalvo, 2002). When the styles of employees and successors are incompatible, this might be a huge roadblock.
- D. The strong family networks of business owners might be a hurdle when it comes to hiring unqualified relatives to work in the businesses. Business failures and grief for affected families are caused by a lack of skills (Ranja, 2003).

In their paper, Louise M. Kelly, Nicholas Athanassiou, and William F. Crittenden (2000) looked at how family business founders' impact strategic management. The authors argue that it is critical to examine the founder's major effect on the top management group as well as the firm's strategic principles, goals, and behaviour. From a social network approach, the authors investigate the key role that a founder plays in a family business and provide the groundwork for the founder centrality notion.

Conflict Management

As many family businesses will be handing over leadership from one generation to the next in the coming years, the likelihood of family disputes will be significant. Family conflicts are an undesired aspect of running a family business. Galagan (1985) believed that family-owned businesses were particularly vulnerable to conflict because they were typically the battleground between two strong social systems. The success or failure of the company is typically decided by the competition between the family and business systems. In first-generation family enterprises, disagreements and problems among family members are inescapable, but the risk of conflict seems to increase when concerns about succession planning come up. Family members who work together in a family-owned firm may clash for a variety of reasons. According to Bentayou (1999), deciding how to share the company's financial, leadership, and legal duties among future generations is the root of some of the most controversial challenges in family-owned enterprises. There must be decisions made about who receives the funds, who receives the stock, who receives the leadership, who receives the power, and who is left out. In addition to a family's failure to agree on how to allocate resources and responsibilities, other conflicts may occur during the succession process as a result of unresolved family disputes, communication issues, different expectations, role confusion, and an unwillingness to shift roles (Freudenberger, Freedheim, & Kurtz, 1989). Founders of family businesses should also keep in mind that some of history's worst leaders were picked by birth rather than merit (Augustine & Adelman, 1999). As a result, it may be necessary for business owners to establish standards for family members who want to work in the company or take over leadership (Groshong, 1998). To minimise some of the possible complications that can develop when family members also become employees and business partners, founders will need to set those standards on paper and keep to them.

CONCLUSION AND FUTURE DIRECTIONS

When a new generation of leadership is required in a family business, a paradigm shift from old to new leaders is required. Older generation leaders have a more power-based leadership style and find it difficult to let go of it. This could make it difficult for the incoming CEO to fully take over the company. When ageing leaders continue to lead, leadership becomes uncertain for employees, which may have a negative impact on the organisational structure and performance. For family business leaders, understanding the need for changing leadership styles and the potential of empowerment-based leadership is critical. Though scholars have attempted to understand different leadership styles





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present in family businesses, no definitive findings were found in these studies on the influence of different leadership styles on performance in family or business dimensions, indicating that more research is needed. Future studies may be aimed at answering questions like: Why do founders use diverse leadership styles? Research on personality features and beliefs on the proper power gap between family and non-family members may shed light on why they do. Furthermore, a better knowledge of founders' long-term objectives in terms of family and business performance may impact their management and leadership styles, as well as any observable differences in these styles over time. The stage of life that an individual, family, and business are in may have an impact on the founders' observed leadership style. Researchers may explore the influence of common features of leader personality and business culture on family business transition success, which could serve as the foundation for future research. Even though numerous scholarly papers emphasise the need for excellent management and leadership in family businesses, leadership has received less attention in the literature on family businesses than themes such as secession planning and conflict management. For family business owners, consultants, and academics in this subject, further studies to create a deeper understanding of family businesses and real applications of leadership theories to the management of family enterprises are valuable.

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Impact of COVID 19 Lockdown on QoL and Mental Health in Adolescents: A Literature Review

Advita Neville Deepak^{1*}, Shumaila Hasan², Madhavan G Iyenger³ and Bhavana Gadhavi⁴

¹Ph.D Scholar, Associate Professor, Parul Institute of Physiotherapy, Parul University, Vadodara, Gujarat, India.

²MPT Scholar, Parul University, Vadodara, Gujarat, India.

³Professor, Parul Institute of Medical science and Research, Parul University, Vadodara, Gujarat, India.

⁴Principal, Parul Institute of Physiotherapy, Parul University, Vadodara, Gujarat, India.

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*Address for Correspondence

Advita Neville Deepak,

Ph.D Scholar,

Associate Professor,

Parul Institute of Physiotherapy,

Parul University,

Vadodara, Gujarat, India.

Email: advita.deepak@paruluniversity.ac.in



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ABSTRACT

The recent COVID-19 pandemic related lockdown brought about unprecedented changes all over the World. The current homeschooling style was generally considered acceptable by the students, parents and teachers in India due to COVID – 19 pandemics. Many research studies says that in school going adolescents due to long time use of computer in online classes and health related changes as observed by parents. In physiotherapy research study task oriented exercises has proved good effect in adult but there are lack of evidence of task oriented exercises on school going adolescents to study the effect of task oriented exercises on health in school going adolescents. We searched PubMed and Google scholar for take an evidence article which proves that task oriented exercises are beneficial for improving health in school going adolescents. Total 65 articles were search which includes a physiotherapy treatment use to improve adolescents health. And by screening articles were exclude remaining 10 articles were re-read and excluded with reason which has not clear findings and not relevant methodology. A total of 19 studies were finally included in the review. We include article related to effect of task oriented exercises on adolescents. According to the researches proves that task oriented exercises are beneficial on improving health in adolescents.

Keywords: Home schooling, Adolescents health risk, Task oriented exercises



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INTRODUCTION

The 2019 novel corona virus disease first broke out in Wuhan , Hubei provision , China on 31st December 2019 and it was later declared an International public health emergency by the World Health Organization. Home confinement was implemented nationwide in India in response to corona virus disease 2019 (COVID 19) pandemic [1]. Consequently all school aged adolescents received homeschooling from the beginning of the 2020 spring semester. Given the length of home confinement period, homeschooling was considered both effective under the circumstances. Unlike the conventional homeschooling style was applied in other countries, where parents, relative or other knowledgeable persons act as an instructor and conduct basic education at home , the Indian homeschooling style combination of live/recorded broadcasts , group communication and software based homework submission[2]. All school subjects are taught online , including the major subjects of language , science and math and the minor subjects of morality , music, art and gym also more time spent with family ,virtually with friends , using more social media[3] Descriptive characteristics in the 1264 participants. Among the participants, 474 (37.5%) children were in Wuhan city , 498 (39.4%) were in grade 2 or 3 and 707 (55.9%) were boys. The average age was 9.81 year old (range 10-19). A percentage of the adolescents(41.8%) took physical exercise more than 2 days a week for over 60mins during the home quarantine[4] Perhaps the most significant impact of technology use is the impact on their mental, social , emotional , cognitive (i.e health) in adolescents.[5]. Accime spent withholding to the Council on Communication in Media (2011) media use is associated with sleep issues, aggressive behavior and attention issues in adolescents.

Grusser, Thaleman & Griffiths noted excessive use causes aggressive attitude and behavior. Bavelier *et al.* noted it changes arousal level and mood. Numerous researchers including Lebow Uribe reported excessive media and technology use leads to isolation. Isolation can lead to depression which has been reported by Jang, Hawang & Choi[6]. It can also lead to dissociative symptoms according to Boxoglan, Demirer. Several research studies have reported mental overload . Rowan reported excessive technology use can impact youth sense of identity as well since they can no longer separate the real world from the make believe world. Misra and Stokols reported excessive technology use can have negative behavioral psychological impacts [7]. Much of the research on widely used consumer technologies in youth on television viewing and children since the television has been readily available since the 1950s. Negative effect have been observed with excess use. Lilliard found TV viewing has a negative effect on enterprise skills in adolescents. According to the University of Leicester enterprise skills are key skills in adolescents need in life such as motivation , initiative , creativity , individuality , the ability to get along with other and strategic thinking. Lilliard found just nine minutes of viewing caused immediate negative effect on these enterprise skills in adolescents [8]. Thus there is evidence to support the effectiveness of exercise intervention on health in school going adolescents. Activities based intervention are strategies that uses functional task to improve health .Studies that assessed the effectiveness of school based physical activity program on improving health in adolescents. Selected interventions that included an additional physical activity program and not only physical education[9]. There is increasing number of scientific evidence of the positive effect of physical activity (Strong et al 2005; Physical Activity and Guideline Advisory Committee,2008) on the physical and mental health in children and youth. Considering the current situation , it is necessary to increase the volume (frequency, intensity or duration)of physical activities in all age group (Cvejic,2012) and especially those types of activities that will contribute to the development of health related fitness. There are numerous program in the world for increasing physical activity and improving health related fitness of children and adolescents, school based, family based program of local or wider community , on line program.[10]

Objective

To access the literature of effectiveness of task oriented exercises on mental health of adolescents during COVID 19 lockdown. To access the literature of effectiveness of task oriented exercises on quality of life during COVID 19 lockdown.



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METHODOLOGY

Preferred Reporting Item for Systematic Review and Meta-analysis We searched PubMed and Google scholar for take an evidence article which proves that task oriented exercises are beneficial for improving health in school going adolescents. Total 103 articles were search which includes a physiotherapy treatment use to improve adolescents health. And by screening articles were exclude remaining 47 articles were re-read and excluded with reason which has not clear findings and not relevant methodology. A total of 19 studies were finally included in the review. Firstly all 103 articles were found which are related to positive effect of task oriented exercises on health .Then which are not relate with each other and conclusion is not positive that all are excluded from review and after the entire factor which have to included review that total number of article are 19. We include article related to effect of task oriented exercises on adolescents. According to the researches proves that task oriented exercises are beneficial on improving health in adolescents.

DISCUSSION

All school aged adolescents received homeschooling from the beginning of the 2020 spring semester. Given the length of home confinement period, homeschooling was considered both effective under the circumstances. Unlike the conventional homeschooling style was applied in other countries, where parents, relative or other knowledgeable persons act as an instructor and conduct basic education at home , the Indian homeschooling style is a combination of live/recorded broadcasts , group communication and software based homework submission[2]. All school subjects are taught online , including the major subjects of language , science and math and the minor subjects of morality , music, art and gym also more time spent with family ,virtually with friends , using more social media[3] Descriptive characteristics in the 1264 participants. Among the participants, 474 (37.5%) children were in Wuhan city, 498 (39.4%) were in grade 2 or 3 and 707 (55.9%) were boys. The average age was 9.81 year old (range 10-19). A percentage of the adolescent (41.8%) took physical exercise more than 2 days a week for over 60mins during the home quarantine.[4] Perhaps the most significant impact of technology use is the impact on their mental, social , emotional , cognitive (i.e health) and functional capacity in adolescents.[5]. Accime spent withholding to the Council on Communication in Media (2011) media use is associated with sleep issues, aggressive behavior and attention issues in adolescents. Grusser, Thaleman & Griffiths noted excessive use causes aggressive attitude and behavior. Bavelier *et al.* noted it changes arousal level and mood. Numerous researchers including Lebow Uribe reported excessive media and technology use leads to isolation. Isolation can lead to depression which has been reported by Jang, Hawang & Choi[6].

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CONCLUSION

COVID 19 is worldwide disease which spread throughout the world and according to this literature review task oriented exercises are useful for school going adolescents to improve their mental health and quality of life

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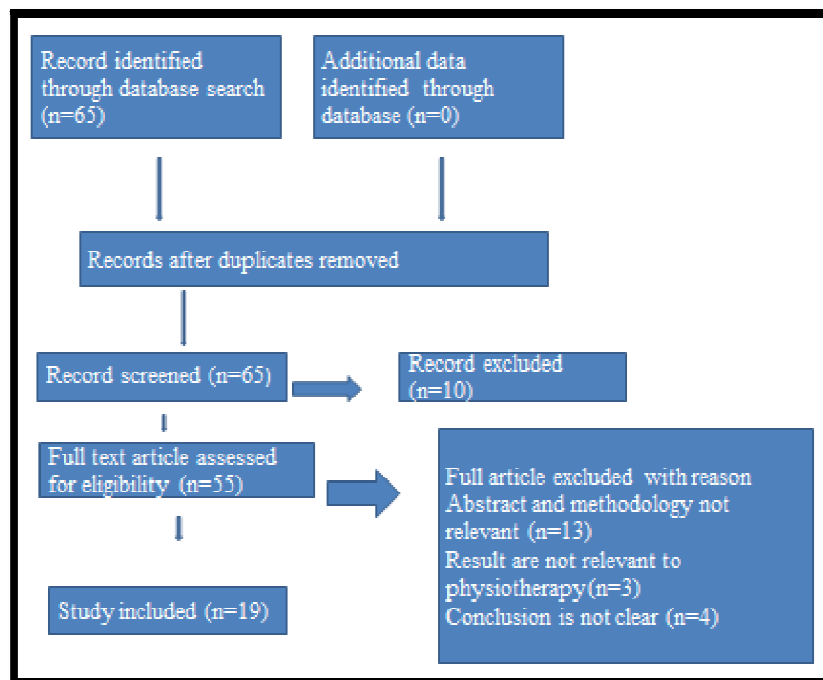


Figure 1 : PRISM flowchart





The Microbial Biosynthesis of α -Amylase: a Review

Bhimana Sasisdhar^{1*} and Ravindran Saravanan²

¹Research Scholar, Department of Pharmaceutics, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India

²Professor in Department of Pharmaceutics, Bharath Institute of Higher Education and Research, Chennai, Tamil Nadu, India

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*Address for Correspondence

Bhimana Sasisdhar

Research Scholar,
Department of Pharmaceutics,
Bharath Institute of Higher Education and Research,
Chennai, Tamil Nadu, India.
E.Mail: bhimanasidhar@gmail.com



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ABSTRACT

Amylase is one of the most important enzymes, serving various roles in research and industry. α -*amylase* is often produced by microorganisms such as bacteria, fungi, and yeast. Because of the increasing demand for α -*amylase*, its biosynthesis could be boosted by using genetically modified organisms, new brewing techniques, less expensive and high-quality carbon, and nitrogen sources, and optimizing the many process parameters during fermentation as temperature, pH, and fermentation time. To estimate the microbial production and assay of synthetic α -*amylase*, many approaches such as iodine, *dinitrosalicylic acid*, *dinitrosalicylic acid*, and dextrinizing procedures are used. The activity of crude α -*amylase* may be increased to its maximum by adjusting both temperature and pH. Certain metals, including K⁺, Na⁺, Mg²⁺, and Ca²⁺, can interact with α -*amylase* and increase its efficiency. α -*amylase* is extensively used in various industries, including starch conversion, food, detergent, paper, textile, and fuel alcohol manufacturing.

Keywords: α -amylase, microorganisms, fermentation, parameters, application

INTRODUCTION

This article is about a review on biosynthesis of α -*amylase* by using new brewing techniques, genetically modified organisms, less expensive and high-quality carbon, and nitrogen sources, and optimizing the many process parameters during fermentation as temperature, pH, and fermentation time. In addition, the estimation and assay of the microbial, with approaches such as iodine, *dinitrosalicylic acid*, *dinitro salicylic acid*, and dextrinizing procedures.



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Moreover, increasing the activity of crude and purified α -amylase to its maximum by adjusting both temperature and pH. It even covers, increasing the enzyme efficiency by certain metals, including K^+ , Na^+ , Mg^{2+} , and Ca^{2+} , which interact with α -amylase. Finally, this review ends with extensive applications of α -amylase in various industries, including starch conversion, food, detergent, paper, textile, and fuel alcohol manufacturing.

Types of Amylases

Kirchhoff identified the enzyme *amylase* in wheat in 1811, which was used to break down starch. Kuhn termed the α -amylases in 1925 because the hydrolysis components are in the alpha form. In 1930, Ohlsson discovered another amylase that produced β -mannose and named it β -amylase. In 1894, Jokichi Takamine created the first enzyme from a microbiological source: a digesting enzyme termed *taka-diastase* from *Aspergillus sp.* Amylase from a fungal source was the first industrially synthesized enzyme in 1894, and it was utilized as a therapeutic aid to treat digestive issues. Boidin and Effront [1] were the first to describe the use of *B. subtilis* and *B. mesentericus* for the commercial production of α -amylases in large fermenters in submerged fermentation. Enzymes that hydrolyze starch from the amylase belong to the *endo-amylase*, and *exo-amylase* families. These enzymes are classified according to how they break the glycosidic bond. Many *glycoside hydrolase* families include enzymes that break down the starch (hydrolyzing enzyme), accounting for about 15% of overall industrial enzyme sales [2].

Endo-acting Amylases **α -amylase (EC3.2.1.1)**

Endo-amylases cleave α -1-4 glycosidic bonds in the amylose or amylopectin inner component. *Endo-amylase*, α -amylase is a well-known enzyme. It is found in various microorganisms, including *archaea* and *bacteria*. [3]. The end products of α -amylase activity include α -configuration oligosaccharides of varying lengths and α -limit dextrans, which are branched oligosaccharides. There are two types of α -amylases based on the degree of substratum hydrolysis. Saccharifying α -amylases hydrolyze 50 to 60% of starch glycosidic linkages, whereas liquefying α -amylases break down 30 to 40%. α -amylase degrades long-chain carbohydrates and eventually amylose, resulting in maltotriose and maltose by acting at random sites in starch branches. Amylopectin produces maltose, glucose, and 'limit dextrin.' α -amylase is more active than β -amylase. α -amylases, such as saliva and pancreatic amylases, are found in humans and animals, as well as fungi and bacteria.

Exo-acting Amylases **β -amylases (E.C.3.2.1.2)**

A few microbial strains may also manufacture β -amylases (1,4-D-glucan *maltohydrolase*, EC 3.2.1.2), mostly of primarily origin [4]. Exo-acting enzymes called β -amylases break the nonreducing chain ends of the molecules amylose, amylopectin, and glycogen. The removal of β -maltose units from the non-reducing end of starch is another significant family of amylolytic enzymes by flipping the anomeric structure [5]. These enzymes, mostly in plants and microorganisms, are classified as members of the Glycoside hydrolase family GH14. The preferred substrate for each enzyme varies; *glucoamylase* works best when hydrolyzing long-chain polysaccharides, whereas α -glucosidase performs better when working with short malto oligosaccharides.

 γ -amylases (EC3.2.1.3)

Glucoamylases, *maltases*, *saccharogenic amylases*, and γ -amylases are other names for this enzyme. Exo-1,4- α -D-glucan glucanohydrolase, also known as *glucoseamylase* (EC-3.2.1.3), hydrolyzes the nonreducing ends of amylose and amylopectin in a stepwise way to produce single glucose units [6]. Since only a few bacteria can make *glucoamylase* or *amyloglucosidase*, it is a fungal enzyme [7]. They are glycoproteins in this form, mostly made up of mannose and glucose residues [8]. They are widely used in the brewing, starch saccharification, and food and fermentation sectors [9]. This enzyme acts on starch to generate 100% of glucose. It functions well with large molecular-weight polysaccharides [10].

Amylase Producing Microorganisms

α -amylases may be generated by a variety of microorganisms, including fungus, yeast, and bacteria, with fungal and bacterial amylases being the most widely employed in the industry.



**Bhimana Sasisdhar and Ravindran Saravanan****Bacterial Amylase**

Bacterial amylases are beneficial compared to other sources because they have several distinctive qualities that make them superior to other sources, such as thermo-tolerant, acidophilic, alkalophilic, and halo-tolerant traits [11]. Many microorganisms produce α -amylase, which may be acquired. Since it provides several significant advantages over fungal amylase, bacterial amylase is also the most popular choice for industrial applications [12]. However, it is mainly developed from *Bacillus* for commercial application [13]. *Bacillus* sp. alone is thought to create around 50% of the world's need for enzymes, including amylase [14]. Commercial amylase applications involve *Bacillus* sp. strains, primarily *B. amyloliquefaciens* and *B. licheniformis*.

Fungal Amylase

The majority of amylases identified are from terrestrial fungi isolates, which need mesophilic conditions to thrive [15]. Most fungal amylase is produced by *Aspergillus* species, with a few additional species from yeast, *Penicillium*, *Rhizopus*, etc., rounding out the list [16]. *Aspergillus oryzae* and *Aspergillus niger* are two filamentous fungus crucial for the synthesis of amylase by *Aspergillus* species. Most of the fungi enzymes, which are widely employed in industry, are produced by these two species. *Aspergillus niger* has drawn attention in particular because of its increased tolerance of acidic (pH 3) conditions and synthesis of amylase, which is crucial in avoiding bacterial contamination [17]. For the secretion of essential proteins and industrial enzymes, such as α -amylase, *Aspergillus oryzae* is a preferred host [18]. With many causative morphology, which gives them a substrate to quickly colonize and enables them to infiltrate the solid substrate, this fungus group is most suited for solid-state fermentation (SSF) [19]. Additionally, fungi-derived amylases have been awarded the GRAS (generally recognized safe) designation, making them a favored source above others. Thermophilic fungi like *Thermomys lanuginosus*, which are good producers of thermostable amylase, have also been reported to exist.

Recombinant α -amylase

The efficient α -amylase gene is chosen for amylase synthesis in recombinant DNA technology. To get a high yield of recombinant mRNA and amylase overproduction, an appropriate vector carrying a gene of interest is introduced into an efficient bacteria. On the other hand, searching through mutant libraries for the mutant variation that is most efficient in amylase production is also a success. Removing amyR (a transcription factor) from *A. niger* increased amylase production with low background proteins.

Types of Fermentation for α -amylases Production**Solid-State Fermentation (SSF)**

SSF primarily uses solid substrates, including paper pulp, bagasse, fruit and vegetable peels, and bran. These environmentally harmful waste products may be readily repurposed by employing them as substrates. In this process, substrates are applied continuously at a plodding pace. SSF takes longer for the fermentation process to complete. Therefore, this method promotes the controlled release of nutrients. Fungi and microbes are key players in the SSF fermentation process. SSF needs less moisture. However it cannot be used in fermentation processes like bacteria that need a high-water activity (a_w) [20].

Submerged Fermentation (SmF)

SmF makes use of free-flowing liquids like molasses and broths. The fermentation broth secretes bioactive substances. In this procedure, substrates are utilized relatively quickly. As a result, the process requires that nutrients be changed or supplemented regularly. This fermentation technique is excellent for microorganisms like bacteria with a high fluid need. This method has the benefit of being comparatively simple to cleanse compounds. SmF is mainly used in the fluid-form extraction of secondary metabolites [21].

Substrates

Because the outcome of fermentation varies greatly depending on the substrate, it is essential to choose the proper substrate and optimize the fermentation processes for each substrate. For every substrate, every microbe produces a



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distinct outcome. Different nutrient consumption rates exist for each substrate, which also reveal productivity inequalities. Sugarcane bagasse, wheat bran, rice husk, maize husk, gram husk, wheat flour, and waste from soybean, banana, tea, cassava, and palm oil mill are often utilized as acceptable substrates in the fermentation process. Dust from trimmed grapes, corncobs, coconut coir pits, aspen and beet pulp, cassava flour, boiled rice, pulp from sweet sorbet, pulp from peanuts, rapeseed cake, coconut oil cake, mustard oil cake, etc. [22]. Soluble sugars, molasses, fluid media, fruit and vegetable juices, and other substances are typical substrates used in submerged fermentation. Small substrate particles are often regarded as acceptable because they provide a significant surface area for microbial activity. Conversely, bigger particles deemed acceptable have more robust respiration/aeration potentials (owing to increased inter-particle space) but provide fewer surfaces for microbial activity. Therefore, a compromise particle size for the particular process need and the best outcome should exist.

Low-cost media

Amylase is produced in large part by the media. Materials utilized in synthetic media, such as nutritional broth, soluble starch, etc., may be costly to create amylase. The use of agricultural byproducts may take its place. These materials are readily accessible, less expensive, and cost-effective to lower production costs [23]. To reduce production costs as well as waste disposal and emissions, low-value agro-industrial leftovers are used as a substrate for α -amylase. A lot of agricultural and agro-industrial residues are created each year. It is among the most nourishing and energizing products in the world. They are among the finest natural repositories of fixed carbon [24]. The most popular agro-domestic wastes are utilized as inexpensive fermentation substrates.

Wheat bran

Wheat bran is a byproduct of the wheat milling industry, and because of biotechnological advancements in enzyme processing and fermentation technologies are often utilized in animal feed. Using wheat bran has created several opportunities to produce goods with high economic value [25]. Sugars might be found in wheat bran. More than 650 million tons of wheat are produced each year globally. 150 million tons of stored wheat bran biomass are expected to be utilized mainly in the food industry [26]. This is a critical ingredient in the production of amylase. Owing to pre-treatment, pore size, availability, and nutrient availability, wheat bran is a suitable substrate for fermentation due to its increased surface area [27].

Rice bran

Rice is a staple cuisine in around 15 different nations, according to Giddel and Jivan [28]. The production of starch and glucose for fermented and unprocessed alcohol, beer, and other industrial uses is the primary purpose of rice utilization [29]. Rice bran, a byproduct of processing rice, has 36.6% cellulose, 23.9% toxillon, 19.6% ash, 15.5% lignin, and 8.7% starch in its chemical makeup. Environmental contamination results from the improper handling of rice bran.

Sugarcane bagasse

Sugar cane is the main crop in Brazil, India, and China is sugarcane, which makes a significant economic contribution to the agricultural industry [30]. Sugarcane bagasse is the word for the material that is left over from the sugarcane stem after the juice has been extracted. A significant amount of the world's agricultural leftovers, or around 1.6 billion tons per year, comes from sugarcane production. Across 279 million metric tons of sugarcane, trash are produced yearly around the globe. This waste, utilized extensively in sugar mills as a source of heat and electricity, pollutes the air.

Process Parameters

Various fermentation parameters are appropriate depending on the microbial strain, kind of product, product formation, fermentation technique, and several other comparable factors.



**Bhimana Sasisdhar and Ravindran Saravanan****Temperature**

Maximum enzyme synthesis requires two temperature ranges, one where microbes can grow at their fastest pace and another where enzyme production is at its peak. *Bacillus sp.*, isolated from dhal industrial waste, discovered that 60 °C was the best temperature for producing amylase [31]. When *Clostridium acetobutylicum* generated α -amylase was incubated at temperatures ranging from 30 °C to 60 °C, 45 °C was determined to have the best activity [32]. *Rhodothermus marinus*, a species of marine thermophilic microbe, demonstrated that its α -amylase output was best at 61 °C [33]. *Atteromonas haloplankitis* was reported to produce α -amylase most effectively at a temperature of 4 °C [34]. Bacteria have generated amylase across an extensive temperature range. *Bacillus amylofaciens* was found to produce amylase at a temperature of 36 °C. Like this, high temperatures (80 °C) were employed to produce α -amylase using the hyperthermophile *Thermococcus profundus* [35].

pH

By causing morphological changes in the organism, the pH of the fermentation medium plays a crucial influence in the secretion of the enzyme, among other physical factors. While the organism is growing, specific metabolic processes lead to a pH change in the growth medium. SmF often uses the majority of *Bacillus* strains to make bacterial amylases. The pH range between 6.0 and 7.0 was shown to be ideal for *Bacillus sp.* during the generation of enzymes and maximal cell development. The similar outcome has also been seen in SSF's synthesis of enzymes. *Pyrococcus furiosus*-produced α -amylase has been shown to activate best at a pH between 4.5 and 5.5 [36]. *Bacillus amyloliquefaciens* was shown to produce enzymes at an ideal pH of 7.0 [37]. *Halomonas meridiana* may produce α -amylase best at a pH of 4.0 because it tolerates alkaline environments rather well. *Bacillus sp.*, which was isolated from industrial waste gradients, found that the optimal pH for the synthesis of amylase was 6.5. *Aspergillus sp.*, including *A. ficuum*, *A. niger*, and *A. oryzae*, have an ideal pH range of 5.0 to 6.0 in SmF [38].

Agitation

The fermentation process depends heavily on agitation. A significant part of the total fermentation process is the medium mixing. By continuously mixing the media, this makes it easier for mass and oxygen to move throughout the various phases and maintains uniform chemical and physical conditions [39]. The degree of agitation has an impact on mycelial shape, oxygen transfer, and product production during microbial fermentation [40]. Fast motions have been shown to sometimes hinder mycelial development, which might harm the synthesis of enzymes. The production of enzymes at a consistently prescribed growth rate, however, has not been impacted by variations in mycelial morphology, one of agitation rate variations. Amylase was often produced by a variety of microorganisms at speeds up to 300 rpm [41].

Carbon Sources

Although starch is still employed in the α -amylase synthesis process, carbon sources including glucose and maltose have been added to the fermentation medium in order to create α -amylase. Other unconventional substrates have been employed to produce α -amylase, including lactose, fructose, and oilseed cakes [42]. Maltose, sucrose, and glucose are employed as substrates because they are typical carbon sources. Maltose, starch, and glycogen are present in the media and *A. tamaritii* is actively producing the amylase enzyme under static conditions. Compared to shaking cultures, this produced four times as much [43]. *B. licheniformis* and *Bacillus.sp.1-3* were selected as carbon sources because glycogen, galactose, and inulin are suitable substrates for amylase synthesis, according to Xusheng et al. [44]. The synthesis of enzymes in *Bacillus sp. PS-7*, *B. subtilis* IMG22, and *Bacillus sp. 1-3* was predicted to be aided by starch and glycerol [45]. Soluble starch was discovered by *B. stearothermophilus* to be a superior substrate for the production of alpha-amylase. [46]. It has been discovered that yeast extract (15%) and lactose-containing medium (1%) help *Bacillus sp. amylase's* generate the best raw starch digestion. *Thermomyces lanuginosa* has been observed to produce the most α -amylase when maltodextrin is added to the medium [47]. Utilizing agricultural household wastes reduces the cost of the fermentation media in both submerged and solid-state fermentation. Agricultural and domestic wastes are essential for the development and metabolism of microorganisms because they are rich in



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carbon and nitrogen sources. Among these biomasses are mostly orange, carrot, maize, tapioca, wheat, and rice flour wastes [48].

Nitrogen Sources

Sources of nitrogen are crucial for the formation of enzymes. Sources of nitrogen may be either organic or inorganic. Among the inorganic sources of nitrogen are ammonium hydrogen phosphate, ammonium chloride, and ammonium sulphate. Peptone and soybean meals are the two most often used organic nitrogen sources. It has been discovered that soybean meal is a superior source of nitrogen for α -amylase production in *Bacillus* sp.. The greatest levels of α -amylase were generated by *B. stearothermophilus* and *B. amylolyticus* strains when 1% peptone, 0.5% maltose, and 0.5% yeast extract were added with vigorous stirring [49]. *Licheniformis* SPT 278 examined the effects of nitrogen sources that are organic and inorganic. The finest inorganic source of nitrogen, ammonium phosphate, is shown to be inferior to peptone as a supply of nitrogen for enzymes. One of the best sources of nitrogen for the formation of α -amylase has been found to be *L-asparagine* by *Thermomyces lanuginosus* [50]. α -amylase was also produced in considerable amounts by the yeast extract.

Role of Metalions and phosphates

The synthesis of enzymes by *Bacillus* sp. is coordinately stimulated by Na^+ and Mg^{2+} [51]. Zeolite was added to *B. amyloliquefaciens* to regulate ammonium ions, which boosted the output of α -amylase. Phosphate has a crucial regulatory function in the synthesis of primary and secondary metabolites in microorganisms and has an impact on α -amylase production and organism development. The addition of 0.2 M phosphate concentrations has been shown to significantly improve *A. oryzae*'s production of amylase [52]. According to certain observations, *B. amyloliquefaciens* produced less α -amylase and had an exceptionally low cell density because of low phosphate levels. Enzyme growth was hindered by high phosphate concentrations [53].

Medium optimization

Medium optimization is still one of the most critically explored phenomena that occurs prior to any large-scale metabolite synthesis, and it is difficult to tackle. Prior to the 1970s, media optimization was done using traditional approaches that were costly, time demanding, and included a lot of tests with low precision. Nonetheless, with the introduction of new mathematical/statistical approaches, media optimization has grown more lively, effective, efficient, inexpensive, and resilient in its output. The most optimal fermentation conditions (e.g., pH, temperature, agitation speed, etc.) and medium components (e.g., carbon, nitrogen, etc.) must be discovered and adjusted before constructing a production medium. Furthermore, maximum product concentration might be reached by adjusting the aforementioned parameters. Figure 1 depicts a schematic illustration of a systematic method to constructing fermentation mediums.

Media Optimization Strategies

During the medium designing and optimization, there are various strategies available which are frequently used to improve the efficiency of the production medium. Figure 2 is a schematic representation of various techniques used in the medium optimization.

Purification of Alpha-amylase

Enzymes are often employed in their raw form and need minimal purification in industrial applications, but they must be substantially purified for usage in the pharmaceutical and medical fields. When utilized to examine structural functions and biochemical features, the enzymes must also be in pure form [46]. Precipitation, chromatography, and the extraction of fermented liquids are the three purifying techniques that are most often used. These concentrate on the unique characteristics of the intended enzyme. A mixture of these techniques is utilized to achieve the highest level of purity. The required level of purity has a significant impact on how many downstream procedures are necessary [54]. By filtering and centrifuging the raw extracellular sample from the fermentation medium, crude enzyme samples may be produced. After filtering, raw corn starch could be used as a supplement in



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the case of intracellular enzymes. Using ammonium sulphate or organic solvents like acetone precipitation, the crude enzyme may be concentrated and precipitated. The precipitated enzyme might be added to a buffer for dialysis or further concentration, along with chromatographic methods for further isolating and purifying the enzyme, such as ion exchange, gel filtration, and affinity chromatography [55].

Assay for enzymes

Various approaches are used to assess enzyme activity. A few enzyme assay techniques are discussed here.

Iodine-Based Enzyme Activity Determination

With iodine, the starch solution becomes blue. α -amylase hydrolyzes starch, resulting in a reddish-brown solution. An acid is used to stop the process. The absorbance is then measured, which indicates the enzyme's activation. For the first time, Pfueller and Elliott (1969) devised this strategy.

Method of Dinitrosalicylic Acid (DNS)

Aliquots of substrate solution are mixed with crude enzyme and incubated for 10 minutes at 50 °C before adding DNS reagent and heating for 5 minutes in a boiling water bath. Allow it to cool to 25 °C before calibrating the absorbance of this combination at 540 nm. Finally, the absorbance value of the blank is subtracted from the absorbance value of the sample. Figure 2 depicts the DNS mechanism in action. For the first time, Bernfeld (1951) improved this approach.

Activity that dextrinizes

After mixing an aliquot of starch solution and crude enzyme solution, the combination is incubated for 10 minutes at 92 °C (Fig. 2). The mixture should then be cooled in ice to cease the reaction. The colourful complexes are produced with the starch **Nelson Somogyi** with the addition of iodine. The solution is then diluted, and the absorbance is measured at 600 nm. Fig. 2 also depicts the dextrinizing technique process.

Nelson Somogyi (NS) Technique

After incubating an aliquot of substrate solution for 5 minutes at 50 °C, it is combined with warmed enzyme solution. Then reheat it for 10 minutes at 50 °C. Somogyi copper reagent is used to stop the process. This is then cooked for 40 minutes in a boiling water bath before cooling to 25 °C. After cooling, add the Nelson arsenomolybdate reagent to the mixture and incubate at room temperature for 10 minutes. Finally, add water and centrifuge it for 1 minute at 13,000 rpm before measuring the absorbance of the sample at 610 nm. Fig. 3 also depicts the technique for the NS approach.

Characteristics of crude amylase**Influence of the temperature on the stability and activity of crude amylase**

The optimum activity of α -amylase is typically tested at pH 8.0 at temperatures ranging from 30 to 90 °C. The optimal temperature range is 40 to 60 °C, and the crude enzyme is more stable at moderate temperatures. It has 100% relative activity at room temperature (25 °C), but less activity at higher temperatures (60 to 80 °C).

Influence of the pH on the stability and activity of crude amylase

Amylase is the finest industrial catalyst for long-term stability under harsh circumstances. When the activity of α -amylase is measured at various pH levels, the highest activity is found at slightly acidic pH 6.0. The activity reduces drastically when the pH is raised from 7.0 to 9.0, with just 10% relative activity remaining.

Influence of metal ions on the α -amylase activity

On the industrial front, α -amylase has a wide range of uses. α -amylase is receiving a lot of interest because of its function in starch saccharification. Amylases account for roughly 30% of the global enzyme market. α -amylase has the following industrial applications: starch conversion, food, detergent, paper, textile industries, and fuel alcohol manufacturing among biofuels.



**Bhimana Sasisdhar and Ravindran Saravanan****Application of Alpha-amylase****Starch conversion**

α -amylases are employed for starch hydrolysis in the majority of methods used in the starch industry. The process by which starch transforms into fructose and glucose syrup is known as starch liquefaction [56]. Enzymatic conversion of starch, which includes the liquefaction, partial hydrolysis, and viscosity loss of starch granules, is a key step in the gelatinization process. Processing of glucose and maltose by saccharification, which involves further hydrolysis. The enzymes of *Bacillus sp.* are of special relevance in these extensive commercial applications due to their noticeably high thermostability and effective expression methods.

Detergent Industry

The detergent sector is the largest user of enzymes in terms of volume and cost. Enzymes are added to detergent formulations to increase their effectiveness in removing stubborn stains and make them friendlier for the environment. 90% of all liquid detergents include amylase, which is a component of enzymatic detergents [57]. Amylase is used to remove residue from starchy foods like potatoes, gravy, chocolate, custard, etc. in automated dishwashing systems and fabric detergents [58]. Lower temperatures and alkaline pH values activate amylases. Under detergent conditions, it aids in preserving the stability and oxidative stability of amylases. The usage of these substances in detergents with highly oxidative washing conditions is one of the most pertinent circumstances [59]. To maintain the whiteness of clothing, starch from surfaces must also be removed. Many different forms of particulate dirt may be drawn to starch. Most amylases utilized in the detergent industry are produced by *Bacillus* or *Aspergillus species*. [60].

Bakery Industry

α -amylase, which is added to the dough before baking, hydrolyzes the starch, which the yeast then ferments into smaller dextrins. By increasing the texture and volume of the loaf with rising dough, this increases the pace of fermentation and decreases the viscosity of the dough. Changes might occur while the baked goods' storage after baking is complete. Staling is the collective term for all undesirable alterations, including the loss of bread taste, a reduction in crumb wetness, and a reduction in crust crispness. The enzyme is furthermore used to avoid parching, lengthen the shelf life of baked goods, and preserve their smoothness [61]. Although it has an anti-parching effect, a little excess will result in the bread becoming sticky because of the formation of branched dextrin [62].

Paper Industry

To protect it from physical stresses during manufacturing operations, sizing agents are also applied to paper in the same way they are to textiles. The size also contributes to the paper's outstanding quality in terms of its durability, smoothness, writing, and erasability. Starch is often used for sizing purposes. Starch hydrolyses is what α -amylase does. In the paper industry, it is used to reduce viscosity during batch or continuous processing. It is as a result of natural starch's high viscosity, which makes it inappropriate for paper stacking.

Textile Industry

Amylases are employed in the desizing process in the textile industry. To guarantee that the weaving can be done quickly and precisely, sizing agents like starch are put to the thread before fabric manufacture. One significant benefit of starch is that it is inexpensive, simple to use, and can be disposed of swiftly and effectively. In a wet procedure, the starch from the woven cloth is subsequently separated in the textile finishing business. Desizing is the process of removing starch from a substance used as a reinforcing ingredient during weaving. To prevent fibers from sticking to one another and to maintain them supple, amylase works to decrease the size of the fibers [63]. In the textile business, amylase from the *Bacillus strain* has long been employed.

Fuel Alcohol Production

The most widely utilized biofuel is ethanol. Starch is a cost-effective source, but it is also necessary for the creation of ethanol, which may then be used as a biofuel. This procedure is finished in phases. Initial liquefaction of the starch



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results in the formation of a viscous suspension. Through the saccharification process, α -amylase hydrolyzes the starch in this procedure to create sugars. Later, yeast ferments these sugars to create alcohol. This approach improvises by joining the protoplasts of the amylolytic yeast *S. fibuligera* and *S. Cerevisiae* to create a novel yeast strain. That eliminates the need for a saccharification step by producing the biofuel straight from starch. α -amylase is one of the bacterium generated by thermoresistant bacteria. The first stage of starch suspension hydrolysis uses modified *Escherichia coli*, *Bacillus subtilis*, or *Bacillus licheniformis* bacteria [64].

SUMMARY AND FUTURE PERSPECTIVES

This review discusses the biosynthesis, activity, and industrial applications of α -amylase, as well as the many methodologies (e.g., fermentation, recombinant DNA technology) and factors (such as pH, temperature, moisture, and metal ions) that influence the synthesis and activity of α -amylase. The synthesis of α -amylase has become a fascinating topic of biotechnology due to the significant demand for α -amylase in the industrial and medicinal realms for a range of applications. To synthesize the inexpensive and easily available amylase from microbial sources, many optimization approaches and criteria are applied. Despite significant improvements in α -amylase biosynthesis, its output may still be enhanced utilizing genetic engineering approaches such as cloning, gene expression, and α -amylase protein engineering. Various agro-wastes, such as fruit and vegetable peels, might also be utilized to synthesize low-cost α -amylase, which could help to reduce pollution. With this method, the price of α -amylase may be greatly decreased, and production process could be met more effectively.

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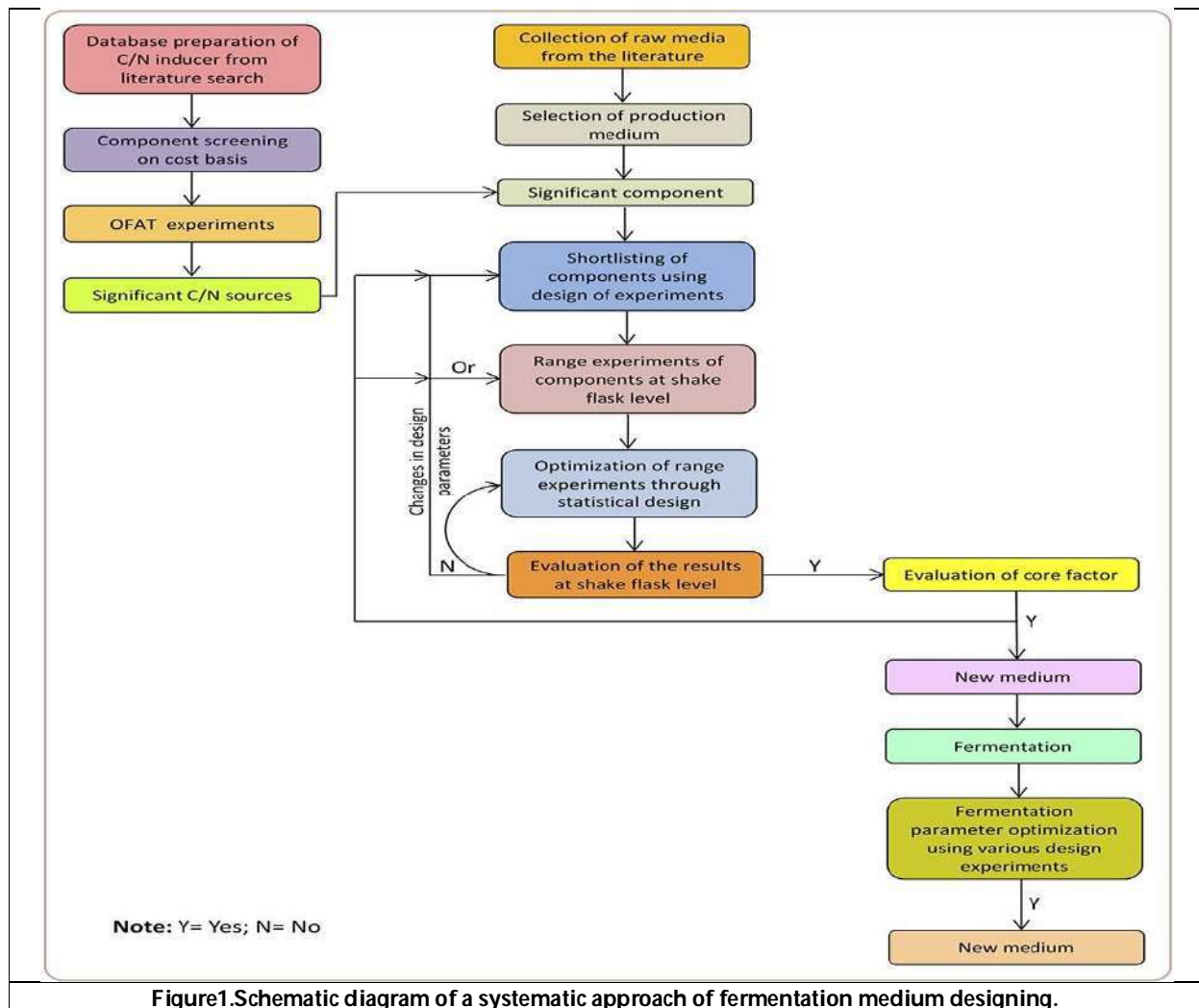


Figure1.Schematic diagram of a systematic approach of fermentation medium designing.





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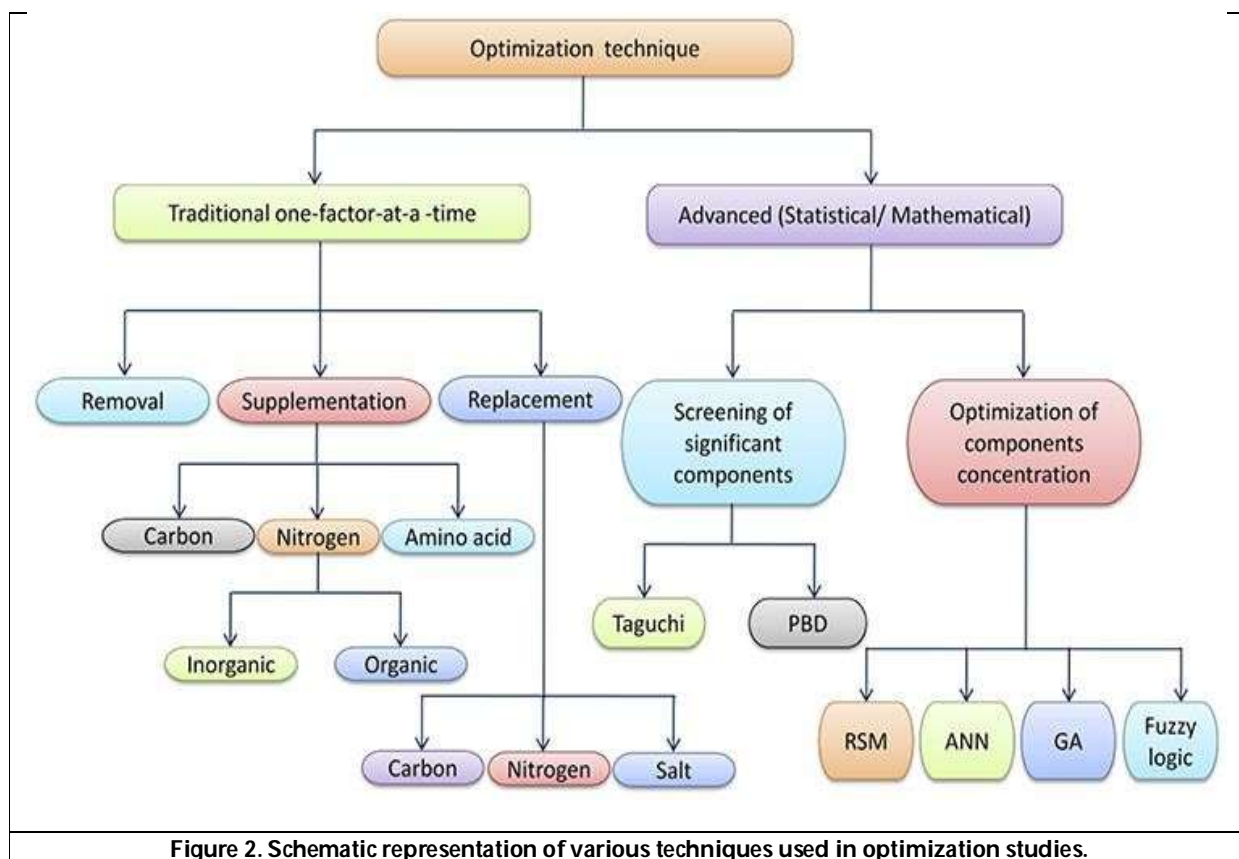


Figure 2. Schematic representation of various techniques used in optimization studies.





A Review on Emerging Trends in Block Chain Technology and its Applications

K. Ashtalakshmi*

Assistant Professor, St. Francis de Sales College, Electronic city, Bengaluru, Karnataka, India.

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*Address for Correspondence

K. Ashtalakshmi

Assistant Professor,
St. Francis de Sales College,
Electronic city, Bengaluru,
Karnataka, India.
E.Mail: ashtalakshmi@sfscollge.in



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ABSTRACT

Supply chain management, healthcare, banking, and other sectors are just a few of the industries where block chain technology has found widespread application. New trends that could change the block chain ecosystem are developing as technology progresses. Including DeFi, NFTs, CBDCs, interoperability, privacy & security, and sustainability, this paper presents an overview of new trends in block chain technology and its applications. In order to provide a thorough analysis of these trends and their potential effects on the future of block chain technology, we study recent advancements, academic research, and market insights.

Keyword: Block Chain, DeFi, NFT, CBDC, interoperability, sustainability

INTRODUCTION

Traditional database technologies present a number of challenges when it comes to recording financial transactions. Take, for example, the sale of a home. Ownership of the property is transferred to the buyer once the money is exchanged. Both the buyer and the seller can independently record monetary transactions, but neither source can be trusted. The seller can easily claim they have not received the money when they have, and the buyer can equally claim they have paid when they have not. To avoid potential legal issues, transactions must be supervised and validated by a trusted third party. This central authority complicates the deal and introduces a singular point of failure. Both parties could suffer if the central database was compromised.

Block chain addresses such concerns by establishing a decentralized, tamper-proof system for recording transactions. In the case of a property transaction, block chain creates separate ledgers for the buyer and seller. All transactions





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must be approved by both parties and are automatically updated in real time in both of their ledgers. Any tampering with historical transactions will taint the entire ledger. These characteristics of block chain technology have led to its application in a variety of industries, including the creation of digital currency such as Bit coin. Block chain is a distributed ledger technology that allows for secure, open, and unchangeable transactions. It has the potential to transform a variety of industries by enabling decentralized applications that can improve trust, transparency, and efficiency. As technology advances, new trends that have the potential to change the block chain environment emerge. This essay attempts to provide a thorough analysis of current developments in block chain technology and its applications, as well as their potential effects on the field's future.

A block chain is distinguished by its resistance to censorship, immutability, and global usability, and it is supported by a global network of validators known as miners, who maintain it through block rewards known as cryptotokens (Jeremy Gartner, in Shulman, 2018). According to Ethereum creator VitalikButerin (2017), decentralization ensures fault tolerance, attack resistance, and collusion resistance. Furthermore, the block chain is decentralized on two of the three possible software decentralization axes:

- It is politically decentralized, which means that no one controls it.
- architecturally decentralized - there is no infrastructure central point of failure;

Logically centralized - there is one commonly agreed-upon state, and the system behaves like a single computer. Anyone has the ability to access a block chain, download a copy, and participate in the maintenance of the block chain, converting that computer into a node. The copy will be actively updated along with every other node's copy; changes to the block chain can only be made with general consensus among the individuals running a node (ConsenSys, 2018). Mining refers to the process of adding a new block (containing thousands of transactions) to a blockchain using hash verification procedures. The new block in blockchain is linked to the previous one.

LITERATURE REVIEW

Researchers and developers are already aware of the new technology's capabilities and are investigating various applications in a wide range of industries (Christidis and Devetsikiotis, 2016). Three generations of block chains can be distinguished based on the intended audience (Zhao et al., 2016): Block chain 1.0, which includes applications enabling digital cryptocurrency transactions; Block chain 2.0, which includes SCs and a set of applications extending beyond cryptocurrency transactions; and Block chain 3.0, which includes applications in areas beyond the previous two versions, such as government, health, science, and IoT. A block chain, in theory, should be viewed as a distributed append-only timestamped data structure. Block chains enable us to have a distributed peer-to-peer network in which non-trusting members can interact with each other in a verifiable manner without the need for a trusted authority (Christidis and Devetsikiotis, 2016). To accomplish this, consider block chain as a collection of interconnected mechanisms that provide specific features to the infrastructure, as shown in figure 1. The signed transactions between peers are at the most basic level of this infrastructure. These transactions denote a contract between two parties that may include the transfer of physical or digital assets, the completion of a task, and so on. This transaction is signed by at least one participant and distributed to its neighbours.

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the rules of Block chain. The majority of the research focused on improving existing block chain technologies, with a significant amount on security and privacy concerns. In contrast, little research has been conducted on other issues such as usability and wasted resources. Surprisingly, much of the research at the time was focused on Bitcoin (Yli-Huumo et al., 2016).

METHODOLOGY

You may have observed that many companies have been incorporating Blockchain technology in recent years. But how does Blockchain technology actually operate? Is this a substantial modification or merely an addition? Let's start by demystifying Blockchain technology since it is still in its infancy and has the potential to be transformative in the future.

Combining three popular technologies, blockchain:

- Keys for cryptography
- A common ledger on a peer-to-peer network
- A computing method for storing network events and records

Two keys make up a cryptography key: a private key and a public key. These secrets aid in the execution of successful transactions involving two people. These two keys are unique to each person and are used to create a secure digital identification reference. The most significant component of Blockchain technology is this protected identification. This identification is known as a "digital signature" in the world of cryptocurrencies and is used to approve and manage transactions. The peer-to-peer network and the digital signature are combined; many people who serve as leaders use the digital signature to agree on transactions and other matters. As soon as they approve a transaction, it is mathematically verified to ensure that it is valid, which leads to a successful protected transaction between the two network-connected parties. In conclusion, cryptography keys are used by Blockchain users to conduct various kinds of digital transactions over the peer-to-peer network. The methodology of the Block chain has been illustrated in the following diagram figure 2

DISCUSSION

This research paper is a review of existing block chain literature and research. Academic journals, books, whitepapers, and reports from reputable organizations such as the World Economic Forum, the European Union, and the International Monetary Fund were used as information sources. The study focuses on the technical aspects of block chain technology, as well as its potential applications and impact on various industries. A few of the newest developments in blockchain technology and its uses:

DeFi(Decentralized Finance) is a financial system built on blockchain that aims to do away via mediators in financial transactions. Users can exchange, lend, and borrow cryptocurrencies using DeFi without using regular banks or other financial institutions. Known as **NFTs** (Non-Fungible Tokens), these special digital assets are kept on a database. Due to their ability to enable the creation and sale of distinctive digital artwork with a traceable possession history, NFTs have gained popularity in the art world. Central bank digital currencies, or **CBDCs**, are electronic money that are distributed by central banks. The purpose of CBDCs is to offer a reliable and effective replacement for conventional monetary currencies.

Sustainability: By enabling transparency and accountability in transactions, blockchain technology can be used to support sustainability.

Interoperability: The capacity of various blockchains to communicate and cooperate without any issues is referred to as interoperability. As it enables the integration of various blockchain-based solutions and apps, interoperability is an emerging trend in blockchain technology.





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Decentralized autonomous organizations, or DAOs, are businesses that are managed by blockchain smart contracts. The goal of DAOs is to develop a more decentralized and open method of organizational decision-making. Blockchain technology is enabling users to retain control over their personal data, making privacy an emerging trend. Applications that prioritise anonymity, like secure messaging services and decentralized identity management systems, can be developed using blockchain-based solutions.

Beyond cryptocurrencies, block chain technology has many potential applications, including supply chain management, voting systems, and digital identity management. The decentralization and transparency features of the technology make it suitable for these use cases. Block chain has the potential to transform the way businesses and governments operate by increasing efficiency, decreasing fraud and corruption, and increasing transparency. Scalability, interoperability, and security are some of the technical limitations of block chain technology that must be addressed before it can be widely adopted. These issues are being addressed through ongoing efforts such as the development of new consensus mechanisms and the integration of block chain with other technologies. We've talked about what block chain is, but why should anyone care? Despite the fact that block chain appears to be a rather ambiguous technology to the general public, a monetary application of the block chain has received significant financial support. With the price of a Bitcoin currently around \$10,000 (Wikipedia & Contributors, 2018a), it appears important to understand why people are investing in it.

Block chain has implications for a wide range of fields, as demonstrated by the thematic analysis above. Some seem more hopeful or useful than others. While applying block chain to highly complex and regulated industries such as securities may be difficult at the moment (Tranquillini, 2016), we can see that it has already had some success.

CONCLUSION

Block chain technology is a revolutionary technology with the potential to transform a variety of sectors. Its decentralization, transparency, and security characteristics make it suitable for a wide range of applications. However, wider adoption will be contingent on overcoming technical limitations and regulatory challenges. More research and development in this area is required to realize the full potential of block chain technology.

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Table 1: Current and Future Research in Block chain

Current research - review	Food Security	Banking
Securities services	Product	Finance
Supply Chain	Higher education	sharing services
City Planning	Management	Employment
Real estate		Library Management

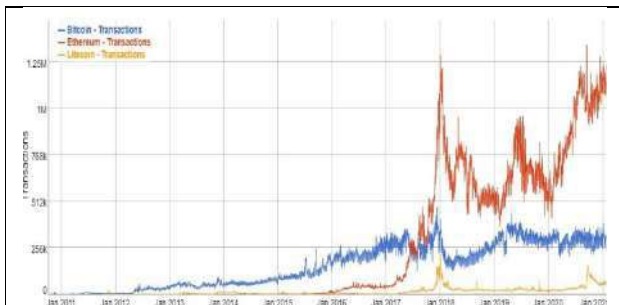


Fig. 1. Block Chain Technology

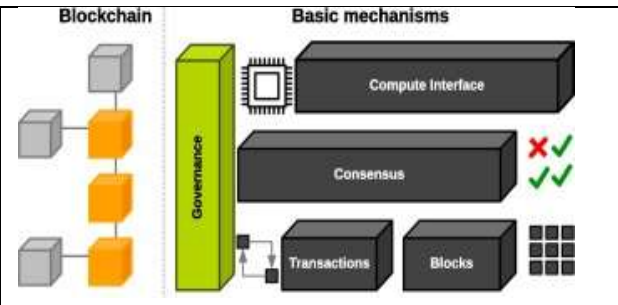


Fig. 2. Basic mechanisms of Block chain

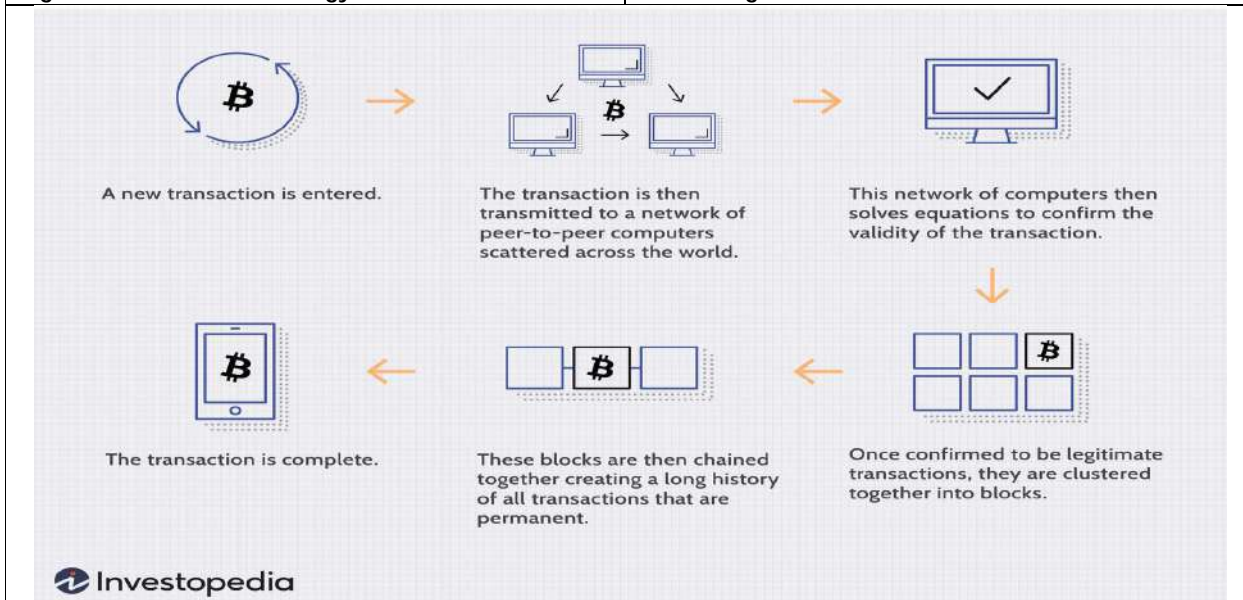


Fig. 3. Process of Block Chain





Impact of Game Addiction to Emotional, Physical Distress and Academic Performance on College Students: Prediction using Machine Learning and Ensemble Algorithms

Nisha Varghese^{1*} and Shafi Shereef²

¹Department of Computer Applications, Krupanidhi Group of Institutions, Bangalore.

²TKDM, GVHSS Kerala Vocational Higher Secondary Education, Kollam.

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*Address for Correspondence

Nisha Varghese

Department of Computer Applications,
Krupanidhi Group of Institutions,
Bangalore, India.

E.Mail: drnishatvarghese@gmail.com



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ABSTRACT

The academic performance of the students' is one of the inevitable concerns of the institutions. This article examines the correlation between gaming on various devices and academic performance among students aged 18-25. Data collected from students through Google form Questionnaire after stating the relevance of each question. The survey questionnaire contains the type of game, financial benefits or loss, number of hours of playing time, mode of game advantages and disadvantages and many more. The aim of this research article is the analysis and study of the impact of gaming on students' academic performance. Regression results shows that 75.2% and 24.8% of students having the habit of playing games among them 66.3% of males and 33.6% of females. For the data analysis four models are considered including – Logistic Regression, Decision Tree, Random Forest and Support Vector Machine. Among the Machine Learning and ensembled models the Support Vector Machine has been provided the significant results.

Keywords: Machine Learning, Online/Offline games, Game addiction, Academic Performance, Mental/physical Distress.

INTRODUCTION

With the advent of technological development, the use of electronic devices has also increased tremendously. The dynamics of our lives have changed dramatically as a result of internet usage. It impacts every part of our lives including social interactions, transactions, banking, cab booking, travel, social media and e-commerce. These changes

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have been driven by the ease of accessing the internet through our smartphones and the development of high-speed internet connectivity technologies such as 4G and 5G. Online games are proliferating, and the longer they last, the more enjoyable they become overall due to improvements in display, game play, game visuals, image resolution, etc. The ability to browse the Internet without buffering is made possible by high-speed Internet connectivity and a significant portion of the global population is consumed by Internet addiction [1].

As a result, the time spent on these devices also increases. Not only social media, but also gaming plays a major role in it. The result of these technologies excites the public and causes us to use the Internet more often than we intend. People believe that they cannot live without smart phones [2]. Young people are more affected by this effect. Many adolescent users of the Internet suffer from depression [3]. Online games are accessible to many players, connecting player machines through the Internet. By the very nature of online games, which present challenges and make players think about the outcome of winning or losing, they can also act as a way to stimulate the imagination. Online games also save more losses than they win, especially as a result of significant time wasted as a result of the gains made. The game is enjoyable because of the variety that includes war games, action, adventures, study games, brain games, simulation and fights.

According to statistics, The Indian gaming market will have 373 million players by 2022, making it the second largest in the world. These are played on mobile devices 91% of the time. The Indian mobile gaming sector alone is generated revenue in \$2.2 billion in 2022 [4]. According to Statista, in 2021, 44.4% of users will fall into the high-income category. "By 2027, there will likely be 239.6 million consumers in the mobile games market". programmes that enable you play games on smart phones and tablets. Pay-to-download apps and Freemium games with in-app purchases that are also available for download. Fig. 1 and Fig. 2 are representing the statistics of users and revenue in millions.

LITERATURE REVIEW

This section includes the related works and details to understand the studies already conducted in this area. The purpose of this study [5] is to ascertain how online games affect student achievement and motivation to learn. According to the study's findings, playing online games can be utilized to motivate kids to learn up to a point, but once they become addicted, it becomes problematic for their ability to learn. The study's findings support the notion that online games may have an impact on students' motivation for learning. Overplaying it can have negative effects and lessen one's sense of sociability with other people. Student achievement may be impacted by online games. In order to forecast the students' performance, the study tested different classification techniques such the Artificial Immune Recognition System v2.0 and AdaBoost. The study's [6] highest categorization accuracy, 95.34%, was generated using deep learning techniques. In order to discover the most accurate classification techniques, the following statistics were calculated: precision, recall, f-score, accuracy, and kappa statistics performance. The 10140 student records in the dataset were used in this investigation.

This study [7], offered a unique machine learning approach that can solve these important issues for forecasting student performance in graduation. There are two key components to the suggested method. For producing predictions based on students' changing performance states, first a bi-layered structure made up of several base predictors and a cascade of ensemble predictors is built. Second, a data-driven strategy based on probabilistic matrix factorization and latent factor models is suggested to find course relevance, which is crucial for developing effective base predictors. The purpose of this study [8] is to investigate how learners' gender affects their motivation and learning outcomes. As part of the project, a digital game on the subject of emergency first aid is created with the goals of the curriculum for a content-based instruction course in mind. While participating in the game, students can simultaneously improve their language and first aid skills. The findings indicate that while learning achievement is not significantly influenced by gender, learning motivation is significantly impacted. Digital game-based learning has been demonstrated to improve learning outcomes for students of diverse genders.



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This article [9] focused on the students' success is influenced by a variety of factors, including their behavioral, academic, and personal characteristics. Using a questionnaire-based survey and the academic division of the selected institution, a dataset was gathered. The acquired dataset has undergone data-pre-processing and factor analysis in order to eliminate anomalies, reduce the dimensionality of the data, and find the most correlated feature. For better prediction, use the support vector regression linear method. This research article proposed [10] a data mining-based model for predicting student performance with brand-new data attributes/properties known as student behavioral features. These attributes have to do with how interactively a learner is with the e-learning management system. A group of classifiers, including Artificial Neural Network, Naive Bayesian, Decision Tree and ensemble models to evaluate the effectiveness of the student's predictive model.

The primary goal of this research [11] is to investigate and suggest a Deep Neural Network (DNN) framework for binary classification with two hidden layers, for the early prediction of teams' performance in the field of software engineering. Different activation functions and optimizers were used to assess the framework. The framework was trained and evaluated using a dataset made up of more than 30000 entries with 74 teams. Additionally, the framework was interpreted using the SHapley Additive exPlanations (SHAP) method to extract the key characteristics that would have a favorable or negative influence on the prediction. This article proposed [12] a model for predicting students' academic achievement that makes use of supervised machine learning techniques. Comparing the outcomes of numerous trials conducted using various technologies, it can be seen that sequential minimal optimization method surpasses logistic regression by obtaining greater accuracy. Additionally, the information gleaned from this study can assist educational institutions in forecasting students' future conduct so that they can rank their performance. The goal is to not only anticipate students' future performance but also to offer the best method for identifying the most important aspects to improve.

The study [13] focused on three perspectives such as the ways in which learning outcomes are anticipated, the predictive analytics models used to predict student learning, and the key variables influencing student outcomes. The major findings were synthesized and reported using the best methods for performing systematic literature reviews. Performance class standings and achievement scores were the key metrics used to assess the achievement of learning outcomes. Regression and supervised machine learning models were frequently employed to classify student performance. The most obvious indicators of learning outcomes were student academic attitudes, term assessment grades, and student online learning activities. The major goal of the study [14] is to use several machine learning algorithms and ensemble techniques to predict student performance more accurately than with individual machine learning methods. For the purpose of assessing student performance, the study considered the student's dataset, with 1000 instances and 22 attributes. Decision Tree (DT), Naive Bayesian (NB), K-Nearest Neighbors (KNN), and Extra Tree (ET) are four machine learning algorithms that used in this study. The model created to integrate the output of each separate base learner using Bagging and Boosting ensemble methods. To choose the best model, the results from bagging and boosting ensemble strategies were compared.

Data Collection

Data collected for the research analysis on the impact of gaming on college students. The students with age group 18-25 through the Google form Questionnaire. The questionnaire attached in the supplementary details of this article. The acquired dataset contains 723 instances and 20 distinct attributes. Out of the 723 students, 150 students are not playing any games using devices that is 20.75% of the whole instances. The questionnaire incorporated the features like age, gender, type (single/multiplayer, single level/multilevel), category (Action, Adventure, Simulation, strategy, Brain games, Study games) and mode of the game (Online/Offline), financial gain or loss from the game, Advantages and Disadvantages of playing games, preferable time and the hours of playing, influence of gaming in studies and the survey is ending with the question "Do you feel you are addicted in games?". The positive and negative impact on the gaming can be extracted using the sub-features that are added in the Advantages and Disadvantages in the Questionnaire (Survey Question No.11 & 12).



**Nisha Varghese and Shafi Shereef****Specifications of Features**

Based on the data collected from the students and their statements, there are few things that have positive and negative impact. The positive impacts including Improved hand-eye coordination and cognitive function - Mobile gaming has been shown to improve hand-eye coordination, cognitive function, and reaction time. This can be especially beneficial for older individuals and those with cognitive decline, increased social connections - Multiplayer mobile games provide an opportunity for people to connect and play games together, regardless of their physical location. This can help build and strengthen social connections, particularly for individuals who may have difficulty connecting with others in person, Access to education - Many mobile games are designed to educate players on a variety of subjects, such as history, geography, and science. These games can provide a fun and engaging way for individuals to learn and expand their knowledge, improved mental health - Mobile gaming has been shown to have a positive effect on mental health, providing a way for individuals to escape stress and anxiety, and helping to reduce symptoms of depression and anxiety and Economic benefits - The mobile gaming industry is a growing and lucrative market, providing jobs and economic opportunities for individuals and businesses. The survey incorporated the Advantages and Disadvantages of gaming with 10 sub features as shown in Table.1 and the statistics as shown in Fig.3 and Fig.4.

The excessive gaming can lead to psychological problems and emotional disturbances. These problems are closely connected to the stress, depressive mood, and anxiety. A cognitive behavioural model proposed that psychological distress acts as a catalyst for excessive internet use. A considerable comorbidity between excessive gaming and anxiety problems, physical and psychological distress has been discovered by epidemiological studies. The challenging toxic games are compromising the emotional quotient of a person and that may lead to the social anxiety, shyness and social disconnection. The students they spending hours in gaming they try to avoid the essential daily routine and food. They are not mentally strong to accept the failure in the game and avoiding the face-to-face interpersonal communication to society.

Some of the criteria are - Isolation and Loneliness - When people lack social connections, they can feel isolated and lonely, which can have a negative impact on their mental health and well-being, decreased sense of purpose - Social connections provide people with a sense of purpose and meaning in life, which can be lost when those connections are severed, decreased support systems - Social connections provide people with support systems, which can be crucial during difficult times. Without these connections, people may struggle to cope with challenges and stressors, decreased sense of belonging - When people feel disconnected from others, they can also feel a decreased sense of belonging, which can lead to feelings of isolation and marginalization, negative impact on physical health - Studies have shown that social isolation and loneliness can have a negative impact on physical health, increasing the risk of chronic conditions such as heart disease, stroke, and depression, Difficulty navigating social situations - When people lack social connections, they may struggle to navigate social situations and may experience difficulty in forming new relationships, Difficulty accessing resources and opportunities - Social networks can provide people with access to resources, information, and opportunities, which can be lost when those connections are severed, Harassment - Toxic players often engage in harassment, bullying, and hate speech, creating a hostile environment for other players. That may lead to players feeling stressed, anxious, or even traumatized, decreased enjoyment - When players are exposed to toxic behaviour, it can decrease their enjoyment of the game and make it less fun to play. That may result in players quitting the game or avoiding playing with certain players, decreased sense of community - Toxic behaviour can lead to a decrease in the sense of community among players. That can result in players feeling isolated and disconnected from the game and its players, negative impact on mental health - Exposure to toxic behaviour can have a negative impact on a player's mental health, leading to feelings of stress, anxiety, and depression, decreased diversity - Toxic behaviour can drive away players from diverse backgrounds, leading to a decrease in the diversity of players in the game. This can result in a homogeneous player base that may not accurately reflect the diverse interests and perspectives of the gaming community.



**Nisha Varghese and Shafi Shereef****Game Specifications**

The students are mostly using Mobile (74.9%) and laptop (11.4%) for gaming and the online multiplayer gaming are doing (64.4%) and the rest of them are playing single player or alone. The most frequently playing games are BGMI, Free fire, Call of Duty (COD), PUBG, Ludo, Clash of clans, Candy crush, Temple run, subway surfers, Plants vs Zombies, Brain Games and other E-Sports. According to the statistics most of the players are often playing Online Action games as shown in Fig.5.

Data Pre-Processing

Data pre-processing is the standardization of the data and make the raw data to an analysable form. The dataset incorporated 573 game players and 150 non players. Non-players are not considered for the analysis. The dataset contains missing (null) values, missing values are treated with most accurate values of the same game from the dataset and finding the average of the same instances. None of the instances are removed from the dataset to maintain the actual size of the dataset. The dataset for the analysis treated after the correlation between the features. The irrelevant features like name of the game, type of the game, Category of game, Number of players and mode of the game are eliminated from the data analysis. The major features are considered for the analysis are sub-features of advantages and disadvantages, hours of playing, impact of gaming in studies and the game addiction.

METHODOLOGY

The study and analysis of this research article incorporate various machine learning and Ensembled algorithms. This sub-section explores the various algorithms considered for the comparative study. Logistic Regression (LR) Supervised Machine Learning model and which calculates the probability of events based on the independent variables in the dataset and the outcome of the algorithm is the categorical dependent variable and the probability of the output variable ranged from 0 to 1, yes or no, true or false. Logistic regression can be used for solving both Regression and Classification problems. The model fits sigmoid or logistic function and that predicts 0 or 1.

Decision Tree (DT) is a Supervised learning model, which can be used for both classification and Regression, but mostly DT is preferred for the Classification problem solving. Decision Tree can be used for regression or classification models in the form of a tree structure. Decision tree breaks down a dataset into subsets and the final result is in the form a tree with decision nodes and leaf nodes. It is a tree-structured classifier, where internal nodes stand in for a dataset's features, branches for the decision-making process, and each leaf node for the classification result. The dataset's features are used to inform the decisions. The decisions are performed on the basis of features of the dataset. The DT algorithm starts from the root node of the tree and that compares the values of root attribute with the dataset attribute. The algorithm takes a decision based on the comparison and follows the branch and moves to the next node. Then the algorithm compares next node with the attribute value till the leaf node.

Random Forest (RF) is a Supervised Machine Learning Algorithm for both Classification and Regression problems. RF classifier is an ensemble model with a subset of decision trees and considers the average to improve the prediction accuracy by taking the majority votes of predictions from the trees in the forest to get the final output. By the way RF classifier leads to the improved accuracy and overcome the problem of overfitting. Support Vector Machine (SVM) is a supervised machine learning algorithm best suited for both classification and regression, which find a hyper plane in an N-dimensional space by mapping data to a high-dimensional feature space. A separator between the categories is found, then the data are transformed and a hyper plane could be drawn as a separator.



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RESULTS AND DISCUSSION

To predict the impact of Game Addiction to Emotional, Physical Distress and Academic Performance on College Students four models are considered including Logistic Regression, Decision Tree, Support Vector Machine and the Ensembled Model - Random Forest. The performance Evaluation Metrics are shown in the Fig.6. Among all the models the Support Vector Machine is providing the significant result on the prediction of the Game addiction. The lower accuracy of the model due the imbalanced dataset and inadequate instances.

CONCLUSION AND FUTURE ENHANCEMENT

This research article is emphasized on the prediction of the game addiction based on the Emotional, Physical Distress and Academic Performance and the data collated from the college students. After the pre-processing and Exploratory Data Analysis (EDA) the features are extracted based on the Correlation between the attributes. Four popular models are used for the prediction. Support Vector Machine out performs the other models with respectable accuracy. More instances and detailed academic records can be considered for the future enhancement and to develop the better accurate models.

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Table 1. Advantages and Disadvantages Features of Gaming		
No	Advantages	Disadvantages
1.	Stress Busters	Time Consuming
2.	Social Connecting	Violence
3.	Life Skills	Social Disconnection
4.	Logic Reasoning Skills	Irritability
5.	Education Games improve the studies	Family Relationship Issues
6.	Problem Solving	Toxic Games (Suicide Tendency)
7.	Hand - Eye Coordination	Emotion Suppression
8.	Entertainment	Escapism from Problems
9.	Spatial Skills (Motoring)	Mental Health
10.	Career option (Game Developer, Game Tester))	Physical Problems (tiredness, headache, insomnia, joint pains, forgetfulness, tinnitus (buzzing ears), dry eye and others)

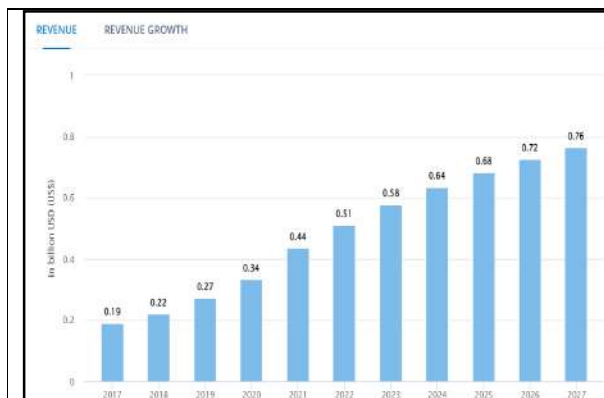


Fig.1 Online gaming in India – revenue statistics in Million per years

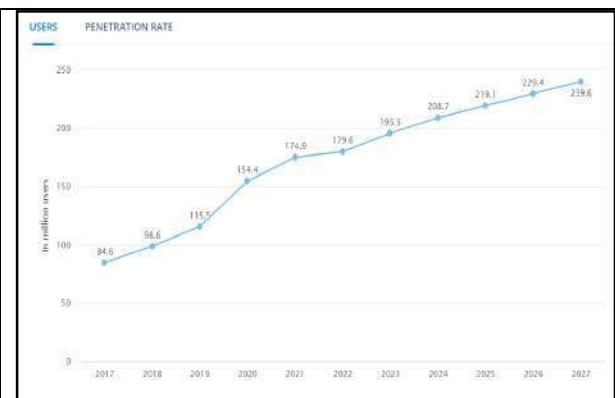


Fig.2 Online gaming in India – Users statistics million per years

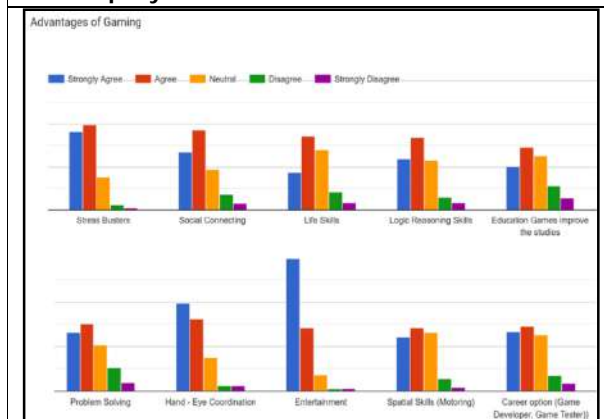


Fig.3 Advantages of Online Gaming

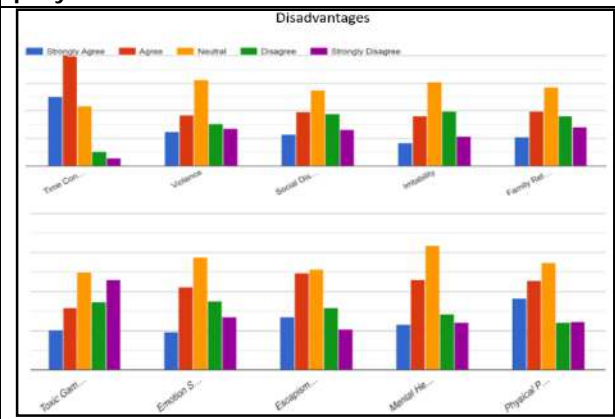


Fig.4 Disadvantages of Online Gaming





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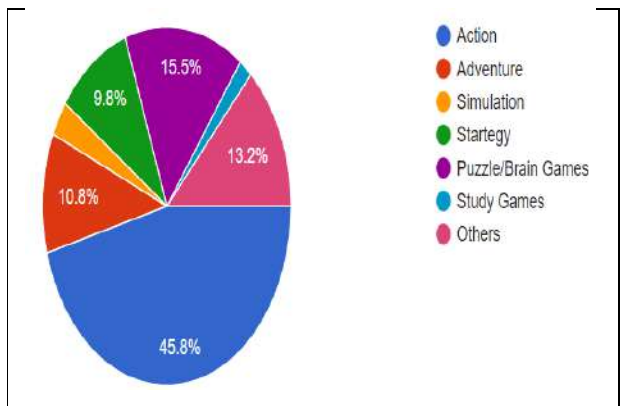


Fig.5 Categories of Gaming

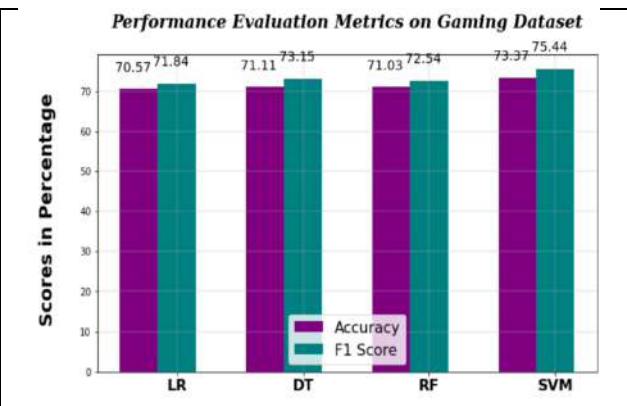


Fig. 6 Performance Evaluation Metrics on Gaming Dataset





Leveraging Autonomous Robotics in Supply Chain

Manish Shashi^{1*} and Puja Shashi²

¹Researcher, Walden University, MN, USA

²Professor, Oxford College Bangalore, India.

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*Address for Correspondence

Manish Shashi

Researcher,

Walden University,

MN, USA

E. Mail : manish.shashi@gmail.com



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ABSTRACT

Supply chain professionals now understand the value of autonomous mobile robotics (AMR) while formulating strategies for their integrated supply chain ecosystem. Perception, decision, and actuations are three major characteristics of AMR that helped make these ones of promising prospects in supply chain operations, such as dangerous and high-risk tasks, repetition, value addition, and allowing people to focus on strategic work. Using robotics process automation (RPA), organizations are now embracing automation technology to improve the productivity and efficiency of their supply chain system. Collaborative robots, also known as cobots, are very popular and are now positioned for substantial growth in diverse industries, mostly because of their faster ROI and safety features. The paper conducts a literature review and aims to identify research and development of robotics digital technology to streamline and further enhance the performance of the supply chain.

Keywords: Autonomous Robotics, RPA, Digitalization, Supply Chain

INTRODUCTION

Autonomous mobile robotics (AMR) are defining the supply chain globally nowadays. Using characteristics such as perception, decision, and actuation, AMR can perceive its environment, make decisions based on what it perceives, and then actuate a manipulation within that environment. Current and future advancements in digital technology will make robotics ubiquitous through more human-like abilities. Optimizing picking, storing, and sorting times, reducing overall spending in non-value-added activities, ensuring stability, and increasing productivity are benefits of implementing robotics solutions in supply chains. Autonomous guided vehicles (AGV) were the robots used before AMR. William Grey Walter invented AMR in 1990. The first commercially available was helpmate It could interact with its environment based on information from sonar, infrared, and vision systems. At that time, it proved to be a cost-effective way of eliminating menial tasks for increased labor costs. Robotics process automation (RPA) is another robotics application used to create an application to define the workflow of any repetitive, rule-based, or logical tasks. As per one survey, every day, 10-20% effort of the workforce in the supply chain is spent on a repetitive



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task, and about 75% of rule-based processes can be automated. In a survey among supply chain managers, 56% of respondents said they are perusing this tool. 87% further indicated that they are interested in doing this and that it is a part of their future supply chain strategies [7]. Software automated solutions in RPA may reside on virtual cloud servers and are named Bots. We have two types of bots: unattended and attended. Most supply chain organizations strive for unattended bots. It can execute entire tasks independently and without any human interventions. They are set up based on specific rule and operates around the clock. Attended bots work alongside humans when a specific part of the process cannot be automated, as there is no particular rule. There are three categories of attended bots: task, IQ, and meta. IQ bots are highly cognitive and can learn in real time and then perform the task based on the knowledge they have newly acquired. Autonomous robots can vary in intelligence, cost, size, functionality, and mobility and are programmed to perform tasks with little human intervention. The supply chain operation market gets more fluid as the demand for autonomous robots increases [6]. Organizations that use autonomous robots have implemented them for targeted functions within their supply chain, piloting various robots to verify expected efficiency gains. As innovative companies grow and expand operations, robots that build robots could be the norm for economically and efficiently optimizing manufacturing operations. Offerings and applications of autonomous robots are growing as companies look for innovative ways to reduce costs and place employees in roles that maximize value-added work [6]. Inefficiency in the supply chain segments, such as utilizing transport capacity and last-mile delivery, make robotics cases perfect for deploying in the supply chain. The manual process is also the trend in these segments. Other business requirements include moving to a varied range of stock-keeping units (SKUs) from previous norms of smaller batch sizes, redesigning the fulfillment center to position inventory closer to the end customers, and picking it faster to meeting day to day customers' promises. All these trends and demand for productivity enhancement and reducing cost presents a compelling case for more automation and deployment of robotics technologies [9].

Problem Statement

Supply chain disruptions post covid 19 epidemics are primarily the result of labor shortages, overwhelming ports, and general transportation issues. There is also a critical issue of less efficiency and accuracy in routine operational activities in areas such as warehouses and manufacturing and more accidents in dangerous working environments. Robotics-based automation can be a proposed solution. However, many supply chain organizations still need proper strategies to deploy robots in their processes, as robots are still seen as meant to replace workers rather than complement them.

Purpose Statement

This paper aims to understand the concept and utility of robotics in supply chain processes.

RESEARCH METHODOLOGY

A multidisciplinary systemic review is conducted by reviewing various literature on robotics and its applications in the supply chain. In this approach, we selected research articles from different disciplines of robotics and then looked from our perspectives at robotics utility and advantages in supply chain applications. The advantage of this methodology is that each aspect can be analyzed in detail, which is often required to answer complex research-related questions.

LITERATURE REVIEW

Using digital enablers, supply chain digital technologies have fostered a new era of competitiveness. (Ehie & Ferreira, 2019). Büyüközkan and Göçer identified eleven novel technologies and analytical methods supply chain leaders could use to achieve competitive advantage and satisfy their customers [4]. As shown in fig. 1, the enablers include Robotics, Sensor Technology, Augmented Reality (AR), Big Data, Internet of Things (IoT), Cloud Computing Technology (CCT), 3D Printing, Omni Channel, Self-Driving Vehicles, Unmanned Aerial Vehicle, and



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Nanotechnology. [4]. Business leaders who use emerging digital enablers for business advantages could enhance business performance with enhanced financial performances [10].

There is a significant difference between artificial intelligence (AI) and robotics process automation (RPA). RPA is rule-based automation and driven by the process, while AI is data-driven and requires good quality data to learn the pattern and then simulate the decision of humans [1]. Some of the popular AMR used in the industry are shown in fig. 2. All these robots use advanced sensors.

A new type of industrial robot, known as cobots (collaborative robots), has now emerged with the advancement of motion sensing technologies and computer vision [2]. It is depicted in fig. 3. They operate alongside humans under the supervision of someone. These robots are game changers for securing the safety of humans working in hazardous conditions, such as transporting or lifting a hazardous and heavy object. Much growth is estimated in this segment of robots in the next few years. In overall industrial robotics segments, the market for cobots may reach \$7.5 billion capturing 29% of the entire industrial market. Some of the collaborative robots manufactured by ABB are shown in fig. It can have a payload from 0.5 KG to 11 kg. Reach can be anywhere from 555 mm to 1400 mm, and max TCP can vary between 1.5m/sec to 6.2m/sec depending upon business requirements. These are some of the very popular robots used extensively globally.

Some of the features of collaborative robots are explained below.

Cost in Deployment It comes with safety features and does not require any other safety equipment to integrate. It helps in reducing lead time in deployment and cost. That is the reason it is immensely popular in industries.

Return on investment (ROI) Cobots are proven to deliver faster ROI by contributing to productivity. The upfront cost of this type of robot is significantly low, and deployment can be done quickly. Organizations can expect ROI in as many as a few months only.

Safety Ensuring the safety of humans is one of the primary features while designing a cobot. Sensors facilitate robots to avoid collision and shut down automatically in case of over current or forced collisions.

Flexibility This is easiest to operate, even without knowledge of robotics programming. Robots can sometimes guide workers by physically showing their arms moving.

Robotics technology significantly impacts the supply chain by helping unload commodities, palletize, and pick. It can transform the supply chain and help create a productive, faster, and safe logistics chain [3]. Fig. 4 shows the use of advanced robotics in logistics. Robot type, functions, and popular vendors supplying that robotics are also demonstrated in Fig.4.

1. After picking, container and trailer unloading robots place the items into the conveyor. It then moved them into the sorting center of the facility.
2. Robots can help pick up a shelf of goods and deliver them to the stationary picker. It then moves away to bring different shelves once the picker selects the required items.
3. In mobile piece-picking mode, robots can move around the traditional warehouse and pick items like humans do.
4. In the home delivery type, robots can directly deliver the package to consumers by slowly driving a walkway.

A few industrial used cases of robotics are discussed in the following section.

I. [5] DHL Supply Chain, a contract logistics services provider, collaborated with Locus Robotics, an autonomous mobile robots (AMR) provider for fulfillment warehouses. It helps navigate autonomously within warehouses to locate and quickly pick items for associates. DHL Supply Chain started with 100 bots deployed in two locations and later scaled up to 1000. They created a pilot in 2017 towards a collaborative, autonomous robotics solution—LocusBots, which focused on supporting employees in piece-picking order fulfillment in warehouses. Locus, the robot manufacturer, has already deployed 200 warehouses globally. The company said that machines are not meant to remove workers from their job but to extract more productivity from them [5].



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II. [8] Honeywell collaborated with Carnegie Mellon University to advance artificial intelligence and robotic technologies. It was to help distribution centers address rising demands fueled by rapid growth in both brick-and-mortar business models. The two organizations collaborated to advance the capability of artificial intelligence and robotics technologies to benefit distribution centers, which are becoming more integrated and complex. They also worked together on robotics solutions to improve productivity and performance in fulfilling customer orders [8].

Per one estimate, last-mile delivery represents over 50% of overall shipping cost and contributes major milestones in customer satisfaction. Generally, it is considered as least productive and least efficient. Robots used in last-mile delivery should be capable of delivering small goods most efficiently and safely. Industries use four types of robots for last-mile delivery, such as (i) drones, (ii) autonomous vans, (iii) legged sidewalk pods, and (iv) wheeled sidewalk pods. Autonomous vans are the most efficient of all. It can carry small to large packages and operate in all environmental conditions and geography.

Analysis of Findings

Robotics poses to transform end-to-end supply chain processes by automating the system efficiently. Fig 5 indicates the life cycle of the end-to-end supply chain and using this, we will analyze the application of robotics in each phase.

Develop Activities associated with development or prototyping involve repetitive and continuous tasks and numerous tastings. Robotics process automation (RPA) can help develop a new product in these repetitive, around-the-clock testing activities.

Plan RPA can help in data entry activity activities in demand and supply planning. Robots, like drones, can help in inventory counting, reconciliation, and replenishment if needed. It ultimately helps in optimizing on-hand inventory.

Sourcing autonomous robots can perform an inbound inspection when received from the supplier. They can provide information to both supplier and receiving organizations. RPA can also help achieve a standard sourcing process, such as identifying suppliers based on pre-determined criteria, such as historical data on delivery adherence, quality, and pricing.

Make Collaborative robots can work alongside humans and help them to focus on more strategic work. The robot can also help in reducing quality defects during manufacturing processes.

Return Robotic processes can help quickly put away customer returns and faster redeploy returned products using scanning functionalities built on lasers and improved cameras.

Robots can be deployed as a flexible leasing service from manufacturers or third-party vendors, or they can be directly procured by organizations to implement in their organizations. Flexible leasing options are popular in organizations with limited funds for acquisitions [6]. It is also required for organizations that need an operator skill set based on their operations. Attended bots are generally used for short-term efficiency, and unattended bots are more for long-term efficiency and to support supply chain businesses. However, both types of bots can help businesses reallocate employees' skill sets from repetitive tasks to strategic work. In the process, they help reduce operating tasks and increase productivity. With the help of innovative robots, cold chain warehouses can protect employees from workplace hazards and boost efficiency. In pharmaceutical industries, cold chain warehouses and transportation contribute a bigger role in maintaining temperature and humidity [11]. Applying RPA ensures that common human error does not negatively impact products stored in cold chain warehouses. It also ensures that because of puddles or ice, employee safety is not endangered.

Collaborative robots, called cobots, differ significantly from their industrial robots counterparts. Advancement in IoT sensors helps them to avoid collisions with their human colleagues. As per one estimate, by 2027, the cobot market is expected to reach \$7.5 billion. It is most popular in industrial robot segments mostly by its features, such as safety, faster ROI, flexibility, and low-cost deployment. Many organizations still need the foundation for utilizing robotics



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to its full potential. Their warehouses might need more stability in their processes, the scale of the warehousing infrastructure, and even their setup and culture. That does not help to apply robots at scale in their supply chain operations, and humans still need to play a significant role till it stabilizes [9].

CONCLUSION

The autonomous robot can help the supply chain in various ways, such as by improving collaboration with humans, faster customer delivery, safe operations in a high-risk environment, reducing labor costs, reducing product defect and return rates, and increasing overall efficiency. Industrial installation of these robots is also user-friendly. It can be done using easy steps, such as creating a facility map using robotics software and setting up tasks for robots. Advanced robotics, such as collaborative robots, is a game changer in ensuring the safety of humans working in hazardous conditions. It is time for organizations to assess their needs and pilot autonomous robots within the supply chains to improve productivity, reduce cost, and increase customer satisfaction. It can be deployed as a service provided by a third party or as a direct procurement to implement in supply chain operations.

The combination of attended and unattended bots in RPA creates a holistic solution and paves the way for the competitive success of the business. With deployment ease and streamlined workflows, they promote scalability, efficiency, and a better customer product or service. Logistics operations in the supply chain are complex, with many facilities needing sorting SKUs of varying orientations, weights, and sizes. Organizations also need a substantial rate of reliability and accuracy while using robots in their operations. The application of robotics may increase productivity but at a diminishing rate. There is no one size fits, and supply chain organizations need to learn a balance between automation using robotics and human involvement across the supply chain. The digitalized world is evolving every day, and the future will, unfortunately, probably introduce new issues and challenges. Robotic solutions will surely bring better opportunities, more innovations, and effective solutions to satisfy industrial supply chain needs.

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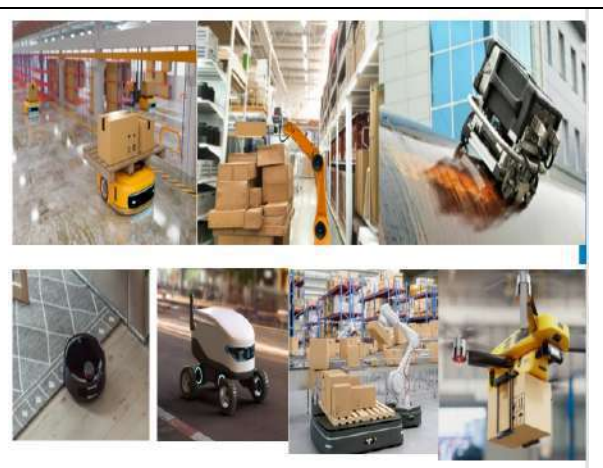
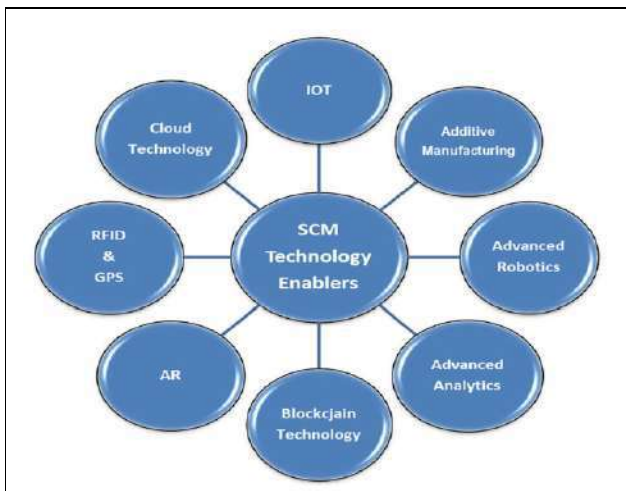


Fig. 1: Digital technology enablers in the supply chain (Source: Attaran, 2020) [2].

Fig. 2: Popular AMR for industry utility.



Robots Types	Functions	Vendors
Container Unloading	<ul style="list-style-type: none"> Picks up a box and places it onto a conveyor 	<ul style="list-style-type: none"> DHL-Parcel robot Wynnigite-Trailer loading robot
Stationary Piece Picking	<ul style="list-style-type: none"> Brings a shelf of goods to a stationary picker 	<ul style="list-style-type: none"> Kiva-Mobile robots SSI Schaefer-Robo-pick Knapp Viastore
Mobile Piece Picking	<ul style="list-style-type: none"> Drives around warehouse shelves and picks items 	<ul style="list-style-type: none"> VAM Robotics-Mobile robot Fetch Robotics-Mobile robot Magazine- Picking robot named TORU
Home-Delivery	<ul style="list-style-type: none"> Delivers small packages directly to consumer homes 	<ul style="list-style-type: none"> Starship Technologies-Parcel delivery robot

Fig. 3: Use of advanced robots, functions, and vendors (Source: ABB robotics offering, 2023)

Fig. 4: Use of advanced robots, functions, and vendors (Source: Attaran,2020) [2].

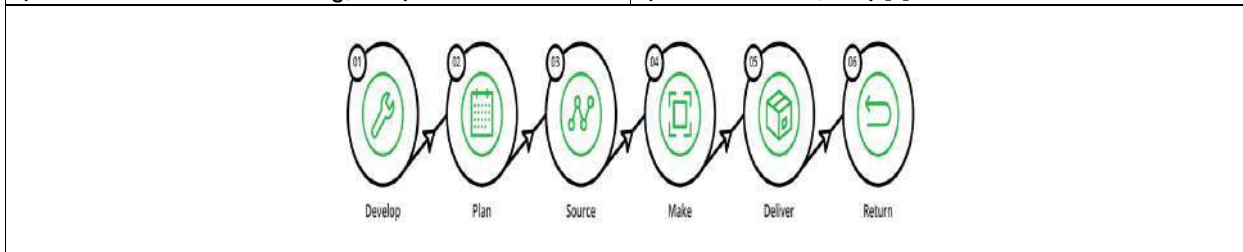


Fig 5: Life cycle of the supply chain





The Impact of Social Media Images on Youth: A Literature Review

Indu Joseph Thoppil

St. Francis De Sales College, Bangalore, India.

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*Address for Correspondence

Indu Joseph Thoppil

St. Francis De Sales College,
Bangalore, India.

E. Mail : indujoseph@sfscollge.in



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ABSTRACT

Attitudes, behaviors, and sense of self-worth could be shaped by social media sites like Instagram and Snapchat as well as the images posted on these sites. According to research, social media exposure to idealized and unrealistic images of beauty and body types can have a negative impact on young people's development in a number of ways, including eating disorders, body dissatisfaction, and poor self-esteem. The way that young people see themselves and their interactions with others can also be impacted by social media images. Youth can benefit from social media, which has the ability to improve social connectedness and self-expression. Parents, teachers, and lawmakers must take into account the potential effects of social media images on young people and work to encourage positive body image and healthy social media use.

Keywords: Social media, Digital images, Impact, Social Comparison, Body Shaming, Cyberbullying.

INTRODUCTION

The advent of social media has brought about a revolution in communication and networking. Social media platforms such as Instagram, Facebook, and Twitter, Pinterest, YouTube have become a central part of modern society, particularly among youth. Social media images, in particular, have become an essential part of the online experience. The impact of social media images on the behavior and attitudes of youth has become a concern for parents, educators, and policymakers. This paper aims to review the literature on the effect of social media images on youth and to provide recommendations for mitigating the negative effects.

LITERATURE REVIEW

The impact of social media images on youth can be viewed in different ways. Firstly, social media images can affect body image. A study by Perloff (2014) found that viewing images of thin and attractive individuals on social media can lead to increased body dissatisfaction and negative self-perception among youth. This can result in eating disorders, depression, and anxiety. Social media images can also affect self-esteem. Valkenburg *et al.* (2016) found





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that social comparison on social media can lead to decreased self-esteem among youth. The study found that youth tend to compare themselves with others on social media, and this can result in negative feelings about themselves.

It is generally true that including pictures in a post can lead to higher user engagement on social media platforms such as Facebook and Twitter. Studies have shown that posts with images receive more likes, comments, shares, and clicks than those without images. This is because images can capture the attention of users and make the post more visually appealing.

However, the effectiveness of images in driving user engagement can depend on various factors, such as the content of the image, the quality of the image, the placement of the image within the post, and the audience's preferences. Certain image characteristics can also induce more interaction and propagation than others. For example, images that are emotionally appealing, visually striking, or humorous tend to perform well on social media platforms. Additionally, images that are relevant to the post's content and are sized appropriately for the platform can also help increased engagement (eMarketer 2011; Vavrek 2012).

Impact of Social Media Images

The impact of social media images on youth can be both positive and negative. Social media images can have a positive impact on youth by providing them with a platform for self-expression, connection, and inspiration. However, it's important for young people to also be aware of the potential negative effects of social media, such as unrealistic beauty standards, cyberbullying, and social comparison.

A Positive Impact

Social media platforms can provide young people with access to a diverse range of images and ideas that can broaden their horizons, expand their creativity, and inspire them to pursue their passions. Social media can also provide a platform for youth to express themselves and connect with others who share their interests and perspectives.

- Inspiring creativity: Social media images can inspire young people to explore their creativity and express themselves through photography, art, and design.
- Promoting diversity and inclusion: Social media images can showcase a wide range of cultures, lifestyles, and identities, helping young people to appreciate diversity and become more accepting of others.
- Fostering connection: Social media images can help young people to connect with others who share their interests and passions, even if they live in different parts of the world.
- Raising awareness: Social media images can raise awareness about important issues such as social justice, environmentalism, and mental health, encouraging young people to get involved and take action.
- Providing inspiration: Social media images can provide inspiration for young people to pursue their dreams, set goals, and achieve their aspirations.

B Negative Impact

Social media images can also have negative impacts on youth. Young people are often bombarded with images that promote unrealistic beauty standards, materialism, and unhealthy behaviors. These images can lead to negative self-esteem, body image issues, and feelings of inadequacy. They can also contribute to the development of mental health issues such as anxiety and depression.

- Body image concerns: One consistent finding is that exposure to social media images can contribute to body image concerns among youth, particularly girls. A 2019 study published in the journal *Body Image* found that Instagram use was associated with increased body dissatisfaction and anxiety among adolescent girls. Another study published in the *Journal of Youth and Adolescence* in 2020 found that girls who spent more time on social media reported higher levels of appearance comparisons and body dissatisfaction. Social media images often portray idealized and unrealistic beauty standards, which can lead to negative body image among the youth. The constant exposure to perfect and curated images can lead to feelings of inadequacy and lower self-esteem. The impact of social media images on youth can be viewed in different ways. Firstly, social media images can affect body image. A



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study by Perloff (2014) found that viewing images of thin and attractive individuals on social media can lead to increased body dissatisfaction and negative self-perception among youth. This can result in eating disorders, depression, and anxiety. Social media images can also affect self-esteem. Valkenburg *et al.* (2016) found that social comparison on social media can lead to decreased self-esteem among youth. The study found that youth tend to compare themselves with others on social media, and this can result in negative feelings about themselves. Social media images can affect the perception of beauty. Social media images often promote unrealistic standards of beauty, leading to a distorted perception of beauty among youth. A study by Fardouly *et al.* (2015) found that exposure to images of thin models on social media can lead to an increase in body dissatisfaction and a desire for thinness among youth. This can result in unhealthy behaviors such as excessive dieting and exercise.

- Self Esteem: Negative self-perception: When youth are constantly exposed to highly edited images of others, it can lead to feelings of inadequacy and low self-esteem. They may start to compare themselves to the unrealistic beauty standards or luxurious lifestyles depicted in these images, leading to negative self-perception.
- Social comparison: Social media can also contribute to social comparison among youth, which can negatively impact self-esteem and well-being. A 2018 study published in the journal *Computers in Human Behavior* found that social media use was associated with increased envy and decreased life satisfaction among young adults. Similarly, a 2019 study published in the *Journal of Social and Clinical Psychology* found that social media use predicted higher levels of social comparison and depressive symptoms among college students.
- Negative self-perception: When youth are constantly exposed to highly edited images of others, it can lead to feelings of inadequacy and low self-esteem. They may start to compare themselves to the unrealistic beauty standards or luxurious lifestyles depicted in these images, leading to negative self-perception.
- Fear of missing out: Social media images can create a sense of missing out on social events or experiences that others are enjoying. This can lead to anxiety, stress, and a sense of isolation.
- Pressure to conform: Youth may feel pressure to conform to the norms and trends represented in social media images, leading to a loss of individuality and creativity
- Social Isolation: When young people are bombarded with images of their peers appearing to lead perfect, exciting lives, they may feel inadequate or left out if their own experiences do not measure up. Additionally, social media can create a sense of distance between people, despite the appearance of connectedness. Online relationships can feel shallow or insincere, and young people may feel like they don't have anyone they can truly confide in.
- Woods and Scott's (2016) article on social isolation provides a comprehensive review of the current research on the topic. The authors define social isolation as the objective lack or reduction of social contacts, relationships, and social participation, as opposed to loneliness, which is a subjective feeling of social disconnectedness. One potential limitation of the article is its focus on Western societies. While the authors briefly discuss social isolation in other cultures, the majority of the research cited comes from Western countries. This limits the generalizability of the findings to other cultures and societies.
- Cyber bullying: Social media images can be used to bully and humiliate the youth. This can lead to a range of negative consequences, including low self-esteem, anxiety, and even suicide.
- Mental Health: Social media can also impact mental health of the youth. Excessive use of social media can lead to feelings of anxiety, depression, and loneliness, especially if the images they see do not align with their reality. Social media can also exacerbate existing mental health issues. Youth who are constantly exposed to images of perfect bodies and lifestyles may feel pressure to conform to these ideals, which can lead to anxiety and depression. Additionally, social media can create a sense of social isolation, which can exacerbate existing mental health issues. For example, a study conducted by Woods and Scott (2016) found that social media use was associated with higher levels of anxiety and depression in youth.
- Influence on behaviors: Social media images can sometimes promote risky behaviors such as drug and alcohol use, and can expose youth to explicit content that can be harmful to their psychological and emotional development.

Overall, it is important for young people to be aware of the potential impact of social media images on their well-being, and to engage with social media in a responsible and mindful way. It is also important for parents, educators, and other adults to be aware of the impact of social media on youth, and to support young people in developing healthy habits around social media use.



**Indu Joseph Thoppil****Techniques to Overcome Negative Impact of Social Media Images**

Educating youth about the positive and negative impact of social media images is important to help them develop a healthy relationship with social media and to prevent them from developing unrealistic expectations about themselves and others. Here are some steps that you can take to educate youth about the impact of social media images:

- Start a conversation: The first step in educating youth about the impact of social media images is to start a conversation with them. Ask them what they think about social media, what they like about it, and what concerns them.
- Teach critical thinking skills: Teach youth how to critically evaluate social media images by asking questions such as: Who created this image? What is the message behind it? Is it realistic? Is it promoting a healthy or unhealthy body image?
- Discuss the effects of social media images: Discuss the positive and negative effects of social media images on mental health, self-esteem, body image, and relationships. Use real-life examples and statistics to illustrate your points.
- Encourage positive content: Encourage youth to post positive and uplifting content on social media, such as quotes, inspiring stories, or positive news articles.
- Promote self-care: Encourage youth to take care of themselves by limiting their social media use, practicing self-care, and seeking help if they are struggling with mental health issues.
- Be a role model: Set a good example by modeling healthy social media habits yourself. Limit your own social media use, post positive and uplifting content, and be mindful of the impact of social media images on your own mental health and self-esteem.

By taking these steps, we educators can help youth develop a healthy relationship with social media and make informed decisions about the content they consume and create.

CONCLUSION

In conclusion, the impact of social media images on youth is a complex and multifaceted issue that requires our attention. As we have seen, social media images can have both positive and negative effects on young people's self-esteem, body image, and behavior. On the one hand, social media can provide a platform for promoting positive body image and self-expression, and can also help young people connect with peers and find support. On the other hand, social media can also promote unrealistic beauty standards, perpetuate harmful stereotypes, and contribute to the development of negative body image and disordered eating behaviors. To address these issues, we need to take a more holistic approach to social media use. This means promoting media literacy and critical thinking skills, advocating for more diverse and inclusive representations in media, and creating safe spaces for young people to express themselves online. We also need to support initiatives that promote positive body image and self-esteem, such as body-positive campaigns and mental health services. In the end, it is up to all of us to be mindful of the impact our social media use can have on young people, and to take steps to promote a healthy and empowering online environment for everyone. By working together, we can help young people navigate the complex world of social media and develop a positive relationship with their bodies and themselves.

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Exploring the Prospects and Challenges of using Artificial Intelligence in Teaching LSRW Skills

J.Umamaheswari*

Assistant Professor, SFS Degree College, Bangaluru, Karnataka, India.

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*Address for Correspondence

J.Umamaheswari

Assistant Professor,

SFS Degree College,

Bangaluru, Karnataka, India.

E. Mail: umamahibala2014@gmail.com



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ABSTRACT

In the age of technology, Artificial Intelligence (AI) is a boon to the present generation students to enhance their Listening, Speaking, Reading and Writing (LSRW) skills. When it comes to teachers, the usage of technology in education intimidates them to a great extent. It is a prerequisite to understand how the artificial intelligence can be used according to the needs and interest of the students. This research article aims at exploring the AI tools that can be used to develop the LSRW skills. When the teacher's support and creativity allied with AI tools, will work for students better and also to encourage students master the four skills in English Language. In education, AI has changed the English language teaching-learning scenario and implementation of AI in education integrates the experiential learning in the classroom environment. The different methods which we use in AI are Robotics, Learning Management System (LMS), Virtual Reality and Chat bot. This will help students to get hands-on experience in improving their creativity using AI. The four language skills like Listening, Speaking, Reading and Writing are intertwined and AI can assist students to strengthen their language skills. This research proves that the AI could integrate all four skills and AI tools increase the interest of students in mastering the four language skills.

Keywords: LSRW, Education and Artificial Intelligence

INTRODUCTION

Artificial intelligence (AI) appears to be unavoidable in every area of our life in present scenario. From vehicle driving to house hold chores, AI has long since moved from science fiction to scientific reality. As a result, it plays its vital role everywhere in our life as no surprise that AI can assist us in learning languages more earnestly and effectively. This Study explores the prospects and challenges of AI in teaching LSRW skills to college students. Teachers can utilise AI for teaching LSRW skills to the students effectively by whenever and wherever they choose.





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To broaden students' skill development knowledge traditional institutions can include artificial intelligence language learning. The advantages of using artificial intelligence in e-Learning are incredible. Language acquisition is the process in which humans get the ability to perceive and comprehend the language and they learn to produce and use the words to frame sentences for communication. Learning a second language is an arduous process that requires dedication, perseverance, interest and involvement. Traditional teaching method for LSRW skills in language teaching are totally different from the strategies which we use in present scenario. AI works and takes decisions like human being as power of human brain transfers to machine. AI gives opportunity to teachers to teach effectively using technology and students to learn quickly and easily using same AI applications and devices or tools. Education is getting advanced with the assistance of Computer technology. It will not reduce the teachers in numbers but at the same time, it will enhance their teachings effectively.

"The rapid expansion of technology and digital applications that characterizes the "4th Industrial Revolution" is changing the way we live, work – and learn. It's a revolution driven by the fusion and amplification of emerging breakthroughs in artificial intelligence, automation and robotics, and multiplied by the far-reaching connectivity between billions of people with mobile devices that offer unprecedented access to data and knowledge." (Manns, 2017).

The drastic change in the education sector leads to modernize the different aspects of teaching and Learning process.

METHODOLOGY

The methodology used for this analysis is quantitative research. Many articles related to the analysis, secondary resources, online resources, research papers have been taken for references. The data collected from all the secondary sources have been well organised in a complete manner regarding how the role of Artificial Intelligence is involved in teaching LSRW skills. The purpose of the research article is to light up certain experiences in order to observe the experiences people shared in their articles that are gained by many in a specific condition when they use the AI in their classroom teaching with various aspects related to it.

Prospects in Teaching LSRW Skills

It is evident that the most artificial intelligence applications are not replicating human cognition. The main focus of AI is to use the wide technological capabilities of present and modern computers in teaching LSRW skills in the effective way than the humans. It is a challenge to human brain to execute multi task at a time but AI tools are more effective when it comes to simple or complex calculations at a time. AI can create various virtual learning circumstances, smart class, ease language learning, create various exercises for each student with their level of understandings and their standards. AI works with precisions because it has the data input of well-established mathematical formulas to make exact and accurate predictions. The potentiality of Artificial Intelligence involves in personalise the digital language learning forum open for each and every student. There is an application called Vocabulary Trainer. The unique features of the app are to calculate every learner's vocabulary strength and weaknesses wherein it tests the learners' real-time capacity of grasping the words and vocabulary strength of the learner. It teaches the student according to their standard of learning capacity of the students. IT seems to be complicated one, but after getting trained well and the power of vocabulary will be revealed by an individual efficiently, we will recognise the power and potential of the technique. The Artificial Intelligence tools help the learner and teacher to concentrate on other developing conversational skills like gaining fluency, confidence, gestures, styles and pronunciation in communication in the global market. The main prospect of AI for the students is to permit students to learn on their own pace of time and they can identify their own weakness and strength when it comes to all LSRW Skills in language teaching. "Students can get feedback and it assists them in scoring their knowledge in language and communication. Students can optimise their real time classroom classes focussing on the other capabilities that no other AI can teach or deliver for them. Many studies have investigated student attitude in the Computer- Assisted Language Learning (CALL) environment and found learner's positive attitudes towards using technology in language learning". E.g. Kessler, Bikowski and Boggs (2012), Zhang, Song and Huang(2014), Zou, Wang and Xing (2016), Xu and Peng (2017) and Zou, Li and Li(2018).



**Umamaheswari****Artificial Intelligence and Voice Recognition Technology (AI and VRT)**

The role of English in multidisciplinary sectors has been increasing due to upcoming demands of globalization and modernisation. The development of voice recognition technology in Call Assisted Language Learning has great deal for the app creation assisting the learning of speaking skill among the LSRW skills. There are more mobile applications featuring Voice Recognition Technology such as Nuance Dragon Dictation(2018), Praat (2018) and Duolingo (2018), available for free to improve speaking skills in English. There are some VRT products in the market like Siri (Apple Inc.,2018) was created in 2011 as a virtual user assistance for users of Apple devices such as iPad and iPhone. This technology helps students to pronounce the word perfectly for speaking skills. Many innovative companies are creating AI tools and some applications which helps in assisting teaching the LSRW skills in English.

Nuance's Dragon Speech Recognition

There is a software which provides speech recognition is Nuance's Dragon Speech Recognition. It can be used by both the students and faculty members. It can transcribe up to 160 words per minute, which helps students who find it difficult to write or type. The main feature of this is supporting verbal commands. It dictates class work with accuracy where the students improve their listening skill using the app.

Knowji

Knowji is an another AI education tool available in the market which is an audio-visual vocabulary application that enhances the current research on education. It is exclusively designed for language learners and it uses various methods and concepts to learn the language based skills easier and faster. In language learning, AI will not chastise or condemn students for their mistakes instead it will give another opportunity to answer correctly. Learners may be assessed without being judged by artificial Intelligence.

Language Bots

Chatbots have created in the way that people think that they are conversing to the real person. Many people use chatbots for learning some foreign languages. All you have to do is to engage in a conversation with an AI bot and learn language and gain many experience out of that. Artificial Intelligence powered language learning chat bots gives feedback and respond to the people immediately according to their questions and requirements.

ROSETTA STONE

Students can study more than 25 languages with this language learning software on any device, at any time. The user gets benefitted from this software to continue their education both offline and online. We can use the software in iOS and Android devices. The true accent speech engine is used by the Rosetta stone software program to ensure that students or users attain the correct articulation. This software teaches students and users in real-time using augmented reality and students gain the practice of using correct pronunciation.

Machine Translation

Machine Translation helps students in better comprehending a language as well as developing comprehension, sentence creation, sentence pattern, vocabulary in the English Language. Machine Translation is a teaching technique in which students find and fix inconsistencies and mistakes in machine-translated material.

Duolingo

Duolingo is the renowned language-learning chatbot. This Duolingo is integrated with AI platform that allow it to comprehend the user's context and reply to them contextually and individually. This is programmed in the way that different users receive different responses to the same question. Duolingo has given the opportunities to thousands of individuals to learn a new language without losing the confidence of miscommunicating with a native speaker. The bots could only converse in English, Spanish, German, or French before. This AI tool can now converse in over





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23 different languages in any topics. "PC Magazine named Duolingo as one of the finest language learning programs."

Memerise

The Memerise chatbot program offers language instruction and also a variety of other course. This program gives opportunity with its unique techniques to engage readers in mastering one of the Language skills and also to improve vocabulary moreover like natives in more than 20 languages throughout the world. The iOS and Android platforms give way to use Memerise application in our mobile phone. This software enables the real-time object recognition methods to engage users in learning in real-time, which means that users may take a snap of any material or object and feed it to the app to learn the object's name in the students or user's preferred language.

Challenges of Using AI

Learners will be able to study anywhere in the globe at their own speed, Students can establish their own objectives, and follow a personalized curriculum thanks to AI utilized for acquiring LSRW skills in language acquisition. There is a customized approach to learning that differs from student to student, teachers will not have to go over the same content every year. AI will assist in the development of games, quizzes, and other activity based learning and exploration activities that integrate academic programs with students' interests and active participation. There is always the other side of the coin. As there are many prospects, there are challenges also in using AI in classroom environment.

"Negative perceptions and challenges of using AI consists discomfort created by reading from electronic display screens and it limited by Wi-Fi access, when the App are needed good network connection. Negative perceptions of VRT centre on practical and technical aspects, such as the associated high costs of CALL digital Technology, of its maintenance and apps' limited accessibility when needing complicated instructions". (Chen, 2011; Meisam & Tavakoli,2015) There are several challenges in using AI in the process of language teaching are

Lack of Human Conversation

"The main limitation of AI language learning tools is the lack of human conversation".(Khanzode & Sarode 2020). The most learning experience in English language is self-guided and does not involve directly in human interaction. This is problematic to the students who likes interactive learning.

Requirement of Large Amount Of Data

AI language learning tools rely on large amount for learning using apps in mobile phones which can challenge the underrepresented language. This can lead to the biased learning materials for the students.

Limited Capacity to Identify Errors

AI language learning tools may not identify the errors perfectly like language tutors or teachers. This can lead students tend to do errors while learning.

CONCLUSION

In recent days, Artificial Intelligence tools have become more renowned because they are practical, easy to assess and use. When students learn LSRW using AI, they can learn very fast and making learning more personal without fear of punishment. This study has explored the prospectus and challenges of using AI in teaching LSRW skills. The findings indicate that there are pros and cons of using AI in the classroom environment for teaching LSRW skills. Most of the articles related to AI and AI in the field of education reports showed positive comments in the enhancement of learning LSRW skills from students and the teachers also reported that there are active participation and responds from students in the process of teaching. It is recommended that further research maintains an



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interdisciplinary perspective to gain more knowledge in the field of education using AI in the process of teaching LSRW skills.

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Isolation of *Streptococcus mutans* From Clinical Dental Caries Samples and Extraction of Glucosyltransferase Enzyme from *S. mutans*

J Anusha¹, A Salman¹, Shramya¹, M. Vishal^{2*} and N. Mallikarjun³

¹B.Sc. Student, Department of Studies and Research in Microbiology, Sahyadri Science College, Shivamogga 577203, Karnataka, India.

²Research Scholar, Department of Studies and Research in Microbiology, Sahyadri Science College, Shivamogga 577203, Karnataka, India.

³Professor, Department of Studies and Research in Microbiology, Sahyadri Science College, Shivamogga 577203, Karnataka, India.

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*Address for Correspondence

M. Vishal

Research Scholar,
Department of Studies and Research in Microbiology,
Sahyadri Science College,
Shivamogga 577203, Karnataka, India.
E.Mail: mvishal9632@gmail.com



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ABSTRACT

The aim of our present study is to extract the glucosyltransferase enzyme (GTFs) from *Streptococcus mutans*, Dental caries is one of the critical common human infectious diseases that can lead to loss of tooth structure, it occurs due to the metabolic activation of the plaque microorganisms, especially *Streptococcus* sp. Glucosyltransferase genes are recognized as essential enzymes leading to biofilm production, the destruction of the ecosystem of typical bacterial communities, and the development of dental caries. *Streptococcus mutans* are the main etiological agents of dental caries formation, in our preliminary studies, 66 clinical isolates were isolated from clinical dental caries samples, and out of 66 isolates, 30 were found to be positive for *Streptococcus mutans* based on biochemical, morphological identification and these 30 *S. mutans* were screened for glucosyltransferase enzyme production out of thirty, twenty-eight found to be positive for glucosyltransferase enzyme production.

Keywords: Dental caries, *Streptococcus mutans*, Glucosyltransferase, Biofilm.



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INTRODUCTION

Dental caries is the local destruction of dental hard tissues due to acidic by-products produced by bacterial fermentation of dietary carbohydrates [1-2]. The early phases of decay are characterized by abnormalities in the hard dental tissue, but the disease process begins within the bacterial biofilm that covers a tooth. Dental caries is a condition caused by multiple factors that begins with microbial shifts in the biofilm and is influenced by exposure to salivary flow to fluoride, consumption of dietary sugars, and preventive behaviors (cleaning teeth). The disease is initially curable if enough biofilm can be eliminated. However, in most people, dental caries gradually advances and becomes a chronic condition. Dental caries development is associated with biofilm formation affecting a large population worldwide [3]. Besides, increasing evidence suggests that dental caries may have an adverse effect on cardiovascular diseases [4].

Streptococcus mutans has been a significant focus on the etiology of dental caries, it has long been considered a pathogenic bacterium of dental caries because it not only produces lactic acid but also grows at low pH [5]. *Streptococcus mutans* is the most common pathogen associated with tooth caries. The cariogenic potential of *Streptococcus mutans* is associated with its ability to form biofilms on both soft and hard oral surfaces such as the palate, tongue, restorations, and teeth. These bacteria rapidly metabolize sugar such as sucrose and fructose into glucans or fructans by extracellular glucosyltransferase (GTFs) and fructosyltransferase (FTFs) enzymes. These substances have a crucial role in the virulence of *Streptococcus mutans* [6]. The virulence factor of *Streptococcus mutans* that contributes to oral biofilm development is its ability to produce glucosyltransferase 'B'. This extracellular enzyme is responsible for glucan formation from sucrose contained in the diet. The synthesized glucan causes the adhesion of *Streptococcus mutans* to the tooth enamel [7]. The sucrose-dependent mechanism mainly depends on glucosyltransferases (GTFB, GTFC, and GTFD) produced by *Streptococcus mutans* which are responsible for the synthesis of glucan from sucrose [8]. In our present study, isolation and identification of *Streptococcus mutans* from Clinical Dental caries samples and extraction of glucosyltransferase enzyme were carried out.

MATERIALS AND METHODS

Isolation of *Streptococcus mutans* from clinical Dental Caries samples:

Clinical dental caries samples were collected from the Department of Dentistry, District McGann Hospital, Shivamogga, Giriraj Dental Clinic, Shivamogga, and other private dental clinics, in Shivamogga, Karnataka. Dental caries-infected teeth samples were collected, transferred into 2 ml of saline, transported into a laboratory, and streaked onto blood agar media. The plates were incubated at 37°C for 24- 48 hours. Colonies Showing α -hemolysis were selected for further streaked on Brain Heart Infusion (BHI, HI Media Agar), Mutans-Sanguis Agar (MSA, HI Media Agar), Nutrient Agar (NA, HI media Agar). The plates were incubated an aerobically at 37°C for 24 to 48 hrs. The obtained pure cultures were subjected to biochemical tests, and standard culture of *Streptococcus mutans* (NCIM Accession No:5660) was procured from NCIM Pune in Lyophilized form for the confirmatory test with our clinical isolates.

Morphological and Biochemical Identification

Isolated bacterial colonies from the dental caries samples on the Brain Heart Infusion (BHI) plates were further characterized by Gram's staining, and various biochemical tests were carried out by following Bergey's Manual of Determinative Bacteriology[9]and Murray Manual of clinical microbiology 8th edition[10].The bacterial isolate was further confirmed by 16S rRNA gene sequencing and also specific test for identification of *Streptococcus mutans* confirmation were performed by following the methodology of Gold *et al.*,(1973) [11].



**Anusha et al.,****Molecular Identification (16S rRNA Based Identification)**

S. mutans was grown on Brain Heart Infusion (BHI) agar medium. The genomic DNA was isolated from overnight bacterial culture using a genomic DNA isolation kit -RKN15 (Chromos Biotech Pvt. Ltd, India) according to the manufacturer's instructions.

- DNA was isolated from the culture, its quality was evaluated on 1.0 % agarose gel, and a single band of high-molecular-weight DNA has been observed.
- Fragment of 16S rRNA gene was amplified by 16S rRNA-F and 16S rRNA-R primers. A single discrete PCR amplicon band of 1500 bp was observed when resolved on an agarose gel.
- The PCR amplicon was purified to remove contaminants.
- Forward and reverse DNA sequencing reaction of PCR amplicon was carried out with 16SrRNA-F and 16SrRNA-R primers using BDT v3.1 Cycle sequencing kit on ABI 3730xl Genetic Analyzer.
- Consensus sequence of 16S rRNA gene was generated from forward and reverse sequence data using aligner software.
- The 16S rRNA gene sequence was used to carry out BLAST with the 'nr' database of the NCBI GenBank database. Based on the maximum identity score first ten sequences were selected and aligned using the multiple alignment software programs Clustal W. Distance matrix and a phylogenetic tree were constructed using MEGA 10.

Extraction of Glucosyltransferases Enzyme from *S. mutans*

The clinical isolates were evaluated for extracellular glucosyltransferases enzyme synthesis by following the methodologies of Essam *et al.*, (2009), Beeley and Black (1977)[12-13] with necessary modifications. Todd-Hewitt (TH)broth (250ml) was supplemented with 1.8% glucose, inoculated with 24 hrs. Old bacterial culture and incubated at 37°C for 18-24 hrs, after incubation, the broth was centrifuged at 5000rpm at 4°C for 15 mins and supernatant was collected and the pH of the supernatant was adjusted to 6.9 to this 2.5ml of glucose solution (50%), and 12.5ml of sodium azide (0.02%) was added to the supernatant and incubated at 37°C for 18 hrs. The supernatant was centrifuged at 5000 rpm at 4°C for 30 minutes. To this supernatant, 200ml of cold absolute ethanol was added and kept in a refrigerator for 4 hrs and again centrifuged at 6000rpm at 4°C for 30 minutes. After centrifugation, the precipitate obtained (glucans) was dissolved in 5ml of tris-HCl buffer (0.025M) containing 0.1M NaCl were stored at the refrigerator for further analysis.

RESULTS AND DISCUSSION**Isolation of *Streptococcus mutans* from Clinical Dental Caries samples**

A total of 66 infected teeth samples were collected from the patients diagnosed with dental caries, irrespective of age and sex, under the supervision of a dentist at District Mc-Gann Hospital, Giriraj dental clinic, and other private dentist clinics in Shivamogga, Karnataka. Samples were immediately brought to the laboratory in the transport medium.

Morphology and biochemical identification

Out of 66 samples inoculated on BHI, MSA, and NA agar, 43 samples with colony counts of more than 250 (10⁴CFU/ml) were considered positive samples for Streptococcal species. The positive samples were repeatedly subcultured on BHI agar for purification of the isolates. Raised, convex, undulate, and opaque (Fig: 1) were selected and they were reinoculated on blood agar containing 5 percent sheep RBC. The majority of the isolates exhibited greenish discoloration around the colonies due to partial lysis of red blood cells characteristic of alpha hemolysis (Fig: 2) and the same colonies were devoid of β and γ haemolytic colonies authenticating the isolates. The observation of the colony characteristics of isolates and the colony characteristics of the reference culture of *Streptococcus mutans* (NCIM Accession No: 5660) showed similar characteristics.



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Further, 40 alpha-hemolytic colonies were subjected to Gram's staining. The microscopic examination of all Gram's-stained isolates showed Gram-positive cocci in chains or pairs (Fig: 3). The selected isolates were tested for optochin (Ethyl hydrocupreine hydrochloride) sensitivity. The 36 isolates were resistant to optochin with no zone of inhibition around (Fig: 4) and all 36 isolates were found to be catalase negative as they did not form any bubbles or effervescence with H₂O₂. Further, the 36 isolates were found to be tolerant to 4% NaCl, whereas none of them showed visible growth at 6.5 percent NaCl. The isolates were screened and subjected to other biochemical reactions. All 34 isolates were positive for both esculin hydrolysis and VP test and negative for urea and arginine hydrolysis. Ferment sugars like sucrose, mannitol, lactose and sorbitol to form acid and turns the media to yellow (Table: 1). All the samples were subjected to a specific test designed by Gold *et al.*, (1975) for the confirmation of *S. mutans*. The 34 isolates sprayed with 2, 3, 5 triphenyltetrazolium chloride followed by incubation they were turned to dark pink and confirmed as *S. mutans*. Whereas, 4 isolates were remained unchanged and were considered as negative (Fig: 5).

Molecular Identification (16S rRNA Based Identification)

Genomic DNA from the Bacterial sample was isolated using the 'Bacterial Genomic DNA isolation Kit' (RKN15, Chromous Biotech, Bangalore). A good quality and quantity of gDNA was isolated from the selected isolate SM-18 and was separated using 1% agarose gel electrophoresis. The DNA >10 kb of mobility was observed, indicating the good quality of genomic DNA. Concentration of SM-18 gDNA was found to be 100 ng/ul. The assembled 16S rRNA sequence was subjected to n BLAST analysis present in the Gene Bank using basic local alignment search tool (BLAST). The sequence data was analyzed to identify the bacterium to its closest neighbours. Based on these results isolate *S. mutans* was identified as *Streptococcus mutans* and it was found to be most similar to *Streptococcus mutans* strain SCA103 complete genome (Sequence ID: MW263099.1). The next closest homologue was found to be *S. mutans* strain MGBGSU01 16S rRNA gene, partial sequence (Sequence ID: MT318140.1). The phylogenetic tree was constructed by Weigh or tree method using Molecular evolutionary genetics analysis (MEGA 3.1) software. On the basis of BLAST search, the top ten *Streptococcus mutans* species showing 99 percent homology were selected and phylogenetic tree was constructed (Fig:6). The 16S rRNA sequences of clinical isolate. *S. mutans* have been deposited in the gene bank database, NCBI, under the accession number OP848246 as *Streptococcus mutans* SM-18.

Screening of Glucosyltransferase Enzyme from *Streptococcus mutans*

A total of thirty clinical isolates were screened for the production of glucosyltransferases enzyme (GTF), of which twenty-eight clinical isolates were found to produce glucosyltransferase enzyme (Prevalence rate of 93.33%).

DISCUSSION

Dental caries is a biofilm-mediated, multi-factorial, and chronic infection. It is a significant public health problem globally. The groups of microorganisms in caries have diverse types of facultative and obligatory-anaerobic bacteria microbial imbalance in the oral cavity results in dental plaque and caries [14,15]. *S. mutans*, a member of the viridian's streptococci, is considered to be primarily responsible for dental caries, which are the most common oral diseases. In our study, *S. mutans* isolates were identified based on microscopic examination showing gram-positive cocci that are arranged in long chains. In addition, the isolates were able to produce alphahemolysis on blood agar media as previously confirmed for *S. mutans* [16]. Based on biochemical testing, *S. mutans* isolates were catalase-negative, able to ferment the sugars like mannitol, sorbitol, and sucrose and to change the colour of phenol red indicator from red to yellow due to acid production from carbohydrate fermentation. Similar results were observed by Al-Jumaily *et al.*, (2014) and Vos *et al.*, (2011) [17,18]. It is evident that the interaction of Gtfs and Ftfs with sucrose and starch hydrolysates is the primary source of exopolysaccharides (EPS) [19]. In pathogenesis studies, with microbial enzyme as an etiological agent, isolation of enzyme from the clinical isolates was required. It was previously reported that mutans group streptococci are capable of producing various types of glucosyltransferases [20]. It is important to screen the highest enzyme-yielding strain out of clinical isolates, therefore, prior to large-scale production of glucosyltransferase enzyme from clinical isolates of *S. mutans*, Thirty isolated *Streptococcus mutans* isolates were tested for the production of glucosyltransferase enzyme of which twenty-eight clinical isolates were found to





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produce glucosyltransferase enzyme (93.33%). In a similar study by Yuanita *et al.*, (2020) [21], glucosyltransferase enzymes were extracted and screened for their inhibitory effect. Another study by Katherine (2019), [22] Showed one of the most important components of the biofilm matrix is the glucan polymers produced by the glucosyltransferases Gtf B and GtfC secreted by *S. mutans*. Further Preliminary Screening, Partial purification, and inhibition of glucosyltransferase enzyme are in progress.

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Conflicts of Interest: The authors declare no conflict of interest

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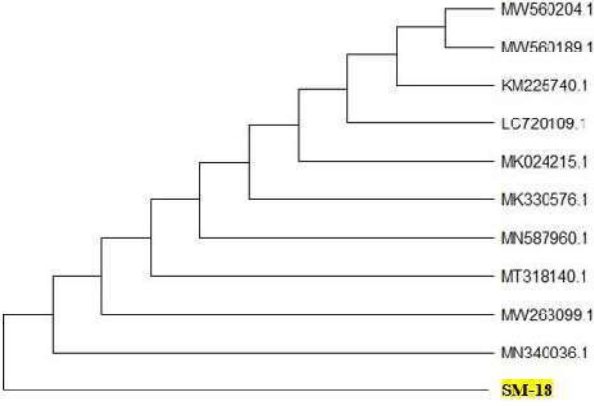
Table 1: Biochemical characterization of *S. mutans* isolates.

Test	Results
Gram stain	Gram positive
Shape	Cocci in long chains
Motility	Non -Motile
Catalase	Negative
Hemolysis	α and β
Esculin hydrolysis	Positive
Arginine hydrolysis	Negative
Urea hydrolysis	Negative
Voges-Proskauer test	Positive
Optochin sensitivity	Negative
Growth on 6.5% NaCl	Negative

**Fig1: *Streptococcus mutans* on BHI (Brain heart infusion) Media and MSA (Mutans sanguis agar) Media.**



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<p>Fig 2:Blood Agar Media Showing α-Hemolysis.</p>	<p>Fig 3: Microscopic observation of <i>S.mutans</i> showing Gram Positive cocci in chains.</p>
 <p style="text-align: center;">A B</p>	 <p style="text-align: center;">Before spraying with TTC After spraying with TTC</p>
<p>Fig 4: Optochin sensitivity test of clinical isolates A: Control, B: Test Plate.</p>	<p>Fig 5: Confirmation of <i>S.mutans</i> (Gold et al., 1973).</p>
	
<p style="text-align: center;">Fig. 6: Phylogenetic tree of <i>Streptococcus mutans</i> SM-18</p>	





A Critical Analysis of E-Learning during the Pandemic using Data Mining

S. Annie Christila*

Dept. of Computer Applications, St. Francis de Sales College, Bengaluru, Karnataka, India.

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*Address for Correspondence

S. Annie Christila

Dept. of Computer Applications,

St. Francis de Sales College,

Bengaluru, Karnataka, India.

E. Mail : anniechristilas@sfcollege.in



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ABSTRACT

The main crux of this research study is to address the issues of the pandemic namely the COVID-19 that brought a Copernican revolution in the educational system and also to analyse the issues encountered by the students, teachers, and institutions and also by the parents. The pandemic brought a new method or style of learning into the education system popularly known as online learning or e-learning. Once the survey and research are done based on the topic, it is finally concluded using data mining algorithm derived for finding out the result or outcome of the survey conducted. Artificial neural network (ANN) and Support Vector Machine (SVM) data set is tested by different Data Mining (DM) algorithms using WEKA data science tool to develop the models. The result model manifested the major problem faced by students during COVID-19 pandemic. Student's data set which has been examined with Support Vector Machine is more accurate to identify the challenges of the students. The accuracy of this algorithm has been noted 90.85% which can be considered the best developed model among the different models which is being developed by other algorithms including Artificial Neural Network (ANN) and Decision Tree

Keywords: COVID 19, Data Mining, Data Analysis, Data Model, E learning

INTRODUCTION

Globally, COVID-19 has had an impact; as a result, colleges and universities were closed in many nations; while this is a temporary situation, it has had a significant impact on many people worldwide. This presents a significant challenge for both students and teachers in the teaching and learning process in the educational sector. Over 60% of the student population worldwide will be impacted by these widespread closures. In this study, various data models are created using student data on the biggest issues that students encountered throughout the COVID-19 survey. These models can be applied in government and educational institutions to determine the problem's strength and potential solutions. The models were developed using data that was gathered by survey questioner approach, and



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dataset examples of the student's difficulty were taken into consideration. To create the models, various data mining algorithms were investigated.

LITERATURE REVIEW

In order to forecast student results in the form of efficiency, the authors Sharma and Mamta used the DT model in 2013 and compared it to the Naive Bayes algorithm [13]. In 2009, Siraj, Fadzilah, and Mansour Ali Abdoulha used various algorithms with the Weka tool to analyse and cluster graduate data more effectively [8]. In 2009, Hoo Yann Seong employed DT and neural networks to create a predicted model by comparing it to their organization's classification and grouping of student performance [14]. Espejo and César Hervás developed a data mining model in 2008 using several algorithms and came to the conclusion that DT is the best model for educational sectors in terms of decision-making [15].

METHODOLOGY

The dataset was obtained from questioner survey which has been collected from different college students in Bangalore. It contains 550 instances with 6 attributes like:

1. How effective was online learning?
2. What are the issues faced for attending online classes?
3. What amount of knowledge have you gained through online learning?
4. Are you Anxious about your Education during the pandemic and what is the level of your Anxiety?
5. What is the reason for lack of concentration during the online sessions?
6. What is the Scale on Lack of Clarity and Communication about topic delivered on online sessions?

These datasets have been gathered and properly parameterized using data analysis software and algorithms like KNIME, Rapid Miner, Oracle Data Mining, SQL Server Data Tools, WEKA, and others. These programmes help analyse data more effectively and predict errors and model behaviour using various methods. For the analysis of the data model based on the dataset, WEKA has been employed among these tools. When contemplating data mining's purposes, tracking patterns is one of them. Learning to spot patterns in data sets containing various faces is one of the most fundamental data mining techniques. The above figure shows the process in data analysis and methodology in the research using data mining to predict the model which is helpful to identify the major problems faced during the covid-19 pandemic situation.

Visualization of Output

The following pie charts denotes the graphical representation of the online classes where the students face a lot of problems related to studies. There are different types of questions which have a wide variety of unique answers for it received as an output of the survey conducted. The above pie chart contains the information regarding the effectiveness of the online classes. It contains three options from which anyone could be chosen. From the output obtained, it clearly shows that most of the online classes weren't that interesting to the students. The above pie chart contains the information regarding all types of issues faced by the students in attending the classes online. It is clearly understood that the students face all kinds of issues uniformly, few faces network issues due to the low network availability in the place where they stay, few encountered financial issues in getting mobiles phones or laptops for attending online classes and others face both the problems. The above pie chart indicates the graph regarding the amount of knowledge gained through online learning. Taking the output into consideration we can come to a conclusion saying that, it is almost an average amount of knowledge that the students have gained by attending online classes. However, the outcome of the traditional educational atmosphere would have been completely astronomic. The above pie chart indicates the graph representing the level of anxiety among the students about their education during the pandemic situation. It clearly depicts the fact that 60.7 percent of students have faced a lot of difficulties to cope up with situation. The above pie chart indicates the graph representing the reason



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for lack of concentration among the students during online classes. It represents the session time duration with three scales. First scale is 0 to 30 minutes, the second scale is from 30 to 60 minutes and last scale is more than 60 minutes. Among these scales 51.4 percent of the students are facing concentration issues. It causes negative impact in the academic progress of the student. The above pie chart indicates the graph representing the scale on lack of clarity and communication about the topic that is taught during the online sessions. About 61.2 percent of students haven't had sufficient clarity on the specific subject and communication was a common challenge for the students during the online sessions.

FINDINGS AND DISCUSSIONS

The different data mining algorithm such as artificial neural network, decision tree and support vector machine were examined by using WEKA tool. The model evolved with artificial neural network algorithm was examined with height accuracy of 96.32% and this model is considered as the best model among others.

CONCLUSION

This research paper is a comprehensive analysis of the kind of impact the pandemic had on the education system and the ways by which it affected the students. By taking into consideration the results of the survey conducted, it can be very clearly concluded that online learning has more disadvantages than advantages. Due to the evident downside in this new modern way of e-learning/online learning and the continual struggles experienced by students as well teachers, the online learning poses a big threat to the quality of education and it raises a lot of question about the efficiency and experiences of students. No matter how efficient and powerful online education may be, it cannot replace the tradition classic education which creates, refines and edifies students not just a theoretical learning but also practical knowledge. Students not only grow tired of online learning but also grow less in social and academic competence which the traditional education provides.

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Table: Performance Evaluation

Sl no.	Examined data models	Accuracy in percentage
1.	Support Vector Machine	89.74%
2.	Artificial Neural Network	96.32%
3.	Decision Tree	887.15%

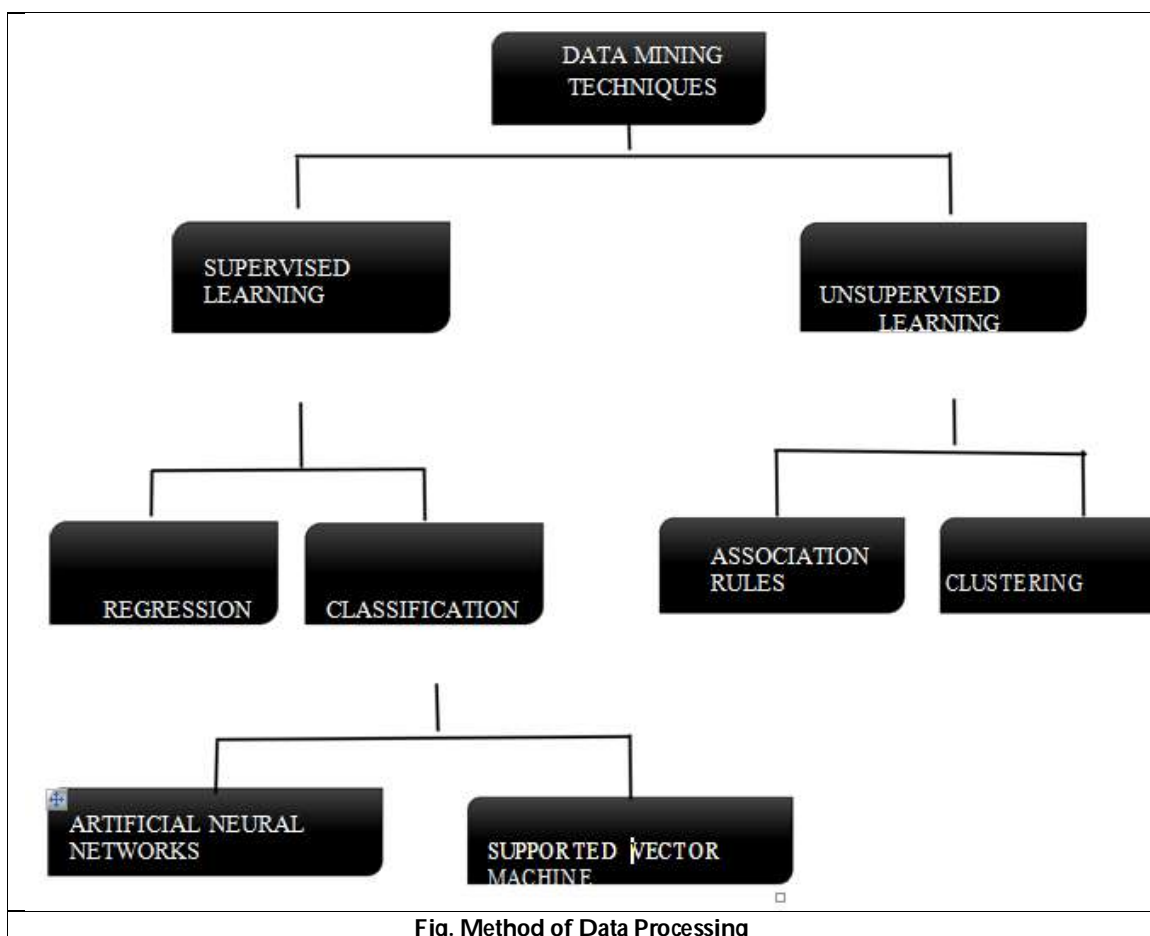
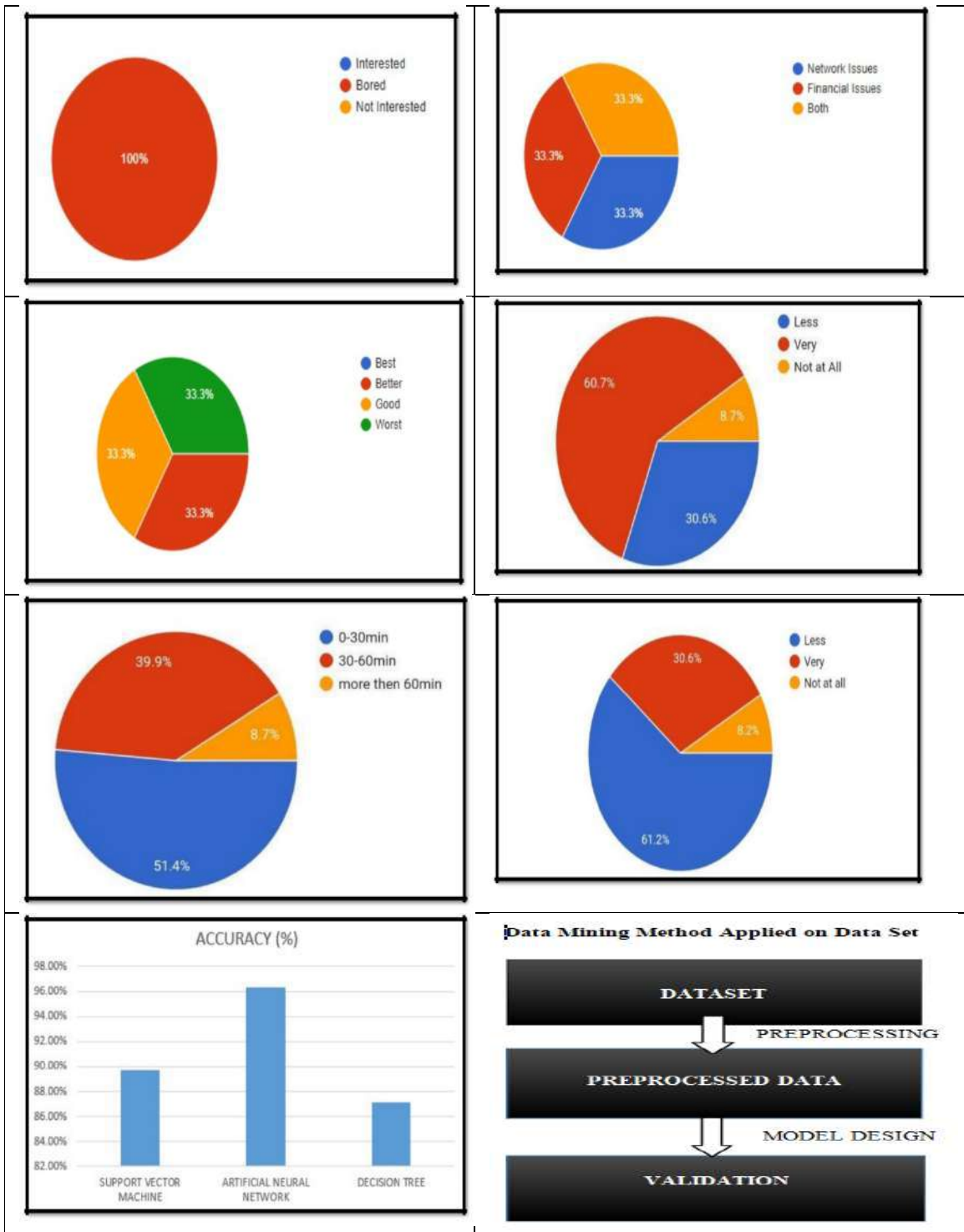


Fig. Method of Data Processing



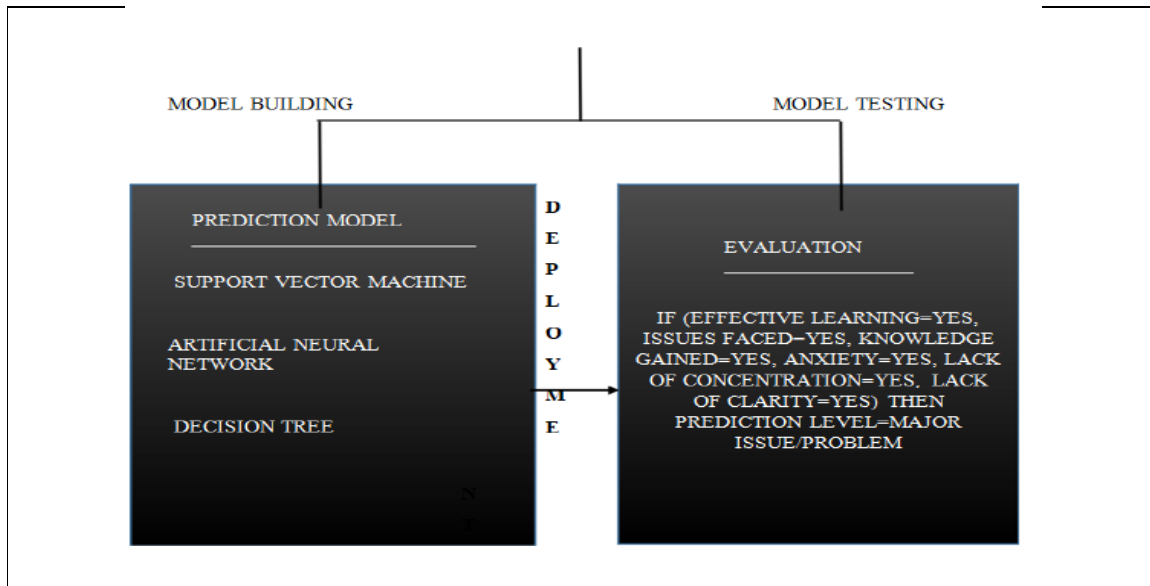


Annie Christila





Annie Christila





Non-Newtonian Bingham Plastic Fluid Flow across A Porous Medium

Neeraj Khirwar^{1*} and Rajesh Johari²

¹Research Scholar, Department of Mathematics, Agra College, (Dr. B.R. Ambedkar University, Agra), Uttar Pradesh, India.

²Associate Professor, Department of Mathematics, Agra College, (Dr. B.R. Ambedkar University, Agra), Uttar Pradesh, India.

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*Address for Correspondence

Neeraj Khirwar

Research Scholar,

Department of Mathematics,

Agra College, (Dr. B.R. Ambedkar University, Agra),

Uttar Pradesh, India.



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ABSTRACT

Fluids flowing through porous media can encounter a wide range of flow velocities and shear rates due to the pore space's structure. As a result, the non-linear relationship between the Darcy velocity and spatial viscosity is readily apparent. It's not uncommon to talk about Darcy flow in terms of its effective viscosity. In most non-Newtonian fluids, the shear rate can be used to explain the non-linear rheology. Effective viscosity is estimated by establishing an effective shear rate that accounts for the Bingham plastic fluid rheology. The effective viscosity can be calculated by combining the fluid's rheology and the average shear rate. Cross model fluids have been used to develop semi-automatic expressions for the local viscosity profile. The average viscous resistance can be estimated by solving the flow equations in a circular cross section of a capillary. Scaling viscosity distributions with this method avoids the use of capillary bundle models. Using tortuosity or permeability as inputs for capillary bundle models is a divergence from the method described here. Because porous media have a unique stoichiometry, empirical coefficients aren't necessary.

Keywords: Effective viscosity, Effective Shear rate, Darcy velocity, tortuosity, Porosity

INTRODUCTION

A few materials which we use in our regular day to day existence, for instance, toothpaste, emulsions, whipped cream, stain, gels, syrups, palatable oils, and so forth, can't be ordered into either flexible solids or basic liquids, are delegated non-Newtonian liquids. Among the few non-Newtonian liquids, to be sure, some of them show the yield edge (yield pressure), implying that it is the feeling of anxiety beneath which the liquid moves like a strong (which is named as attachment stream) and assuming the anxiety surpasses this edge limit, the liquid goes through ordinary

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shear stream. A few instances of the notable non-Newtonian liquids are semi-strong food sources, paints, slurries, sauce, ketchup, corn starch, mud, penetrating liquids, raw petroleum, and so on. Herschel-Bulkley (H-B) liquid, Casson liquid, and Bingham liquid are a portion of the yield pressure liquids which tracks down applications in many fields of biological sciences, bio-clinical designing, oil, and substance designing, food businesses, and so on. Buckingham (1996) got the equation for observing the pace of liquid stream in a round and hollow line which is named as Buckingham-Reiner regulation. Dapra and Scarpi (2004) researched the flimsy course through the plane channel and involved the Pascal model to acquire the series answer for the beginning up stream and later, they stretched out this review to move through the barrel shaped pipe. Chen *et al.* (2005) examined the one-layered stream inside the structure of the two-layered network. Sochi (2010) introduced an audit of the single-work stream of non-Newtonian liquids in permeable media. They inspected the four fundamental methodologies continuum models, heap of cylinders models, mathematical strategies and pore-scale network displaying for depicting the move through permeable media overall. Balhoff *et al.* (2012) propounded viable mathematical strategies for assessing the rheological proportions of the liquid move through permeable organizations. Chevaliar *et al.* (2014) tentatively got the proper Darcy regulation for the Herschel-Bulkley move through a permeable medium and called attention to the non-Newtonian qualities of the streaming liquid. Bleyer and Coussot (2014) mathematically demonstrated the progression of Bingham liquid through a variety of roundabout cylinders. Chevalier and Talon (2015) investigated the stream in a jewel formed permeable organization, and they appointed an arbitrary edge to various ways. Nash and Rees (2017) explored the impacts of pores in the one-layered Bingham liquid course through a channel and line, expecting that the pores in the channel/pipes are dispersed in certain sorts of likelihood thickness capacities. Eberhard *et al.* (2019) demonstrated the way that for a Carreau liquid, the nearby consistency can be gotten straightforwardly from the liquid's constitutive regulation and the speed profile in a mean pore size, utilizing a round slim to copy the stream at pore scale. Sankar and Viswanathan (2022) examined, the impact of microstructure in the Casson liquid move through a permeable medium expanding the Buckingham-Reiner's one-layered model to plane-Poiseuille stream and Hagen-Poiseuille stream calculations.

Formulation of Problem

The Bingham Plastic model is described by

$$\tau = \tau_0 + K\dot{\gamma} \quad (\tau > \tau_0) \tag{1}$$

where K is the viscosity at the shear rate $\dot{\gamma} \doteq 1s^{-1}$

Most regularly applied models to gauge μ_{eff} can be determined by likening the stream pace of a Poiseuille stream with the stream pace of a Bingham Plastic liquid

$$Q_{Poiseuille} = Q_{BinghamPlastic} \tag{2}$$

$$\frac{\pi}{8\mu} \left(\frac{\Delta P}{L}\right) R^4 = \frac{\pi R^3}{K} \left[\frac{R}{2} \left(\frac{\Delta P}{L}\right) - \frac{\tau_0}{3} \right]$$

$$\mu_{BinghamPlastic} = \frac{K}{8 \left[4 - \frac{2\tau_0(L)}{3R(\Delta P)} \right]} = \frac{K}{8} \frac{3R\Delta P}{(12R\Delta P - \tau_0 L)} \tag{3}$$

From equation (1) and (3), we get

$$\dot{\gamma}_{eff} = \frac{8 \left[\frac{12R\Delta P}{L} - \tau_0 \right] \tau_0}{K \left[-93R\frac{\Delta P}{L} + 8\tau_0 \right]} \tag{4}$$

The term can be expressed mathematically using the Rabinowitsch equation

$$\frac{\Delta P}{L} = \frac{2}{R} \left[\frac{\tau_0}{3} + \frac{KQ_{cap}}{\pi R^3} \right] = \left\{ \frac{2\tau_0}{3R} + \frac{2KQ_{cap}}{\pi R^4} \right\} \tag{5}$$

Putting the value of $\frac{\Delta P}{L}$ in equation

$$\dot{\gamma}_{eff} = \frac{8 \left[24 \left(\frac{\tau_0}{3} + \frac{KQ_{cap}}{\pi R^3} \right) - \tau_0 \right] \tau_0}{K \left[-186 \left(\frac{\tau_0}{3} + \frac{KQ_{cap}}{\pi R^3} \right) + 8\tau_0 \right]} \tag{6}$$

This can be calculated as $Q_{BinghamPlastic} / \pi R^2 \tau$ for the mean capillary velocity. It's also possible to define Q_{cap} as the ratio of Darcy velocity to porosity.

$$Q_{cap} = \frac{Q}{\phi} \tag{7}$$

it can be represented in terms of the radius R_{eq}





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$$R_{eq} = \sqrt{\frac{8\kappa\zeta}{\phi}} \tag{8}$$

A capillary bundle's radius R_{eq} depends on its tortuosity ζ . (6), (7), and (8) provide the following equation:

$$\dot{\gamma}_{eff} = \frac{8 \left[24 \left\{ \frac{\tau_0}{3} + \frac{\phi^{3/2} K Q}{\pi(8\kappa\zeta)^{3/2} \phi} \right\} - \tau_0 \right] \tau_0}{\kappa \left[-186 \left\{ \frac{\tau_0}{3} + \frac{\phi^{3/2} K Q}{\pi(8\kappa\zeta)^{3/2} \phi} \right\} + 8\tau_0 \right]} \tag{9}$$

The compelling thickness μ_{eff} of the non-Newtonian liquid was then figured from the deliberate Darcy speed q , the deliberate strain drop $\frac{\Delta P}{L}$ and the recently estimated porousness κ as per

$$\mu_{eff} = \frac{\kappa \Delta P}{q L} = \frac{2\kappa}{q} \left[\frac{\tau_0}{3R} + \frac{K Q_{cap}}{\pi R^4} \right] = \frac{2\kappa}{q} \left[\frac{\tau_0}{3R} + \frac{K Q}{\pi R^4 \phi} \right] \tag{10}$$

$$q = \frac{2\kappa}{\mu_{eff}} \left[\frac{\tau_0}{3R} + \frac{K Q}{\pi R^4 \phi} \right] \tag{11}$$

Here we present another way to deal with gauge μ_{eff} by settling straightforwardly for the consistency profile of a completely evolved Cross liquid stream inside a solitary slender of sweep R that impersonates a mean pore with a mean stream pace of $\frac{q}{\phi}$. The Cross liquid model permits to acquire a typical consistency profile in a pore without conjuring a viable shear rate and a transitional Bingham Plastic rheology.

The constitutive law of a Cross model liquid is defined by

$$\mu(\dot{\gamma}) = \left[\mu_{\infty} + \frac{\mu_0 - \mu_{\infty}}{1 + m^n (m\dot{\gamma})^n} \right] \tag{12}$$

where n is the power-regulation type, μ_0 and μ_{∞} are the constraints of the thickness at nothing and endless shear and m is a proportion of intramolecular fascination powers.

A circular capillary with low Reynolds numbers and a steady state Navier-Stokes equation has the following steady state equation

$$\frac{1}{r} \frac{d}{dr} \left[\mu \left\{ \frac{du}{dr} \right\} r \frac{du}{dr} \right] = \frac{dp}{dx} \tag{13}$$

Constant $\frac{dp}{dx}$ pressure gradient along the capillary This is what you get when you integrate by r .

$$\left[\mu \left\{ \frac{du}{dr} \right\} \frac{du}{dr} \right] = \frac{r}{2} \frac{dp}{dx} + C_1 \tag{14}$$

On the basis of the flow profile's symmetry, the capillary's maximum velocity is located in the middle at $r = 0$. The shear rate $\dot{\gamma} = \frac{du}{dr}$ vanishes by definition of a maximum. This meant that C_1 was zero.

$$\mu(\dot{\gamma}) \dot{\gamma} = \frac{r}{2} \frac{dp}{dx} \tag{15}$$

We can substitute the pressure drop $\frac{dp}{dx}$ along the capillary with a reference pressure $p_{ref} \neq 0$. Selecting R as a characteristic length, we arrive to the following definition:

$$\begin{aligned} \frac{1}{2} \frac{dp}{dx} &= \frac{p_{ref}}{R} \\ \mu(\dot{\gamma}) \dot{\gamma} &= \frac{r}{R} p_{ref} \\ \mu(\dot{\gamma}) \dot{\gamma} &= \left[\mu_{\infty} + \frac{\mu_0 - \mu_{\infty}}{1 + m^n (m\dot{\gamma})^n} \right] \dot{\gamma} \\ \frac{r}{R} p_{ref} &= \left[\mu_{\infty} + \frac{\mu_0 - \mu_{\infty}}{1 + (m\dot{\gamma})^n} \right] \dot{\gamma} \\ r &= \frac{R}{p_{ref}} \left[\mu_{\infty} + \frac{\mu_0 - \mu_{\infty}}{1 + (m\dot{\gamma})^n} \right] \dot{\gamma} \end{aligned} \tag{16}$$

It is possible to use the boundary condition for shear rate to rewrite this formula.

$$(\dot{\gamma})_{r=R} = -\dot{\gamma}_w$$

The shear rate at the capillary wall is given by $\dot{\gamma}_w$. As a result, the following equation gives the reference pressure:

$$\begin{aligned} R &= \frac{R}{p_{ref}} \left[\mu_{\infty} + \frac{\mu_0 - \mu_{\infty}}{1 + \{m(-\dot{\gamma}_w)\}^n} \right] (-\dot{\gamma}_w) \\ p_{ref} &= -\dot{\gamma}_w \left[\mu_{\infty} + \frac{\mu_0 - \mu_{\infty}}{1 + \{m(-\dot{\gamma}_w)\}^n} \right] \end{aligned} \tag{17}$$





$$\begin{aligned}
 \int_0^{-\dot{\gamma}} r d\dot{\gamma} &= -\frac{R}{p_{ref}} \int_0^{\dot{\gamma}} \left\{ \mu_{\infty} + \frac{\mu_0 - \mu_{\infty}}{1 + (m\dot{\gamma})^n} \right\} \dot{\gamma} d\dot{\gamma} \\
 &= -\frac{R}{p_{ref}} \int_0^{\dot{\gamma}} \left\{ \mu_{\infty} + \frac{\mu_0 - \mu_{\infty}}{1 + (m\dot{\gamma})^n} \right\} \dot{\gamma} d\dot{\gamma} \\
 &= -\frac{R}{p_{ref}} \int_0^{\dot{\gamma}} \left\{ \mu_{\infty} \dot{\gamma} + \frac{(\mu_0 - \mu_{\infty}) \dot{\gamma}}{1 + (m\dot{\gamma})^n} \right\} d\dot{\gamma} \\
 &= -\frac{R}{p_{ref}} \left[\frac{1}{2} \mu_{\infty} \dot{\gamma}^2 + \int_0^{\dot{\gamma}} \left\{ \frac{(\mu_0 - \mu_{\infty}) \dot{\gamma}}{1 + (m\dot{\gamma})^n} \right\} d\dot{\gamma} \right] \\
 &= -\frac{R}{p_{ref}} \left[\frac{1}{2} \mu_{\infty} \dot{\gamma}^2 + (\mu_0 - \mu_{\infty}) \int_0^{\dot{\gamma}} \left\{ \frac{\dot{\gamma}}{1 + (m\dot{\gamma})^n} \right\} d\dot{\gamma} \right] \\
 \int_0^{-\dot{\gamma}} r d\dot{\gamma} &= -\frac{R}{p_{ref}} \left[\frac{1}{2} \mu_{\infty} \dot{\gamma}^2 + \frac{(\mu_0 - \mu_{\infty})}{nm^2} \left\{ \left(\frac{2}{n} - 1 \right) (m\dot{\gamma})^{2-2n} - 2(m\dot{\gamma})^{2-n} + \frac{n(n-1)}{2!} \left(\frac{2}{n} + 1 \right) \cdot (m\dot{\gamma})^2 \right\} \right]
 \end{aligned}
 \tag{18}$$

Since by chain rule, we have

$$\begin{aligned}
 r d\dot{\gamma} &= d(r\dot{\gamma}) - du \\
 \int_0^{-\dot{\gamma}} r d\dot{\gamma} &= \int_0^{-\dot{\gamma}} d \left[\frac{R}{p_{ref}} \left\{ \mu_{\infty} + \frac{\mu_0 - \mu_{\infty}}{1 + (m\dot{\gamma})^n} \right\} \dot{\gamma}^2 \right] - \int_{u_{max}}^u du \\
 \int_0^{-\dot{\gamma}} r d\dot{\gamma} &= -\frac{R}{p_{ref}} \left\{ \mu_{\infty} + \frac{\mu_0 - \mu_{\infty}}{1 + (m\dot{\gamma})^n} \right\} \dot{\gamma}^2 - u + u_{max} \\
 u &= -\frac{R}{p_{ref}} \left\{ \mu_{\infty} + \frac{\mu_0 - \mu_{\infty}}{1 + (m\dot{\gamma})^n} \right\} \dot{\gamma}^2 - \int_0^{-\dot{\gamma}} r d\dot{\gamma} + u_{max} \\
 u &= u_{max} - \frac{R}{p_{ref}} \left[\mu_{\infty} + \frac{\mu_0 - \mu_{\infty}}{1 + (m\dot{\gamma})^n} \right] \dot{\gamma}^2 - \frac{R}{p_{ref}} \left[\frac{1}{2} \mu_{\infty} \dot{\gamma}^2 + \frac{(\mu_0 - \mu_{\infty})}{nm^2} \left\{ \left(\frac{2}{n} - 1 \right) (m\dot{\gamma})^{2-2n} - 2(m\dot{\gamma})^{2-n} + \frac{n(n-1)}{2!} \left(\frac{2}{n} + 1 \right) \cdot (m\dot{\gamma})^2 \right\} \right] \\
 u &= u_{max} - \frac{3R\mu_{\infty}\dot{\gamma}^2}{2p_{ref}} - \frac{R}{p_{ref}} \left[\frac{(\mu_0 - \mu_{\infty})\dot{\gamma}^2}{1 + (m\dot{\gamma})^n} + \frac{(\mu_0 - \mu_{\infty})}{nm^2} \left\{ \left(\frac{2}{n} - 1 \right) (m\dot{\gamma})^{2-2n} - 2(m\dot{\gamma})^{2-n} + \frac{n(n-1)}{2!} \left(\frac{2}{n} + 1 \right) \cdot (m\dot{\gamma})^2 \right\} \right]
 \end{aligned}
 \tag{19}$$

For velocity $u_{r=R} = 0, \dot{\gamma}_{r=R} = -\dot{\gamma}_w$

$$\begin{aligned}
 u_{max} &= \frac{3R\mu_{\infty}\dot{\gamma}_w^2}{2p_{ref}} + \frac{R}{p_{ref}} \left[\frac{(\mu_0 - \mu_{\infty})\dot{\gamma}_w^2}{1 + (m\dot{\gamma})^n} + \frac{(\mu_0 - \mu_{\infty})}{nm^2} \left\{ \left(\frac{2}{n} - 1 \right) (m(-\dot{\gamma}_w))^{2-2n} - 2(m(-\dot{\gamma}_w))^{2-n} + \frac{n(n-1)}{2!} \left(\frac{2}{n} + 1 \right) \cdot (m(-\dot{\gamma}_w))^2 \right\} \right] \\
 u_{max} &= \frac{3R\mu_{\infty}\dot{\gamma}_w^2}{2p_{ref}} + \frac{R}{p_{ref}} \left[\frac{(\mu_0 - \mu_{\infty})\dot{\gamma}_w^2}{1 + (m\dot{\gamma})^n} + \frac{(\mu_0 - \mu_{\infty})}{nm^2} \left\{ \left(\frac{2}{n} - 1 \right) (m(-\dot{\gamma}_w))^{2-2n} - 2(m(-\dot{\gamma}_w))^{2-n} + \frac{n(n-1)}{2!} \left(\frac{2}{n} + 1 \right) \cdot (m(-\dot{\gamma}_w))^2 \right\} \right]
 \end{aligned}
 \tag{20}$$

NUMERICAL RESULTS AND DISCUSSION

Effective viscosity falls as Darcy velocity increases, as shown in graphs (1-4). It should also be remembered that when porosity increases, effective viscosity decreases. In Graph (2), effective viscosity rises as yield stresses rise. Effective viscosity decreases as capillary radius grows in graph (3). In the graph (4), effective viscosity rises as permeability rises. The effective shear rate increases as K grows while decreasing as yield stresses increase, as seen in Graph (5).





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Closing Comments

A new way for extending Darcy's law to Cross model fluids was established as a result of this work, in which the mean capillary viscosity was used to represent actual flow resistance. The new model, which is based on the microscopic constitutive law of the fluid, eliminates the necessity for an intermediate effective shear rate in order to compute average viscosity. By using this method, we may scale the average viscosity of a single pore with a mean pore size to the Darcy scale, which is useful in many situations. In addition, because the characteristic length scale of the porous media was employed instead of an empirical shape parameter, this method completely avoids the usage of an empirical shape parameter! This approach eliminates the need to make assumptions about tortuosity or permeability when estimating an equivalent capillary diameter because these assumptions are normally made in capillary bundles, and the suggested approach does not make these assumptions.

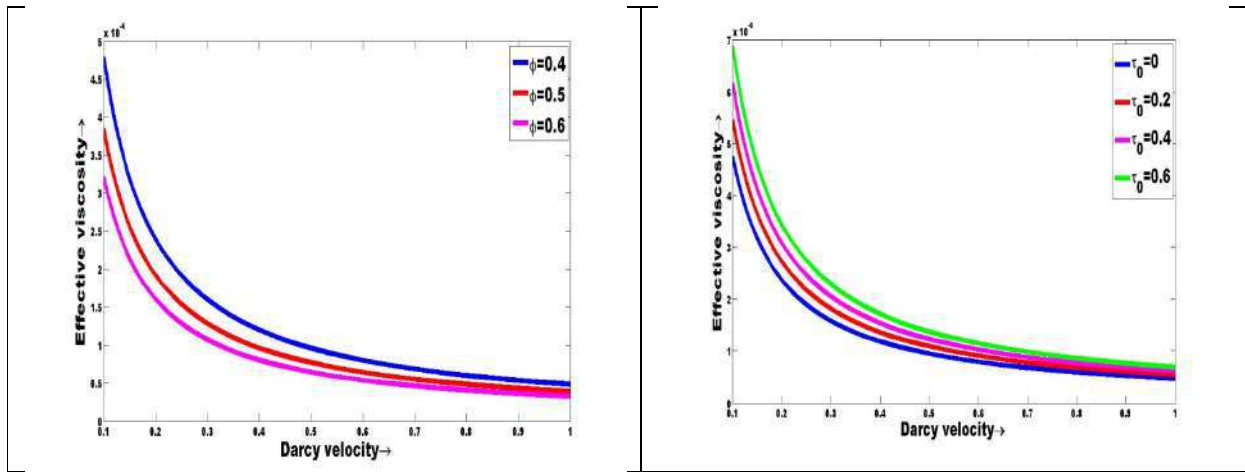
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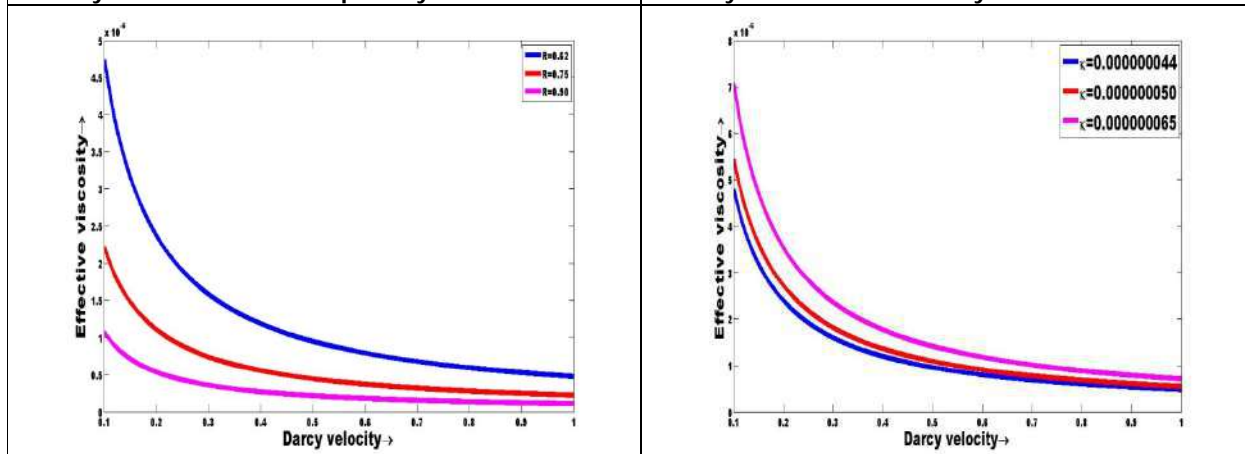


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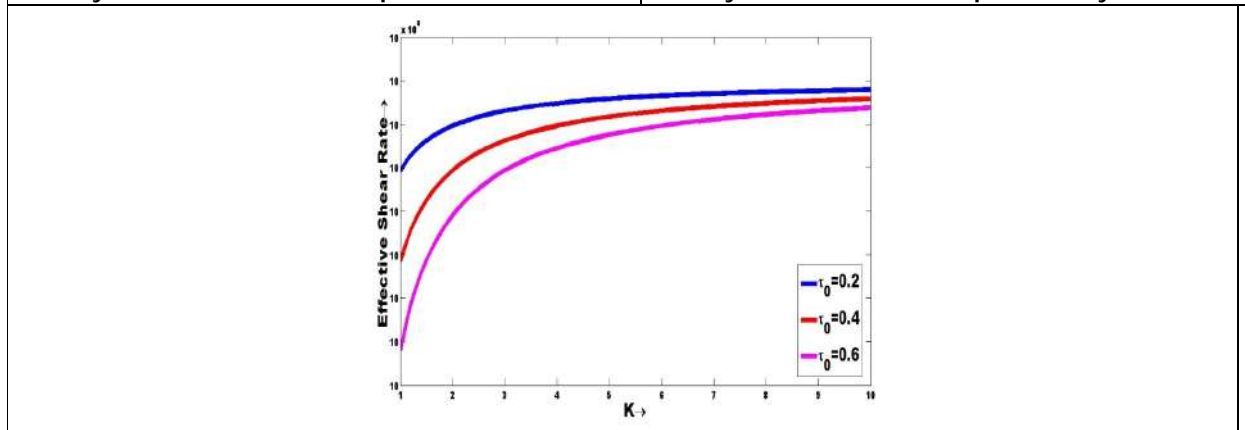
Graph-1: Variation in Effective viscosity with Darcy velocity for different value of porosity

Graph-2: Variation in Effective viscosity with Darcy velocity for different value of yield stresses



Graph-3: Variation in Effective viscosity with Darcy velocity for different Radius of capillaries

Graph-4: Variation in Effective viscosity with Darcy velocity for different value of permeability



Graph-5: Variation in Effective shear rate with Darcy velocity for different value of yield stresses





Development, Validation and Pilot Testing of a Tool for Assessing Knowledge, Attitude and Practices (KAP) on First Aid Emergency Management of Dental Trauma and Tooth Avulsion among ASHA Workers in Mysuru City

Chandrashekar BR^{1*}, Suma S², Shubhi Goel³ and Mirunalini Sundaravadivelu³

¹Professor and HoD, Department of Public Health Dentistry, JSS Dental College and Hospital, JSS Academy of Higher Education and Research, JSS Medical Institutions Campus, SS Nagar, Mysore, Karnataka, India.

²Reader, Department of Orthodontics and Dentofacial Orthopedics, JSS Dental College and Hospital, JSS Academy of Higher Education and Research, JSS Medical Institutions Campus, SS Nagar, Mysore, Karnataka, India.

³Post Graduate student, Department of Public Health Dentistry, JSS Dental College and Hospital, JSS Academy of Higher Education and Research, JSS Medical Institutions Campus, SS Nagar, Mysore, Karnataka, India.

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*Address for Correspondence

Chandrashekar BR,

Professor and HoD,

Department of Public Health Dentistry,

JSS Dental College and Hospital,

JSS Academy of Higher Education and Research,

JSS Medical Institutions Campus,

SS Nagar, Mysore, Karnataka, India

Email: drchandrubr@yahoo.com



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ABSTRACT

Traumatic Dental Injury (TDI) is showing an increasing trend in recent times affecting almost every section of the society. Literature on effectiveness on DHE in enhancing knowledge, attitude and practices related to first aid emergency management of dental trauma and tooth avulsion among ASHA workers in Mysuru City is non-existent. To develop, validate and pilot test a tool for assessing change in knowledge, attitude and practices (KAP) related to first aid emergency management of dental trauma and tooth avulsion among ASHA workers in Mysuru City following DHE. This was an educational interventional study conducted among ASHA workers in Mysuru city. A cluster sampling technique was used for selecting three Primary Health Centers (PHCs) in Mysuru city, All available ASHA workers were considered. The baseline data was collected using a validated questionnaire. DHE on first aid emergency management of dental trauma and tooth avulsion was given by a public health dentist. Post

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intervention data was collected immediately and three months following DHE. Mean KAP increased from 3.29 ± 1.49 at baseline to 9.8 ± 0.41 at immediately following intervention and 9.4 ± 0.77 at three months following intervention. DHE was effective in enhancing the knowledge, attitude and practices (KAP) related to first aid emergency management of dental trauma and tooth avulsion among ASHA workers in Mysuru City.

Keywords: Dental trauma, tooth avulsion, dental health education (DHE), Accredited Social Health Activist (ASHA), Traumatic dental injury (TDI).

INTRODUCTION

Dental trauma is showing an increasing trend in recent times affecting almost every section of the society. Traumatic Dental Injury (TDI) occurs during childhood in around 50% of population in any society. The severity of TDI may vary from simple fracture of enamel to more severe trauma involving both soft and hard tissues. TDI can result in complete avulsion of the tooth [1]. TDI can result in a strong negative impact on quality of life of children and adolescents. TDI may result in physical and emotional distress leading to adverse impact on social relationships of these children and adolescents in their future life [2]. TDIs can cause severe pain and psychological discomfort as children with TDIs tend to avoid laughing or smiling which can disturb social relationships [3]. Increasing violence, road traffic accidents, and participation of children in various sports activities such as rugby, football, hockey, wrestling, boxing, etc are contributing factors for increasing TDIs in recent times[3-5]. Tooth avulsion (Exarticulation) is defined as total displacement of the tooth out of its alveolar socket. It contributes to 0.5 - 16% of TDIs in permanent teeth. Tooth avulsion can result in serious assault on gingiva, periodontal ligament and pulp in comparison with other types of dental injuries. Avulsion of permanent teeth is common among children aged between 7 to 9 years. Alveolar bone during this age period offer very minimal resistance to extrusive forces. Less resistance by alveolar bone and most prominent location in the oral cavity, makes maxillary central incisors to be teeth most commonly affected [6]. Tooth avulsion results in aesthetic, functional, and psychological consequences, not only on the child but on parents as well [7]. Clinical management of an avulsed permanent tooth will be a challenge. It is very important to keep the innermost cell layers along the root surface vital to facilitate healing with a normal periodontal ligament (i.e., regeneration) following replantation of an avulsed tooth [6]. Immediate re-implantation is generally acknowledged as the most appropriate management strategy for a traumatically avulsed permanent tooth. Literature indicates that re-implantation should be done immediately following tooth avulsion, ideally within minutes after the injury [7,8].

According to The International Association of Dental Traumatology and American Academy of Pediatric Dentistry, the successful outcomes following dental injury and tooth avulsion can be improved by enhancing the knowledge on the first aid remedial action to be undertaken during such injuries and on the importance of visiting a dentist with these remedial measures within the first one hour of injury among general public. In this background, it becomes critical to enrich knowledge about the appropriate first-aid procedures to be adapted at the injury site following TDIs among population groups[9]. ASHA workers play a vital role in primary health care delivery in India serving at the village level. An ASHA worker with awareness on first aid emergency services to be offered during TDIs and tooth avulsion can in turn educate the general public about these first aid services. Literature on the effectiveness of dental health education (DHE) in enhancing knowledge, attitude and practices related to first aid emergency management of dental trauma and tooth avulsion among ASHA workers in Mysuru City is non-existent. Hence the present study is undertaken to develop and validate a tool for assessing change in knowledge, attitude and practices related to first aid emergency management of dental trauma and tooth avulsion among ASHA workers in Mysuru City following DHE.





MATERIALS AND METHODS

This was an educational interventional study conducted among ASHA workers in Mysuru city over a period of eight months. Ethical clearance was obtained from the ethics committee of the institution. Permission to conduct this study was obtained from District Health and Medical Officer, Mysuru. Dental Health Education was offered by a qualified public health dentist in selected primary health centers in Mysuru city. Data was collected from ASHA workers in primary health centers in Mysuru city after obtaining informed consent.

Sample size estimation

The sample size was estimated using n Masters software for hypothesis testing for single mean with repeated measures and equal variances assumed. Sample size was estimated to be 35 at an assumed mean difference of 0.3 at 80% power and 5% level of significance. The sample size will be rounded off to 40 anticipating 10% loss to the follow up.

Sampling procedure

A cluster sampling technique was used for selecting required number of ASHA workers from Mysuru city. The list of primary health centers in Mysuru city was collected. Three primary health centers (PHCs) in the city were randomly selected using lottery method of simple random sampling technique. All the ASHA workers from these selected PHCs, who fulfilled the following eligibility criteria were invited to participate in the study.

Inclusion criteria

- ❖ ASHA workers willing to participate in the study selected primary health centers in Mysuru city

Exclusion criteria

- ❖ ASHA workers not completing the follow ups
- ❖ Incomplete data sheets

Development and validation of tool:

This was done over a period of first three months using the following steps[10-13].

- ❖ Review of literature
- ❖ Obtaining inputs from subject experts
- ❖ Synthesis of review of literature and inputs from subject experts
- ❖ Development of items for initial tool
- ❖ Content validation using subject experts
- ❖ Response process validity evaluation using cognitive interview
- ❖ Accumulating known group validity evidence
- ❖ Assessment of reliability of the tool
- ❖ Pilot testing of the tool on ASHA workers
- ❖ Application of the tool in the interventional study

The initial tool having 14 items basically involving the procedures to be undertaken in a sequential manner was drafted. This was sent to six subject experts for content validation. The experts were requested to score the relevance of each of these items on a scale of 5 “(1 – Not at all relevant, 2 – Not relevant, 3 – Neutral, 4 – Relevant, 5 – Highly Relevant)”. Based on inputs from subject experts, three items were removed from the initial draft owing to redundancy and 1 item for lack of relevance. The final questionnaire having ten items was subsequently subjected to cognitive interview using retrospective verbal probing technique to elicit the response process validity on six ASHA workers.^[10] The wording in two items were modified following inputs during cognitive interview. The questionnaire was then subjected to reliability assessment using test – retest method on ten ASHA workers. The Cronbach alpha





for scale level correlation was 0.89. The final questionnaire was then pilot tested during data collection from 35 ASHA workers. The questionnaire in local language that was used during the study is attached as Annexure 1.

Baseline data collection

Data on baseline knowledge, attitude and practices related to first aid emergency management of dental trauma and tooth avulsion among ASHA workers in Mysuru City was collected by a trained investigator using a pre-designed structured and validated questionnaire.

Intervention

DHE on first aid emergency management of dental trauma and tooth avulsion was given by a qualified public health dentist in the selected PHCs using audio-visual aids. Any queries by ASHA workers were clarified during the DHE session. A brochure on first aid emergency management of dental trauma and tooth avulsion was also handed over to them during the training.

Post intervention data collection

This was done by the same trained investigator who collected baseline data using the questionnaire immediately and three months after DHE.

Statistical methods

Data was analyzed using SPSS version 24.0 (IBM, Chicago). Mean knowledge, attitude and practices scores related to emergency management of dental trauma and tooth avulsion at different time intervals (at baseline, immediately and three months after intervention) between those aged less than 30 years and those aged 31 years and above was compared using independent sample t-test while the change in KAP score between different time intervals was compared using Repeated Measures Analysis of Variance. The statistical significance was fixed at 0.05.

RESULTS

35 ASHA workers in the age range of 25 to 42 years participated in the study. The mean age was 32.26 ± 4.8 years. 15 (42.9%) participants were aged less than 30 years and 20 (57.1%) were aged 31 years and above (table 1). There was no statistically significant difference the mean KAP score between the participants aged less than 30 years and those aged 31 years and above at baseline ($p = 0.459$, table 2), immediately following intervention ($p = 1.000$, table 2) and three months following intervention (0.190, table 2). Mean KAP score for the participants at baseline was 3.29 ± 1.49 which increased to 9.8 ± 0.41 at immediately following intervention and 9.4 ± 0.77 at three months following intervention. The change in KAP score between different time intervals was statistically significant ($p < 0.001$, table 3). The post hoc revealed a significant improvement from baseline to other two post intervention time intervals ($p < 0.001$, table 3). However, the score significantly decreased at three months following intervention compared to the score at immediately following intervention ($p < 0.001$, table 3). These results were true even when a separate comparison was done among those aged less than 30 years and those aged 31 years and above.

DISCUSSION

Health promotion specifically focuses on enabling and empowering people to increase control over their own actions to improve health of individual or population.^[14] Primary prevention comprises health promotion by health education^[15]. First aid is the preliminary emergency care that is given at the site of an accident before the victim is shifted to a medical care center. First aid services can be offered by any individual regardless of their professional background, if the person has a basic knowledge and orientation. The population in general may possess some amount of basic knowledge on certain first aid measures that could be offered during animal bites, road accidents, poisonings etc. Knowledge in the general population on first aid emergency management of tooth avulsion may be limited and in fact, many are not even aware that they could give first aid services in situations where a tooth is





avulsed. Tooth avulsion is one such emergency situation in dental practice in which prompt action at that critical moment substantially enhances the positive prognosis of treatment [16]. Many studies in the existing literature which focused only on assessing knowledge, attitudes and practices related to emergency management of dental trauma and tooth avulsion were available [17-20] with very few studies assessing the impact of health education interventions aimed at improving their knowledge, attitudes and practices [21-24]. In view of this, the present study was undertaken to develop and validate a tool for assessing the knowledge, attitude and practices related to emergency management of dental trauma and tooth avulsion and subsequently, evaluate the effectiveness of dental health education in enhancing knowledge and practices related to emergency management of dental trauma and tooth avulsion among ASHA workers in Mysuru city. ASHA play a dominant role as primary health care workers at gross roots level in India. An ASHA worker with basic knowledge and skills on emergency first aid management of tooth avulsion is expected to act as a change agent who can spread awareness among the general population and initiate prompt remedial action at gross roots level. The toll was developed and validated by subject experts.

The baseline KAP score among ASHA in the present study was 3.29 ± 1.49 . The study found no significant difference in the mean KAP score among ASHA workers aged less than 30 years in comparison with those aged more than this. The low KAP score at baseline among all ASHA workers irrespective of their age could be attributed to the fact that ASHA workers might have had some basic training and orientation on common oral diseases like dental caries, gingival periodontal diseases, oral cancer, but, they would not have undergone any training and orientation on emergency management of tooth avulsion which is becoming a major dental public health problem in the recent past. Keeping this in mind, knowledge and skills training in the management of common dental emergencies is included as a core competency for ASHA workers in the operational guidelines under national oral health program[25]. The mean KAP score significantly increased immediately following DHE (9.8 ± 0.41) which later significantly decreased to 9.4 ± 0.77 at three months following intervention. Similar results were observed among ASHA workers in two different groups with no significant difference in their mean KAP scores between them at each time interval following DHE. The improvement in the mean KAP score immediately following DHE could be attributed to the introduction of terminologies like dental trauma, tooth avulsion etc in the DHE material which they might not have heard in the past. Moreover, the DHE material which offered basic orientation on what needs to be done in a sequential manner in an emergency like tooth avulsion using a scenario might have made them understand first aid measures to be undertaken in such emergency situations, replantation procedure, golden period, storage media etc. The scenario based DHE has resulted in an active learning by creating interest among ASHA workers who might have put themselves into that situation [26].

These results were similar to the results of study by Frujeri & Costa which was conducted on five different groups of professionals. The participating professionals were given health education on prevention and emergency management of the avulsed tooth. A questionnaire was used to elicit their knowledge at baseline and post intervention. The results found that the knowledge levels increased from 23 % at baseline to 70 % post intervention among teachers, from 32 % to 56 % among physical education professionals, from 32 % to 66 % among bank employees, from 17 % to 22 % among dentists and from 53 % - 69 % among pediatricians[23]. Another study by Pujitha C *et.al* among school teachers found an increase in the knowledge levels from 19.2%, 25.2% at baseline to 82.4%, 82.9% after health education among rural and urban teachers respectively demonstrating the effectiveness of health education similar to the results of our study[26]. The decline in mean KAP score three months following DHE could possibly be attributed to the natural human tendency of disremembering the novel concepts over a period of time in the absence of reinforcement at timely intervals. This observation highlights the importance of DHE at regular intervals among primary health care workers [26,27].





CONCLUSION

The study was effective in enhancing the knowledge, attitudes and practices related to emergency management of dental trauma and tooth avulsion among ASHA workers and the tool that was developed for the purpose was feasible to be used in such studies.

Novelty

This study was the first of its kind in this region where DHE on first aid emergency management of tooth avulsion was offered to ASHA workers who play a vital role in the primary health care delivery in the country. An ASHA with adequate knowledge on emergency management of tooth avulsion can educate the community acting as a change agent in the society.

Limitations and way forward

The study was done as a pilot study among ASHA workers selected from three PHCs in Mysore city after the development and validation of a tool for assessing the knowledge, attitude and practices related to emergency management of dental trauma and tooth avulsion. A larger study involving more number of ASHA selected from rural and urban PHCs of Mysore district needs to be undertaken to validate the results of the present study.

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Table.1: Age distribution of study participants

Age groups	Less than 30 years N(%)	31 years and above N (%)	Total N (%)
		15 (42.9)	20 (57.1)
Age range	25 years to 42 years		
Mean age ± Standard deviation	32.26 ± 4.8		

Table.2: Mean KAP score between two age groups at baseline, immediately and three months following intervention

Age groups	Baseline Mean ± SD	Immediately following intervention Mean ± SD	Three months following intervention Mean ± SD
Less than 30 years	3.07 ± 1.53	9.8 ± 0.41	9.2 ± 0.68
31 years and above	3.45 ± 1.47	9.8 ± 0.41	9.55 ± 0.83
Statistical inference	t – value: - 0.750 df: 33 p value: 0.459	t – value: 0.00 df: 33 p value: 1.000	t – value: -1.338 df: 33 p value: 0.190



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Table.3: Mean KAP score between baseline, immediately and three months following intervention in each group

Age groups	Baseline Mean \pm SD	Immediately following intervention Mean \pm SD	Three months following intervention Mean \pm SD	Statistical inference*	Post hoc comparison
Less than 30 years	3.07 \pm 1.53	9.8 \pm 0.41	9.2 \pm 0.68	F value: 229.41 df: 2 p value: < 0.001	BL Vs IFI: < 0.001 BL Vs TMFI: < 0.001 IFI: Vs TMFI: 0.003
31 years and above	3.45 \pm 1.47	9.8 \pm 0.41	9.55 \pm 0.83	F value: 249.67 df: 2 p value: < 0.001	BL Vs IFI: < 0.001 BL Vs TMFI: < 0.001 IFI: Vs TMFI: 0.056
Total	3.29 \pm 1.49	9.8 \pm 0.41	9.4 \pm 0.77	F value: 483.9 df: 2 p value: < 0.001	BL Vs IFI: < 0.001 BL Vs TMFI: < 0.001 IFI: Vs TMFI: < 0.001

BL = Baseline, IFI = Immediately following intervention, TMFI = Three months following intervention

*Repeated Measures Analysis of Variance applied





Comparative of Static and Dynamic Balance Exercise on Pain and Balance Performance in Sub-Acute Ankle Sprain

Vineetkumar R Vaghela¹, Rushi Gajjar² and Gaurav Patel^{3*}

¹MPT Student, Parul Institute of Physiotherapy, Parul University, Vadodara, Gujarat, India.

²Assistant Professor, Ahmedabad Physiotherapy College, Parul University, Ahmedabad, Gujarat, India.

³Principal, Ahmedabad Physiotherapy College, Parul University, Ahmedabad, Gujarat, India.

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*Address for Correspondence

Gaurav Patel

Principal,

Ahmedabad Physiotherapy College,

Parul University,

Ahmedabad, Gujarat, India

E. Mail : indurekaa@gmail.com



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ABSTRACT

Ankle injury is one of the most common musculoskeletal injuries in athletes and sedentary persons, can cause an ankle sprain. Ankle sprains with an estimated incidence of 61 ankle sprains per 10,000 persons each year. They are the most common injury sustained by high school and collegiate athletes, accounting for up to 30% of sports injuries in this is the most commonly lateral ligament injury is seen and it rates between 75% and 85% of all ankle injuries. To compare the effect of static and dynamic balance exercises on pain and balance performance in a subacute ankle sprain. A total number of 36 patients were selected for the study. Participants were divided into two groups of 18 patients in each group. Group A treated with Static balance exercise and Group B was treated with dynamic balance exercise for 5 exercise sessions per week for 4 weeks. Three outcome measures were used, Numerical Pain Rating Scale (NPRS), the Star Excursion Balance Test (SEBT) and Foot and Ankle Ability Measure (FAAM). Thirty-six patients were randomized into the static group (n=18) or the dynamic group (n=18). The result reveals that both exercises are individually effective to reduce pain measuring with NPRS ($P < 0.05$) and improving balance measuring with SEBT ($P < 0.05$) and FAAM ($P < 0.05$). while comparing both the groups there was no significant difference in-between the groups ($P > 0.05$). The Test was used to compare groups, within the group Wilcoxon Signed-Rank Test was used, and between the groups, Mann Whitney U test was used. The study shows that all the two groups were individually effective in improving pain and function. While comparing both the techniques dynamic balance exercise is more effective in the reduction of pain, and improvement of functional ability and balance in an ankle sprain.

Keywords: Static balance exercise, dynamic balance exercise, ankle sprain



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INTRODUCTION

An ankle sprain is one of the most common musculoskeletal ailments in athletes, although it can also happen to non-athletes. Ankle sprains are common, with an estimated 61 ankle sprains per 10,000 people each year. They are the most common injury among high school and collegiate athletes, accounting for up to 30% of all sports-related injuries this is the most commonly lateral ligament injury is seen and it rates between 75% and 85% of all ankle injuries. The talocrural joint is amongst the most common congruent joints in the body. The rotation axis of the talocrural joint runs between the medial and lateral malleoli[2]. The axis is somewhat anterior to the frontal plane when it travels through the tibia, and slightly posterior to the frontal plane when it passes through the fibula. Isolated movement occurs predominantly in the sagittal plane, with some motion in the transverse and frontal planes along the oblique axis of rotation. An ankle sprain is a common sports-related injury with a high recurrence rate [3]. It occurs when the ankle is inverted and causes pain on the lateral side. The frequency of ankle sprains has increased to 12–47 per cent, and those with a history of ankle sprains have a 3.5-fold higher risk of injury than healthy people[3]. Repetitive ankle sprains can lead to chronic ankle instability (CAI), which causes normal ankle weakness, pain, and limited range of motion (ROM). CAI occurs in 40–70% of persons who have repeated ankle sprains, and factors that contribute to CAI improvement include the severity of the injury, structural deformity, and insufficient rehabilitation [4]. Plantar flexion and Dorsiflexion are the voluntary actions that arise. Inversion/eversion or internal/outside rotation accent motions also appear[4]. A talus is usually shaped in the following way it is trapped between the malleoli during dorsiflexion, allowing only minor inversion/eversion and limited amounts of outer rotation. This ankle glides caudally and externally rotates about the mortise during ankle dorsiflexion [4]. During plantar flexion, the talus moves anteriorly and then internally rotates. Superior-posterior float is produced by these talus motions in respect to the mortise as much as lateral displacement at the distal fibula about the tibia. The tri-planar motions of pronation and supination are made possible by the subtalar joint. Supination typically involves inversion and internal rotation, whereas pronation largely involves eversion and outward rotation in the cardinal plane [5]. In the subtalar joint, two separate joint spaces share a single axis of rotation. The rotation axis of the foot is an oblique axis featuring a 42° upward inclination as well as a 23° medial angulation from the perpendicular axes. Individuals' axis of joint rotation, but on the alternative hand, has been observed to vary greatly [5].

METHODS AND MATERIALS

A comparative study was carried out at a Unique orthopaedic hospital and joint replacement centre, Sainath Hospital, Ahmedabad. Ethical clearance was taken from the ethical committee of Sainath hospital. 36 Subjects with sub-acute ankle sprain were taken in the study according to inclusion criteria. They are divided into two groups, 18 in each group. Group A was treated with a Static balance exercise. Group B was treated with a Dynamic balance exercise. The inclusion criteria are: The participants were between the ages of 16 and 50, Those who were just given the RICE regimen and a pain reliever, Previous ankle sprains of 1st and 2nd grade and Positive talar tilts and anterior drawer tests. Exclusion criteria are Fracture of any lower limb, Grade 3 ligament injury, History of chronic ankle instability, Lower limb nerve injury, Any metabolic disorders such as Thyroid, diabetes mellitus, Any cardiovascular disorders such as Cardiac arrest, coronary heart diseases and Any other neurological condition as Spinal Cord injury, Ataxia.

The outcome measure of the present study is the Numerical Pain Rating Scale, Star Excursion Balance Test & Foot and Ankle Ability Measure. Numerical Pain Rating Scale is for Pain then Star Excursion Balance Test is for Balance & Foot and Ankle Ability Measure for foot and ankle related impairments. The Numeric Pain Rating Scale (NPRS) is a single-dimensional pain intensity assessment. In which a person selects a whole number (0–10 integers) that best describes the severity of his or her discomfort. The 11-point numeric scale ranges from '0' to '10,' with '0' indicating no pain and '10' indicating severe discomfort. The respondent is asked to designate the numeric value on the segmented scale that best describes their pain intensity [6]. The Star Excursion Balance Test (SEBT) is used to measure a dynamic balance in a different directions such as anterior, posterolateral, and





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posteromedial. This test is specially used in lower extremity injuries. Participants will be performed 3 consecutive test trials in each direction. The order of directions will be randomized. Participants will stand barefoot with the great toe at the centre of the SEBT grid. While standing on the involved limb, they try to reach as far as possible with the non-stance limb along the reach direction [7]. The Foot and Ankle Ability Measure (FAAM) is a self-report outcome instrument developed to assess physical function for individuals with foot and ankle-related impairments. The Foot and Ankle Ability Measure consists of a 29-item questionnaire divided into two subscales: 21-item Activities of Daily Living Subscale and 8-item Sports Subscale [8].

Group A: Static Balance Exercise [9]

Static Balance Exercise		
Exercise	Discription	Repetition
One-leg stand	Subject performance one leg standing on the affected side	Duration: 15 sec/trial, 16 trials, 30-sec rest after 4 trials 1 set
Single limb Squat	Wall supported single limb squat on the affected side But in a bilateral squat without support	Duration: 6 sec/trial, 20 trials, 30 sec rest after 5 trials 1 set
Calf-raise	With their legs straight, the participant elevated their heels as quickly as possible and then descended them at a moderate speed (two seconds).	3 set of 10 Repetition with 2 min rest between sets There is no holding during calf rise

Group B: Dynamic Balance Exercise [10]

Dynamic Balance Exercise		
Exercise	Discription	Repetition
wobble Board Exercises	Go to the front, both legs straight. Both legs should be moved from right to left. Circulate in a circle using both legs.	Duration: 2 min, for each move with 1 min rest in each set 1 set
Exercise with Theraband	keeps balance on one leg standing with the abduction of the opposite leg against the resistance band.	First week: 3 sets 10 repetitions by blue TheraBand Second week: 4 sets, 10 repetitions by blue Theraband Third week: 3 sets, 10 repetitions by black Thera band
Single leg stance with ball toss		30 s 60 s 90 s with 20 throws/time

RESULT

A total of 36 patients were undergone for the pre and post-intervention assessment. The test used to compare within GROUP A (static balance exercise): WILLCOXON SIGNED RANK TEST. The test used to compare within GROUP B (dynamic balance exercise): Wilcoxon signed-rank test. For between group A and group B comparison Mann Whitney Test is done. Table 1 shows the mean values of Group A. Table 2 shows the mean values of Group B. Table 3 shows the comparison of the mean values of Group A and Group B. Result shows significant improvement in all outcome measures in both groups but Group B showed more significant improvement.

DISCUSSION

In this study, when the mean reduction values of NPRS, SEBT & FAAM were analyzed within the groups, In both groups, it was statistically significant. However, when the two groups were compared, both were statistically significant, with the exception that the mean values of dynamic balance exercise were higher than the static exercise in a subacute ankle sprain. Thus, according to present research, it is concluded that dynamic balance exercise is more





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than a static exercise in a subacute ankle sprain, and this is in agreement with the previous study. D. Cruz Daiz et al. agreed with the present study in which 6 balance Exercises of 6 weeks in an individual with foot instability among young players were examined. RCT shows that the clinical outcome of athletes improved and shows faster and better recovery. outcome measures CAIT, SEBT, NPRS were taken before and after 6 weeks of intervention. Their research found revealed following 6 weeks of involvement in various things, the results were more successful. According to the findings of the current study, a balanced exercise programme is the most comprehensive strategy for decreasing injury chances. That focused on enhancement in various ways which may increase injury. Nonetheless, improvements in sensory-motor input & output, COM control, gamma motor neuron activity, muscular stimulation, as well as co-contraction have been thoroughly reported as favourable results of balancing strategies. Jaime Salom-Moreno et al. conducted a study on trigger point release and proprioception exercise in chronic ankle instability and taking outcome FAAM, and pain. They claim that combining trigger point release using proprioception exercises improves the functional level and pain reduction. The exact therapeutic strategy whereby TrP-DN transmits therapeutic effects has to be clarified, according to the current study. Mechanical (breakage of the tension bundle or sarcomere lengthening) and neurophysiological (reduction of periphery nociception & cerebral pain pathways activation) explanations have been proposed. It's possible that the improved pain and function were the consequence of a mix of processes. For example, restoring the length of the lateral peroneus muscle sarcomeres may improve motor output, explaining apparent improvement in function, whilst a decrease in peripheral nociception may be connected to the improvement in function.

CONCLUSION

The static and dynamic balance exercises are effective for the reduction of pain and balance performance in a subacute ankle sprain. Hence, this study concluded that dynamic exercises are more effective than static exercises.

Future Recommendation of the Study More research into the effectiveness of different strategies and modalities should be done in the future. The same study might be repeated with a longer follow-up period.

Conflict of Interest: Nill

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Table 1 shows the comparison of pre and post values of Group A

Group A	NPRS (Pre)	NPRS (Post)	SEBT (Pre)	SEBT (Post)	FAAM (Pre)	FAAM (Post)
Mean	5.22	1.56	97.073	75.009	35.3	15.7
Standard deviation	1.12	0.39	3.632	5.198	6.98	4.83
P values	<0.001		<0.001		<0.001	

Table 2 shows a comparison of pre and post values of Group B

Group B	NPRS (Pre)	NPRS (Post)	SEBT (Pre)	SEBT (Post)	FAAM (Pre)	FAAM (Post)
Mean	5.65	1.52	87.002	75.831	39.35	16.3
Standard deviation	1.09	0.32	3.260	4.840	6.76	3.55
P values	<0.001		<0.001		<0.001	

Table 3 shows Group A and Group B pre and post mean of NPRS, SEBT, FAAM

	NPRS (Pre)	NPRS (Post)	SEBT (Pre)	SEBT (Post)	FAAM (Pre)	FAAM (Post)
Group A	5.22	1.56	97.073	75.009	35.3	15.7
Group B	5.65	1.52	87.002	4.840	39.35	16.3





Role of Artificial Intelligence in Teaching and Learning: An Exploratory Study

Noor Nigar*

Assistant Professor, Department of English, St. Francis de Sales College, Bangalore, Karnataka, India.

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*Address for Correspondence

Noor Nigar

Assistant Professor,
Department of English,
St. Francis de Sales College,
Bangalore, Karnataka, India.
E. Mail : msnoornigar@gmail.com



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ABSTRACT

Artificial Intelligence (AI) has the potential of revolutionizing and transforming the education system by addressing the major challenges in education today. AI can be an effective education tool for teaching and learning that would benefit both teachers and students. However, considering the digital divide and the risks associated with technology, it is imperative that the challenges of using AI in education (AIE) are evaluated before incorporating it in the teaching and learning process. Also, an attempt should be made to harness the human-element in AI, especially when implemented in education. Hence, the objective of this paper is to explore and analyze the various AI tools that are used in teaching and learning process and assess their effectiveness in improving the teaching and learning process. Furthermore, it will also address the challenges and risks of incorporating AI in education. This paper will give recommendations to overcome the challenges of AIED and reflect on the implications of using AI in education.

Keywords : Artificial Intelligence in Education, Technology, Challenges and Prospects.

INTRODUCTION

The term artificial intelligence was used for the first time by McCarthy in 1956. Baker and Smith (2019) define artificial intelligence as computers that perform cognitive tasks associated with human minds. Artificial Intelligence is a branch of computer science that makes machines replicate or stimulate human intelligence, however, AI is not synonymous with machine learning. Though machine learning and artificial intelligence are often used interchangeably, they are two different terms. Artificial intelligence includes an array of technologies and methods such as machine learning, data mining, language processing, neural networks etc. Thus, we see that machine learning is an application of AI where computer systems automatically learn and improve themselves. "Artificial



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intelligence in education opens new opportunities, potentials and challenges in educational practices” opines Ouyang & Jiao (2021). Artificial intelligence and adaptive learning are the two most prominent developments in educational technology. Educators all over the world are exploring the pedagogical potential of AI in higher education and AI is undoubtedly the future of higher education. AI can provide humongous support to both teachers and learners by facilitating effective teaching and learning. Though Artificial intelligence is considered to be the future of education, teachers are not aware of its scope and potential in education. Also, despite the advantages that AI provides to teaching and learning, there is a huge risk that comes along with the application of AI in higher education. In this backdrop, this research paper intends to discuss the various AI tools used in education, analyse the potential of artificial intelligence applications in education. This paper will also discuss the challenges associated with the use of AI in education and give recommendations to overcome these challenges.

AI Tools used in Education**Game-Based Language Learning**

Educational games make learning interesting and fun for students. AI has great potential in aiding language learning. Voice-interactive systems can play the role of a teacher as well as a conversational partner to provide umpteen opportunities to learners to practice conversation and give immediate feedback to the learner regarding the quality of speech. It can also be used for pronunciation and intonation training for non-native speakers of a language. However, the major concern is that the voice-interactive system is technological constrain that hinders comprehension of non-native speech. Wang and Seneff (2007) developed a web-based voice-interactive translation game for second language learner that provides a fun-environment to practice speaking of a foreign language i.e Chinese. However, research in second language learning has revealed that learning a new language through translation hinders fluency. Mathew *et al.* (2011) tested the effects of game-based and tutor-based assistance on learning and interest and found that tutor-based assistance was more effective in teaching concepts to students. They recommended that smart-tutors must be incorporated in educational games. Games-based education create more interest in students and tutor-assistance increase learning. Hence, to amalgamate interest and learning, tutor-assistance must be incorporated in educational games assistance.

Intelligent Tutoring System

Intelligent Tutoring System is an educational softwares that works on artificial intelligence to do a number of tasks. In a big classroom, the teacher cannot give individual attention to each student. Nonetheless, this disadvantage can be overcome by using Intelligent Tutoring Systems (ITS) that can promote one-to-one personalized tutoring of each student based on their needs. Thus, ITS provides cognitive scaffolding to students and caters to their educational needs and requirements. It collects information about the student’s academic performance along with various cognitive and non cognitive variables and based on this information, it makes inferences about a student’s area of strengths and weaknesses and suggests suitable tasks and gives appropriate feedback. It effectively diagnoses the student’s errors and delivers instructions based on the diagnoses. These tutors are designed to have the knowledge of the learner, subject and pedagogical strategies.

Virtual Reality and Augmented Reality

Virtual Reality (VR) and Augmented Reality (AR) have immense potential in the field of education. Both these technologies enrich learning experience by bringing together the virtual world and the real world.. Virtual Reality (VR) is a technology that creates a virtual immersive user experience that feels real. It is a computer generated simulation that stimulates a new reality which enables students using it to interact in a virtual world that seems real to them. Augmented Reality(AR) is an amalgamation of digital content and physical environment in real-time. Special headsets with sensors are used in Virtual Reality that transforms the real-world into modelled reality (Team Viewer), whereas AR can be accessed in regular smart phones and headsets. Both AR and AV provide interactive and meaningful learning experiences for the students.



**Noor Nigar****Learning Management Systems**

Learning Management System is a software tool that is used to create, deliver, track and report educational courses and outcomes. It helps teachers to develop courses, deliver instruction, evaluate students' performance and track learner's progress and activities. It provides a centralized learning platform for teachers where they can do multiple tasks conveniently like sharing instructional materials with the students, make important class announcements, collect assignments, grade them and also communicate with students etc. It also helps in the professional development of teachers.

Chatbots

Chatbots are computer programs that stimulate human conversation and allow humans to interact with digital devices. It uses conversational artificial intelligence technology to respond to real-time user interaction. Chatbots tutors are designed to help students in their studies and help them learn new concepts easily. Teachers are not available round the clock to interact with the students, whereas chatbots are accessible to students whenever they want.

Educational Robotics

Educational Robotics can create immense interest and motivation among students to acquire new skills in an interesting engaging manner. Researchers see robotics as a new promising tool in the field of education. Robots and educational robotics have great potential in education and can be used as great learning tools to help both teachers and students in the teaching and learning process. Robotics Mubin et al (2013) in their research concluded that robots can be used as stimulating, engaging and instructive aids in the classroom. can be used to foster creativity in the classroom. Sanchez *et al.* (2019) said that "educational robotics can improve interdisciplinary learning environments where students and teachers can structure their research and solve problem situations in a concrete way; developing new skills and abilities in people...contributing to the development of student's creativity and cognitive capability. Robotics can be a blessing for children with special needs.

Potential Benefits of AI in Education**Support Inquiry-based Learning.**

In a traditional classroom, most of the questions are asked by the teachers and students get very few opportunities to ask questions. Technology-assisted teaching systems use virtual-reality to present concepts in an interesting way. However, this kind of interaction is, no doubt, interesting and helps students understand the concepts but it fails to develop inquiry-based learning as students don't get an opportunity to question and inquiry, they are often mute recipients of knowledge. Wood *et al.* (2003) have developed an **inquiry tutor - Rashi** that they say has the potential to scaffold students to use inquiry-based approach to posit theory to explain the situation. AI tools are used to guide students through ill-structured problem spaces, supporting student knowledge and scaffolding reasoning and diagnostic skills. Thus, it engages students in long-term investigations and cognitive problem solving.

Personalised Learning or Adaptive Learning

In a large mixed-ability classroom, the students have different skill levels and different levels of learning ability. It is quite difficult for a teacher to assess the skill level of the learner and design instructions based on their skill level and learning needs. However, an Intelligent Tutor or Adaptive tutor can assess the skill level of students and design personalized learning experiences for each student. Thus, it can help in adaptive learning.

Feedback using AI

Some students are either very shy or not very sportive in receiving critical feedback in the class, hence, they often don't respond or interact in the class because of the fear of making mistakes. However, mistakes are necessary for learning and feedback is crucial for improvement. AI provides meaningful and immediate feedback to students directly and discretely so students don't shy away from trying and making mistakes. Mathan and Koedinger (2003) in their research discuss the pros and cons of immediate and delayed feedback and described an experimental comparison between an intelligent novice version of a spreadsheet tutor and an expert version consistent with an immediate feedback tutor. They found out that participants using intelligent novice tutor outperformed the





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participants using expert tutor on a number of tests. We can conclude that immediate feedback is not always very effective; at times, students need to be guided to correct their mistakes on their own using AI.

Researchers have suggested interesting and effective ways of providing feedback to students; one such method is proposed by Kunichikaet al.(2003) who developed a method that generates animation from English sentences composed by the learner. The young learners are provided with a story in English with animation and when they write the story in their own words, animation is generated based on the sentences written by them. If there are any errors, it gets reflected through animation and students get a chance to reflect on their errors and correct them. This method was used for primary-level students for simple sentences in English. More research has to be done for giving feedback to students of higher grades.

Tutoring and support outside the classroom

AI can assist students round the clock unlike teachers who are available only during the school or college hours. AI not only provides supports inside the classroom but also outside the classroom.

Learning Analytics

AI helps in identifying the strengths and weaknesses of students. AI-driven analytics can also identify latest trends in education and draw key markers that can help educators to design and develop most effective classrooms that derive digital transformation (Joshi *et al.* 2021). Artificial Intelligence algorithms can help teachers to systematically monitor the performance of the students in a specific course and design appropriate learning materials and decide suitable pedagogical methods to improve the performance of weak students. AI can also capture visual, auditory and physiological data of the students and teachers and help both teachers and learners to make important academic choices.

Automation

The potential envisioned for AI in education focuses on reducing time spent by teachers on tedious administrative and other non-teaching tasks so that teachers can use their time for more meaningful tasks like preparing for the class or interacting with the students. AI can automate simple tasks for teachers like evaluation, grading, organising classes and classifying online resources. It also automates administrative tasks for teachers.

Artificial Intelligence in Assessment

AI can be used to fully or partially automate the assessment process. It has been effective in grading exams using an answer key. In addition to this, it can automate the grading of students' writing; a more complex assessment type such as grading essays. It can aid in automated question generation as well. Rivera *et al* (2007) have proposed an **Assessment-Based Learning Environment (ABLE)** for English grammar that makes use of student assessment information to guide instruction. In this model, there is a virtual student (Carmen or Gorge) whose mistakes the learners have to correct. There is also a virtual teacher (Dr. Grammar) who provides instructional material for specific grammatical structures, in addition to this, Dr. Grammar also offers immediate verification and adaptive instructional feedback.

AI for Student with Special Needs

AI can be of great help for students with special needs. Features like narrator and other accessibility softwares can help visually challenged students to read online resources and softcopy of the textbooks. Voice-to-text features can help physically-challenged students to write through dictation. Thus, the assistive technology helps specially-abled students and give them the right to equitable education.

Challenges in using AIED

Application of AI in education presents myriad challenges that must be carefully considered before implementing them in education, some of the challenges are as follows:



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AI is a double-edged sword, one one hand it provides innovative educational solutions and on the other hand, it puts our personal data at risk. Data stored online can be easily manipulated or misused by people with bad intentions. Ethical use of AI is still a far cry as there are no set guidelines to use AI ethically. Machines are not humans, hence, they are not good at making ethical and moral decisions. In addition to this, they cannot apply socio-emotional intelligence in making decisions. However, these challenges can be overcome if children are taught AI ethics from early childhood. As discussed earlier in this paper, AI helps in automating assessment, however, this rips the assessment of professional expertise of a teacher specialised in the subject matter. Moreover, evaluation by machines, though objective, fails to take into consideration the socio-economic background, educational experiences and personal values of the individual being assessed. AI-assisted evaluation also discourages teachers getting involved in the process of evaluating their students which is very crucial for providing appropriate strategies for scaffolding students in their process of learning (Swieck 2022).

High cost of AI is a major deterrent in implementing it in education. Humanoid Robots and Virtual Reality are very expensive for developing countries or small educational institutions to use. AI enables continuous and comprehensive assessment round the clock which leads to a kind of pedagogical surveillance that is more administrative and less pedagogical. This might create a sense of anxiety among learners who feel overwhelmed by this invisible monitoring that amplifies everything they do online. Though AI is a very effective tool in education, teachers, especially in developing countries, are not very tech-savvy and mostly prefer traditional mode of teaching. Making these teachers adapt to AI will be a major challenge.

Recommendation

1. Blended learning or the hybrid-mode of learning must be used, it takes away the fear of teachers losing their jobs and AI gets a human touch.
2. Teachers must be trained on how to make best use of AI in their teaching. Kazi rightly suggests "As Research into AI and its application to the education sector expands, we need to consider the readiness of current teachers, and prepare future teachers for this new reality."
3. There is a need for interdisciplinary research in AI in education where teachers of various disciplines can collaborate with computer or IT faculty to develop softwares that will assist them in their area of specialization. Also, cross-disciplinary collaboration among computer scientists, educators and ethicists is required to overcome the challenges that AI poses for students.
4. AI technology for education must be made more cost-effective so the developing countries and small educational institutions can all use them.
5. All the stakeholders must come together to set up standards and design ethical guidelines on the use of AI in education.
6. As the children's interface with AI is more, from a very young age, teachers must nurture ethical decision making skills and the use of social-emotional intelligence in children while using AI. Monitoring students while they use AI is very crucial to train them how to use it ethically.

CONCLUSION

Artificial Intelligence in Education is a contentious topic today. Recent years have seen a significant growth in research on IA. Nonetheless, the research on AI in education is very limited and done mostly in developed countries. In developing countries like India, research on IAE is still in a nascent stage and incorporating IA in the Indian educational context is a challenge. However, despite the challenges associated with artificial intelligence, the advantages it provides cannot be ignored. Instead of looking at it as a threat for the teachers, it should be used to complement the teachers to help them in effective teaching. IA makes educational content both engaging and interesting and it is also pedagogically very effective. AI can help students in understanding the concepts better, create motivation and interest towards learning new or difficult concepts. Thus, it can be concluded that AI can help improve the quality of education and help in achieving educational goals and must be incorporated in education. At



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the same time, AI brings along with it a new set of challenges that must be diligently considered while implementing AI in Education.

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Synthesis, Characterization, and Antimicrobial Activity 4, 4'-Arylmethylene-bis (3-methyl-5-Pyrazolones

R. Kalaivanan^{1*}, S.Senthilkumar² and V.Sughanya³

¹Research Scholar, Department of Chemistry, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu 608002, India.

²Associate Professor, Department of Chemistry, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu 608002, India

³Associate Professor, Department of Chemistry Periyar Government Arts College, Devanampattinam, Cuddalore, Tamil Nadu – 607 001, India.

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*Address for Correspondence

R. Kalaivanan,

Research Scholar,

Department of Chemistry,

Annamalai University,

Annamalai Nagar,

Chidambaram, Tamil Nadu 608002, India.

Email: senraj05@gmail.com



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ABSTRACT

Synthesize and characterize various 4, 4'-Arylmethylene-bis(3-methyl-5-pyrazolones derivatives by an efficient methodology. The synthesized compounds (1-10) were evaluated for their *in vitro* anti-microbial activity. Some selected synthesized pyrazolone derivatives were examined for Antibacterial activity of using disc diffusion method and antifungal activity using cup plate method. The bacterial strains of gram positive bacteria are such as *Staphylococcus aureus* and *Streptococcus pyrogenes*. Then gram negative bacteria are such as *Pseudomonas aeruginosa* and *Escherichia coli*. In this study ciprofloxacin was used as standard. The fungal strains of *Aspergillus niger* and *Candida albicans*. In this study amphotericin B was used as standard. *In vitro* antimicrobial data indicated that most active compound B, D, E and G is safe as its MIC value is much lower than the cytotoxic value.

Keywords: Anti bacterial, Anti fungal, Pyrazole, Synthesis, *Staphylococcus aureus*

INTRODUCTION

Pyrazole compounds based on pyridone ring moiety were evaluated against their antibacterial and antifungal activities pyrazolopyridone derivatives exhibit positive acceptance as antimicrobial character. Pyrazoles have attracted considerable attention for many researcher, the pyrazole moiety is a versatile lead molecule in the

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pharmacological activities such as agrochemicals, antimicrobial, antifungal, anticancer, antidiabetic, anti-inflammatory, anticancer, antiviral, analgesic, antipyretic, anticonvulsant and anti-HIV activity [1]. As well as, when introducing pyrazole and thiazole fragments to parent pyrazole were enhancement antimicrobial power. The novel heterocyclic compounds based on pyrazole moiety and investigate their biological evaluation as antimicrobial and antifungal activities[2]. The word antimicrobial was derived from the Greek words anti (against), mikros (little) and bios (life) and refers to all agents that act against microbial organisms. This is not synonymous with antibiotics, a similar term derived from the Greek word anti (against) and biotikos (concerning life). Antimicrobial use is known to have been common practice for at least 2000 years. Ancient Egyptians and ancient Greeks used specific molds and plant extracts to treat infection[3]. In the 19th century, microbiologists such as Louis Pasteur and Jules Francois Joubert observed antagonism between some bacteria and discussed the merits of controlling these interactions in medicine[4]. Antimicrobial agents, including various antibiotics and synthetic antibiotics that have bactericidal or bacteriostatic effects, are drugs that kill or inhibit the effects of bacteria[5]. An antimicrobial is an agent that kills microorganisms or stops their growth. Microbes are responsible for several poisonous syndromes and prevalent epidemics in human civilizations[6]. Microbial diseases such as plague, diphtheria, typhoid, cholera, pneumonia and tuberculosis have taken high toll of humanity in recent pasts[7]. In present times, many of the accessible antimicrobial drugs are poisonous and create recurrence of diseases because they are bacteriostatic and not bactericides[8]. In view of the high degree of bioactivity shown by the above ten heterocyclic systems and continuation of the search for novel antimicrobial agents, it was predicted to construct a system in which all these systems are in a single molecular frame for exploring the additive effects towards antimicrobial activity. Hence, a new series of 4,4'-Arylmethylene-bis(3-methyl-5-pyrazolones (1-10) have now been synthesized.

MATERIALS AND METHODS

Synthetic scheme

Mixture of 5-methyl-2-phenyl-2, 4-dihydro-3H-pyrazol-3-one (2 mmol), aldehyde (1 mmol) and H₂O (10 mL), 10ml acetic acid – 3hr reflux (0.1 mmol) was added. The mixture was stirred at 80 °C for an appropriate time. After completion of the reaction (TLC), the resulting solid was collected by filtration and recrystallized from ethanol[9-12].

Elemental analysis[13-15]

Elemental analysis (% C, H, N) was carried out by a Perkin- Elmer 2400 CHN analyzer. IR spectra of all compounds were recorded on a Perkin-Elmer FT-IR spectrophotometer in KBr, frequencies are reported in cm⁻¹. ¹H NMR spectra were run on Varian Gemini 300 MHz and ¹³C NMR spectra on Varian Mercury- Compound1 Pyrazole (0.01 mol) and 4- Nitrobenaldehyde (0.01 mol) were dissolved in acetic acid (20 mL) and the reaction mixture was refluxed for 8 hr. After cooling, the crystals formed were filtered and purified by recrystallization from absolute alcohol.

Antimicrobial assay[16-19]

Antibacterial studies of newly synthesized compounds 1-10 were carried out against the representative panel of Gram-positive (Staphylococcus aureus, Streptococcus pyogenes) and Gram-negative (Pseudomonas aeruginosa, Escherichiacoli) bacteria. All bacterial cultures were collected from Department of Biotechnology, Annamalai University. The activity of compounds was determined as per National Committee for Clinical Laboratory Standard protocol using Mueller Hinton Broth. Screening was done first for antibacterial activity against *E.coli*, *S.aureus*, *P. aeruginosa* and *S. pyogenes*. Inoculum size for test strain was adjusted to 10⁶ Colony Forming Unit per millilitre by comparing the turbidity (turbidimetric method). Mueller Hinton Broth was used as a nutrient medium to grow and dilute the compound suspension for test organisms. 2% DMSO was used as a diluent/vehicle to obtain the desired concentration of synthesized compounds 1-10 and standard drugs to test upon standard microbial strains. Synthesized compounds were diluted as stock solution. The control tube containing no antibiotic was immediately before inoculation by spreading a loopful evenly over quarter of a plate of medium suitable for the growth of test organisms [20]. The culture tubes were then incubated for one day at 37°C and the growth was monitored visually and spectrophotometrically. Suspensions of 10 µg/mL were further inoculated on an appropriate





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media and growth was noted after 24 hr and 48 hr. The highest dilution (lowest concentration) required to arrest the growth of bacteria was regarded as minimum inhibitory concentration (MIC) i.e. the amount of growth from the control tube before incubation (which represents the original inoculum) was compared. Solvent had no influence on strain growth. The result of this was greatly affected by the size of inoculum. DMSO and sterilized distilled water were used as negative control while ciprofloxacin antibiotic (1 U strength) was used as positive control. Standard drug used in the present study was 'ciprofloxacin' for evaluating antibacterial activity which showed MIC against *E. coli*, *P. aeruginosa*, *S. aureus* and *S. pyogenes*[21]. The newly prepared compounds 1-10 were also screened for their antifungal activity as primary screening against *C. albicans* and *A. niger*. The antifungal activity of each compound was compared with Amphotericin B as a standard drug. For fungal growth, in the present protocol, Sabourauds dextrose broth has been used at 28°C under aerobic conditions for 48 hr. DMSO and sterilized distilled water were used as negative control while Amphotericin B (1 U strength) was used as positive control.

RESULTS AND DISCUSSION

In the attempt to synthesize cost effective drugs, pyrazole was identified as better targets, easy and economical to synthesize. The synthetic route for the preparation of few compounds was followed as reported in synthetic Scheme. 5-methyl-2-phenyl-2, 4-dihydro-3H-pyrazol-3-one in presence of Diammonium hydrogen phosphate as main starting material and used various aldehyde to obtain derivatives of 4,4'-(methanediyl)bis(3-methyl-1-phenyl-1H-pyrazol-5-ol) ten different compounds. The structure of the synthesized compounds was confirmed by elemental analyses and spectroscopic methods. The IR spectrum of 4,4'-(4-methoxyphenyl)methylenebis(3-methyl-1-phenyl-1H-pyrazol-5-ol) **E1** as a descriptive example which showed in Figure.1, revealed the lack of an NH₂ and NH group absorption peak at 3292, 3250 cm⁻¹ and 3149 cm⁻¹ and appearance of an absorption peak at 3059 cm⁻¹ and 1936 cm⁻¹ owing to the presence of OH and C=N groups. The ¹H-NMR spectrum of **E1** showed in figure.2 it displays new signals at δ 3.73, 5.0, 6.9, and 7.3 ppm assigned to methoxy and aromatic protons. In ¹³C-NMR spectrum of **E1** revealed the presence of C=N signal at 147.6 ppm and appearance of 21 carbon signals as shown in figure.3. Moreover, the mass spectra of compounds **E1** gave molecular ion peaks at *m/z* 314, 328, and 348, respectively. This clearly indicates the formation of complete structure of **E1** by condensation of 2 molecules of pyrazole with methoxy benzaldehyde moiety was involved in cyclization reaction to give 4,4'-(4-methoxyphenyl)methylenebis(3-methyl-1-phenyl-1H-pyrazol-5-ol) **E1**.

The antibacterial screening results (Table I) revealed that some of the tested compounds showed excellent inhibition against various tested microbial strains compared to the standard drug. In general, compounds 1-10 demonstrated better antibacterial activity rather than antifungal activity. From antibacterial activity data (Table I), it was observed that compounds A-E and G, I & J were the most potent antibacterial agents. Out of them, compounds B1 (4-C₂H₅); D1 (4-CH₃) and E1 (2-OCH₃) emerged as the most effective antibacterial agents against *Staphylococcus* with the reference drug ciprofloxacin. Compounds A1 (4-NO₂) exhibited comparable antibacterial activity against *Streptococcus* with the standard drug. The highest inhibition of such derivatives may be accredited to the presence of electron donating groups at ortho, meta or para positions of the phenyl ring. Compounds B1 (4-C₂H₅), G1 (3 & 4-OCH₃) and J (3-OCH₃) displayed excellent activity against *E. coli*. Compounds E1 (2-OCH₃) emerged as candidates with the highest inhibition against *Pseudomonas* compared to standard ciprofloxacin.

The *in vitro* antifungal activity of synthesized compounds 1-10 was determined against *Candida albicans* and *Aspergillus niger* by conventional broth dilution method. Similar trends were observed for the antifungal activity and compounds D1, E1 and G1 were the most potent antifungal agents. Furthermore, the results indicated that compounds D1 (4-CH₃), E1 and G1 (2, 3 & 4-OCH₃) substituted with methyl and methoxy group at para position of the phenyl ring were found to be the most promising agents against all the fungal strains in comparison with control drug Amphotericin B. The enhanced activity of compounds D (4-CH₃), E (2-OCH₃) and G (4-OCH₃) may be ascribed to the presence of electron donating group at para position. Here also the electron donating groups played a main role for increasing the antifungal activity. Compound E1 (2-OCH₃) displayed excellent inhibition against both *Candida albicans* and *A. niger* compared to standard Amphotericin B.





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CONCLUSION

In summary, some new structural hybrid pyrazole derivatives of 4,4'-(4-substituted phenyl)methylenebis(3-methyl-1-phenyl-1H-pyrazol-5-ol) were synthesized and investigated for their *in vitro* antimicrobial property. We anticipate generation of new structural leads serving as potent antimicrobial agents. Many of the synthesized motifs (B, D, E and G), possessing electron donating groups such as methoxy, methyl and ethyl at para and meta position was identified as the most potent antimicrobial agents. In addition, compounds D (4-CH₃), E (2-OCH₃) and G (4-OCH₃) emerged as the most potent antimicrobial agents. The promising activity of these precursors is mainly due to the presence of electron donating functional groups (OCH₃, CH₃, C₂H₅) on phenyl ring. Though, it was observed that para position was more favourable for enhancing the antimicrobial activity. The potent antimicrobial activity of most active compounds B, D, E and G was accompanied with relatively low level of cytotoxicity. The results described here, merit further investigations in our laboratories using an advancing synthetic genetic approach for finding lead molecules as antimicrobial agents.

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Table.1: Structure and name of substituted derivative of pyrazole compounds(A1-J1)

	R1	Compounds	Name
1	4-nitrobenzaldehyde + Pyrazole(A1)		4,4'-(4-nitrophenyl)methylenebis(3-methyl-1-phenyl-1H-pyrazol-5-ol)
2	4-Diethylamino benzaldehyde + Pyrazole(B1)		4,4'-(4-Diethylamino)methylene bis(3-methyl-1-phenyl-1H-pyrazol-5-ol)





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3	Indole-3-carboxylic+ Pyrazole(C1)		4,4'-(4-indole)methylenebis(3-methyl-1-phenyl-1H-pyrazol-5-ol)
4	p-Dimethylamino benzaldehyde+Pyrazole(D1)		4,4'-(4-(Dimethylaminophenyl)methylene)bis(3-methyl-1-phenyl-1H-pyrazol-5-ol)
5	2-methoxy benzaldehyde+Pyrazole(E1)		4,4'-(4-(2-methoxyphenyl)methylene)bis(3-methyl-1-phenyl-1H-pyrazol-5-ol)





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6	Meta-Nitro benzaldehyde+ Pyrazole(F1)		4,4'-(4-metanitrophenyl)methylenebis(3-methyl-1-phenyl-1H-pyrazol-5-ol)
7	Veratraldehyde + Pyrazole (G1)		4,4'-(4-(methoxy hydroxyl)methylene bis(3-methyl-1-phenyl-1H-pyrazol-5-ol)
8	4-Chloro benzaldehyde+ Pyrazole(H1)		4,4'-(4-chloro phenyl)methylenebis(3-methyl-1-phenyl-1H-pyrazol-5-ol)





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9	3-Ethoxy hydrozaldehyde Pyrazole(I1)	-4- +		4,4'-(4-(3-ethoxy-4-hydrozaldehyde)methylenebis(3-methyl-1-phenyl-1H-pyrazol-5-ol)
10	Vanillin+ Pyrazole(J1)			4,4'-(3-methoxy-4-hydrozaldehyde)methylenebis(3-methyl-1-phenyl-1H-pyrazol-5-ol)

Table.2 Antibacterial and antifungal activity of synthesized compounds(A1-J1)









Sample/ Compound Name	Zone of inhibition in diameter mm					
	Gram positive Bacteria		Gram negative Bacteria		Fungi	
	<i>Staphylococcus</i>	<i>streptococcus</i>	<i>Pseudomonas</i>	<i>E. coli</i>	<i>Aspergillus</i>	<i>Candida</i>
A1	15	10	10	14	11	10
B1	15	11	12	13	13	13
C1	16	10	14	16	10	12
D1	11	13	11	14	09	11
E1	20	18	21	22	22	16
F1	16	14	15	12	10	13
G1	11	15	11	11	11	10
H1	12	11	11	13	13	09
I1	15	14	10	12	12	08
J1	16	13	18	11	14	11
Ciprofloxacin	23	27	23	28	-	-
Amphotericin B	-	-	-	-	14	15
NC	-	-	-	-	-	-





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Table.3:Zone of inhibition of antibacterial and anti-fungal activity

S.NO	Control	Compound
1		
2		
3		
4		
	Anti-fungal activity	





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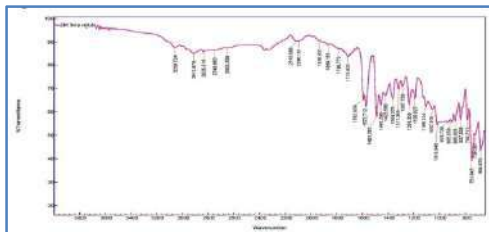
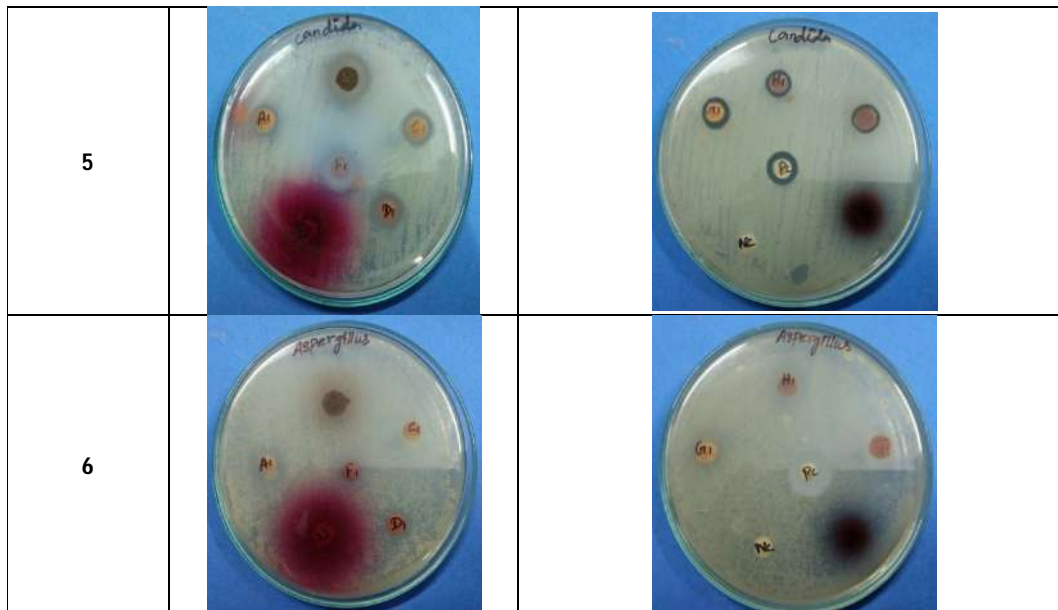


Fig:1 IR spectrum of E1

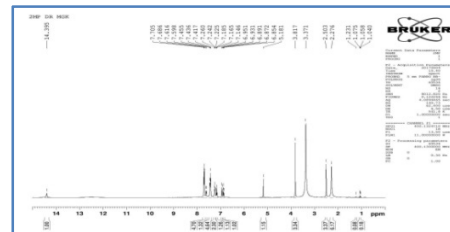


Fig:2 H1 NMR spectrum of E1

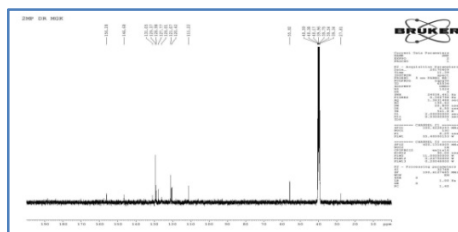
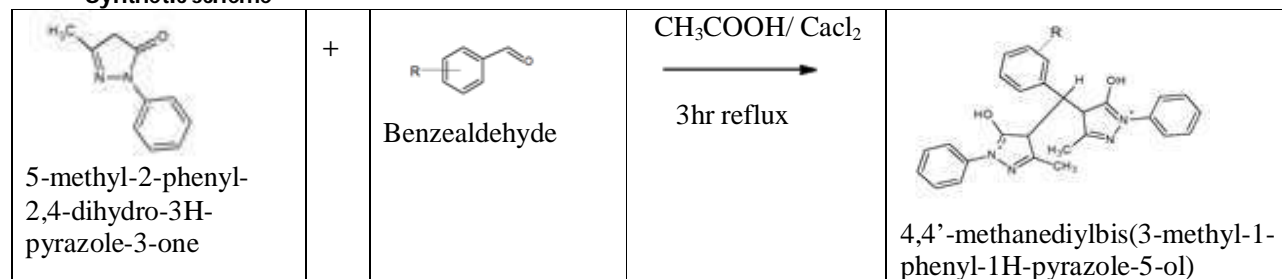


Fig:3 C13 NMR spectrum of E1





Synthetic scheme





RESEARCH ARTICLE

Robot-Assisted Therapy for Children with Autism and Intellectual Disabilities using Deep Learning Systems

Veena N*

Assistant Professor, St Francis de Sales College, Bengaluru, Karnataka, India

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Address for Correspondence*Veena N**

Assistant Professor,

St Francis de Sales College,

Bengaluru, Karnataka, India

E. Mail : veenanbca@sfscollege.in



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ABSTRACT

In the rapidly expanding field of robot-enhanced treatment (RET), robots are used to support various therapeutic interventions. The use of robots to aid in the treatment of Autism Spectrum Disorder has gained popularity in recent years (ASD). Communication, social interaction, and behaviour are all impacted by ASD, a neuro developmental disease. The goal of RET for ASD is to connect with children who have ASD in an organized and predictable environment so they can learn and practice social skills. This paper explores the implementation of unique deep-learning neural network architectures for automatically determining whether a child is engaging with the robot during treatment sessions by concentrating their visual attention on it.

Keywords: autism, robot-assisted therapy, autism disorder, deep learning systems, human-robot interaction, intellectual disability

INTRODUCTION

Rapid technological advancement presents significant opportunities for therapeutic innovation for people with autism spectrum disorders. This seems to be especially relevant to the field of robotics (ASD). Robotic advancements in recent years have made it possible for them to do a variety of human-like tasks and to contribute to the growth of social skills in ASD patients. Despite the fact that efficacy and effectiveness studies on the therapeutic use of interacting robots with people with ASD are still in their infancy, this topic has attracted a lot of media attention during the past 10 years. Furthermore, the majority of the published research appears in robotics-focused publications rather than well-known ASD journals or clinically-focused journals. As a result, it's crucial to carefully examine current studies on the clinical applications of the technology. The clinical use of interactive robots is a promising development in light of research showing that people with ASD: exhibit strengths in understanding the physical world and relative weaknesses in understanding the social world; and are more receptive to feedback, even

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social feedback, when administered via technology rather than a human (Yet, most of the support to date for its use in therapy is based on anecdotal evidence and lacks support for the generalizability of the findings.

Autism Spectrum Disorder

Autism spectrum disorder is a condition that affects how a person perceives and engages with others, which can lead to issues with social interaction and communication. Limited and recurring behavioural patterns are another aspect of the disorder. With autism spectrum disorder, the word "spectrum" alludes to the vast range of symptoms and severity. Autism, Asperger's syndrome, childhood disintegrative disorder, and an unidentified type of pervasive developmental disorder are all disorders that were formerly thought to be distinct conditions that make up the autism spectrum disorder. The name "Asperger's syndrome," which is usually considered to be at the mild end of autism spectrum disorder, is nonetheless occasionally used by some people.

Early-onset autism spectrum disorder eventually causes problems with social, scholastic, and occupational functioning in society. Children with autism usually display symptoms within the first year. A very small percentage of children appear to develop normally in the first year, but between the ages of 18 and 24 months, when they begin to exhibit signs of autism, they undergo a period of regression. Although there is no proven cure for autism spectrum disorder, rigorous early care has been shown to significantly improve the lives of many children. Autism is estimated to affect around 18 million people in India. Additionally, statistics indicate that more children in India are being diagnosed with autism.

Despite having completely normal appearances, many autistic youngsters spend their time engaging in perplexing and upsetting behaviours that differ noticeably from those of kids who are usually developing. They may have little or no interest in other people, including their parents, and engage in repeated behaviours that seem to serve no purpose. They are frequently referred to as existing "in a world of their own". ASD sufferers can be verbal or nonverbal, but not always. Although this phenomenon often referred to as savant or savant syndrome—is extremely uncommon, certain autistic people may exhibit extraordinary talent in certain fields, such as music or mathematics, as shown in the movie Rain Man. They all require support.

Social Assistive Robotics for Children with Autism

Given the complexity and broad amplitude of the autism "spectrum," which covers a range of disorders and degrees of severity, it is advisable to adopt a multi-modal intervention that may be customized to the needs of the individual in order to maximize the therapeutic advantages. Robots' controlled autonomy has therefore been utilized to give these children social partners they can get along with. With the help of multimodal interfaces (speech, gestures, and input devices), Socially Assistive Robotics (SAR), a novel field of robotics application, creates new platforms and services to assist users through advanced interaction driven by their needs (such as tutoring, physical therapy, daily life assistance, and emotional expression). Robots have been successfully used in recent research to mediate interactions between people and people with ASD. Participating human partners demonstrate gains in affective behaviour and attention sharing. Since communicating with a robot can be less daunting than with a human, social robots may benefit people with ASD who have trouble communicating.

Humanoid robots, which resemble humans but are far less complex than humans, may help ASD children learn more readily and subsequently make it less complicated to transfer the abilities they have gained via imitative human-robot interaction to child-human contact. In fact, imitation as a communication tool has been linked to good social behaviour and is seen as a reliable indicator of social abilities. Impersonation is used in therapy to improve bodily awareness, a feeling of self, creativity, leadership, and the capacity to begin interactions because children with autism sometimes struggle to imitate the behaviour of others. Numerous advantages of robot assistants in treating children with ASD have been demonstrated by recent robotics research.



**Veena****Research Questions**

- When compared to conventional therapy methods, does robot-assisted therapy help autistic children with their social skills?
- What specific aspects of robot-assisted treatment work best to encourage social interaction and interaction in autistic children?
- How do autistic kids react to and perceive robots in therapies, and how does this affect how effective the therapy is?
- Can robot-enhanced therapy be provided remotely, and if so, how does this alter how well it works to help autistic youngsters with their social skills?
- When compared to conventional therapy methods, are robots used in therapy to make autistic children more motivated and engaged?
- What are the attitudes of parents and other caregivers of autistic children towards including robot-assisted therapy in their child's treatment plan?
- How do the long-term effects of robot-assisted therapy for autistic kids compare to conventional therapy modalities?
- How cost-effective is robot-assisted therapy for autistic children compared to conventional therapy methods?
- How can robot-enhanced therapy be modified to match the unique requirements of various autistic children, and how can this method be personalized to maximize its efficacy?

The Objective of the Study

This study's objective was to conduct a critical assessment of the literature on the clinical applications of robotics for people with ASD in light of the application framework mentioned above. Our review was limited to papers that provided sufficient diagnostic information and clinical outcome data for the technique's evaluation and were either published in peer-reviewed journals or peer-reviewed, published conference proceedings. We highlighted crucial methodological aspects of therapy trials involving people with ASD, such as how participants were found and how diagnoses were verified, the suitability of control conditions/groups, and sample sizes. Understanding the existing state of empirically-based evidence for this experimental therapy approach, identifying gaps in the literature, and laying the groundwork for future study were the objectives.

Framework for Therapeutic Application of Robots

Robots are gaining significance in the healthcare industry and may have therapeutic applications in an assortment of contexts. Here is a potential strategy concerning how robots could potentially be used in therapy:

Assessment: Determine the patient's needs, objectives, and preferences through an assessment. Depending on the patient's health, the potential advantages, and the risks, decide whether a robot is the right option.

Robotic preference: Consider a robot that is appropriate for the patient's requirements and objectives while making your decision. Take into account the interface design, programming, and capabilities of the robot.

Robot personalization: Tailor the robot's interface and programming to the needs and preferences of each patient. To increase patient involvement and pleasure, customize the robot's looks and actions.

Therapeutic action: Use a robot to administer a therapeutic intervention, such as physical therapy, cognitive training, or social assistance. As well as maintaining an eye on the patient's development and input, make sure the robot is operating safely and effectively.

Evaluation: Measure the individual's effects, such as cognitive improvement, quality of life, and contentment, to evaluate the effectiveness of the robot-based intervention. To assess the comparative efficacy and cost-effectiveness of the robot-based intervention, compare it to other interventions or control situations.

Optimization: Based on the results of the evaluation and the patient's comments, improve the robot-based intervention. To further improve the robot's therapeutic impact and usefulness, keep improving its programming, interface, and content.





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Ethical concerns: Discuss issues like privacy, autonomy, and informed consent that is relevant to the use of robots in healthcare. Ascertain that the robot-based intervention respects the patient's rights, beliefs, and preferences and does not violate them or subject them to discrimination or damage.

Although research conducted in this area does not explicitly examine clinical therapies as do research in the other categories, they do directly compare how people with ASD react to robots or individuals with characteristics/behaviours that are comparable to robots and those that are human. It is crucial to note that we are concentrating on the overall strategy of deploying robots rather than any specific objective behaviour.

Data and Statistics on Autism Spectrum Disorder

- One in 36 children has an autistic spectrum disorder diagnosis, according to the CDC's Autism and Developmental Disorders Surveillance Network (ADDM) (ASD).
- Reports of ASD from people with various socioeconomic, racial, and ethnic backgrounds.
- ASD is more likely to occur in boys than in girls by a factor of more than 4.

According to caregivers' reports, between 2009 and 2017, 17% of children aged 3 to 17 were found to have an intellectual disability. They include attention-deficit/hyperactivity disorder, blindness, and cerebral palsy

METHODS

The following outlines the methods that can be applied to the machine learning experiments in the study

Convolution Neural Networks with Region Proposal (R-CNN)

In autism research, the use of region proposition (R-CNN) holds great potential in enhancing the accuracy and rapidity of identifying characteristics and patterns in brain imaging data. The connection and structural abnormalities of the brain in autistic individuals have been examined using brain imaging techniques like MRI and fMRI. Nonetheless, it takes a lot of time and processing to analyze such a big amount of image data.

R-CNN has been employed in autism research to improve the analysis accuracy and efficiency of brain imaging data. R-CNN effectively locates regions of interest in brain imaging using object propositions, which may then be further examined using CNN. It has been proven that using this method accelerates and increases the precision of autism-affected brain region detection. It is also been employed in autism studies to discover imaging biomarkers that can be used as diagnostic indicators for autism. One recent study, for instance, employed R-CNN to examine fMRI data and discovered a network of brain regions that showed decreased functional connectivity in autistic individuals. With the use of this biomarker, early intervention for autistic individuals may be facilitated.

K-Nearest Neighbour Classifier

This approach has shown promising results in identifying subgroups of individuals with autism who share common characteristics and symptoms. One study used K-NN to classify individuals with autism based on their behavioural and clinical features, such as age, sex, IQ, and autism symptoms. The K-NN algorithm was able to classify individuals with autism into subgroups based on their shared characteristics, such as age and autism symptoms. This approach could potentially be used to identify subtypes of autism and develop targeted interventions for each subtype. Another study used K-NN to classify individuals with autism based on their brain connectivity patterns. The K-NN algorithm was able to identify subgroups of individuals with autism who shared similar brain connectivity patterns. This approach could potentially be used to develop personalized interventions for individuals with autism based on their specific brain connectivity patterns. Moreover, K-NN has also been used in the diagnosis of autism. A recent study used K-NN to classify individuals with autism based on their eye-tracking patterns. The K-NN algorithm was able to accurately classify individuals with autism with a high degree of accuracy. This approach could potentially be used as a non-invasive diagnostic tool for autism.



**Veena****HOG Descriptors**

To examine and categorize brain images according to their structural features, researchers studying autism have used Histogram of Oriented Gradients (HOG) descriptors. HOG descriptors are a popular technique for extracting features to examine the texture and form an image. In one study, structural MRI scans of the brains of people with autism and people who are usually developing were examined using HOG descriptors. According to the analysis, the HOG descriptor may distinguish between the modifications to brain architecture between those with autism and people who are usually developing as shown in figure 2. According to the study, HOG descriptors can be utilized as a feature extraction method to find structural variations in autistic people's brains. Moreover, HOG descriptors have been applied to the analysis of EEG signals in autistic people. One study compared the time-frequency characteristics of EEG signals in people with autism versus others who are usually developing. Based on the research, HOG descriptors can distinguish between variations in the time-frequency characteristics of EEG data in people with autism and those who are usually developing. According to the study, HOG descriptors can be utilized as a feature extraction method for examining EEG signals in autistic people.

DISCUSSION

Robot-assisted therapy is a promising application area for intelligent social robots. However, most studies in the paper focus on autistic people without ID or do not analyze comorbidities. There are very few studies in this area, which can be considered one of the current gaps between scientific research and clinical application. In the clinical context of ASD with ID, the goal is to use robots for social assistance to assist therapists, reducing the workload by allowing the robots to take over certain parts of the intervention. It includes monitoring and recording children's activities, actively engaging children when distracted, and adapting robot behaviour to each child's level of intervention. In order to achieve this, computational intelligence techniques should be used to enhance the robot's capabilities to favour greater adaptability and flexibility, allowing the robot to be integrated into any therapeutic setting in accordance with the particular needs of the therapist and the individual child.

CONCLUSION

The use of interactive robots with individuals who have Autism Spectrum Disorder in therapeutic settings has a lot of potential advantages. These benefits include the inherent appeal of technology to those on the autism spectrum, robots' capacity to repeatedly execute simple and isolated behavioural traits, and the ease with which they can be programmed and customized to provide specialized care for each child. Despite these exciting prospects, this field of study is still in its infancy, therefore further investigation is required to establish the incremental validity of this methodology.

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Table 1: Application categories for interactive robots in medical therapy.

Classification	Explanation	Possible Application Examples
Exercising skills	A robot is employed to learn and perform a desired action or ability.	Robot engages in scripted interaction with the child to help them practice a skill while modeling behaviour for them to imitate
Evoking actions	Robot engages in an activity or interaction with the child to inspire a particular behaviour.	To collect distinguishing characteristics for a diagnostic assessment; To encourage socialization conduct with an interactive human partner, such as joint attention
Responses to robots	Compares speed, and/or frequency of interactive replies given to a robot or a conversation partner who exhibits robot-like traits to those given to a human or device that is not robotic.	The research sheds light on how children with ASD may react to robots or traits that resemble robots in diverse ways, although they do not directly have clinical applications.
Giving feedback or support	Robots provide social assistance or behavioural alterations during an activity.	Robot provides assistance and the required reminders to encourage interaction with another active partner when a child accomplishes a specific skill.

Table 2: Identified Prevalence of Autism Spectrum Disorder Data Aggregation from across all sites for the ADDM Network 2000–2020

Year of Surveillance	Birth Year	Number of Reported ADDM Sites	Combined Prevalence per 1,000 Children (Range Across ADDM Sites)	This relates to about 1 in X children.
2020	2012	11	27.6 (23.1-44.9)	1 in 36
2018	2010	11	23.0(16.5-38.9)	1 in 44
2016	2008	11	18.5 (18.0-19.1)	1 in 54
2014	2006	11	16.8 (13.1-29.3)	1 in 59
2012	2004	11	14.5 (8.2-24.6)	1 in 69
2010	2002	11	14.7 (5.7-21.9)	1 in 68
2008	2000	14	11.3 (4.8-21.2)	1 in 88
2006	1998	11	9.0 (4.2-12.1)	1 in 110
2004	1996	8	8.0 (4.6-9.8)	1 in 125
2002	1994	14	6.6 (3.3-10.6)	1 in 150
2000	1992	6	6.7(4.5-9.9)	1 in 150





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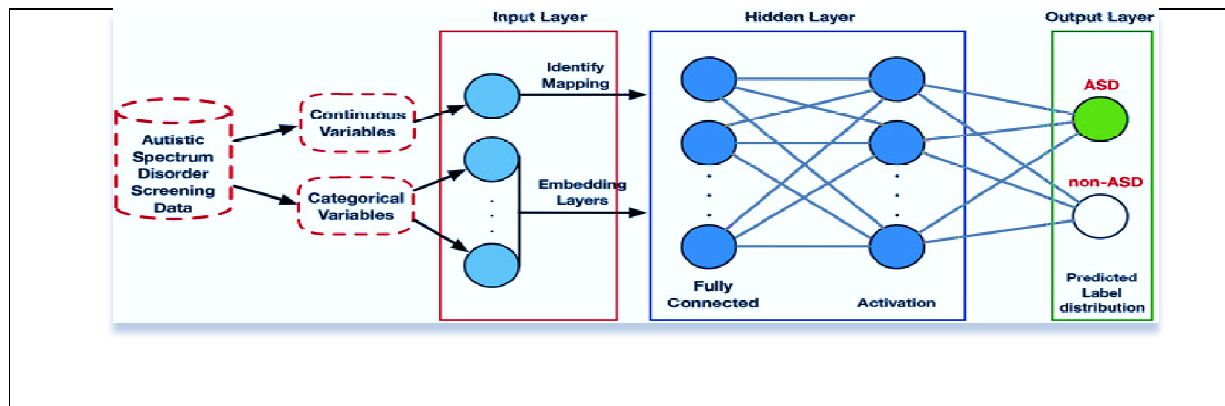


Fig. 1. KNN Architecture

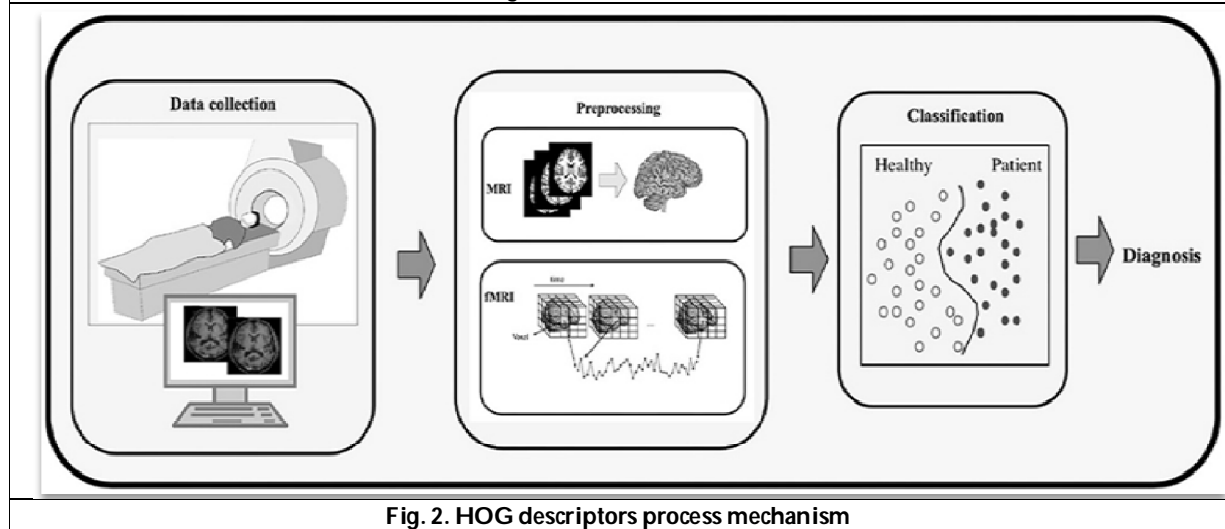


Fig. 2. HOG descriptors process mechanism





Lane Line Segmentation using Watershed Algorithm

Harish.H^{1*} and A.Sreenivasa Murthy²

¹Associate Professor, Department of Computer Science, Maharani Lakshmi Ammanni College, Bengaluru, Karnataka, India.

²Professor, Department of Electronics and Communication Engineering University Visvesvaraya College of Engineering, Bangalore University, Bengaluru, Karnataka, India

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*Address for Correspondence

Harish.H

Associate Professor,
Department of Computer Science,
Maharani Lakshmi Ammanni College,
Bengaluru, Karnataka, India.
E.Mail: hh.harish@gmail.com



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ABSTRACT

Transportation is getting more expensive due to the increase in the vehicle population. On a day-to-day life, the automobile field is getting more intelligent and robust. Lane lines represent the rules for mobile vehicles. Identification of these lane lines is a challenging and advanced concept in the field of computer vision. This work may be applicable for auto-drive engine vehicles. This paper represents the road lane line segmentation using a watershed segmentation algorithm. The algorithm is tuned mainly for highways. The readily capture colored images are treated as input images. Then watershed segmentation algorithm is fed with the morphology of the image instead of markers and colored to differentiate from the other part of the image. This work is irrespective of input image size. We evaluated the accuracy of segmentation at 99%. Can enhance the same result to the video stream.

Keywords: lane line, watershed algorithm, morphology, segmentation, python

INTRODUCTION

A human is evolving with comforts day by day. We already have mature technology in Cruze technology for four-wheelers, which is helpful on long drives, mainly on highways. With technological advancement, we are trying to add an autopilot or auto-drive mode engine. This enhancement in the technology field will revolutionize the automobile field. A lane line will guide the vehicle to drive on the road. So identification of this lane line by computer vision is essential to show a vehicle to move on roads. The agenda of this paper is to segment the lane lines



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present on the road efficiently. The segmentation algorithm is tuned to segment mainly for highway roads only. The images used in our work are collected online. Capture a color image from the charge-coupled device (CCD) and feed it as input to the system. Convert the input color image into grayscale image. Estimate the local maxima and morphology of the image, and those values are input for the watershed algorithm. The algorithm segments the lane line from the road. The segmented part of the image is colored for clear visualization. The evaluated segmentation algorithm is 99% accurate. The same technique is used for video frames in the identification of lane lines..

Related Work

The algorithm selection is inspired by Babu KS et al., approach for watershed algorithm in segmenting and identifying a Diabetic wound healing status. In their process, the resultant segmentation accuracy was 99.24% [1]. Muhammad Shafique et al. have proposed a robust lane line detection with object tracking using canny edge and Heuristic algorithm had efficiently detected lane lines and objects on the road. The entire process is developed in a Matlab environment [4]. Abhishek Goyal et al. proposed lane detection on the road using the Sobel operator to segment the lane lines and reached accuracy up to 92% [2]. Yang Xing et al. Approached different ideas in extracting the lane lines and compared each algorithm involved in computer vision by assessment and integration. The manuscript applied CNN and RANSAC algorithms for segmentation and three-features-based automatic lane detection algorithm (TFALDA), and efficient lane and vehicle detection with integrated synergies (ELVIS) algorithms for integration [3]. Youcheng Zhang et al. have proposed a system for Artificial Intelligence. Ripple Lane Line Detection Network (RiLLD-Net) and Ripple-GAN networks give segment results using Wasserstein generative adversarial networks and multi-target semantic segmentation, which results in the accuracy of 96.77% for one-target and 97.28% for three-target [5]. Lin Li et al. had approached to mark a lane by detecting and reconstruct with line-scan imaging data. This approach evaluates the road condition and reconstructs lane lines if dimmed or vanishes [6]. Ganlu Deng et al. was worked on a double Lane Line edge identification approach using constraint conditions Hough transform. This method identifies the bending road and straight lane lines, and the entire process developed using Matlab 2016 [7]. Puttaswamy B.S. and Dr. Veena M N are done a manuscript on a comprehensive study paper that gave an idea of various environment condition image filtering [8]. Alireza Kheyrollahi and Toby P. Breckon had given an idea of real-time road marking recognition which identifies various features like slow, speed limits marking, parking lines, and road direction identifiers

written on the road. This approach is resulting in an accuracy of 92 % using the ANN technique [10]. In [9], a dense vanishing point for an individual row of the image is estimated. The globally optimum vanishing point of the road image is extracted and used for multiple curved lanes marking detection on the non-flat road surface. A curve detection algorithm based on a straight-curve model proposed by Huifeng Wang et al. [13] Xiaoyun Wang et al. proposed a structured lane based on the gradient-pair constraint. Here the image is pre-processed and edge detected. Using Hough Transform, the parametric equation about the midline of the road is obtained, assuming the pair of edge pixels has opposite gradient direction on both sides of the lane [12]. The spatial CNN (SCNN) method uses generalized traditional deep layer-by-layer convolutions to slice-by slice convolutions within feature maps, enabling message passing between pixels across rows and columns in a layer to identify traffic lanes, walls, and poles [14]. CNN are successfully applied to semantic segmentation problems for autonomous driving [16,18,20] and medical images [15,17,19]. Generative adversarial networks (GANs) make the output of semantic segmentation network realistic or structure-preserving, decreasing the dependency on post-processing. The GAN framework to mitigate the discussed problem using an embedding loss [21]. The several kinds of literature illustrated various approaches for lane line segmentation. This manuscript states a morphological-based watershed segmentation algorithm for lane line identification by segmenting the lane lines from input RGB road images.

Proposed Method

We have opted for various types of road images to test the segmentation. Four steps can perform the entire process.





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Step 1: The process begins by collecting blur-free color (RGB) images from an online open-source. As we are working on blur-free images, there is no need for any filtering of images. The various images used here are single-lane line roads, double-lane line roads, and three-lane line roads.

Step 2: As there is no need to resize of original images. We are converting an input color image into a grayscale image. Perform a distance transform to find the nearest distance between the pixel values by extracting a binary component. Later we calculate the local maxima of each pixel by taking an input from distance transform. Finally, the image's morphology is extracted, which is the key feature of our manuscript because instead of markers, we are feeding the morphology of the image to a watershed segmentation algorithm. The f represents the input image, and the topographical distance between points p and q is defined by,

$$T_f(p, q) = \inf_{\gamma} \int_{\gamma} \|\nabla f(\gamma(s))\| ds,$$

Step 3: The watershed algorithm accepts various types of input, which are marker-based, grayscale-based, and morphology-based. Our work uses a morphology-based watershed segmentation algorithm to segment the lane lines from the road. Once the distance transform and morphology are appropriately estimated, those two parameters are input to the watershed segmentation algorithm. The watershed catchment basin $CB(mi)$ of minimum (mi) is defined as the set of points $x \in D$ which are topographically closer to (mi) rather than to any other regional minimum m_j is,

$$CB(mi) = \{x \in D \mid \forall j \in I \setminus \{i\} : f(mi) + T_f(x, mi) < f(m_j) + T_f(x, m_j)\}$$

' f ' defines a set of points that do not belong to any watershed catchment basin.

$$Wshed(f) = D \cap \left(\bigcup_{i \in I} CB(mi) \right)^c.$$

Let W be some label, $W \in I$. The watershed transform of ' f ' is a mapping $\lambda : D \rightarrow I \cup \{W\}$, such that $\lambda(p) = i$ if $p \in CB(mi)$, and $\lambda(p) = W$ if $p \in Wshed(f)$.

Step 4: After effective segmentation from the watershed segmentation algorithm, we need to evaluate the segmentation algorithm. As we don't have a standard database, we can't estimate a ground truth value. Hence, we compare a segmented output image with the input grayscale image by estimating a structural similarity index (SSIM). The SSIM is used to estimate image degradation and provides the accuracy of segmentation. The SSIM is calculated using the below formula,

$$SSIM(x, y) = \frac{(2\mu_x\mu_y + C_1)(2\sigma_{xy} + C_2)}{(\mu_x^2 + \mu_y^2 + C_1)(\sigma_x^2 + \sigma_y^2 + C_2)}$$

In the above formula, μ_x , μ_y , σ_x , σ_y , and σ_{xy} are the local means, standard deviations, and cross-covariance for images coordinates (x, y) .

EXPERIMENTAL RESULTS

Experiments were performed on PC with 2.0GHz Intel Core i5 CPU and 8GB DDR III RAM. The entire work was conducted using python language with python Interpreter of Python 3.9 using PyCharm Community Edition. The images used in work are collected from online. After Preprocessing, segmentation of images is done using the Watershed algorithm. Feature extraction and post processing of the images are not carried out in this experiment setup. We tested on multiple images of single lane line, two-lane line, and three-lane line images collected from open-source online images. The clean blur-free color images in jpeg format are treated as an input for our work. We have worked on three images: single-lane line road images, double lane line road images, and three-lane line road



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images. In each category, we have tested a watershed segmentation algorithm for five images. In each category and segmentation accuracy is plotted as in the below graph. Fig 3 to Fig 6 represented the different types of lane line identification and marked with color to visual identification. Fig 7 represents the accuracy graph for validating the watershed algorithm segmentation

CONCLUSION

On a day to day life, the automobile field is getting more innovative and robust by making mobile easy as we are internally working on segmenting lane lines present on roads, which can feed for the system during auto-drive mode engine. The agenda of this work is to perform lane line segmentation for highway roads using a watershed segmentation algorithm. Blur-free color images are taken as input to this process. Pre-processing the color image by converting it into a grayscale image. Perform a distance transform and estimating the morphology of the grayscale image. The distance transformed and morphology of grayscaled image are inputs to the watershed segmentation algorithm. Then lane lines are segmented from the road and further evaluated the segmentation using the SSIM technique. The segmentation accuracy was calculated at 99% for the watershed segmentation algorithm. This segmentation is applied to auto-drive engine mode technology. If lane lines are faded or shaded in the image, then the identification is impossible from this technique, and if no lane lines are present on the road, this process is useless, which can be treated as the drawback of this work. The same robust technique is applied for video frames in the identification of lane lines.

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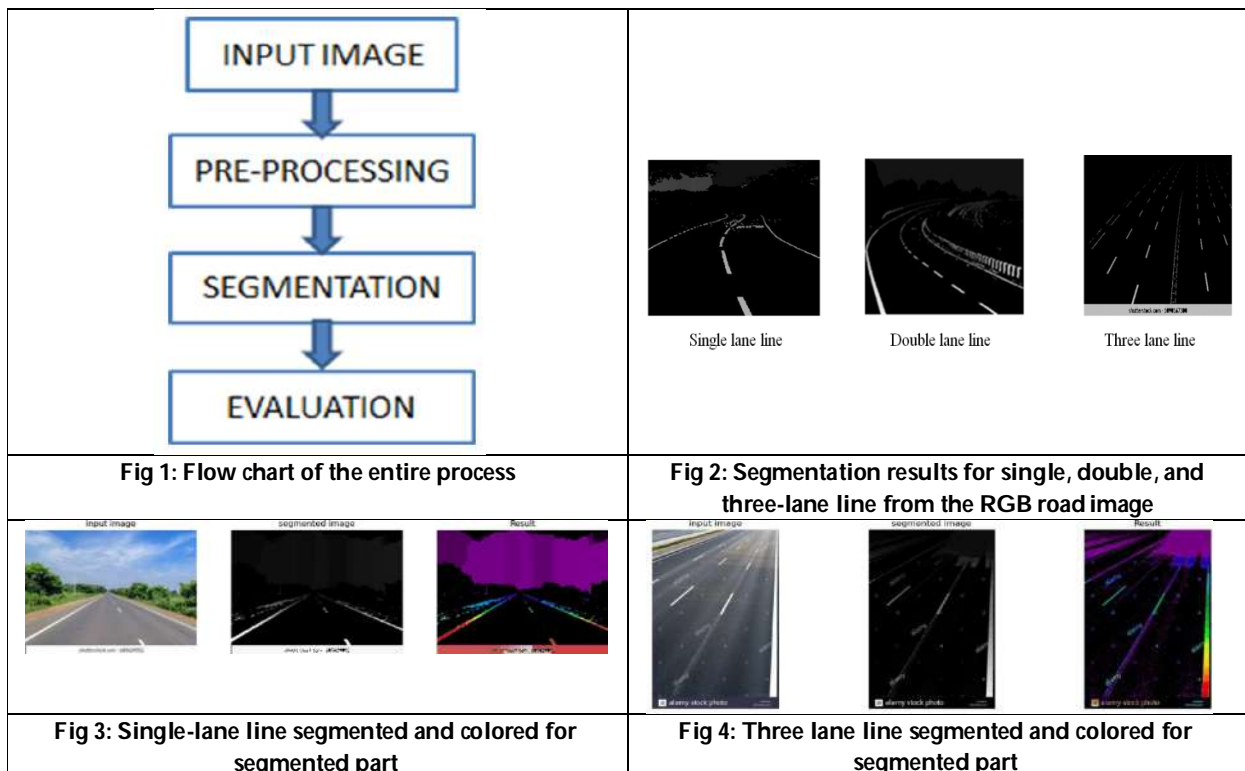




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Fig 5: Cross double lane line segmented and colored for segmented part

Fig 6: Feature lines Identification

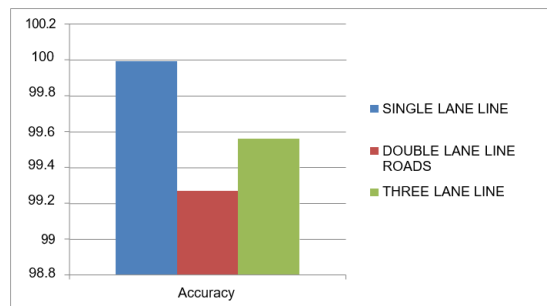


Fig 7: Segmentation validation graph





Effect of Janda's Approach and Dynamic Muscle Stabilization Exercises on Pain and Range of Motion in Subjects with Cervical Spondylosis Having Inter-Scapular Pain: A Comparative Study

Krutika Sharma¹, Adyata Dave² and Gaurav Patel^{3*}

¹MPT Student, Ahmedabad Physiotherapy College, Parul University, Ahmedabad, Gujarat, India.

²Assistant Professor, Ahmedabad Physiotherapy College, Parul University, Ahmedabad, Gujarat, India.

³Principal, Ahmedabad Physiotherapy College, Parul University, Ahmedabad, Gujarat, India.

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*Address for Correspondence

Gaurav Patel

Principal,

Ahmedabad Physiotherapy College,

Parul University,

Ahmedabad, Gujarat, India.

E. Mail : indurekaa@gmail.com



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ABSTRACT

Neck pain is one of the major musculoskeletal problem in modern society. The etiological factors are altered posture, anxiety, depression, occupational and sports activities can cause cervical spine pain. Cervical spondylosis is one of the condition which lead to neck pain. It is an age related changes in a cervical spine. It is also known as Degenerative disc diseases. In severe cases the pain of cervical spondylosis can spread to the arms, head or to the inter-scapular region. Hence, the purpose of the study is to evaluate and manage the inter-scapular pain which is due to cervical spondylosis. An experimental study was conducted on 34 subjects with inter-scapular pain due to cervical spondylosis and randomly divided into two different groups based on inclusion and exclusion criteria. Both groups were given conventional therapy before the treatment. Group A [n=17] was received Janda's approach and Group B [n=17] was received Dynamic muscle stabilization exercises. A pre and post intervention numeric pain rating scale, Neck disability index and range of motion by universal goniometer was the outcome measures for the study. The data was analyzed by the SPSS and Microsoft excel. within group analyses of the data was suggested that both groups have significant effect [p<0.05] on all outcome measures. Between group analyses of the data was suggested significant effect [p<0.05] on all outcomes except pain [p=0.121]. Both the treatment approaches shows significant effect individually. However, Janda's approach shows more effect then the dynamic muscle stabilization exercises.

Keywords: Neck pain, Scapular blade pain, Neck exercises, stabilization exercises.





INTRODUCTION

Cervical spondylosis is a one of the chronic condition which is related to the age. Different terminologies are used for describing the condition such as Degenerative cervical spondylosis, cervical osteoarthritis, as well neck arthritis. The friction between the vertebra [wear and tear phenomena] causes damage to the multiple structures. It is most commonly seen in male then female and the peak age for the occurrence of cervical spondylosis is 40 to 60 years for both genders. [1]The cervical spondylosis condition is divided according to the axial neck pain, radiculopathy of the cervical spine and myelopathy presentation of the patients. A multiple literature narrated that 25% of adults under the age of 40 years, 50% of adults over the forty and 85% of adults were showing disc degeneration however they all are asymptomatic. Most common degeneration found between the C4-C5, C5-C6 then C6-C7. [2] The cervical spine consisted most complicated articulation with 37 individual articulations which controls the movement of the head and neck in all direction with or without response from the eye. The different activities of daily livings such as gesturing, rising, sitting, walking, speaking lead to stress on cervical spine [3]. With the progression of age gradually the retention of water occurs, height and size of the inter vertebral disk reduce. The inter-vertebral space become narrowed by the compressive force and create a fiction over the inter-vertebral disk, end-plates, vertebral body. The friction causes the injury to the periosteum of the bone which lead to osteophyte formation.

(4) Early changes in a proteoglycan matrix lead to increase keratin sulfate to chondroitin sulfate which reduces the water within the disc. This process causes losses the elastic property of nucleus pulposus and shrink the size of the disc which directly alter the axial weight bearing capacity of the spine. The annular fibers of disc are mechanically compromised with further stress and hence unable to take weight axially. [5] Clinically various symptoms and signs can help to diagnose a cervical spondylosis such as pain intensity increases with the movement of the cervical region, pain can have referred to occiput, between shoulder blades and upper limbs, stiffness of the cervical spine, vague numbness, tingling or weakness of the upper limb muscles, Vertigo, poor balance, Localized tenderness and restricted range of motion, neurological involvement causes neural symptoms. [4]Inter-scapular pain is a most commonly seen musculoskeletal problem. It is a multi factorial origin condition which includes Facet joint syndrome, disco-genic pain, Upper back pain due to myofascial pain, strain to any ligament, trigger points in a muscle and nerve entrapment. Most frequently affected area for the inter-scapular pain is a medial side of the scapula or between the shoulder blades. [6]

When the muscle remains stretched or contracted for a prolong period of time, gradually inside the muscles nodules will develops which are also known as trigger points. [7]Forward head posture is one of the abnormality which may lead to pain over the inter-scapular region. [8] Various treatment approaches are used for the management of the inter-scapular pain. Pharmacological and non-pharmacological approaches include non-steroidal anti-inflammatory drugs, analgesics, LASER therapy, massage, acupuncture, yoga and other adaptive therapies. [9] hence, the study was included The Janda's approach and the Dynamic muscle stabilization exercises on inter-scapular pain. The Janda's approach is one of the stretching with strengthening approach.[10] Dynamic muscle strengthening exercises increases the strength of the muscle which will help to reduce pain and improve the alignments of joint. [11] The neck stabilization exercise training is designed to restore cervical muscle endurance and coordination [14, 15, 16]. All the participants in both the group performed the following exercises Chin tuck In standing position, participant pulls back the chin [as if trying to make a double chin] while keeping the eyes level. This was done for 15 repetitions. Cervical extension In standing position, participant grasps the base of the neck, with both hands while extending the neck as far as possible. . Shoulder shrugs In standing position, participant shrugs the shoulders, bringing them up towards the ears.Shoulder rolls In standing position, participant rolls the shoulders forward in a circle. Then, rolls the shoulders backwards in a circle. Then participant relaxes and repeats the procedure for 15 times.[24-25-26]Pain, restricted range of motion and functional disability are the concerns to look after for the present study. Therefore, numeric pain rating scale for pain, range of motion examination by goniometer and neck disability scale for assessment of the functional disability in cervical spondylosis with having inter-scapular pain were taken as an outcome measure for the study. [12,13,14]





Krutika Sharma *et al.*,

MATERIALS AND METHODS

Data Source: Ahmedabad Physiotherapy College: Sainath Hospital.

Study Design: An Comparative study.

Sample Design: Simple random Sampling.

Sample Size: 34 subjects with Cervical spondylosis having Inter-scapular pain.

Intervention Duration: 3 days per week up to 6 weeks.

Inclusion Criteria [4-5-6]

1. Subject having chronic neck pain since last 3 months.
2. Both male and female were included in the study.
3. Age criteria: 40-60 years.
4. Positive Spurling test and Scapular Retraction Test [SRT].
5. Subject having tingling numbness and weakness in arm and hands.

Exclusion Criteria [7-8-10]

1. Orthopaedics deformities such as Fracture of ribs, scapula and vertebra.
2. Spinal deformities such as scoliosis, Kyphosis and bony abnormality.
3. Unable to co-operate and mentally retarded.
4. Presence of neurological signs such as hypertonia/hypo-tonia, altered reflexes.
5. Other conditions such as tumour, Vertebro-basillary syndrome and vertigo.

MATERIALS

- Chair
- Paper and Pen
- Assessment form
- Consent form
- Neck Disability Index scale [NDI scale]
- Universal Goniometer
- Thera-band [Blue and Green]

Outcome Measures

Numeric Pain Rating Scale [12]

NPRS was used for the assessment of pain intensity in a subject with cervical spondylosis having inert-scapular pain. All subjects were provided a page on which a 10 cm line was drawn, every 1 cm distance the numerical were mentioned from 1 to 10. Subjects were instructed to mark a number which was best indicated his/her pain. The lowest value on that scale was zero that mean no pain and the maximum number on that scale was ten that mean maximum pain.

Neck Disability Index [NDI] [13,14]

It is a self-report measure for the evaluate disability in subjects with neck pain. A total ten items are included in the scale. Seven items are for the activities of daily living, two items for the pain and item for the concentration. Each items in scale were scored 0 to 5, at the percentage calculation was taken. The maximum score for the scale was 50 [Severe disability] and the minimum score was zero [No disability]. Therefore, higher the score indicated with severe disability.

Range of Motion: [15,16]

The range of motion examination was done by the universal goniometer technique. The subject was in sitting position. The therapist stands beside to evaluated side. Initial and end position of goniometer arms were the records

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for the specific movement. The reliability value is 0.95 to 0.98. For checking the flexion and extension of cervical spine, fulcrum of the goniometer was placed over the subject's external auditory meatus. Moveable arm was parallel to the nose and stable arm was vertically up. For checking the Lateral flexion of cervical spine, fulcrum of the goniometer was placed over the subject's sternal notch. Moveable arm was line with the nose and stable arm was parallel to the acromion process.

PROCEDURE

After the signing the consent form, the subjects were randomly divided into two groups by the simple randomization technique. Group A included 17 subjects who received Janda's approach and Group B included 17 subjects who received Dynamic muscle stabilization exercises. The study was conducted for the 3 days a week for 6 weeks of time duration. Before the initiation of study pre evaluation of subjects were done. After the completion of the 18th session of the subject post analyses of the data were analyzed. Both group were treated with conventional therapy like chin tuck, shoulder shrugs, cervical extension & cervical rolls before the treatment for up to 15 repetitions each[24-25-26]. - Both group were treated with conventional therapy like chin tuck, shoulder shrugs, cervical extension & cervical rolls before the treatment for upto 15 repetitions each.[24-25-26]

RESULT

A Thirty-four subjects with inter-scapular pain due to cervical spondylosis were included in the present study. In group: A, seventeen subjects were provided Janda's approach. In group B, seventeen subjects were provided Dynamic muscle stabilization exercises. Statistical package for social sciences [SPSS] software version 26 was utilized for performed statistical analyses of pre-post data. Comparison of within group data for the group A was performed by paired t-test. Statistical analyses of the data were suggesting statistical significant different within group analyses. Comparison of within group data for the group B was performed by paired t-test. Statistical analyses of the data were suggesting statistical significant different within group analyses. Comparison of between group data for both the groups were performed by unpaired t-test. Statistical analyses of the data were suggesting statistical significant different within group analyses except in pain variable [NPRS], which is not statistically significant.

DISCUSSION

According to International Association for the Study of Pain [IASP], the pain is "An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage." [18]All the participants in both the group performed the following exercises Chin tuck In standing position, participant pulls back the chin [as if trying to make a double chin] while keeping the eyes level. This was done for 15 repetitions. Cervical extension In standing position, participant grasps the base of the neck, with both hands while extending the neck as far as possible. Shoulder shrugs In standing position, participant shrugs the shoulders, bringing them up towards the ears. Shoulder rolls In standing position, participant rolls the shoulders forward in a circle. Then, rolls the shoulders backwards in a circle. Then participant relaxes and repeats the procedure for 15 times [24-25-26].

Within group comparison of the all outcome measures were suggested statistical significant improvement in both the groups. The Janda's approach is interdependent approach on musculoskeletal and central nervous system. The approach works on following principles such as normalization of the periphery, restore muscle balance, increase afferent input to facilitate reflexive stabilization and increase endurance in coordinated movement pattern. Hyper tonic antagonist muscle may be reflexively inhibiting their agonist is the law of Reciprocal inhibition by Sherrington's. to reverse the situation, restore the muscles normal length of shorten muscle and tone of weaker muscle by providing stretching and strengthening [19].



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According to Ji-Eun-Kim *et al.* alteration in range of motion is influenced by the lengthening or shortening of the muscles. Lack of flexibility can lead to restricted range of motion which can be overcome by the providing the appropriate stretching manoeuvre to the tight muscle. Muscle strengthening is one of the crucial aspect to provide strength and stability to the joint by aligning the posture. Which adversely affects activity of daily living and reduces quality of life [20]. The similar result was demonstrated that static stretching exercises along with isometric strengthening exercises were provide more statistical significant effect in range of motion and pain as compare to just static stretching group [21].

Lee *et al* suggested a similar alteration in neck rotation angle and forward head posture using the Thera-band for the shoulder muscles. Change in a motor unit recruitment pattern for the serratus anterior and lower trapezius muscle provide a normal scapula-humeral rhythm which help to maintain a shoulder and scapular alignment during the overhead activities. [22] it can be predicted that with dynamic stabilization exercises used to provide a strength to the muscle by effectively recruiting a motor unit which reducing pain and improving a function in present study. Dynamic exercises provided generalized body relaxation by releasing the beta endorphin in the body which is natural pain killer of the body. Additionally, release of stress relaxing hormones and reduction in tone after the stabilization exercises help to reduce the anxiety level which improve the functional ability by enhancing the quality of life. [23] A study conducted by a Khare D and *et al.* effect of Thera-band exercises on trapezititis concluded reduction in pain and improvement in functional range of motion. The results are co related with the present study the predicted mechanism was by inhibiting the nociceptor stimulation and a contraction of the muscle long enough which crosses the barrier limit to provide a functional range. [24]

CONCLUSION

The present study concluded that both the techniques has effect on inter-scapular pain and restricted range of motion due to Cervical spondylosis. However, the Janda's approach was mixed approach which includes both stretching and strengthening protocol whereas Dynamic stabilization exercises mainly focus for the strengthening aspect. Hence, the Janda's approach has more effect than Dynamic stabilization exercises.

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Group A [n=17]: Janda's Approach

Name of the exercises	Position	Repetition
Side flexion on right side	Sitting on chair with back supported: stretch on same side and advised subject to stretch on opposite side	Hold for 30 seconds, 3 repetition for 3 weeks up to 6 weeks of protocol
Side flexion on left side	Sitting on chair with back supported: stretch on same side and advised subject to stretch on opposite side	Hold for 30 seconds, 3 repetition for 3 weeks up to 6 weeks of protocol





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Group B [n=17]: Dynamic Muscle Stabilization Exercises

Name of the exercises	Position	Repetition
Cervical extension Dynamic Isometric	Sitting on chair with Thera-band, back supported: start from progression green and progress to blue	Hold for 15 seconds, 15 repetition for 3 weeks up to 6 weeks of protocol
Cervical Flexion Dynamic Isometric	Sitting on chair with Thera-band, back supported: start from progression green and progress to blue	Hold for 15 seconds, 15 repetition for 3 weeks up to 6 weeks of protocol
Chest Fly's exercises	Standing on chair with Thera-band, back supported: start from progression green and progress to blue	Hold for 15 seconds, 15 repetition for 3 weeks up to 6 weeks of protocol

Table 3: Group A: Janda's Approach, Within Group Comparison of Data

Variables			MEAN	SD	T	p
NPRS	Pre		5.6471	1.16946	18.107	<0.001
	Post		1.4706	0.94324		
NDI	Pre		72.8235	2.92052	91.331	<0.001
	Post		6.5882	1.69775		
ROM	Flexion	Pre	30.3529	2.11959	11.093	<0.001
		Post	34.7059	1.96102		
	Extension	Pre	37.7647	1.64048	14.199	<0.001
		Post	42.7059	1.68689		
	Side-Flexion [Right]	Pre	17.4118	1.46026	17.188	<0.001
		Post	22.0588	1.74895		
	Side-Flexion [Left]	Pre	17.8824	1.90008	13.015	<0.001
		Post	21.8235	1.46779		

Table 4: Group B: Dynamic Muscle Stabilization Exercises, Within Group Comparison of Data

Variables			MEAN	SD	T	p
NPRS	Pre		5.3529	0.99632	13.786	<0.001
	Post		2.0588	1.19742		
NDI	Pre		77.8824	3.19926	51.854	<0.001
	Post		19.6471	4.37237		
ROM	Flexion	Pre	30.8824	1.76360	11.086	<0.001
		Post	33.1176	1.21873		
	Extension	Pre	36.7059	1.89620	11.717	<0.001
		Post	39.3529	1.65609		
	Side-Flexion [Right]	Pre	17.9412	1.56007	7.906	<0.001
		Post	19.7647	1.71499		
	Side-Flexion [Left]	Pre	17.5882	2.12305	9.294	<0.001
		Post	19.4118	2.00184		

Table 5: Post-Intervention Between Groups Comparison of the Data

Variables	Group A [Mean ± SD]	Group B [Mean ± SD]	T	P
NPRS	1.4706 ± 0.9432	2.0588 ± 1.1974	1.591	0.121
NDI	6.5882 ± 1.6977	19.6471 ± 4.3723	11.479	<0.001
Flexion	34.7059 ± 1.9610	33.1176 ± 1.2187	2.836	0.008



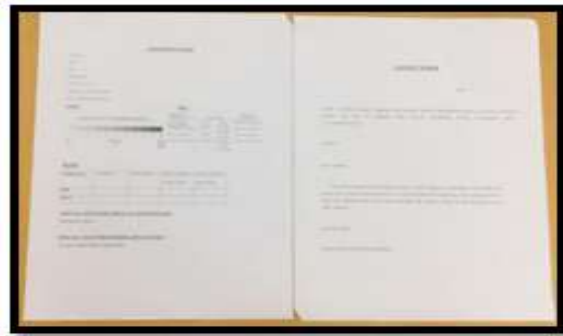


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Extension	42.7059 ± 1.6868	39.3529 ± 1.6560	5.848	<0.001
Side flexion [RT]	22.0588 ± 1.7489	19.7647 ± 1.7149	3.862	0.001
Side flexion [LT]	21.8235 ± 1.4677	19.4118 ± 2.0018	4.006	<0.001

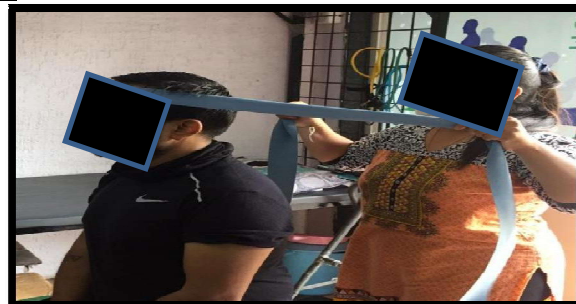


Photograph 1: Material



Photograph 2: Side Flexion On Right Side

Photograph 3: Side Flexion On Left Side



Photograph 4: cervical extension dynamic isometric

Photograph 5: Cervical Flexion Dynamic Isometric

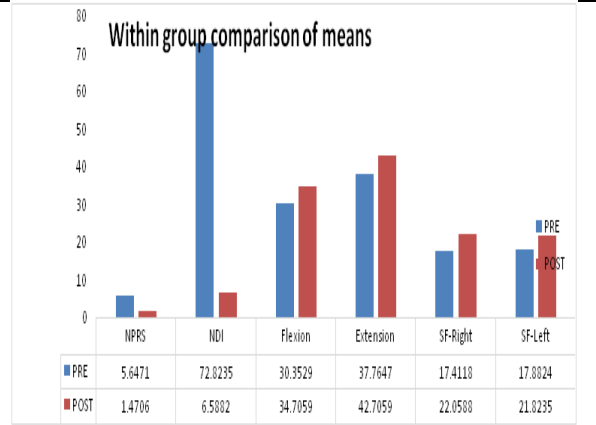




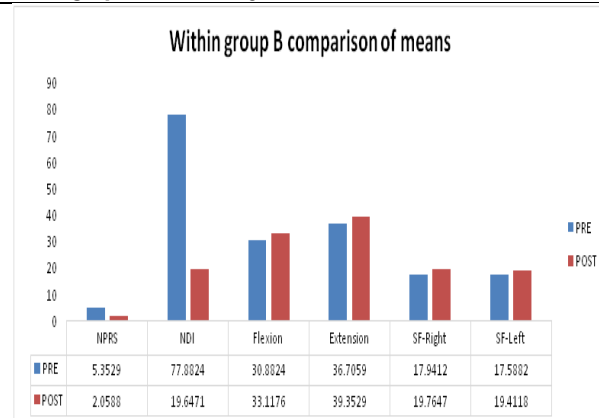
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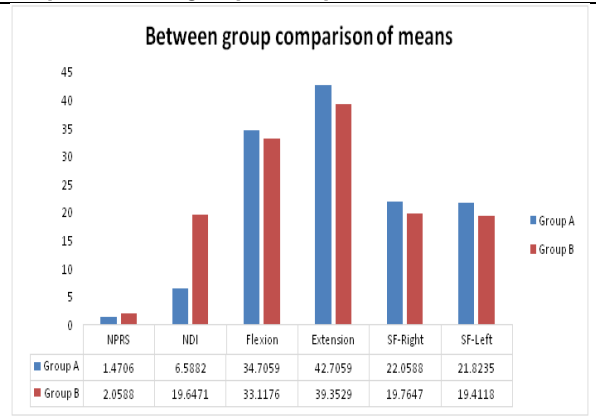
Photograph 6: Chest Fly's Exercises



Graph 3: Within group A comparison of means



Graph 4: Within group B comparison of means



Graph 5: Between Group Comparison Of Means





A Sensor-Based Seamless Handover Solution for Express Train Access Networks (ETANS)

Saranya C*, S. Sivagami and Kalpana R

Assistant Professor, St. Francis de Sales Degree College, Bengaluru, Karnataka, India.

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*Address for Correspondence

Saranya C

Assistant Professor,
St. Francis de Sales Degree College,
Bengaluru, Karnataka, India.
E. Mail : saranyac@sfcollege.in



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ABSTRACT

In India, express train transit is increasingly important for carrying about a million people every day. The biggest obstacle to delivering broadband information services to railway commuters is finding a seamless handover solution to ensure wireless service continuity. This inspires us to build an Express Train Access Network (ETAN), where the deployed sensor network captures the train movement state and can reveal the wireless signal strength, using Radio over Fiber architecture and sensor technology. It is possible to create an intelligent handover decision system because the train travels along a fixed track in a fixed direction. In this system, a critical movement state can precisely cause an optical switch unit in the central station to carry out the handover procedure. The suggested architecture can perform handover in 22 ms at a train speed of 350 km/h, providing wireless services for users without interruption, even for a cell radius as small as 100 m, according to theory analyses and simulation results. The study of the aforementioned greatest challenge for ETAN is the primary focus of this essay. Since the majority of Indian railways have fiber communication networks and benefit from RoF, this paper uses the fundamental RoF architecture for ETAN. In contrast to current approaches, we integrate sensor technology into ETAN, resulting in the creation of a specific handover choice system with the ideal fusion of sensors (such as pressure or light sensors) and optical switch technologies. Simulation findings show that our proposal can effectively address the handover issue and offer express train passengers seamless wireless service.

Keywords: Radio over Fiber(RoF), Access network, Light sensors, Mobile cellular networks.





INTRODUCTION

In Wireless Mobile Networks, Handover

Handover is the process by which an active link between a mobile host (MH) and a corresponding terminal or host is moved from one point of access to another network to another in conventional mobile cellular networks and wireless LANs. The signal strength deteriorates as an MH moves away from a BS, forcing it to transfer to a different BS for communication. Any cellular-based wireless network must keep an ongoing connection during handover, so it is crucial. Such places of attachment are referred to as BSs in wireless LANs and access points in cellular voice and mobile data networks. (APs). Such a place of attachment serves a coverage purpose in either scenario. A voice conversation is transferred from one BS to another during handover in cellular telephony. It entails moving the link from one AP to another in the context of WLANs. In hybrid networks, this will entail the transfer of a link between two BSs, an AP, a BS and an AP, or vice versa.

Each time a handover occurs, speech users experience an audible click that ends their communication. Data users may also experience packet loss and unneeded congestion control measures as a result of handover. However, since signal level degradation is a random process, basic decision-making processes, such as those that rely on signal strength measurements, lead to the ping pong effect. Both the network load and the user's impression of quality are severely hampered by this. We go over general handover-related concerns as well as sample conventional wireless networks' handover processes. The average speed of Express Train Access Networks (ETAN), a high-speed train service with a top speed of 150 mph (240 km/h), is less than half that amount. Business and railway travellers now frequently use ETAN.

The ETAN Handover Decision System

It is obvious that an express train moves at a high speed and follows a set path in addition to having a fixed direction. This finding can be used to combine sensor networks and optical switch technologies to create a handover decision system specifically for ETAN. The Standard Propagation Model (SPM) is used in our theoretical model to calculate path loss; however, the channel model differs slightly from the field test findings in terms of the large-scale fading impact in the Beijing-Shanghai high-speed railway. Therefore, it is appropriate to mention it here for a fundamental theoretical explanation):

Figure 1 explains about working principle of the handover decision system. People now anticipate much more to be able to access the Internet regardless of location due to the Internet's explosive growth over the past 20 years. Trains and airplanes have traditionally been two places where passengers have not always been able to access high-speed Internet. In the specific instance of trains, giving passengers access to the Internet while they are traveling makes sound business sense: while increasing traveler numbers, Internet access for passengers can generate revenue for the train company. For instance, a 2004 study conducted in the United Kingdom discovered that 72% of business travelers preferred trains to automobiles or aircraft when Wi-Fi was accessible on trains. 78% of these business travelers, according to this survey, said they would use Wi-Fi if it were made accessible on trains. When it comes to freight trains, having Internet connectivity enables real-time or nearly real-time tracking of freight-related events on board, which could reduce the freight carrier's insurance costs. Broadband Internet connectivity also offers the following advantages: This paper's primary contribution is a survey of studies and initiatives aimed at making Internet access available on trains. Highlighted are the elements of a rail setting that make communications from trains challenging. We distinguish between the work produced in Japan, Europe, and North America due to the unique characteristics, for reasons that will become clearer later. The remainder of this essay is organized as follows: The problems preventing high-speed railway communications are outlined in Section II. In addition to providing some background on handoff and addressing train-related problems, Section III presents the reference architecture for Internet access on trains. Discusses the early ideas that served as the foundation for the implementation of broadband Internet access on trains. We offer a taxonomy of the online train connectivity tools. Results from test beds that looked at how to install fast Internet on trains are discussed.



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The efforts made—or those in progress—to implement high-speed communications from trains are further broken down into an examination of execution efforts taking place in North America and Europe. outlines business plans created to evaluate the feasibility of offering broadband Internet.

RESULT AND DISCUSSION

So far, we've looked at the reference design, the basic ideas supporting the deployment of broadband Internet on trains, and the taxonomy of access network technologies. This part reviews the outcomes of tried-and-true Internet access on trains. Starting with prototypes, we move from the more theoretical to the actual implementation. In 2004, Sivchenko et al. presented simulation findings demonstrating the expected decline in Internet traffic performance on high-speed trains as the number of users rises. Investigated in is how well various radio technologies perform in terms of data rates encountered by fast-moving trains. In 2005, Gaspard and Zimmermann assessed the correlation of throughputs with Doppler shift (speed). This study was done in two stages: in the first, a mobile transmitter was moved along the track while a channel sounder was used to measure the channel for various mobile receiver placements. The next step involved comparing various access network radio technologies using a hardware simulation of the channel properties. The tests assessed how a channel's throughput would change between a receiver on a train and a trackside transmitter.

Performance Analysis

We present a first optical physical layer network architecture that allows the realisation of the MEC approach after performing a performance analysis of the MEC (Moving Extended Cell) concept in terms of call dropping probability and packet loss values. We focus on providing full MEC configurability directly in the optical domain as we show an optical switching architecture for implementing MEC in the CO. The suggested network architecture makes use of WDM technology to assign each Remote Antenna Unit (RAU) a specific wavelength, which requires the use of a minimum number of wavelength channels equal to the number of RAUs used in the network. Every cell is thus provided with a particular wavelength, making it possible for the MU to transmit data to a new cell by simply switching to the wavelength providing the new cell.

Single 60 GHz RF -Over-X Network

Every MU uses a wireless link at 60 GHz thanks to this network's use of a single 60 GHz RF carrier frequency that is modulated on every optical wavelength and capable of carrying data at up to 2.5 Gb/s data rates. Figure shows the physical layer setup for a network that uses M wavelengths and can support up to N mobile users overall. Each MU's data will be transmitted using a 60 GHz RF carrier when a 7-cell Extended Cell structure is taken into account. This RF carrier will then be superimposed on the 7 wavelengths that correlate to the 7 cells making up the MU's current EC. Only one user can be found in each group of seven cells in order to prevent wavelength collision and RF interference effects, suggesting that the network can sustain a total of $N = M/7$ users. The figure 2 (a) explains about architecture of WiMax System and figure 2(b) explains about WiMax-ROF system in details.

WiMAX-RoF

Multiple BS are used in the WiMAX access network along the railway. For Internet connectivity, each BS is linked to an access service network (ASN) gateway. Four handoffs are necessary for the train to proceed from one BS's cell coverage to the next, for instance, if five BSs are needed to cover the track, as shown in. Although handoffs occur frequently in all wireless systems, they are particularly difficult in extremely mobile connections due to the terrain and speeds of up to 300 km/hr. When the BSs are placed along the railway, as depicted in Figure, the RF cell coverage in each WiMAX BS is roughly 0.5 to 5 km. However, deploying network coverage over mobile areas frequently poses particular and pressing difficulties. These corridors typically pass through thinly populated regions as well as difficult terrain like tunnels, mountains, bridges, and various man-made obstructions. The deployment of wireless coverage throughout the entire corridor comes at a high expense and, in many instances, results in marginal to poor reception throughout the corridor.





It has been determined through characterising and analysing WiMAX-RoF performance that RoF transmission occurs during TDD framing over a WiMAX link. The WiMAX-RoF link states that a single BS over HSR could be used to increase the RF range. Additionally, the throughput and packet loss characteristics at various fibre connection lengths have been examined and analysed. Therefore, it may be anticipated that using WiMAX-RoF will stop handovers. In the Song Shan tunnel in the THSR, a WiMAX-RoF field experiment using a straightforward architecture of two RAUs in RoF link was set up and carried out. The performance of the WiMAX-RoF connection will be further examined and characterised through additional static and quick trials. The figure 3 explains about the principles of handover decision system as Follows.

1. Each railway is given a unique ID that gives it access to ETAN. To record the state of a train's movement, light sensors are installed on the boundary of two adjacent cells. (e.g. its location and speed). A handover request is triggered and sent to the Central Station (CS) to begin a fresh link when the train passes LS-A. Another handover request will be created to delete the old link after the train crosses LS-B.
 2. Because the train's movement characteristics are closely linked to the wireless signal coverage and strength information, as depicted, the movement status of the train can provide an indication of the wireless signal's strength. The next subsection discusses it hypothetically.
 3. The CS makes a choice and uses an optical switch unit to transfer its signal from its initial BS to the following BS. (which is applicable because up-to-date optical switch technology can complete switching within 10 ns).
- The following table 1 compares the speed and frequency of data on various Access Technologies.

CONCLUSION

This paper compares the performance of ROF(Radio Over Fiber) , ETAN(Express Train Access Network), WiMaxon access network, among these three networks radio over fiber network produces better result compare to other networks. Integrating sensor technology into ETAN, resulting in the creation of a specific handover choice system with the ideal fusion of sensors (such as pressure or light sensors) and optical switch technologies will give better result than ROF. Simulation findings show that our proposal can effectively address the handover issue and offer express train passengers seamless wireless service.

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Table. 1. Comparison of Access Technology

Access Network Technology	Data Rates	Frequency of Handoff	Technology Maturity	Comments
IEEE 802.11	Upto 54 mbps	High	Mature	Tested in the access network, as a gap filter
WiMax	Upto 104 mbps	Medium	Mature, other draft standards are added to improve performance	Used by southern rains
GPRS	Upto 171 kbps	Medium	Mature	Used by southern trains
Satellite	512 kbps (upload) 2mbps (download)	Low	Mature	Used by SNCF train
Radio-over-Fiber	Targeting 0.5-5 gbps	High	Immature	Not yet deployed

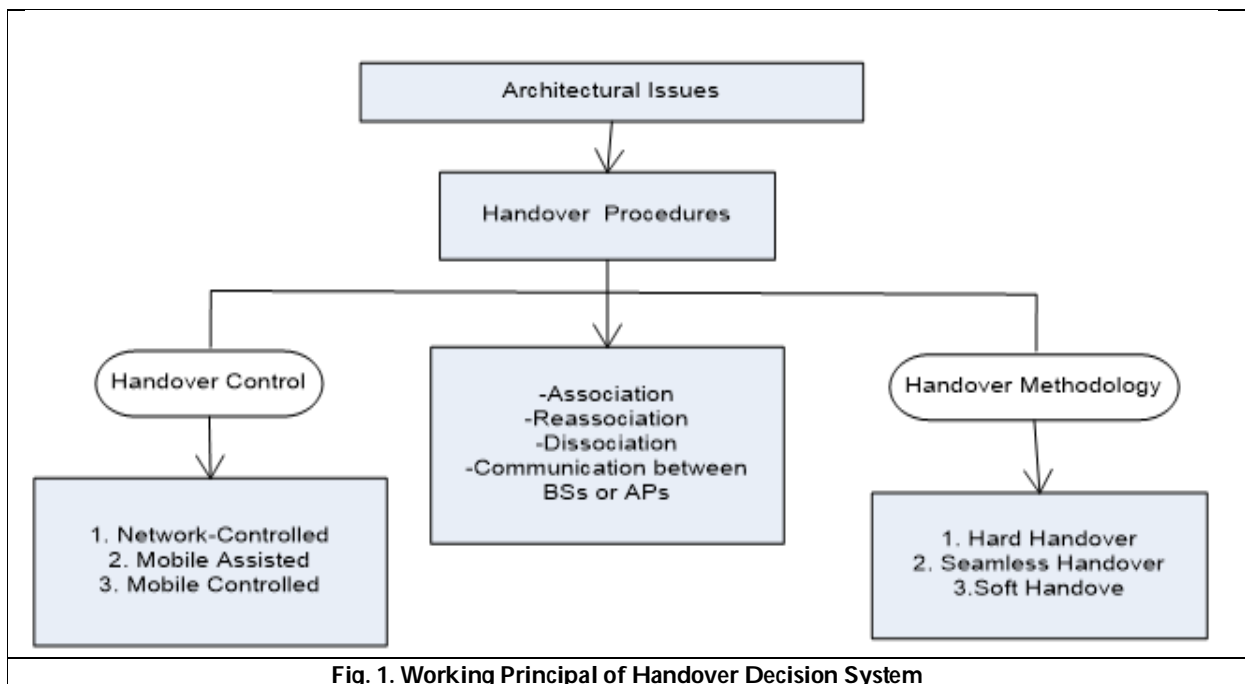


Fig. 1. Working Principal of Handover Decision System





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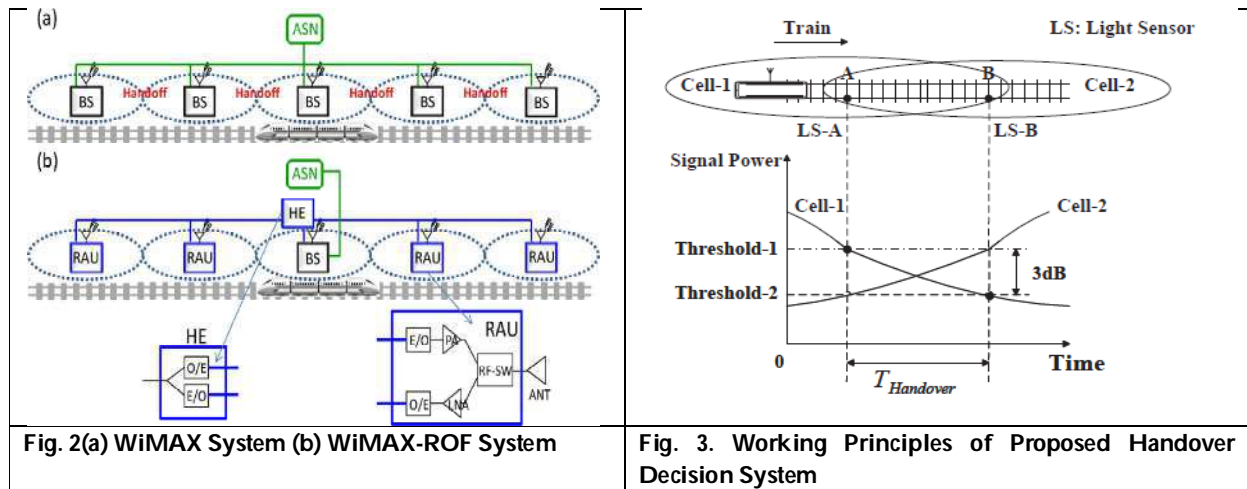


Fig. 2(a) WiMAX System (b) WiMAX-ROF System

Fig. 3. Working Principles of Proposed Handover Decision System





Weak Forms of Omega-Open Sets in Omega-Topological Spaces

A.Benazir^{1*} and N. Kandaraj²

¹Assistant Professor, Department of Mathematics, Hajee Karutha Rowther Howdia College, (Affiliated to Madurai Kamaraj University), Uthamapalayam, Theni, Tamil Nadu, India.

²Associate Professor, PG and Research Department of Mathematics, Saiva Bhanu kshatriya College, (Affiliated to Madurai Kamaraj University), Aruppukottai, Virudunagar, Tamil Nadu, India.

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*Address for Correspondence

A.Benazir

Assistant Professor,
Department of Mathematics,
Hajee Karutha Rowther Howdia College,
(Affiliated to Madurai Kamaraj University),
Uthamapalayam, Theni, Tamil Nadu, India.
E.Mail: benazirbenz139@gmail.com



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ABSTRACT

In this paper is to introduce and investigate the new notions of $b-\omega_\alpha$ -open sets, $\alpha-\omega_\alpha$ -open sets and pre- ω_α -open sets which are weaker than ω -open sets.

Keywords and Phrases: $\alpha-\omega_\alpha$ -open, semi- ω_α -open, pre- ω_α -open, $\beta-\omega_\alpha$ -open, $b-\omega_\alpha$ -open.

INTRODUCTION

In 1982, the notions of ω -cld and ω -open were introduced and studied by Hdeib [5]. In 2009, Noiri et al. [10] introduced some generalizations of ω -open sets and investigated some properties of the sets. In this paper is to introduce and investigate the new notions called $b-\omega_\alpha$ -open sets, $\alpha-\omega_\alpha$ -open sets and pre- ω_α -open sets which are weaker than ω -open sets.

PRELIMINARIES

Throughout this paper, R (resp. N , Q , Q^*) denotes the set of all real numbers (resp. the set of all natural numbers, the set of all rational numbers, the set of all irrational numbers). τ_u denotes the usual topology. By a space X , it means a topological space X with no separation properties assumed. If $K \subset X$, $cl(K)$ and $int(K)$ will, respectively, denote the closure and interior of K in X .





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Definition 2.1 [9] A subset K of a space X is called

1. α -cld (briefly α -cld) if $\text{cl}(\text{int}(\text{cl}(K))) \subset K$,
2. α -open if $X \setminus K$ is α -cld, or equivalently, if $K \subset \text{int}(\text{cl}(\text{int}(K)))$.

For a subset K of X , the intersection of all α -cld subsets of X containing K is called the α -closure of K and is denoted by $\text{cl}_\alpha(K)$. It is known that $\text{cl}_\alpha(K) = K \cup \text{cl}(\text{int}(\text{cl}(K)))$ and $\text{cl}_\alpha(K) \subset \text{cl}(K)$. The union of all α -open subsets of X contained in K is called the α -interior of K and is denoted by $\text{int}_\alpha(K)$.

Definition 2.2 A subset K of X is said to be

1. semi-open [7] if $K \subset \text{cl}(\text{int}(K))$,
2. pre-open [8] if $K \subset \text{int}(\text{cl}(K))$,
3. β -open [3] if $K \subset \text{cl}(\text{int}(\text{cl}(K)))$,
4. b-open [4] if $K \subset \text{int}(\text{cl}(K)) \cup \text{cl}(\text{int}(K))$.

Proposition 2.3 [6] Let K be a semi-open of X . Then $\text{cl}_\alpha(K) = \text{cl}(K)$.

Definition 2.4 [11] Let K be a subset of X , a point p in X is called a condensation point of K if for each open U containing p , $U \cap K$ is uncountable.

Definition 2.5 [5] A subset K of X is called ω -cld if it contains all its condensation points.

The complement of an ω -cld set is called ω -open.

It is well known that a subset W of X is ω -open iff for each $x \in W$, there exists $U \in \tau$ such that $x \in U$ and $U - W$ is countable. The family of all ω -opens, denoted by τ_ω , is a topology on X , which is finer than τ . The interior and closure operator in (X, τ_ω) are denoted by int_ω and cl_ω respectively.

Lemma 2.6 [5] Let K be a subset of X . Then

1. K is ω -cld in X iff $K = \text{cl}_\omega(K)$.
2. $\text{cl}_\omega(X \setminus K) = X \setminus \text{int}_\omega(K)$.
3. $\text{cl}_\omega(K)$ is ω -cld in X .
4. $x \in \text{cl}_\omega(K)$ iff $K \cap G \neq \emptyset$ for any ω -open G containing x .
5. $\text{cl}_\omega(K) \subset \text{cl}(K)$.
6. $\text{int}(K) \subset \text{int}_\omega(K)$.

Remark 2.7 [1,5] In a space X each cld set is ω -cld but not reversed.

Definition 2.8 [10] A subset K of X is said to be

1. α - ω -open if $K \subset \text{int}_\omega(\text{cl}(\text{int}_\omega(K)))$,
2. pre- ω -open if $K \subset \text{int}_\omega(\text{cl}(K))$,
3. β - ω -open if $K \subset \text{cl}(\text{int}_\omega(\text{cl}(K)))$,
4. b- ω -open if $K \subset \text{int}_\omega(\text{cl}(K)) \cup \text{cl}(\text{int}_\omega(K))$.

Definition 2.9 [2] A space X is said to be antilocally countable if each non- empty open is uncountable.

Lemma 2.10 [2] If X is an antilocally countable space, then $\text{int}_\omega(K) = \text{int}(K)$ for any ω -cld set K of X and $\text{cl}_\omega(K) = \text{cl}(K)$ for any ω -open K of X .

Weak Forms Of Ω -Open Sets

In this section the following notions are newly defined.

Definition 3.1 A subset K of a space X is said to be

1. α - ω_α -open if $K \subset \text{int}_\omega(\text{cl}_\alpha(\text{int}_\omega(K)))$,
2. semi- ω_α -open if $K \subset \text{cl}_\alpha(\text{int}_\omega(K))$,
3. pre- ω_α -open if $K \subset \text{int}_\omega(\text{cl}_\alpha(K))$,
4. β - ω_α -open if $K \subset \text{cl}_\alpha(\text{int}_\omega(\text{cl}_\alpha(K)))$,
5. b- ω_α -open if $K \subset \text{int}_\omega(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}_\omega(K))$.





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Proposition 3.2 Let K be a subset of X . Then K is α - ω_α -open iff it is semi- ω_α -open and pre- ω_α -open.

Proof. (\Rightarrow) Let K be an α - ω_α -open. Then $K \subset \text{int}_\omega(\text{cl}_\alpha(\text{int}_\omega(K))) \subset \text{int}_\omega(\text{cl}_\alpha(K))$ and $K \subset \text{int}_\omega(\text{cl}_\alpha(\text{int}_\omega(K))) \subset \text{cl}_\alpha(\text{int}_\omega(K))$. Thus, K is pre- ω_α -open and semi- ω_α -open. (\Leftarrow) Let K be a pre- ω_α -open. Then $K \subset \text{int}_\omega(\text{cl}_\alpha(K))$. Also, $K \subset \text{cl}_\alpha(\text{int}_\omega(K))$, since K is semi- ω_α -open. We have $K \subset \text{int}_\omega(\text{cl}_\alpha(\text{int}_\omega(K)))$. Thus, K is α - ω_α -open.

Theorem 3.3 For a subset of X , the following properties hold:

1. Each ω -open is α - ω_α -open.
2. Each α - ω_α -open is pre- ω_α -open.
3. Each pre- ω_α -open is b - ω_α -open.
4. Each b - ω_α -open is β - ω_α -open.

Proof. (1) If K is an ω -open, then $K = \text{int}_\omega(K)$. Since $K \subset \text{cl}_\alpha(K)$, $K \subset \text{cl}_\alpha(\text{int}_\omega(K))$ and $\text{int}_\omega(K) \subset \text{int}_\omega(\text{cl}_\alpha(\text{int}_\omega(K)))$. Therefore $K \subset \text{int}_\omega(\text{cl}_\alpha(\text{int}_\omega(K)))$ and K is α - ω_α -open.

(2) If K is an α - ω_α -open, then $K \subset \text{int}_\omega(\text{cl}_\alpha(\text{int}_\omega(K))) \subset \text{int}_\omega(\text{cl}_\alpha(K))$. Therefore, K is pre- ω_α -open.

(3) If K is a pre- ω_α -open, then $K \subset \text{int}_\omega(\text{cl}_\alpha(K)) \subset \text{int}_\omega(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}_\omega(K))$. Therefore, K is b - ω_α -open.

(4) If K is a b - ω_α -open, then $K \subset \text{int}_\omega(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}_\omega(K)) \subset \text{cl}_\alpha(\text{int}_\omega(\text{cl}_\alpha(K))) \cup \text{cl}_\alpha(\text{int}_\omega(K)) \subset \text{cl}_\alpha(\text{int}_\omega(\text{cl}_\alpha(K)))$. Therefore, K is β - ω_α -open.

Theorem 3.4 For a subset of a space X , the following properties hold:

1. Each α - ω_α -open is α - ω -open.
2. Each pre- ω_α -open is pre- ω -open.
3. Each b - ω_α -open is b - ω -open.
4. Each β - ω_α -open is β - ω -open.

Proof. (1) If K is an α - ω_α -open, then $K \subset \text{int}_\omega(\text{cl}_\alpha(\text{int}_\omega(K))) \subset \text{int}_\omega(\text{cl}(\text{int}_\omega(K)))$. Hence H is α - ω -open.

(2) If K is a pre- ω_α -open, then $K \subset \text{int}_\omega(\text{cl}_\alpha(K)) \subset \text{int}_\omega(\text{cl}(K))$. Therefore, K is pre- ω -open.

(3) If K is a b - ω_α -open, then $K \subset \text{int}_\omega(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}_\omega(K)) \subset \text{int}_\omega(\text{cl}(K)) \cup \text{cl}(\text{int}_\omega(K))$. Therefore, K is b - ω -open.

(4) If K is a β - ω_α -open, then $K \subset \text{cl}_\alpha(\text{int}_\omega(\text{cl}_\alpha(K))) \subset \text{cl}(\text{int}_\omega(\text{cl}(K)))$. Therefore, K is β - ω -open.

Definition 3.5 A subset K of X is called

1. α - α -open if $K \subset \text{int}(\text{cl}_\alpha(\text{int}(K)))$.
2. semi- α -open if $K \subset \text{cl}_\alpha(\text{int}(K))$.
3. pre- α -open if $K \subset \text{int}(\text{cl}_\alpha(K))$.
4. b - α -open if $K \subset \text{int}(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}(K))$.
5. β - α -open if $K \subset \text{cl}_\alpha(\text{int}(\text{cl}_\alpha(K)))$.

Proposition 3.6 Let K be a subset of X . Then K is α - α -open iff it is semi- α -open and pre- α -open.

Proof. (\Rightarrow) Let K be an α - α -open. Then $K \subset \text{int}(\text{cl}_\alpha(\text{int}(K)))$. It implies $K \subset \text{int}(\text{cl}_\alpha(\text{int}(K))) \subset \text{int}(\text{cl}_\alpha(K))$ and $K \subset \text{int}(\text{cl}_\alpha(\text{int}(K))) \subset \text{cl}_\alpha(\text{int}(K))$. Thus, K is pre- α -open and semi- α -open. (\Leftarrow) Let K be a semi- α -open. Then $K \subset \text{cl}_\alpha(\text{int}(K))$ and $\text{cl}_\alpha(K) \subset \text{cl}_\alpha(\text{int}(K))$. Also, $K \subset \text{int}(\text{cl}_\alpha(K))$, since K is pre- α -open. Hence $K \subset \text{int}(\text{cl}_\alpha(K)) \subset \text{int}(\text{cl}_\alpha(\text{int}(K)))$ and K is α - α -open.

Proposition 3.7 For a subset of X , the following properties hold:

1. Each α - α -open is α - ω_α -open.
2. Each pre- α -open is pre- ω_α -open.
3. Each b - α -open is b - ω_α -open.
4. Each β - α -open is β - ω_α -open.

Proof. (1) Let K be an α - α -open. Then $K \subset \text{int}(\text{cl}_\alpha(\text{int}(K))) \subset \text{int}_\omega(\text{cl}_\alpha(\text{int}_\omega(K)))$. This shows that K is α - ω_α -open.

(2) Let K be a pre- α -open. Then $K \subset \text{int}(\text{cl}_\alpha(K)) \subset \text{int}_\omega(\text{cl}_\alpha(K))$. This shows that K is pre- ω_α -open.

(3) Let K be a b - α -open. Then $K \subset \text{int}(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}(K)) \subset \text{int}_\omega(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}_\omega(K))$. This shows that K is b - ω_α -open.

(4) Let K be a β - α -open. Then $K \subset \text{cl}_\alpha(\text{int}(\text{cl}_\alpha(K))) \subset \text{cl}_\alpha(\text{int}_\omega(\text{cl}_\alpha(K)))$. This shows that K is β - ω_α -open.





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Example 3.8 In R with the topology $\tau = \{\phi, R, Q\}$, (1). $K = Q^*$ is α - ω_α -open, since $\text{int}_\omega(\text{cl}_\alpha(\text{int}_\omega(K))) = \text{int}_\omega(\text{cl}_\alpha(K)) = \text{int}_\omega(K) = K \supset K$. But $K = Q^*$ is not α - α -open, since $\text{int}(\text{cl}_\alpha(\text{int}(K))) = \text{int}(\text{cl}_\alpha(\phi)) = \phi \not\supset K$.
 (2). $K = Q^*$ is pre- ω_α -open, since $\text{int}_\omega(\text{cl}_\alpha(K)) = \text{int}_\omega(K) = K \supset K$. But $K = Q^*$ is not pre- α -open, since $\text{int}(\text{cl}_\alpha(K)) = \text{int}(K) = \phi \not\supset K$.
 (3). $K = Q^*$ is b- ω_α -open, since $\text{int}_\omega(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}_\omega(K)) = \text{int}_\omega(K) \cup \text{cl}_\alpha(K) = K \cup K = K \supset K$. But $K = Q^*$ is not b- α -open, since $\text{int}(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}(K)) = \text{int}(K) \cup \text{cl}_\alpha(\phi) = \phi \cup \phi = \phi \not\supset K$.
 (4). $K = Q^*$ is β - ω_α -open, since $\text{cl}_\alpha(\text{int}_\omega(\text{cl}_\alpha(K))) = \text{cl}_\alpha(\text{int}_\omega(K)) = \text{cl}_\alpha(K) = K \supset K$. But $K = Q^*$ is not β - α -open, since $\text{cl}_\alpha(\text{int}(\text{cl}_\alpha(K))) = \text{cl}_\alpha(\text{int}(K)) = \text{cl}_\alpha(\phi) = \phi \not\supset K$.

Proposition 3.9 For a subset of a space X , the following properties hold:

1. Each open is α - α -open.
2. Each α - α -open is pre- α -open.
3. Each pre- α -open is b- α -open.
4. Each b- α -open is β - α -open.

Proof. (1) Let K be an open. Then $K = \text{int}(K)$. Since $K \subset \text{cl}_\alpha(K)$, $K = \text{int}(K) \subset \text{int}(\text{cl}_\alpha(K)) = \text{int}(\text{cl}_\alpha(\text{int}(K)))$. This shows that K is α - α -open.

(2) Let K be an α - α -open. Then $K \subset \text{int}(\text{cl}_\alpha(\text{int}(K))) \subset \text{int}(\text{cl}_\alpha(K))$. This shows that K is pre- α -open.

(3) Let K be a pre- α -open. Then $K \subset \text{int}(\text{cl}_\alpha(K)) \subset \text{int}(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}(K))$. This shows that K is b- α -open.

(4) Let K be a b- α -open. Then $K \subset \text{int}(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}(K)) \subset \text{cl}_\alpha(\text{int}(\text{cl}_\alpha(K))) \cup \text{cl}_\alpha(\text{int}(K)) = \text{cl}_\alpha(\text{int}(\text{cl}_\alpha(K)))$. This shows that K is β - α -open.

Example 3.10 In (R, τ_ω) , (1). $K = Q^*$ is pre- α -open, since $\text{int}(\text{cl}_\alpha(K)) = \text{int}(R) = R \supset K$. But $K = Q^*$ is not α - α -open, since $\text{int}(\text{cl}_\alpha(\text{int}(K))) = \text{int}(\text{cl}_\alpha(\phi)) = \text{int}(\phi) = \phi \not\supset K$.

(2). $K = (0, 1]$ is b- α -open, since $\text{int}(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}(K)) = \text{int}([0, 1]) \cup \text{cl}_\alpha((0, 1]) = (0, 1) \cup [0, 1] = [0, 1] \supset K$. But $K = (0, 1]$ is not pre- α -open, since $\text{int}(\text{cl}_\alpha(K)) = \text{int}([0, 1]) = (0, 1) \not\supset K$.

(3) $K = [0, 1] \cap Q$ is β - α -open, since $\text{cl}_\alpha(\text{int}(\text{cl}_\alpha(K))) = \text{cl}_\alpha(\text{int}([0, 1])) = \text{cl}_\alpha((0, 1)) = [0, 1] \supset K$. But $K = [0, 1] \cap Q$ is not b- α -open, since $\text{int}(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}(K)) = \text{int}([0, 1]) \cup \text{cl}_\alpha(\phi) = (0, 1) \cup \phi = (0, 1) \not\supset K$.

Theorem 3.11 If K is a pre- ω_α -open subset of X such that $U \subset K \subset \text{cl}_\alpha(U)$ for a subset U of X , then U is a pre- ω_α -open.

Proof. Since $K \subset \text{int}_\omega(\text{cl}_\alpha(K))$, $U \subset \text{int}_\omega(\text{cl}_\alpha(K)) \subset \text{int}_\omega(\text{cl}_\alpha(U))$ since $\text{cl}_\alpha(K) \subset \text{cl}_\alpha(U)$. Thus, U is a pre- ω_α -open.

Theorem 3.12 A subset K of X is semi- α -open iff K is β - ω_α -open and $\text{int}_\omega(\text{cl}_\alpha(K)) \subset \text{cl}_\alpha(\text{int}(K))$.

Proof. Let K be semi- α -open. Then $K \subset \text{cl}_\alpha(\text{int}(K)) \subset \text{cl}_\alpha(\text{int}_\omega(\text{cl}_\alpha(K)))$ and hence K is β - ω_α -open. In addition, $\text{cl}_\alpha(K) \subset \text{cl}_\alpha(\text{int}(K))$ and hence $\text{int}_\omega(\text{cl}_\alpha(K)) \subset \text{int}_\omega(\text{cl}_\alpha(\text{int}(K))) \subset \text{cl}_\alpha(\text{int}(K))$. Conversely let K be β - ω_α -open and $\text{int}_\omega(\text{cl}_\alpha(K)) \subset \text{cl}_\alpha(\text{int}(K))$. Then $K \subset \text{cl}_\alpha(\text{int}_\omega(\text{cl}_\alpha(K))) \subset \text{cl}_\alpha(\text{cl}_\alpha(\text{int}(K))) = \text{cl}_\alpha(\text{int}(K))$ and hence K is semi- α -open.

Proposition 3.13 If U is an α -open of X , then

- (i) $\text{cl}_\alpha(U \cap K) = \text{cl}_\alpha(U \cap \text{cl}_\alpha(K))$ and
- (ii) $U \cap \text{cl}_\alpha(K) \subset \text{cl}_\alpha(U \cap K)$ for any subset K .

Proof. (i) (\Rightarrow) Since $K \subset \text{cl}_\alpha(K)$, $U \cap K \subset U \cap \text{cl}_\alpha(K)$ and $\text{cl}_\alpha(U \cap K) \subset \text{cl}_\alpha(U \cap \text{cl}_\alpha(K))$. (\Leftarrow) Let $x \in / \text{cl}_\alpha(U \cap K)$. Then there exists an α -open U such that $x \in U$ and $U \cap (U \cap K) = \phi$. Now $U \cap K = \phi$ implies $U \subset X - K$ and $\text{int}_\alpha(U) \subset \text{int}_\alpha(X - K) = X - \text{cl}_\alpha(K) \Rightarrow \text{int}_\alpha(U) \cap \text{cl}_\alpha(K) = \phi \Rightarrow U \cap \text{cl}_\alpha(K) = \phi \Rightarrow U \cap (U \cap \text{cl}_\alpha(K)) = \phi$. Then, $x \in / \text{cl}_\alpha(U \cap \text{cl}_\alpha(K))$. Thus, we obtain $\text{cl}_\alpha(U \cap K) = \text{cl}_\alpha(U \cap \text{cl}_\alpha(K))$. (ii) We have $U \cap \text{cl}_\alpha(K) \subset \text{cl}_\alpha(U \cap \text{cl}_\alpha(K)) = \text{cl}_\alpha(U \cap K)$ by (i). Thus, we obtain (ii)

Proposition 3.14 The intersection of a pre- ω_α -open and an open is pre- ω_α -open.

Proof. Let K be a pre- ω_α -open and U an open. Then $U = \text{int}_\omega(U)$ and $K \subset \text{int}_\omega(\text{cl}_\alpha(K))$. Since each open is α -open, $U \cap K \subset \text{int}_\omega(U) \cap \text{int}_\omega(\text{cl}_\alpha(K)) = \text{int}_\omega(U \cap \text{cl}_\alpha(K)) \subset \text{int}_\omega(\text{cl}_\alpha(U \cap K))$. This shows that $U \cap K$ is pre- ω_α -open.





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Proposition 3.15 The intersection of a β - ω_α -open and an open is β - ω_α -open.

Proof. Let K be a β - ω_α -open and U an open. Then $U = \text{int}_\omega(U)$ and $K \subset \text{cl}_\alpha(\text{int}_\omega(\text{cl}_\alpha(K)))$. Since each open is α -open, $U \cap K \subset U \cap \text{cl}_\alpha(\text{int}_\omega(\text{cl}_\alpha(K))) \subset \text{cl}_\alpha(U \cap \text{int}_\omega(\text{cl}_\alpha(K))) \subset \text{cl}_\alpha(\text{int}_\omega(U) \cap \text{int}_\omega(\text{cl}_\alpha(K))) = \text{cl}_\alpha(\text{int}_\omega(U \cap \text{cl}_\alpha(K))) \subset \text{cl}_\alpha(\text{int}_\omega(\text{cl}_\alpha(U \cap K)))$. This shows that $U \cap K$ is β - ω_α -open.

Proposition 3.16 The intersection of a b - ω_α -open and an open is b - ω_α -open.

Proof. Let K be a b - ω_α -open and U an open. Then $U = \text{int}_\omega(U)$ and $K \subset \text{int}_\omega(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}_\omega(K))$. Since each open is α -open, $U \cap K \subset U$

$\cap [\text{int}_\omega(\text{cl}_\alpha(K)) \cup \text{cl}_\alpha(\text{int}_\omega(K))] = [U \cap \text{int}_\omega(\text{cl}_\alpha(K))] \cup [U \cap \text{cl}_\alpha(\text{int}_\omega(K))] = [\text{int}_\omega(U) \cap \text{int}_\omega(\text{cl}_\alpha(K))] \cup [U \cap \text{cl}_\alpha(\text{int}_\omega(K))] \subset [\text{int}_\omega(U \cap \text{cl}_\alpha(K))] \cup [\text{cl}_\alpha(U \cap \text{int}_\omega(K))]$. Thus $U \cap K \subset [\text{int}_\omega(\text{cl}_\alpha(U \cap K))] \cup [\text{cl}_\alpha(\text{int}_\omega(U \cap K))]$. This shows that $U \cap K$ is b - ω_α -open.

Proposition 3.17 The intersection of an α - ω_α -open and an open is α - ω_α -open.

Proof. Let K be α - ω_α -open and U be open. Then $U = \text{int}_\omega(U)$ and $K \subset \text{int}_\omega(\text{cl}_\alpha(\text{int}_\omega(K)))$. $U \cap K \subset \text{int}_\omega(U) \cap [\text{int}_\omega(\text{cl}_\alpha(\text{int}_\omega(K)))] = \text{int}_\omega[U \cap \text{cl}_\alpha(\text{int}_\omega(K))] \subset \text{int}_\omega[\text{cl}_\alpha(U \cap \text{int}_\omega(K))]$. Thus $U \cap K \subset \text{int}_\omega[\text{cl}_\alpha(\text{int}_\omega(U) \cap \text{int}_\omega(K))] = \text{int}_\omega[\text{cl}_\alpha(\text{int}_\omega(U \cap K))]$ which implies $U \cap K$ is α - ω_α -open.

Proposition 3.18 If $\{K_\alpha : \alpha \in \Delta\}$ is a collection of pre- ω_α -opens of X , the $\bigcup_{\alpha \in \Delta} K_\alpha$ is pre- ω_α -open.

Proof. Since $K_\alpha \subset \text{int}_\omega(\text{cl}_\alpha(K_\alpha))$ for any $\alpha \in \Delta$, $\bigcup_{\alpha \in \Delta} K_\alpha \subset \bigcup_{\alpha \in \Delta} \text{int}_\omega(\text{cl}_\alpha(K_\alpha)) \subset \text{int}_\omega(\bigcup_{\alpha \in \Delta} \text{cl}_\alpha(K_\alpha)) = \text{int}_\omega(\text{cl}_\alpha(\bigcup_{\alpha \in \Delta} K_\alpha))$. Therefore, $\bigcup_{\alpha \in \Delta} K_\alpha$ is pre- ω_α -open.

Theorem 3.19 If $\{K_\alpha : \alpha \in \Delta\}$ is a collection of b - ω_α -open (resp. β - ω_α -open) sets of X , then $\bigcup_{\alpha \in \Delta} K_\alpha$ is b - ω_α -open (resp. β - ω_α -open).

Proof. We prove only the first result since the other result follows similarly. Since K_α is b - ω_α -open for any $\alpha \in \Delta$, $K_\alpha \subset \text{int}_\omega(\text{cl}_\alpha(K_\alpha)) \cup \text{cl}_\alpha(\text{int}_\omega(K_\alpha))$ for any $\alpha \in \Delta$. Then $\bigcup_{\alpha \in \Delta} K_\alpha \subset \bigcup_{\alpha \in \Delta} [\text{int}_\omega(\text{cl}_\alpha(K_\alpha)) \cup \text{cl}_\alpha(\text{int}_\omega(K_\alpha))] = [\bigcup_{\alpha \in \Delta} \text{int}_\omega(\text{cl}_\alpha(K_\alpha))] \cup [\bigcup_{\alpha \in \Delta} \text{cl}_\alpha(\text{int}_\omega(K_\alpha))] \subset [\text{int}_\omega(\bigcup_{\alpha \in \Delta} \text{cl}_\alpha(K_\alpha))] \cup [\text{cl}_\alpha(\bigcup_{\alpha \in \Delta} \text{int}_\omega(K_\alpha))] \subset [\text{int}_\omega(\text{cl}_\alpha(\bigcup_{\alpha \in \Delta} K_\alpha))] \cup [\text{cl}_\alpha(\text{int}_\omega(\bigcup_{\alpha \in \Delta} K_\alpha))]$. Therefore, $\bigcup_{\alpha \in \Delta} K_\alpha$ is b - ω_α -open.

Proposition 3.20 Let X be a space and $K \subset X$. Let K be a b - ω_α -open such that $\text{int}_\omega(K) = \phi$. Then K is pre- ω_α -open.

Recall that a space X is called a door space if each subset of X is open or cld.

Proposition 3.21 If X is a door space, then each pre- ω_α -open in X is ω -open.

Proof. Let K be a pre- ω_α -open. If K is open, then K is ω -open. Otherwise, K is cld and hence $K \subset \text{int}_\omega(\text{cl}_\alpha(K)) \subset \text{int}_\omega(\text{cl}(K)) = \text{int}_\omega(K) \subset K$. Therefore, $K = \text{int}_\omega(K)$ and thus K is an ω -open.

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Multiple Enhanced Residual Networks for Deep Learning-Based Medical Image Super Resolution

Jayalakshmi.R^{1*}, Sumathy.P² and Rajkumar.N³

¹Research Scholar, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India.

²Department of Computer Science, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India.

³Department of Sciences, St. Claret College, Bengaluru, Karnataka, India.

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*Address for Correspondence

Jayalakshmi.R

Research Scholar,

Bharathidasan University,

Tiruchirappalli, Tamil Nadu, India.



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ABSTRACT

Image reconstruction technology for obtaining images with high levels of resolution in the sphere of medical imaging has made significant strides because of quick development in the arena of deep learning. In recent years, academics both locally and abroad have focused on the use of non-natural intelligence in processing medical images. It is challenging to use the existing algorithms to extract deep image statistics because it has very less layers and absences the association amid the evidence about the features of in-line layers. As a result, the high-level resolution quality ratings of the image renovation outcome are not upright. I suggest the multiple enhanced residual networks high-level resolution reconstruction method to address this issue. To develop numerous upgraded residual blocks, the proposed method initially schemes the residual pieces linked by multi-level hops. To address the absence of a link between the distinctive evidence of end-to-end layers, a profound lingering network with multi-level hop connections is implemented. Then, a profound residual network linked by several level hops is trained using the specific method with an adaptable knowledge rate approach to create a high-level resolution restoration model of the system. The enhanced super-resolution reconstruction model then receives the low-resolution picture as input, and the residual wedge determines the expected residual characteristic root of the obtained square matrix before combining the lingering image and poor-resolution image to create a high-quality resolution image. Using benchmark datasets, the majority of quantitative and qualitative analyses depict that the proposed model accomplishes better than existing advanced approaches in terms of renovating image particulars and consistencies to avoid the over-smoothing of medical images.

Keywords: Deep learning, Medical image processing, Residual networks, Super-resolution, Upsampling





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INTRODUCTION

The damage to valuable evidence in images can lead to the degradation of images. It occurs throughout the process of medical imaging, broadcast, alteration, storage, etc. The impacts of adversative aspects, such as the medical imaging apparatus and the peripheral setting can also damage the images. The technology of super-resolution (SR) for images, which rebuilds images with very little resolution to images with better resolution, is extensively used in a variety of industries, including surveillance, facial identification, satellite imaging, and medical imaging [1–5]. The three types of image super-resolution techniques now available are as follows. The most popular interpolation-based approaches in this regard are the nearest-neighbour interpolation [6] and bicubic interpolation [7] approaches. Because the interpolation criterion is too straightforward, the nearest-neighbour interpolation approach [8] is vulnerable to the lump effect and the scraggy-uneven boundary influence. The evenness of the boundaries of images is enhanced using the bicubic interpolation method [9], which is only somewhat further complicated than the nearest-neighbour utterance approach. These two approaches share the benefit of having straightforward algorithms that are simple to use and quick to calculate. The sharp details of an image, however, cannot be restored because individual resident pel points are employed to estimate the pel standards of the outburst points; as a result, the subsequent super-resolution image has restricted acuity.

The space-domain and frequency-domain procedures fall within the second category of reconstruction-based methods [10]. By removing the spectral aliasing problem, frequency-domain approaches typically increase the resolution of a picture. The projection onto convex sets technique (POCS) [11–12], the iterative back-projection method (IBP) [13–14], the application of maximum a posteriori method (MAP) [15–17], and the hybrid MAP/POCS method [18–20] are examples of representative reconstruction-based methods. Recently, research has concentrated on learning-based approaches [21]. While dealing out medical images with low-resolution, the previous acquaintance in the prototype is completely merged with the low-resolution image to produce a renovated image with better evidence. The neighbour embedding approach [22–24] and the sparse representation method [25] can both outperform other learning-based methods in terms of super-resolution performance. The symmetrical resemblance between images with low- and high-resolution lumps is used by the single-image super-resolution (SISR) approach founded on neighbour submerging to comprehend their mapping association.

The block of low-resolution images and the accompanying blocks of high-resolution images are each characterized as corresponding lexicons using the theory of sparse coding in the SISR approach based on sparse representation, and the regression relationship between lexicons is established using various techniques. A picture with a better resolution of a certain single-frame image is created via the mapping relationship. The main issues with learning-based super-resolution reconstruction techniques are the creation of prototypes and the choice of training groups. A team of researchers [26,27] assumed that the training sample set may express the input LR picture blocks sparsely and linearly. The erudition of a more efficient over-complete vocabulary from the training trial group was suggested by Wang et al. [28] and is appropriate for quick multi-level, high-resolution picture renovation tasks.

Deep learning has recently produced explore findings in the realm of processing of notable images. Deep learning features partake to consume better representational capabilities in several tasks than features created using conventional techniques [29]. The high-level resolution utilising a convolutional neural network (SR- CNN) approach was proposed by Dong et al. [30] and used in the arena of picture super-resolution rebuilding. The running speed of the network is significantly impacted by the network's simple structure, great super-resolution rebuilding outcome, huge convolution kernel, and usage of conventional bicubic interpolation for upsampling. The fast super-resolution convolutional neural network (FSRCNN) was then proposed by Dong et al. [31] based on SRCNN reconstruction tasks





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MATERIALS AND METHODS

The approach based on Multiple improved residual networks (MIRN) for super-resolution is suggested in this research [32]. The first step is the design of multiple improved residual blocks (MIRBs). A set of eight MIRBs and upsampling modules make up the MIRN [32]. The MIRB uses three improved residual blocks (IRBs) to extract LR image features; it is made up of three sub-residual blocks, each of which is made up of a sophisticated layer and a skip connection, and an upsampling component that is made up of a sub-pel convolution layer [32]. The MIRN is then trained using the stochastic gradient descent (SGD) approach with an adaptable erudition rate scheme to produce a high-resolution renovation prototype of the system. In the end, the suggested model is used to rebuild images of little resolution from an assessment set.

Residual Learning

A residual network was initially suggested by He et al. [33] in 2016. The residual network, which is made up of several lingering chunks connected end to end, overcomes the issue of model degradation while building a deep neural network.

It is said that the function for residual is:

$$y = F(x, \{W_i\}) + x, \quad (1)$$

where y is the residual block's end product vector, x is its input vector, W_i is the layer i weight, $F(x)$ denotes the residual block's end product before the second layer's activation function, then the function $F(x, W_i)$ denotes the residual plotting that is to be learnt. The lingering function is $F(W_2(W_1(x)))$, where the bias is left out to make the representation simpler. The residual block shown in Fig. 1 has two layers. To produce the function y , the participation vector x is associated via a hop association with the function $F(x)$ as shown below:

$$y = F(x, \{W_i\}) + x. \quad (2)$$

The participation vector x and the function $F(x)$ sizes are essentially identical in the residual block

Multiple Improved Residual Blocks

The background evidence of the image section is not correlated because the levels of layers of the deep neural network merely accomplish regression analysis and evaluations on the attribute vectors of the preceding layer and do not utilize the association amid the attribute evidence of two in-line layers. The MIRB was created to address this issue. The effective sub-pel convolution layer serves as the outcome layer of the super-resolution system since the smart-network architecture is a concatenated system.

In this, an IRB is created by connecting two sub-residual blocks and hop networks, and a sub-residual block is created by connecting a convolution layer and hop networks. If the input value of the residual lump connected by the multi-level hop network is assumed to be x , the outputs of the first and second sub-residual blocks are assumed to be y_1 , y_2 , and y_3 , respectively, and the outcome of the multiple enhanced residual modules is assumed to be y_3 , then the following is the output:

$$y_1 = W_1(x) + \lambda x \quad (3)$$

RESULTS AND DISCUSSION

To excerpt the in-depth evidence of the given image, a deep neural network is simply created by piling layers, even though the practice of the structure of the deep neural network can attain supplementary image statistics and



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produce improved results in super-resolution renovation technology. As a result, issues like gradient explosion and gradient disappearance may develop when practising deep neural networks. Additionally, the deep neural network's layers reconstruct the framework knowledge about the image section with little regard because they only use the attribute vectors from the previous layer and do not take into account the association between the attribute evidence of the two end-to-end levels of layers.

FSRCNN's structure is more complex than SRCNN's, and deconvolution bicubic interpolation takes its place. In addition to being substantially faster than SRCNN, FSRCNN also enhances the image's super-resolution appearance. FSRCNN has been successful in reconstructing images at super-resolution, but because of the few layers it contains and the lack of correlation in the attribute evidence of head-to-head layers, it is challenging to excerpt the profound knowledge of the image, leading to subpar super-resolution reconstruction. The high-resolution reconstruction technique based on a very deep super-resolution (VDSR) [32] was developed using SRCNN and was adapted from the VGG [33] network architecture. This technique yields an interpolated image that has already been processed, and it extends the network depth to 20 layers; this system edifice. A total of 200 training epochs were used to train the network. The network was trained using an adjustable learning rate technique to hasten the training process. After 10 epochs, the knowledge rate was reduced to 0.1 times the early knowledge rate from its initial setting of 0.1. The batch size was set to 128 and the learning rate was kept at 0.0001 after it had

dropped to that level. When compared to the bicubic reconstruction method, the network reconstruction model's reconstruction effect with the skip coefficient of 0.1 was much superior[36].

CONCLUSION

This research suggested a manifold enhanced residual high-resolution renovation approach to extract the profound evidence from medical pictures to address the issue of the lack of association in the captivating character image feature evidence. This method's network topology is mostly made up of seven multiple enhanced residual blocks connected end to end. A picture with a little resolution is directed into the network, and using better residual blocks coupled by multi-stage hop, a foreseen residual image is produced. In the end, a high-resolution image is created by combining the residual and low-resolution images. The suggested approach was put up against the most recent versions of the Bicubic [8], A+ [23], SCN [48], SRCNN [30], FSRCNN [31], VDSR [32], DRCN [35], LapSRN [37], and DRRN [38] algorithms, and it was discovered that it performed better and produced better-looking reconstructed pictures. The results clearly show how well the enhanced method suggested in this study works. Better optimization techniques, a wider network structure, and more accuracy in super-resolution picture renovation will be pursued in further research. The study model employed in the work can be a reference for future improvements in medical scan resolution and can help with the advancement of medical image diagnostics.

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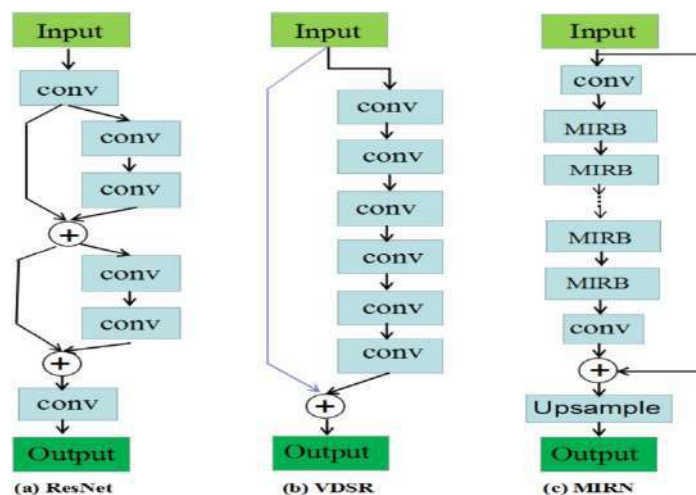


Fig. 1. Operational assessment of Res Net[31], VDSR[32], and MIRN[33]





Disease Detection in Plants using Internet of Things (IoT)

S. Sivagami*, Saranya C² and Kalpana R³

Assistant Professor, Department of Computer Applications, St. Francis de Sales College, Electronic City, Bengaluru.

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*Address for Correspondence

S. Sivagami

Associate Professor,
Department of Computer Applications,
St. Francis de Sales College,
Electronic City, Bengaluru.
E. Mail : sivagamiacar@gmail.com



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ABSTRACT

This paper introduces the concept of internet of things (IOT) technology to perceive data and discusses the role of IOT technology in farming infection and bug nuisance control, including rural disease and bug checking systems, gathering illness and creepy crawly bother data using sensor hubs, information preparing and mining, etc. It is suggested to use an IOT-based framework for disease and bug irritation control that consists of three layers and three frameworks. A different way to access horticulture data for the farm can be provided by the framework. In this study, a computerized system has been developed to determine whether a plant is healthy or sick. Plant disease does have a real impact on the normal growth of plants, their production, and their nature as horticultural products. The goal of this research is to create a robotized framework that can detect the presence of disease in plants. Based on the diversity in plant leaf health status, a computerized disease recognition framework is developed using sensors like temperature, moisture, and color. The characteristics based on temperature, mugginess, and shading criteria are used to identify the proximity of plant disease.

Keywords: Plant diseases, internet of things, temperature sensor plants, farming, IoT

INTRODUCTION

Indian agriculture is well-known worldwide. A third of the population relies on farming for employment. It is the cornerstone of the country's financial development. Additionally, the agricultural industry offers employment opportunities to a very large population. Plant health plays a key role in helping ranchers gain significant benefits. At various stages of plant development, proper plant health inspection is necessary to detect disease before it affects plants. The estimation of harvest development is highly impacted by vermin and disease presence, which also significantly reduces yield. Modern architecture relies on manual eye perception, which is a laborious process. To identify plant illness in its early stages, programmed recognition of plant infection can be used. Farmers have used

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several disease prevention techniques at regular intervals to prevent plant illnesses. Due to possible uses and industrial initiatives for robot advancement, research into agriculture robots has advanced in recent years. Their role was investigated for some agricultural tasks, mostly focused on advancing the mechanisation of conventional farming equipment and creating processes, such as progress planning, seeding, preparation, and reaping. The ideal uses for robots seem to be efficient, boring, and time-restricted tasks, particularly in an arable farming environment with infrequent harvests. Automated plant assurance has also been studied, but may represent the most challenging challenge for analysts and engineers because pathogen-related questions must be taken into account in addition to standard robot-related difficulties. The study of programmed illness recognition has recently been advancing swiftly, with possible applications for building robots that can recognise individual plants, locate and discriminate illnesses, and set up treatment plans across the board. Intricacies of the emerging robotics age that could help plant pathologists are anticipated in this research.

Internet of Things (IoT) in Plants

The general design of the Internet of Things' supporting components demonstrated astounding aptitude in those plant-space headways and the ongoing demonstration of accuracy in plants. Continuous advancements in sensor technology, local equipment downsizing, and a notable decline in their rate have all contributed significantly to the mechanical advancement of conventional farming to accuracy and small-scale accuracy plants. The data streams from sensors such as air, ground, radiation, and atmospheric stations are practically all secured and used for data mining, data analysis, thought, and control. A growing interest in high gauge as well as safe country items has also emerged recently. The need for cover operable, spreadable, amazing, and careful co-appointments tractability systems has been generated by that example. The IoT series of innovations provides all the necessary tools for establishing and maintaining such bases and services, particularly designed to support supply chains in the agricultural and industrial sectors. In the most recent decades, horticulture has extensively used sensors, including connected and remote sensors.

It is crucial for making the proper and increasingly precise decisions, simplifying profitability and cultivar nature, to detect the earth where creation occurs and, more recently, the reactions of the plants to the atmosphere. Today's adaptable devices would be able to be used, on batteries, and work for significant amounts of time, with or without the aid of energy gathering modules. They would have great computing capacities, an extremely advantageous form factor, and ease. Additionally, newer implanted devices have sufficient resources to support more complex sensors, such picture sensors, and the support of more advanced systems administration standards, like TCP/IP, extending the capabilities of conventional systems administration. Web of Stuffs is developing swiftly, and numerous creative presentations as well as businesses are continuing to rise from it. Numerous studies are currently being conducted to improve various corporate structures by combining multiple disparate arrangements, ensuring security at various levels of the Internet of Things, and doing research that will provide researchers a unique understanding of the "Colossal Data." The desire of consumers for honesty in the age cycle and the biological impact of the products they purchase, as well as national policies of governments around the world for increased production rates of fresh cut vegetables and meat at lower costs with higher quality benchmarks, provide IoT with a tremendous field for growth and dispersion. According to Bradley, the estimates of the potential value of the Internet of Things from 2015 to 2020 vary significantly, ranging from at least \$1 trillion to more than \$15 trillion, excluding increased salaries, the advantages of cost reductions for businesses and endeavours, and the overall budgetary growth brought on by IoT. The adaptability, advancement, and accuracy that IoT delivers to the production and industry age methods are major contributors to its increased estimate. Therefore, it is less dangerous to assume that cultivating zone shapes will alter significantly as soon as possible at all levels. IoT is necessary for agribusiness to modernise through a number of methods. Farmlands and nurseries will transition from a precise model of country construction to a smaller scale exactness model. The best conditions for growing or living will be provided for both crops and creatures by widespread, unavoidable registering and precise observation of the offices. Self-governing systems will be able to guide actuators more effectively, increasing utility and resource consumption, as well as control the generation in accordance with market conditions, increasing benefit and lowering costs using every available method. Contrarily,



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food supply chains outfitted with RFID technology will likely monitor every stage of an item's life cycle, develop automated responses in the event of a broken item, and raise customers' feelings of wellbeing through a simple item life cycle data framework. IoT has enormous commercial potential, which has drawn several serious players to invest resources in it. Models, like the ongoing acquisition of Nest Laboratories, a company increasing the practical use of IoT in home automation, by Google for \$4.02 billion in real money, and the acquisition of Jasper Machineries, the company that designed how IoT will work, by Cisco for \$2.04 billion, reveal astounding IoT capabilities as well as exhibit that is incredibly speaking to enormous financial experts and behemoth mechanics. The association's line of action isn't entirely pointless, though. This is a result of the manner that due to the IoT's broad scope, firms connected to it focus resources on one or a few of its components. Therefore, at some point or another, they should work together, putting aside any conflict or notion of who is more important, in order to present some widely used models in the developing IoT publicity.

IoT in Plant Disease Detection

Agriculture experts and farmers have the most stringent requirements when it comes to disease identification in plants. The suggested framework's main objective is to use IoT to identify plant diseases (Internet of Things). The majority of plants have leaves where the disease first manifests itself. Therefore, we have taken into account the location of plant disease that is present on leaves in the suggested work. Based on variations in temperature, moisture, and shade, it is possible to evaluate the separation of normal and affected plant leaf. The vibrant shading variations in the fall are caused by the pigments in leaves. The effects of temperature, light, and soil moisture on the fall foliage are all significant. After the formation of the abscission layer, bright sunlight and cold temperatures accelerate the destruction of the chlorophyll. The DHT11 temperature sensor was used. The temperature of the leaf under consideration is determined by the DHT11 sensor. Through the wifi shield attached to the Arduino UNO board, the sensor's parameters are transmitted to the cloud platform. the data that has been saved for analysis at the cloud stage. We first note the range of a healthy leaf's temperature. When the temperature of the leaf is considered, if it does not fall within that range, the leaf is considered unhealthy. Plant illness is frequently detected by changes in the shade of plant tissue. A common reason of these colour changes is the fading of typical green tissue, which occurs when chlorophyll is destroyed or cannot be produced. This inhibition of leaf shading may be fully or partially complete. The shading sensor picks up the shade of the leaf being considered, which is another criterion used to determine if the leaf is healthy or infected.

According to the typical for rural data stream, from the perspective of innovation, due to the qualities of generally sense, solid exchange, and wise procedure, IoT starts to become the main method for information securing and transmission and would become a significant innovation over a few different types of sensors to gather, investigate, transmit, and deal with the entire information related to plant illness and creepy crawly pests. The sensor is a substantial information-gathering innovation that is mostly employed to capture some current information, relate and synchronizethis information, review them, and then do a responsive action without the involvement of a client. The following are included in the components of a (remote) detecting hub: the detecting and in-citation unit (single component or exhibit), the preparation unit, the correspondence unit, the control unit, and other application-subordinate units. Sensors have the capacity for massive scale arrangements, low support, scale capacity, and flexibility for a variety of situations. They can be simple point components or multi-point location clusters.

LITERATURE REVIEW

This study demonstrates the use of low-effort shade sensors to monitor plant development in a lab setting. By incorporating low-effort shading sensors for monitoring plant development in a research center, a computerized framework for estimating plant leaf shading is made to evaluate the well-being situation of the plant [1]. To assess the health of plants, a computational framework for evaluating plant leaf shading was developed [2]. This paper has demonstrated unique division calculations and programs for identifying vermin proof on plants using image processing. Reduced computational complexity and irritation recognition in both a ranch and nursery setting are



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features of the suggested system. The whitefly was chosen as the source of interest for this article since it is a bio-assailant that poses a threat to a great deal of yields. A precision of 96% of whitefly identification was achieved when the calculation was tested for a few whiteflies influencing different leaves. We have used picture-preparation techniques in MATLAB to demonstrate irritation control in rural ranches. Then, pre-handling, alteration, and bunching are applied to the images [3]. This study illustrates IoT implementation for remote parameter verification in agriculture. A remote framework has been developed to monitor environmental factors related to the finding of leaf diseases in the horticulture field, such as temperature, soil pH, moisture content, and stickiness [4]. We have introduced a small-scale controller-based auto-water system as well as the ability to identify nuisances through image processing. A method for image analysis can be closely related to agricultural education to stretch the most extreme security of plants, which can ultimately result in the most likely produce for executives and future generations [5]. Plant diseases and creepy crawlies have changed the situation, which has led to a significant decline in both crop quality and quantity [6]. In this study, we have presented the design and development of a vermin observation framework for implementing precise agribusiness using IoT. In India, the majority of farmers grow sugarcane but have low yields because of bugs and hatchlings in the plant. Arduino was used in this proposed structural framework to measure temperature and clamour [7]. This research has demonstrated vermin control using Arduino and continuous ecological observation sensors. This study aims to create a robot capable of allocating nuisance control specialists, discouraging shirking for self-direction on the field without client resistance, and creating an unfavourable environment for the optimal development of the harvests in a continuous checked shut condition [8]. In this study, a real nature sensor and an accurate assessment calculation for plant recognition are shown. The developed framework relies on open-source, programmable real-world sensors to continuously recognise and distinguish between individual weed and crop plants using mathematical computations and choice models [9]. Using genetic analysis and a connection-based element determination approach, this research has developed apple leaf sickness distinguishing proof. Following the conversion of RGB structure to HSI, YUV, and dim structure, a shading change construction of information RGB image was initially envisaged. After the foundation evacuated, the disease spot picture was divided with district developing calculation (RGA). Finally, the SVM classifier detected the illnesses [10]. the quick development of new technologies and the shifting landscape of the internet world. Cloud-based plans, the Internet of Everything, and the Web of Things (IoT) offer a fresh way to create mechanised, modern methods for officer administration, farming, and urban planning. Precision agribusiness has benefited from innovative developments in mechatronics, laser technology, actuators, overall organising structures, machine vision, and overall arrangement of structures. The mechanical applications on plant pathology and the board, as well as emerging agricultural developments for intra-urban cultivation, are presented and reviewed in this article. In the most recent years, nursery has essentially pushed the official structures and headways, connecting IoT and WSN (Wireless Sensor Network). For robotic and mechanical development in agriculture, artificial intelligence, machine vision, and AI have all been used and linked. Understanding developments have been made utilising machine vision/learning, not only for planting, watering, weeding (to some extent), pruning, and purchasing, but also for plant disease recognition and confirming identification. Despite this, the test for both abiotic and biotic weight remains an intriguing one with regard to plant disorder recognised proof. There are several successful affirmation techniques and advancements for detecting plant disease reactions, but the bulk of them require a controlled environment for data collection to prevent false positives.

MATERIALS AND METHODS

The suggested framework consists of sensors for temperature, moisture, and shading that collect data from plant leaves based on the variation of plant leaf temperature, mugginess, and shade. The data gathered from the leaves includes details on the present ecological conditions, such as temperature, moisture, and shade. The Temperature, Moisture, and Shade sensors record the changes that a plant goes through, and the Arduino software analyses them. The data obtained from temperature, moisture, and colour sensors is configured for an Arduino UNO unit before being sent to the farmers. The system makes use of WiFi shield to transfer data from the host system to the cloud platform for analysis.



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- 1) Information gathering: In this case, we accept information from experiments on different leaves. The sensors then detect these leaves and determine various metrics based on whether the leaves are considered to be healthy or sick.
- 2) Temperature sensors: The DHT11 is a traditional, ultra-simple temperature sensor that has been upgraded. There are no conventional information pins needed; instead, a propelled sign is released on the data stick through a capacitive moisture sensor.
- 3) A humidity sensor, as shown in figure 3. A crucial, ultra-simplicity-driven suddenness sensor is the DHT11. It measures the ambient air using a thermistor and a capacitive moisture sensor, and it then emits an automatic sign onto the data stick.
- 4) Color Sensor: The TCS3200 is a programmable shading light-to-recurrence converter/sensor, as seen in figure 4. The sensor is a single, fully integrated CMOS device that combines a silicon photodiode with programmable characteristics and a current-to-recurrence converter.
- 5) Arduino: As shown in Figure 5, the Arduino United Nations Organization is a widely used open-source controller board built around the ATmega330P microcontroller and created by Arduino.cc.

6) Cloud stage: In this case, we use the "ThingSpeak" cloud stage to communicate the information that has been discovered to the cloud. To visualise the change in temperature, mugginess, and shading, this transmitted data is plotted against the diagram. We determine whether the attributes fall into a comparable range based on the data that is displayed against the diagram. If they do, the leaf is then either healthy or sick, depending on their actions.

Algorithm 1: Plant disease detection with temperature and colour sensors

Enter: leaf (infected or Normal)

Leaf output: healthy or ill plants

Description: The recommended temperature range for healthy leaves is 15–300°C.

Start

Get a leaf to start with.

Step 2: Utilize the DHT11 and TCS3200 sensors to gauge the leaf's temperature and colour.

Step 3: Determine the temperature and colour if the conditions are met (minimum range temperature maximum range AND minimum range colour maximum range).

Otherwise, display "Leaf is Normal"

Display" Leaf is Diseased" Stop

CONCLUSION

In order to determine the nature of the leaves, a framework is developed in this essay. The suggested approach makes use of sensor devices to identify metrics such as temperature, stickiness, and leaf color. These parameters are then compared with the informational index to see if the obtained characteristics fit within the range defined in the informational collection. Ranchers, businessmen, botanists, food designers, and physicians can all use the proposed approach in different regions. The next step in this project is to combine the suggested framework with image processing techniques to make it more accurate and efficient to determine the characteristics and whether the leaves are healthy or not. The proposed approach is limited to just determining whether the leaf under consideration is healthy or diseased. Additionally, this can be done to recognize the type of illnesses present in the leaves and their distribution. We have limited our research to only the leaf temperature, mugginess, and shading characteristics. By using additional sensors and picture-processing techniques, this can also be improved. The other restriction is that the chosen characteristics for the assumed parameters are not precise. We have taken the parameters' range of quality into consideration, although the range may change depending on the weather.

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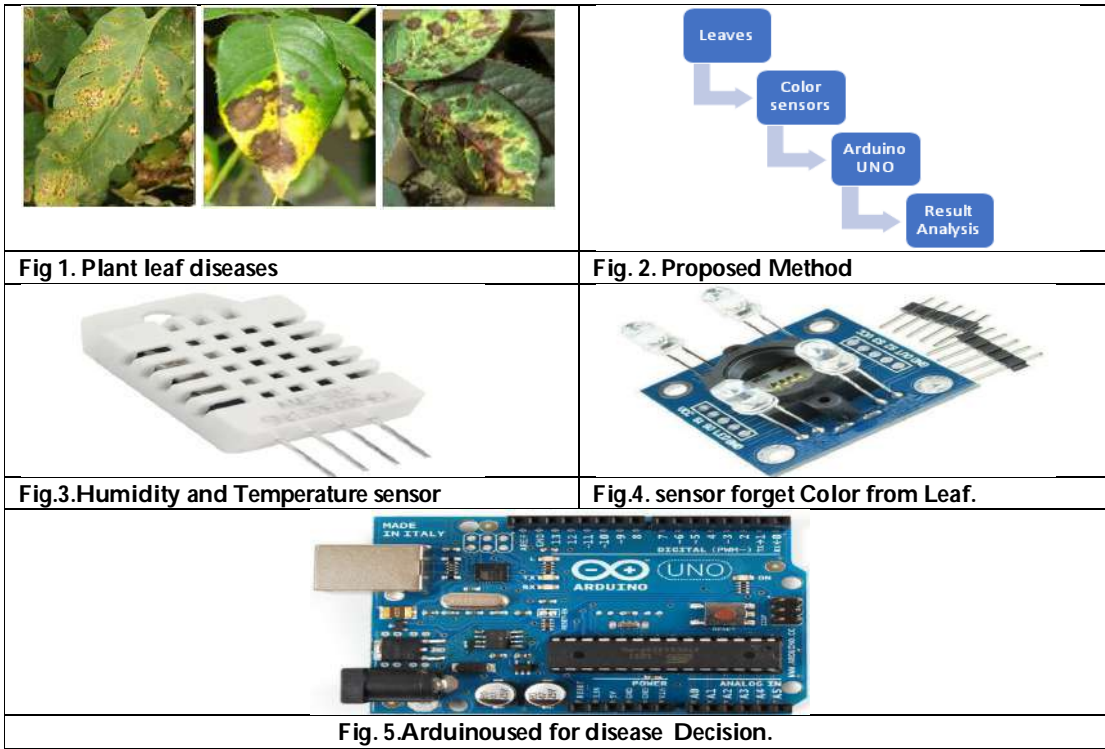




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Alcoholic Detection System using Arduino Uno

ManojKumar Naragund^{1*}, Anitha H¹ and Puja Shashi²

¹Student, Department of MCA, The Oxford College of Engineering Bommanahalli, Bengaluru-560068, Karnataka, India.

²Associate Professor, Department of MCA, The Oxford College of Engineering Bommanahalli, Bengaluru-560068, Karnataka, India.

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*Address for Correspondence

ManojKumar Naragund

Student,

Department of MCA,

The Oxford College of Engineering Bommanahalli,

Bengaluru-560068, Karnataka, India.

E.Mail: manojkumarmca2023@gmail.com



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ABSTRACT

It is now simpler than ever to be involved in an accident because to developing technologies and high end vehicles with more horse power and usable speed. Driving carelessly can compromise the safety of regular people. Road accidents still occur every day, despite the implementation of speed limits and other preventative legislation. Over-speeding, reckless driving, and drunk driving are some of the major causes of car accidents. The proposed effort aims to create a tool that prevents accidents brought on by excessive drinking while driving. This device will be able to recognize excessive speed and be setup to send an SMS alarm. When alcohol intake is detected, an application on the device prevents the vehicle engine from starting. The Global System for Mobile Communication (GSM), the Global Positioning System (GPS), and alcohol sensors were used in the construction of the gadget model.

Keywords: Motor vehicles, Reckless driving, Speed limits, Prevention laws, Drunk driving, SMS, GPS, Alcoholic Sensor.

INTRODUCTION

The most frequent hazards to their life and the lives of others today are drinking and driving. Although we cannot prevent people from drinking, we can prevent accidents by inspecting the person drinking and by keeping such modest gadgets in the car to ensure that no one is drinking and driving. Today, we're building a straightforward alcohol detector. It has a wide range of applications that we can employ. As a result, this is a brief demonstration of a straightforward alcohol detector built with an Arduino and a MQ3 sensor. Arduino, LEDs, and a MQ-3 Alcohol sensor will all be used in today's project to create an alcohol indication. Although there are various MQ-X sensors on the market for a variety of applications, we will pick MQ-3 in this instance because it is the most effective at





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detecting alcohol. The majority of MQ sensors operate similarly. Each one of them has a heating element that uses heat to warm a layer of conducting material whose resistance is constantly monitored. As alcohol vapours or odours come into touch with the MQ-3 sensor, its resistance changes. The sensor outputs data digitally and analogly. In contrast to the analogue signal, which transmits a wide range of values from 0 to 1023 and measures the amount of alcohol in the immediate surroundings, the digital output simply transmits high or low values, which equate to either 1 or 0, to a microcontroller. The LM393 IC used to construct the sensor features an internal amplifier that boosts the voltage signal to the detectable level. Voltage comparators are also included for effective amplification. Potentiometers located on the sensor can be used to modify the amplification level.

RELATED WORK

[1] This paper's objective is to create a system. that checks to see if the driver's Iris is open before taking the picture. person is intoxicated, and creating a trustworthy algorithm to recognise iris. This document is made up of hardware. a com- puter programme and system that emphasises the application of a Gabor Filter-based algorithm. The system is made from with Analog-to-Digital Converter and CCD Camera included into a MATLAB programme and used to replicate the collected which subsequently sends a signal to the image To control the car, use a microcontroller and a relay circuit. ignition. If the MATLAB software determines the driver is While intoxicated, a bypass system comes into play. through a password that MATLAB recognises. then the car or other vehicle starts.

[5] Alcohol-impaired driving is one of the main causes of motor vehicle accidents, according to risk analyses of being involved in an accident. Keeping drunk drivers off the road might potentially save a lot of lives. This study suggests a simple in-vehicle alcohol detection system that uses an optimizable shallow neural network to analyse data from six MQ-3 alcohol sensors (O-SNN). The experimental assessment results demonstrate a high-performance detection system, with a detection accuracy of 99.8percent with a 2.22 s inferencing time. The driver alcohol detection system for safety (DADSS) system aims at the widespread deployment of alcohol-sensing systems, which has the potential to save thousands of lives every year. As a result, the proposed model can be effectively deployed and used to discover in-vehicle alcohol with high accuracy and low inference overhead. [3] An accident is a particular, unforeseen, external action that is unusual and unintended and occurs in a specific moment and location, without any obvious and intentional cause, but noticeable repercussions. Carelessness The primary cause of these collisions is driver error [1]. The traffic authorities issue the drivers a variety of directives, driving professionals. Yet, many of them disregard the rules. Currently, the majority of nations are imposing the motorcyclists must wear a helmet and refrain from using the cars while under the influence of alcohol. But Nonetheless, users continue to break the regulations.

In this project, an alcohol detection system with engine locking for automobiles is designed and put into practise utilising an ultrasonic sensor and an Arduino UNO as the MCU (Master Control Unit). The technology will continuously check the alcohol detection sensor's concentration level and shut off the vehicle's engine if it rises above a certain level. Also, the model will use SIM900A to transmit information on the location of the car. The concept offers a practical way to reduce accidents caused by intoxicated driving.

The suggested method makes use of a number of inex- pensive alcohol MQ3 sensors that are installed inside the car. The data from these sensors are then saved, normalised, time- adjusted, and converted into 5 s window samples. Each sam- ple's statistical features are extracted, and a genetic algorithm, along with a forward selection and backwards elimination approach, are used to carry out a feature selection strategy. An SVM classification model that can identify the presence of alcohol was built using the four features that were obtained from this method. 7200 samples were produced by the tests, and the model was trained on 80 percent of those samples. The remaining data were utilised to assess how well the model performed, and it did so with an area under the ROC curve of 0.98 and a sensitivity of 0.979.



**ManojKumar Naragund et al.,****LITERATURE SURVEY**

The following are some major ideas and sources for a review of the literature on alcoholic detection using car locking systems: Automobile alcohol detection devices can stop drunk driving incidents and save lives. Systems of various kinds, including as breathalysers, touch-based sensors, and biometric sensors, have been created and put through testing. The most popular kind of alcoholic detection device uses a breathalyser to measure the driver's blood alcohol concentration (BAC). On the other hand, touch-based sensors and biometric sensors can identify alcohol through the skin or other physiological fluids. According to one study, a breathalyzer-based system that locked the car if the driver's blood alcohol content (BAC) was higher than the permitted level 0.08 percent proved successful in lowering the incidence of drunk driving. The study also suggested that increasing incident reductions might be achieved by integrating the system with other treatments, such as public awareness campaigns and harsher punishments for drunk driving. Another study assessed the performance of a biometric device that may detect alcohol through the skin of the driver. The system demonstrated a high level of accuracy in identifying alcohol, but the study also identified room for improvement in the system's response time. For the purpose of detecting alcohol in cars, touch-based sensors have also been created and tested. These sensors are capable of detecting alcohol through physiological fluids like sweat or blood on the driver's hands or fingers. A touch-based device that locked the car if alcohol was found on the driver's hands, according to one research, was successful in reducing incidences of drunk driving.

SYSTEM CIRCUIT DIAGRAM AND COMPONENTS**System Circuit Diagram****Components****Arduino Uno**

It is the brain of our project. It has the ability to give all orders to its dependant parts that should be controlled by human behaviour. And it also sends feedback to the other components and humans. In order to facilitate communication between humans and robots as well as vice versa. It has a specification of 8-bit CPU, 16 MHZ clock speed, 2KB SRAM 32KB flash memory, and 1KB EEPROM.

DC Motors

Any form of energy can be transformed into mechanical energy by a DC motor, which also affects motion. In designing a robot, the motor usually plays a significant part by delivering movement to the robot. Here DC motors are used to control the vehicle.

MQ3 Sensor

For detecting gas leaks, the Grove - Gas Sensor (MQ3) module is helpful (in the home and industry). It is suitable for detecting Alcohol, Benzene, CH₄, Hexane, LPG, and CO. Owing to its great sensitivity and short response time; measurements can be obtained as soon as possible. Here the MQ3 sensor is used to detect the alcoholic smell from the driver.

Buzzer

A buzzer or beeper is a mechanical, electromechanical, or piezoelectric audio signalling device (piezo for short). Alarm clocks, timers, training aids, and confirmation of user input like a mouse click or keystroke are common uses for buzzers and beepers. Here the buzzer is used to beep the sound when the system detects the alcohol.

Led Bulb

LEDs are perfect for many industrial uses because to their high efficiency and directed nature. Street lights, parking garage lighting, walkway and other outdoor area lighting, refrigerated case illumination, modular lighting, and task lighting all use LEDs more and more frequently. Here the led bulb will blink when alcohol is detected.





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WORKING AND DESIGN

Dataflow Diagram

Our system uses a MQ3 alcoholic sensor to determine whether the driver or passenger has consumed alcohol. If this happens, a buzzer will sound, a led will blink, and the vehicle will come to a slow stop in the middle of the road. After a few hours or until the alcohol scent has subsided, the system will email the family members the GPS location and alarm message. Further warnings will be sent to the cops/police station registered with the city after the first and second warnings; only cops/police are authorized to open the Vehicle. An accelerometer is also part of our system, which we use to identify irregular driving. The system will warn the driver via the buzzer and LED if it detects erratic driving, which may be a sign of alcohol or distraction. The technology will also notify the cops/police station registered with the city of the irregular driving and the location of the car via an alert.

We have programmed the microcontroller to carry out self- checks and calibrations periodically in order to guarantee the precision and dependability of our system. This makes it easier to spot and fix any faults or discrepancies in the sensor readings, ensuring the system runs efficiently and precisely. Furthermore, our system contains a GSM module that may be used to text messages or alerts to the registered police officers and family members as well as other law enforcement agencies. In the event of an emergency, such as a collision or mechanical failure, this feature may be helpful in giving the driver and passengers prompt support.

MODELLING

The presence of alcohol can be detected by the gas sensor MQ-3. The microcontroller can then start different outputs, such as LED lights, buzzers, or motors, when the sensor detects alcohol. The MQ-3 sensor can be used to make an alcohol detector by connecting it to a microcontroller, like an Arduino board, and programming the board to react to sensor readings. The microcontroller can then start different outputs based on the amount of alcohol detected. For Example, the microcontroller may operate a buzzer to sound an alert, a red LED bulb to show a high alcohol level, and a motor to slow down or stop to prevent the individual from operating the vehicle. The desired functionality and the specific components utilised will determine the programming and circuit design for an alcohol detector employing the MQ-3 sensor. It is crucial to remember that alcohol detectors like the MQ-3 that use gas sensors are not always reliable and shouldn't be used as the only tool for figuring out how drunk someone .

Alcoholic Detection System Prototype Model

The Fig.3.shows the Alcoholic Detection System Prototype Model.

Alcoholic Detection Model

The Fig.4.shows the Alcoholic Detection Model.

RESULTS

Alcohol-related fatalities are on the rise nowadays, and breaching the law can result in a lifetime in prison or fines of thousands or even millions of dollars. To solve this issue, we created a straightforward model that detects alcohol from the driver or passenger. If the sensors detect alcohol from the person, a buzzer will sound and the led will blink, and the vehicle will slowly come to a stop in the middle of the road. Cops and police will need to check every person to see if they are drunk or not. After a few hours or until the alcohol scent has subsided, the system will email the family members the GPS location and alarm message. For further health protection, we have integrated smoke detection to our system in addition to alcohol detection. Smoking is not permitted inside the car, and if smoke is found, the buzzer will sound and the LED will blink to let the driver and passengers know. The technology will also provide the family members with an alarm message and the GPS location of the car. This feature helps reduce potential fire hazards brought on by smoking inside the car in addition to fostering a healthier environment for all passengers. Our system's combination alcohol and smoke detection functions are meant to encourage safe and responsible driving habits and guard against accidents brought on by intoxicated driving or vehicle smoking.



**ManojKumar Naragund et al.,****APPLICATIONS**

We can use Alcohol detector projects in offices, industries, and colleges. It increases workplace safety of all co-workers in companies. This alcohol detector with SMS alerts project is easy to use and is very cost-effective. This project can be advanced and can be used in vehicles to shut down engines. Reducing road accidents: The alcohol detection system can help reduce road accidents by preventing drunk drivers from operating a vehicle. Law enforcement: The system can assist law enforcement officers in detecting drivers who are under the influence of alcohol, allowing them to take appropriate action. Personal safety: The system can help individuals monitor their alcohol consumption and prevent them from driving while under the influence. Commercial fleets: The system can be useful for commercial fleets, such as taxis or buses, to ensure that their drivers are not driving while under the influence. Insurance: The use of an alcohol detection system in vehicles may help to reduce the risk of accidents, which can lead to lower insurance premiums for drivers. Preventing underage drinking: The alcohol detection system can be used in homes to prevent underage drinking by alerting parents if their children have consumed alcohol.

Productivity at work: By preventing employees from being inebriated while at work, which could cause accidents or mistakes, the system can increase workplace productivity. Safety in public transportation: The method can be used to check that drivers are not operating vehicles while under the influence of alcohol on buses or trains. DUI prevention: Using an alcohol detection system in a car can deter people from operating a motor vehicle while intoxicated, lowering the incidence of DUI (Driving Under the Influence) cases. Applications in medicine: The technique can be utilized in medicine to monitor patients receiving alcohol rehabilitation and to stop relapses. Sports and athletic contests can employ the alcohol detection technology to make sure that competitors aren't drinking before or during tournaments, which could affect their performance and safety.

FUTURE ENHANCEMENT

Our ability to build intelligent automobiles with cutting-edge features like GPS tracking, which allows us to share our location with others, is made possible by modern technology. One can send an alert message to their contacts in an emergency informing them of their whereabouts and GPS co-ordinates. This function is especially helpful in circumstances where someone may be missing or in danger and needs rapid assistance. Also, we may use this technology to increase our driving safety. If we are driving carelessly or disobeying the law, a smart vehicle can be designed to send warning or alarm messages to our family members. The first and second warnings can be sent to our contacts to let them know about our activity, and the third warning can be forwarded to the police station if we still don't alter our driving habits. The police will then be able to remotely unlock the car and take the required steps to ensure the driver's and other drivers' safety. The combination of these elements has the potential to dramatically increase our safety both behind the wheel and in other emergency situations. In conclusion, the incorporation of cutting-edge technology into automobiles has created new opportunities for enhancing road safety. In the event of an emergency, we can broadcast our location and inform our contacts using features like GPS tracking and automated alarms. Also, the warning and alert system can be utilised to discourage irresponsible driving and guarantee the safety of both the driver and other road users. Automatically alerting family members and the police station can help avoid accidents and deliver aid quickly in an emergency.

CONCLUSION

Drunk driving is still a serious issue that causes many accidents, injuries, and fatalities. The suggested technology is created to detect alcohol in the driver's breath or bloodstream and stop the operation of a vehicle if alcohol is found. An Arduino microcontroller board, an alcohol sensor, an LCD, a buzzer, and a led bulb make up the system. The working principle of the system is straightforward. If the sensor detects alcohol, the system will send warnings to the driver and their family members via SMS and display an alert on the LCD. The vehicle will gradually slow down until it stops, and its location will be sent to the family members. If the driver continues to ignore the warnings, the police will be notified, and only they can unlock the vehicle remotely and take necessary action to ensure the safety



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of the driver and other individuals on the road. Future improvements might integrate GPS tracking with smart vehicle technology, send warning and alert messages to family members, and lock and unlock vehicles remotely for law enforcement. These features can improve overall road safety and prevent accidents caused by reckless or drunk driving.

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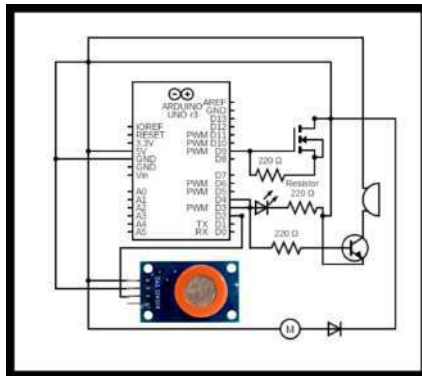


Fig.1.Circuit Diagram

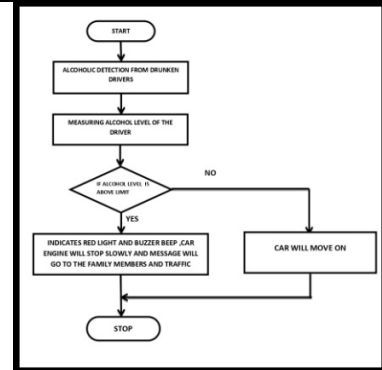


Fig.2. Data flow Diagram

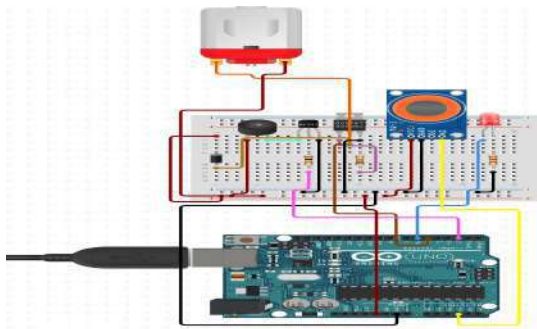


Fig.3. Prototype Model

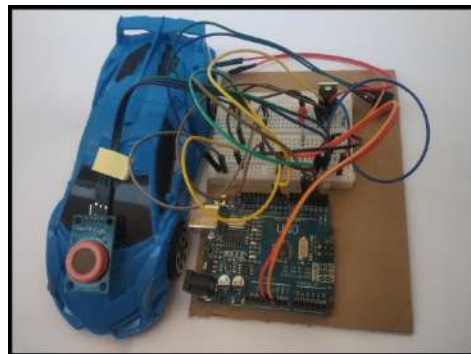


Fig.4. Prototype Model





Optimized Power Consumption AODV Routing Protocols for flying ad-hoc Networks

Deepak Kumar^{1*} and Sonia²

¹Research Scholar, Department of Computer Science, S.J.J.T.U, Jhunjhunu Rajasthan, India.

²Associate Professor, Department of Computer Science, S.J.J.T.U, Jhunjhunu Rajasthan, India.

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*Address for Correspondence

Deepak Kumar

Research Scholar,
Computer Science,
S.J.J.T.U, Jhunjhunu,
Rajasthan, India.

E. Mail : dk795979@gmail.com



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ABSTRACT

Wireless networks play a critical function in assisting society in improving the quality of life. Unmanned air vehicles connected ad-hoc have been deployed for a range of civic and military objectives. Establishing a dependable, secure connection between UAV nodes in the FANET is a significant challenge due to the fast mobility of the nodes, the harsh environment in which they operate, and the nodes' limited energy capability, among other factors. Routing protocols employed in this network should have specific characteristics that allow for dependable and secure connectivity between nodes. Onboard power sources power the complete system of the flying UAV, including the transmitter, receiving equipment, control unit, information processing unit, and payloads. UAVs with limited onboard energy capacity have a shorter flight time, affecting the performance of FANETs significantly. Optimizing the energy consumption of nodes-to-nodes is a critical scientific challenge. AODV protocol extensions outline their characteristics, functionality, benefits, and limitations, followed by a performance comparison. The Proposed protocol is mainly divided into three sections: routing with AODV protocol, Optimization-based Cluster Head Selection, and Cooperative Medium Access Control (MAC). The cross-layer approach is implemented on the network layer and the data layer. The major parameters considered to evaluate the performance of the FANET are Throughput (TP), End-to-End (E2E) delay, and packet drop ratio (PDR).

Keywords: unmanned aerial vehicles (UAVs); flying ad-hoc networks (FANET); ad-hoc on-demand distance vector (AODV)





INTRODUCTION

Wireless mobile networks include flying ad hoc networks. Small drones or small air vehicles outfitted with communications and other specialized equipment for diverse applications are used as mobile nodes. The coverage distance, remote area service, rapid deployment, and real-time data processing capabilities of FANET over MANET enable on-the-spot action, particularly in control applications. The low cost of unmanned aerial vehicles (UAVs) like drones and small air vehicles, as well as other data gathering, processing, and communication equipment including cameras, sensors, microcontrollers, GPS, RF interfaces, and communication equipment, has resulted in rapid development in the use of FANETs. Drones are also used in manufacturing factories to control the stock material availability across multiple stores, assisting in maintaining the required stock level. UAVs provide communication services in remote villages, and hill areas where establishing infrastructure networks are impossible. The use of FANETs. Drones are also used in manufacturing factories to control the stock material availability across multiple stores, assisting in maintaining the required stock level. UAVs provide communication services in remote villages and hill areas where establishing infrastructure networks are impossible [2].

Drones are also used in manufacturing factories to control the stock material availability across multiple stores, assisting in maintaining the required stock level. UAVs provide communication services in remote villages, and hill areas where establishing infrastructure networks are impossible [2]. FANETs differ from other mobile networks in numerous ways, including their distance coverage, node mobility velocity, capacity, and power supply type (VANETs, MANETs) [3]. Using energy measurements, we examined the performance of the classic routing protocols AODV, DSR, and DSDV in FANETs during the first phase of our research. The first phase results show that in FANETs, AODV outperforms competing protocols. AODV protocols use energy measures to optimize paths and hop count in the second step. Finally, a performance comparison of protocols was undertaken; the findings reveal that AODV outperforms others protocols significantly. Performance was assessed using the NS-2 simulator and random waypoint mobility models.

Evaluation of the Performance of Existing Manet Protocols in Fanets

When a node requests to send a packet to another node, it first checks the information in its routing table to see if a route exists, and if one does, it uses it to send the packets. The route discovery process is started using the RREQ broadcast message if there are no valid routes in the routing table. The shortest path is chosen if numerous pathways connect two pairs of nodes [4][5].

Route Discovery Process When the source node does not have correct path information to its intended destination, it starts. The discovery process generates RREQ packets and broadcasts them to nearby nodes, who then post them to their neighbors, and so on, until the RREQ finds an intermediate node with a valid route to the desired destination or reaches the selected destination node. The broadcast ID and the source IP are used to identify each RREQ launched by source nodes individually. When a source node initiates a new RREQ, the source node's previous former broadcast id is increased by one. The intermediate node uses the sequence number to ensure that there are no loops and to assess the freshness of the route information provided. When an RREQ packet arrives at an intermediate node, the adjacent node's address is added to its routing database as the source of the initial copy of RREQ, and the reverse route to the sender node is created. Following reception of the RREQ packet, intermediate nodes that have discovered a new way to the destination or destination nodes generate the RREP packet.

Then send it to the source node through the reverse route established during route discovery. [6][7]. During RREQ transmission, the reverse path is constructed identically to the forward way. As the RREP traverses the reverse route, each intermediate uses RREP packets to record the track in the routing database. As a result, when RREP arrives at the source node, it builds a forward and reverses the path between the source and destination pairs. Furthermore, each following intermediate node must remember the destination's next hop[8].



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Route Maintenance: The source node transmits packets through multi-hop mode transmission via the established path after building a route to the destination using the route discovery approach. Ad-hoc networks may face frequent link failures at the DLL level due to their fast mobility and concerns about stand-alone battery depletion. Intermediate nodes regularly send hello packets to their neighbors to advertise their availability; this message allows the intermediate node to verify the routing information in its database. When a wrong path is discovered, the routing information is deleted from the database, and a reverse route error message is sent to the source nodes using RERR PACKET[12][13].

After receiving RERR, the source node starts the route discovery procedure with the newly given broadcasting id. Figure.1 depicts the route-finding approach, which assumes a network of 15 mobile nodes. Node S starts the route discovery process by sending out RREQ packets to the rest of the network. 'S' is bordered by the nodes 'A,' 'B,' and 'C.' They get the RREQ packet request, inspect the packet replication, and add 'S' to the routing information database as a reverse path node S if any are new. Then, all nodes scan their routing information databases for valid path entries to target nodes; if none exist, the route discovery packet is rebroadcast [8][9]. The RREP packet will be redirected to the source node by intermediate nodes having valid route entries in their routing tables. Assume that none of the intermediate nodes in Figure.1 has a good route and that RREQ packets arrive at the destination in several different ways. Finally, the destination nodes construct RREP packages and send them to the source node S via the shortest reverse path (with the fewest hops).

Destination nodes use the D-K-H-F-B-S method to forward RREP packets since it is the fastest of the three options. The procedure for fixing a DLL link problem is shown in Figure.2. The intermediate nodes communicate with the source and destination nodes via the RERR packet when a link fails.

The connection between the intermediary nodes H and K have been broken in Figure.2, causing H and K to produce and transmit RERR packets to the source and destination nodes, respectively. When nodes in the forward and reverse paths get the RERR message, they delete their route entries before sending the RERR packet to nearby nodes, indicating that this route is no longer available. When a source node receives a RERR packet, it uses the unique broadcast ID to start a new route discovery process [14].

Precise Link SINR Calculation

To make a routing decision, SINR needs to be calculated precisely. In FANETs, the SINR depends on the effect of channel medium, transmission power, inter-UAV distance, node density, mission environment, and UAV mobility. The precise calculation of SINR can increase the performance of the MAC and routing layers. Thus, to improve the SINR performance, joint mobility control and resource allocation need to be allocated optimally [12,20]. Better SINR guarantees high link quality and low packet error rate, which improves the routing performance significantly [23]. Thus, cross-layer design is essential in FANETs.

Cross-Layer Design

In FANETs, the link delay, SINR level, link reliability, UAV residual energy, and relative mobility are the key factors in defining link stability. The optimal transmission power allocation in the physical layer and optimal physical resource allocation, such as the frequency or time slots in the MAC layer, control the SINR and throughput of the links. Joint consideration of these constrained resources can significantly improve the performance of the routing layer (relay selection) because they are highly coupled. Designing a cross-layer routing protocol with optimal resource allocation, such as transmission power according to the changes inter-UAV distances indicated by a topology controller [12], MAC layer frequency, or time slots, can be an interesting research direction [10][11].

Precise Calculation of Energy Consumption

In FANETs, the energy consumption cost of UAVs depends on the power consumption for propulsion and communication to transmit and receive data from neighboring UAVs and GUs. [21]. However, the propulsion



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power of UAVs consumes significantly more energy than the communication energy cost [9]. All of our reviewed routing protocols only consider deliberate the communication energy when calculating the energy cost. For a realistic performance, the energy cost should be obtained attained by considering both propulsion and communication power.

Fanet's Standard Routing Protocols

Due to the unique communication environment of ad hoc networks, it is significant to establish distinct protocols. FANET predominantly makes use of three types of routing mechanisms [14][15]:

Proactive or Table Driven

Each node determines the optimal routing path for each destination and stores the information in its routing table. Nodes frequently communicate routing information with surrounding nodes in order to obtain and acquire current and updated topological information. The proactive approach always maintains viable paths to all source and destination pairs, even if they are not being used at the moment. The key benefit of this technique is that packets may be routed quickly because each source and destination combination have a specified path. The disadvantage is that the overhead associated with control packets consumes significant network bandwidth and node energy. Two important proactive protocols are optimized link state routing (OLSR) and Destination Sequenced Distance Vector (DSDV).

Each node in the network keeps routing information for the other nodes via routing tables that are updated on a periodic basis as the network architecture changes. Proactive protocols come in a variety of flavors, including Destination sequenced Distance vector routing (DSDV), Wireless routing protocol (WRP), Fish eye State Routing protocol (FSR), Optimized Link State Routing protocol (OLSR), Cluster Gateway switch routing protocol (CGSR), and Topology Dissemination Based on Reverse Path Forwarding (TBRPF)[17][18].

Because routing information is stored in a table, the Pro-Active routing protocol is frequently referred to as a "table-controlled" protocol. This strategy requires network nodes to continuously discover the path to all other access nodes and attempt to maintain consistent and up-to-date routing information in the routing table. This enables a source node to obtain a routing path more quickly when it is required (Du Dahai, et al., 2010). Typically, routing information is dispersed throughout the network. Within a defined time, interval, these routing tables are exchanged between network nodes. Routing changes occur at precise time intervals determined by the network's mobility and traffic patterns [16,19].

Reactive or on Demand

Unlike reactive protocols, an 'on-demand protocol' identifies the path on demand via a route discovery technique. When a path between two nodes is required, it establishes the routes. It performs route discovery by utilizing route request packets (RREQ) and route reply packets to determine the paths between specified pairs of nodes. Once a route is established, it preserves this information until the receiving node becomes unreachable or the established route is no longer required by the source. Occasionally, a DLL link will fail during packet transmission, preventing packets from reaching their destination [22].

In this case, a route maintenance method will be performed to determine active alternate routes. The primary advantage of reactive protocols over proactive protocols is that they require less control packet overhead, which results in lower bandwidth usage, lower power consumption, and reduced network congestion. The most frequently used on-demand protocols are (AODV) and (DSR). Routes are developed as needed. The route remains valid as long as the destination can be reached or until it is no longer required. Reactive protocols come in a variety of flavor's, including Ad hoc On-Demand Distance Vector (AODV), Dynamic Source Routing Protocol (DSR), Temporally Ordered Routing Algorithm (TORA), and Associativity-Based Routing (ABR). A node does not continually maintain a path across all network node pairs in this manner. They are only discovered when they are absolutely necessary (Ghazi pour et al., 2016). When a node needs to transport data to another destination, it first





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checks its route database for a feasible path. If no route is found in the table, the path-finding method is initiated. As a result, the demand becomes the discovery of the path. This is often referred to as on-demand routing [21][24].

Combination of both or Hybrid Protocols

Hybrid protocols combine the reactive and proactive qualities of protocols. The vast network is divided into zones, and proactive protocols communicate between nodes within a zone, while reactive protocols communicate between nodes in different zones. (ZRP) and are the two fundamental protocols that fall under hybrid routing (SHARP) [25][26]. These protocols are a blend of proactive and reactive techniques and are hence appropriately referred to as hybrid routing protocols. Nodes located within a given geographical region or at a set distance from the source node are said to be within the source node's routing zone (Jacquet et al., 2001). Within this region, routing is accomplished by using a table-based technique. For nodes located outside of the area, a demand-driven method is used [23].

RESULTS AND ANALYSIS

The performance of three current classical MANETs routing protocols in FANETs environments is evaluated using extensive simulations using NS-2 and the construction of innovative energy-aware routing protocols for FANETs based on AODV. C++ and TCL are used to implement the suggested energy-aware modified form of AODV protocols. The random waypoint mobility model was chosen as the mobility model since it is a commonly used module in MANET network installations. Mobility and node density are the two essential parameters that substantially impact the performance of FANETs networks. These two circumstances are used to assess the performance of the FANETs. We keep one of these conditions fixed in our evaluation while adjusting the other throughout the simulation. The simulation parameters are listed in Table 2. The result has been plotted from figure.3 to figure 8. The following performance measures are used to evaluate the new energy-aware routing protocols:

Network lifetime: The time required for the first node to deplete its battery energy.

Packet delivery ratio: The total number of packets received to the total number of packages broadcast. It reflects how efficiently a protocol transports containers from source to destination.

It is definable as:

$$PDR = \frac{Rp}{Sp} * 100$$

Where Rp denotes the total number of packets received and Sp denotes the total number of packages sent.

End-to-End Delay (E2ED): This time-based metric is expressed in seconds and accounts for all possible network delays. The average E2ED can be defined as the time taken to transmit a data packet over a FANET. Where TR denotes the time of receipt and TS represents the transmission time.

Average throughput (Thp): This is defined as the average number of bits arriving at the destination node per second. This is used to determine the protocol's robustness in numerous conditions; hence, the network's average throughput should be as high as possible. It can be mathematically defined as,

$$\text{Average thp} = \frac{Np * \text{packet size} * 8}{\text{seconds}}$$

MODEL OF ENERGY CONSUMPTION

According to the IEEE 802.11 specification for WAVLAN, the transmitting and receiving nodes consume 280 mA and 330 mA of current, respectively, when a 5V battery is used, and a transmission rate of 2 Mbps is active.





The entire amount of energy required to send or receive a packet is as follows:

$$e = tp \cdot I \cdot V \text{ (Joules) ... (eq. 1)}$$

(tp, the time required for a node to transmit or receive a single packet I = current, V = voltage)

Time required for packet transmission:

$$tp = (\text{phs}/2 * 106) + \text{pps}/(2 * 106) \text{ sec... (eq. 2)}$$

Where 'phs' denotes the size of the packet header, and 'pps'

denotes the size of the packet payload. (bits/sec). The following equation can be used to determine how much energy a node consumes during packet transmission (Te) and reception (Re).

$$Te = (0.33 * 5 * (\text{phs} + \text{pps}))/2 * 106 \text{ ... (eq. 3)}$$

$$Re = (0.28 * 5 * (\text{phs} + \text{pps}))/2 * 106 \text{ ... (eq. 4)}$$

Figure.6 depicts the energy consumption of the network versus number of nodes and speed of nodes. On-demand routing protocols (DSR, AODV) consume more energy as compared to table-driven protocol (DSDV). DSR performs better than AODV although uses source routing. The energy consumption due to the routing overhead of DSR is insignificant as compared to AODV. Figure.6 shows that the energy consumption declines with the increase of nodes. The routing energy consumption upsurges with the increase of either nodes or speed and it is minimum for DSR and maximum for DSDV. The MAC energy consumption decreases and it is minimum for DSDV. The DSR consumes less energy as compared to AODV because the DSR usages cache for route maintenance whereas AODV starts a novel route discovery for link breakage.

Figure.7 depicts that the energy consumption of reactive protocols is considerable relentless when the movement speed is varying while it increases against the number of nodes. But both the reactive protocols (AODV, DSR) outperform DSDV. The Energy Consumption per Successful Data Delivery (ECPSDD) of DSDV increases as compared to speed as the probability of link breakage also increases. The ECSDD of DSR is less than AODV because DSR uses a lesser number of routing overhead than AODV

Figure.8 shows the number of link breaks detected by routing protocols. AODV shows the minimum number of link breaks. DSDV detects maximum link breaks because cannot adjust to the dynamic environment and the condition deteriorates further with the rise of mobility. DSR link breaks are also increasing with the speed but AODV is able to adapt itself with the mobility and keep the link failures to lowest. We know the Short Retry Limit of RTS (07) and Long Retry Limit of Data packet (04) is checked [7] before triggering a link failure in IEEE 802.11 MAC. And as per the considered Energy model, energy consumed in transmitting and receiving depends on the size of the packet sent/ receive. So a link failure may cause at least 15.5 Joule (3.37 x 4 Joule for data packets and 2.02 Joule for RTS packets). Hence the protocols reporting more link failures will consume a larger amount of energy in the network.

CONCLUSION

This study has evaluated three ad-hoc routing protocols in different scenarios considering node density and mobility. Overall, the conclusions recommend that the prevailing routing protocols have not been designed to provide energy-efficient routes but instead to offer the best efforts of less delay. That is why have shown significant differences in energy consumption. There is no single protocol qualifying all the performance metrics. DSDV makes the network lifetime longer than others but consumes a larger amount of energy per packet and less throughput for high mobility. DSR performs better and consumes a minimum amount of energy per packet also the throughput is nearly the same as that of AODV. Overall Energy-aware AODV outperforms other protocols as it is able to adapt itself with mobility by keeping the link failures at lowest.





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Table.1: Comparison of FANET-related circumstances

Parameters	Multi-UAV Cooperation	UAV-to-Ground tasks	UAV-To-FANET Collaborations
UAVs density	High	Medium	Low
Ground environment	Not aware	Aware	Aware
Infrastructure	No	Yes	Maybe
Obstacles effect	Low	High	Medium
Task duration	Limited	Not limited	Not limited
Human operator	No	Yes	Maybe

Table.2 The simulation parameters are listed

No of nodes	10 to 60
Initial energy	60 to 200 J
Maximum speed	30 m/sec
Minimum speed	10 m/sec
Bandwidth	2Mbs
Packet size	512 Bytes
Data traffic	CBR
Pause time	20 Sec
Simulation time	1500 sec
Node queue length	100 packets
Coverage area	5 km
Tx power	1.65 W
Rx power	1.45 W
Transmission range	500
TH	30



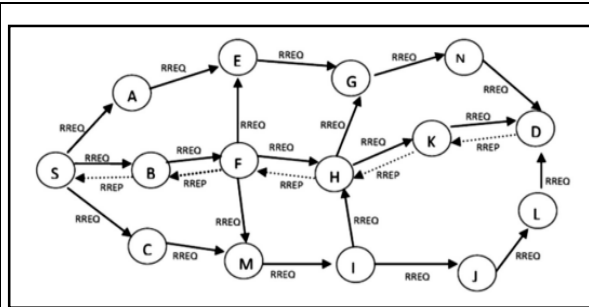


Figure.1 The Route Discovery Procedure

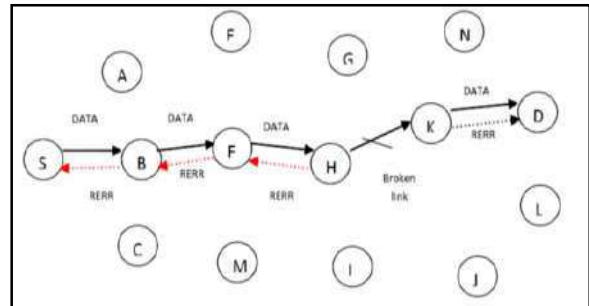


Figure.2 Route Maintenance Process

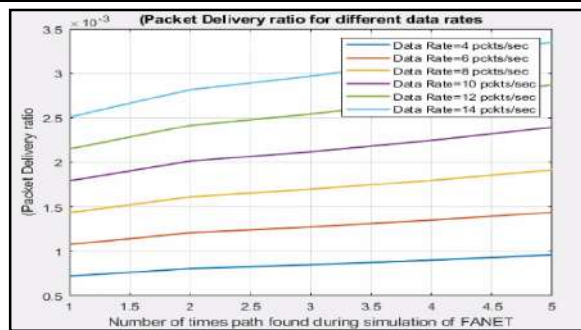


Figure.3

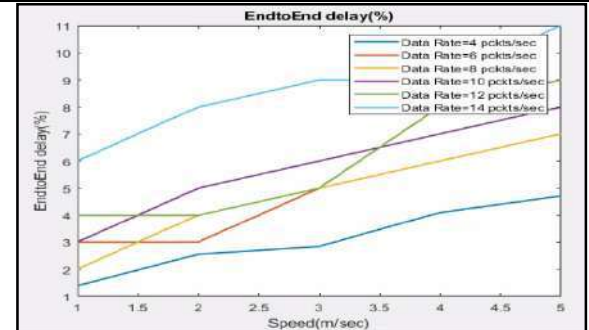


Figure.4

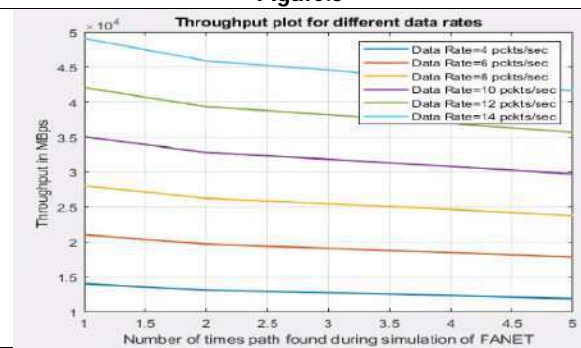


Figure.5

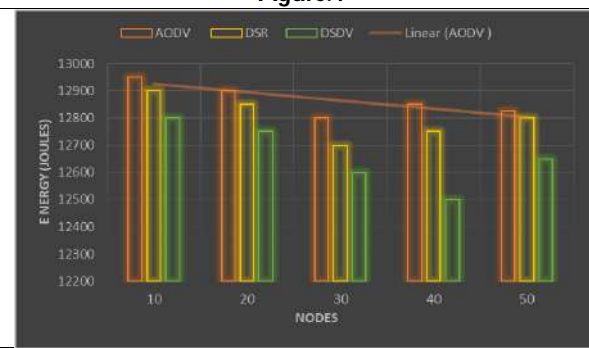


Figure.6

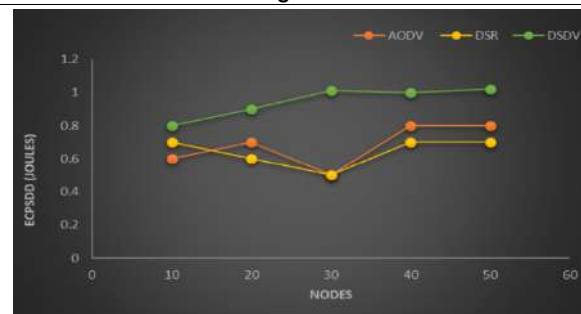


Figure.7



Figure.8





IoT Based Smart Bins for Smart Cities: A Review

Jenifer Sujitha.G *

Assistant Professor, Department of Science, St Francis de Sales College, (Affiliated to Bangalore University) , Bengaluru, Karnataka, India.

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*Address for Correspondence

Jenifer Sujitha.G

Assistant Professor,
Department of Science,
St Francis de Sales College,
(Affiliated to Bangalore University) ,
Bengaluru, Karnataka, India.
E.Mail: jenifersujitha@sfscollge.in



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ABSTRACT

In this Paper, IoT based Smart bins for smart Cities using Arduino and Raspberry Pi is discussed and reviewed. Population growth and rapid urbanization lead to huge increase in waste Generation. Traditional method of waste collection has become inefficient and costly. The most efficient way to collect the waste is Smart Bin Management System. Smart Bin Management System is effectively done using IOT, the Result is Tremendous and it is very useful for all cities and even for overall world. Both Hardware and Software embedded to Produce Good output .Many research already existed by using Arduino and Raspberry Pi. The Internet of Things (IoT) is currently considered as a basic communication infrastructure for Smart Cities, Where machine Communicates automatically between each other. The main objective of this paper is to ensure the protection of the environment through effective Waste Management. Ensure Separation at Source in all metropolitans and local Municipalities. Preventing Pollution and Ecological degradation. To protect the health and well-being of people by providing an affordable waste Collection Service. Arduino and Raspberry pi are open Source Hardware Platform. This Paper mainly focused on comparing their Performance, how effectively it will separate dry waste and wet Waste, Cost and User Friendly by using Arduino and Rasperry pi as which is more reliable and efficient.

Keywords: IoT, Arduino, Raspberry pi, Smart Bin, Environment, Pollution, Ecological Degaradation.



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INTRODUCTION

Waste Management is the term given to a waste Collection System, Which may include in Transportation, disposal and recycling. Waste management is all about the collection of waste from domestic, Corporate, Commercial and an industrial entity after it has served its purpose and is deemed not useful. This can lead to disorder of diseases that are spread by insects. Waste Management also acts on various economic, administrative and social issues that required be handling and solving at high Levels. Every year, an estimated 11.2 billion tonnes of solid waste is collected and decay of the organic proportion of solid waste is contributing about 5 percent of global Greenhouse Gas Emissions of all the waste streams, waste from electrical and electronic equipment containing new and complex hazardous substance presents the fastest growing challenge in both developed and developing Countries[14]. Poor Waste Management of ineffective disposal causes air pollution, water and Soil Contamination of drinking water and which can cause infection and transmit diseases. The solution is the minimization of waste firstly. Where waste cannot be avoided, recovery of materials and energy from waste as well as remanufacturing and recycling waste into usable products should be the Second Option[14]

The UNEP International Environmental Technology centre (IETC) in Japan Supports the implementation of integrated Solid Waste Mangement System. Its Works also focuses on the Proper Treatment of Special Waste(Electronics, Agriculture, Biomass, Plastics)in developing Countries And Cities. Waste Management nowadays is not the Same in Every Country region or Even Vary Among different Sectors Such as Industrial and Residential Sector. Six Elements of waste management are Refuse, Reduce, Reuse or Repair, ROT, Recycle, Repurpose. Waste Generation involves all the activities that identifying if materials are no longer Usable and if they can be used for Systematic Disposal. After Waste Generation there are activities to facilitate easier Collection of the waste .Detection, Monitoring and management of waste are one of the Primary Problems of Present days. Usual way of monitoring the waste is a tedious Process and utilizes human effort, Time and Cost which can easily be avoided with our Present. Currently there are increasing initiatives by Government and Public authorities in relation to waste management to efficiently improve the collection and intelligent disposal of waste generated by a city. Urbanization is a current Society and its rapid growth demands Smarter for Waste Management in Cities. A Probable Solution to this problem is adoption of IOT based Smart Waste Management System.

IoT works on Four Components Devices/ Sensors, Connectivity, Data Processing and User Interface as shown in the Figure 1. Sensor is a device that measure physical input from its environment and converts it into data that can be interpreted by Computer. Sensing, Temperature, Pressure, Light, moisture, sound etc. Sensor is typically integrated with microprocessor Based embedded systems which can collate the data and connect to internet. Several Communication Protocols and Technology used in IoT. Depending upon Power and Cost. All the collected data is send Via Internet to Cloud infrastructure. Processing Stage Computer transform the raw data into information. Information is Carried out by different Manipulation Techniqes. Data Aggregation is the Aggregating from Multiple devices like AC, Light. Data Extraction is Extracting Car number plates from Video Feed of Speeding Cars. Data Classification is Classifying Data .Data Analysis is analyzing data and identify Patterns.

MATERIALS AND METHODS

Arduino: The Arduino is an open Source microcontroller board based on the MicrochipnATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards and other circuits [17]. The board has 14 digital I/O Pins,6 analog I/O Pins and is programmable with the Arduino IDE(Integrated Development Environment)via a type B USB Cable. It can be Powered by a USB cable or barrel connector that accepts voltage between 7 and 20 volts,such as 9 volt battery[15].



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Raspberry pi: Raspberry Pi is a series of small Single board Computers (SBCs) developed in the United Kingdom by the Raspberry pi Foundation in association with Broadcom. Raspberry pi is a very cheap computer that runs Linux, but it also provides a set of GPIO (General Purpose Input / Output) pins, allowing to control electronic Components for physical computing and explore the Internet of Things (IoT). Its main operating System Pi OS is Open Source and runs a suite of open source Software. It is a low cost, credit card sized Computer that plugs into a computer monitor or TV and uses a standard Keyboard and Mouse. It is a capable little device that enables People of all ages to explore Computing and to learn how to program in Languages like Scratch and Python. Debian with Raspberry pi is operating system for PC and MAC. It can run Multiple operating Systems, Through RP2040 Micro Controller chip. With an extensive range of accessories and add ons, the Raspberry pi range can be expanded to utilize computer networks and Visual multimedia Processing, Sensors and emulation while connected to the internet or Local networks [16].

In this Study Several Parameters must be considered to establish if a technology has Reached its Maturity phase or is still in the growth phase. These Cover Various Technical Specifications, Economic Perspectives, Competitors, Population Opinions, etc. Multicriteria Analysis is usually the best approach to accommodate these different areas [12].

MCA is a hierarchy technique that quantifies each object's Performance Considering a set of Criteria. For our study in this paper the boards that we are comparing were Arduino UNO and Raspberry Pi Pico. The criteria that we are used to rank were Hardware Setups, cost, Power assumption and number of Projects based on two boards. The Performance matrix for the chosen criteria is calculated to perform MCA [13]. Each domain has a specific weight and each object receives a score for each Criteria. The Element with highest score receives the entire criteria, while others get Proportional scores.

The Point allocation method is Proposed in this review in the table 1 as it is easy to allocate the Points and it states that "The total of all criterion weights must sum up to 100" and it is applied for scoring and is shown in Table 1. Here Hardware Setups like Memory and digital Pins have given weights as 35 and 15. Cost have given 10 weights, Power assumption given 25 and Papers have given weightage of 15. So total all together 100. The Weighting is adopted based on the Mean Weight Method a straight forward weighting approach that considers all attributes equally important. Since there are five criteria in total, an equal weight of 10% is attributed to each component. Hardware Specifications for Arduino UNO and Raspberry Pi Pico were obtained based on the manufacture Table and are summarized in the Table 2.

The Economic concepts considered the initial investment cost that is the price for the two boards and the Power consumption [18,19]. Power Consumption is relevant for IoT applications because they require constant measurements for extended periods, leading to increased operating costs. Power consumption and cost have been got from the internet and it is tabulated in the Table 3. In this study we considered in a broader sense, like analyzed 10 papers in many research journals and Proceedings related to Smart waste management and the focus of the paper, most commonly used approach, components like Sensors used, different technologies, IoT platforms, Microcontroller boards used, Output components to display the result were reviewed [13]. The most commonly used approach is to prevent the waste container or bin to be overloaded. Level detection implemented in many Paper using ultrasonic sensor and IR Sensor. Distance from one bins to other bins are also measured using many Ultrasonic sensor in some of the paper. Weight of the trash in the bin is measured using weight sensor i.e. Load cell. Wet and dry waste is separated in some of the papers by using soil moisture and humidity sensor. However in Many Research papers Researchers have used different technologies like GSM, GPS, RFID and WIFI Module to share the information over internet. Microcontroller boards like arduino UNO and Raspberry pi were used.

Out of 10 papers reviewed only in 2 Papers Raspberry pi is used. But it is also understood that Arduino UNO and Raspberry pi combined to produce a fabulous result and more modules can be implemented. Arduino UNO does not have External port like Ethernet port and HDMI port. whereas Raspberry pi will have External communication



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technology as well as WIFI(802.11n) and Bluetooth 5.1 which allows to retrieve and transmit data through internet connection[18,19]. And also IOT platforms like Thingspeak is used for communication. The Output will be displayed through LCD's and RGB's LED and even servo motor is also used to display the output in a paper[1-10]. And the result with paper name along with Microcontroller used is displayed in the Table 4.

RESULTS AND DISCUSSION

MCA Performance matrix was constructed and scored 10 point for each Criteria and the best result is found. Result is given in the Table 5. After Summing all the scores obtained by each board the total value represents the ranking criteria for the developed MCA. As can be seen, the Arduino UNO scored the lowest value with 17.08 from 100 [13]. It is clearly indicated that Arduino UNO has reached its Maturity phase and also fulfilled the developed phase now in the decline phase. Raspberry pi pico scored almost twice as much as Arduino UNO and is placed in the other end of the scale being best board according to Proposed MCA. Also Pico board obtained top marks for three criteria Memory, Digital Pins and Cost. The two things that Pico board scored worse was the Power Consumption and also Research Papers were Raspberry pi was very less Compared to Arduino. 10 Papers were Reviewed in that 8 Papers used Arduino UNO and only 2 Papers Used Raspberry Pi[9,10]. Raspberry pi understood the lesson that made Arduino UNO a intimidating board i.e the communication interface and adapted these specification to IoT environment by doubling the number of pins for Communication

CONCLUSION

The Paper Reviews the Arduino UNO Boards evolution in the IoT Context. Hardware Setup, Economic, Feasibility and researching the Papers were Considered. MCA Criteria to evaluate its role in the future of IoT. After gathering all the data and constructing Performance Matrix, One can conclude that Arduino UNO will no longer be Part of IoT future but will Viable Solution for an IoT. Raspberry Pi Pico is the Best Suited board for IoT application as which has excellent Communication Protocols, Balanced Economy and Good Hardware Setups.

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Table 1. Boards Criteria Weight Using Point Allocation Method

S.NO	Criteria	Weights
1	Memory	35
2	Digital Pins	15
3	Power consumption	25
4	Cost	10
5	Papers	15
	Total	100

Table 2 .Hardware Specification

Specification		Arduino Uno	Raspberry Pi Pico
Memory	SRAM(kB)	2	264
	Flash(kB)	32	2000
Digital Pins		14	23

Table 3. Power Consumption and Cost

		Arduino UNO	Raspberry Pi Pico
Power consumption	5.21V	290mA	600mA
	12 Neo pixel LEDS	1.5 W	3.1 W
Cost (Rupees)		1500	350

Table 4.Paper Review of Boards for the iot based smart bins for smart cities: a review

Paper id	Paper Name	Boards Used
P1	Smart Work Management system Using IoT	Arduino UNO
P2	IoT based Framework for smart waste monitoring and control systems :A case Study for Smart Cities	Arduino UNO
P3	IoT based Smart Garbage Monitoring System	Arduino UNO
P4	Smart Dust bin for Efficient waste Management	Arduino UNO
P5	Smart Dustbin Monitoring System Using LAN Server and Arduino	Arduino UNO





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P6	Smart Dustbin	Arduino UNO
P7	Smart Waste Management using IoT	Arduino UNO
P8	Smart Waste Management Using Arduino	Arduino UNO
P9	Smart City Implementation of Smart bin using Raspberry pi	Raspberry pi & Arduino UNO
P10	Accurate and High Speed Garbage detection and Collection Technique Using Neural network and Machine Learning	Arduino UNO

Table 5. Performance Matrix

Specification	Arduino UNO	Raspberry Pi Pico
Memory	0.08	7.5
Digital Pins	6	10
Power Consumption (mA & watts)	6	3
Cost	2	10
Papers with Microcontroller board	3	0.5
Total	17.08	31.0

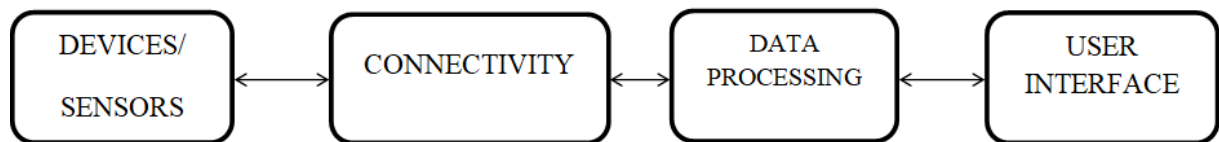


Figure 1. Components of IoT





Thermal Conductivity Enhancement in Nanofluids, with Special Reference to Volume Fraction and Nanolayer Thickness

Shilpi Saraswat^{1*} and Rajesh Johari²

¹Research Scholar, Department of Mathematics, Agra College, Agra (Dr. B.R. Ambedkar University, Agra, Uttar Pradesh, India.

²Associate Professor, Department of Mathematics, Agra College, Agra (Dr. B.R. Ambedkar University, Agra, Uttar Pradesh, India.

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*Address for Correspondence

Shilpi Saraswat

Research Scholar,

Department of Mathematics,

Agra College, Agra (Dr. B.R. Ambedkar University),

Agra, Uttar Pradesh, India.

E.Mail: kanaksaraswat@gmail.com



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ABSTRACT

A numerical model for The improvement in thermal conductivity in nanofluids was generated by integrating the following: the development of nanoparticles into nanoclusters, the thickness of the nanolayer of liquid, Brownian movement, and the volume component of nanoclusters. The articulation that was made passed muster when measured against the exploratory data obtained from the writing. The model offered the possibility of comprehensively making sense of the enhanced conductivity of nanofluids. [Note: According to the findings of this study, nanoparticles will typically take the form of nanoclusters, and both the volume component of the nanoclusters and the captured liquid within the nanocluster contributed to the overall conductivity of the material. Several variations of cluster formation were investigated, and in general, it was discovered that the utilisation of circular nanocluster models was more successful in accurately predicting the thermal conductivity of nanofluids. When compared to the bunch effect, the contribution of Brownian mobility of nanoparticles to the overall conductivity of nanofluids was seen as extremely important yet relatively minor. The formation of nanoclusters and the thickness of the nanolayer are the most important factors to take into account while attempting to improve the thermal conductivity of nanofluids. When compared to standard cooling solutions, a mixture of the base liquid and nanoparticles that have been formed from nanoclusters is known to provide a more effective cooling arrangement.

Keywords: Heat transfer, Thermal Conductivity, Brownian motion, Thickness of nanolayer





INTRODUCTION

The fluids that are used as the conveyance of intensity in heat exchangers are susceptible to being considerably impacted by nanostructured materials. The successful conductivity of the subsequent medium will significantly increase when metallic or non-metallic particles of higher conductivity, whose dimensions are under 100 nm, are dispersed in standard intensity move fluids. This will result in an increase in the successful conductivity of the subsequent medium. Within the context of an automobile cooling system, Leong et al. (2010) utilised copper nanofluids with ethylene glycol as the base liquid. They found that there was an increase in the intensity move coefficient in comparison to the base liquid. Their findings demonstrated that a change in volume concentration of 2% resulted in an increase in intensity move of 3.8 percent when the Reynolds number was calculated to be 6000 for air and 5000 for coolant separately. In addition to this, they have provided a few indications regarding the reduction of the front facing surface. Han and Rhi (2011) investigated the feasibility of utilizing crossover nanofluids in the construction of a notched heat pipe. Xuan et al. (2011) found that applying TiO_2/Ag plasmonic nanofluid for use in volumetric sun orientated beneficiaries led to a dramatic upgrading of photothermal characteristics. When utilizing $Al_2O_3 - Cu/water$ half breed nanofluid in an electronic sink, Selvakumar and Suresh (2012) focused on the intensity move and strain drop qualities of the coolant. They discovered a significant increase in the convective intensity move coefficient when using mixture nanofluid as the coolant in comparison to deionized water. Additionally, they found that the strain drop decreased significantly. Hussein et al. (2014) examined the increase in intensity move that was brought about by using nanoparticles of TiO_2 and SiO_2 in unadulterated water in the presence of laminar stream circumstances. Ray and Das (2014) conducted research on three different nanofluids that contained aluminium oxide nanoparticles, copper oxide, and silicon oxide in a base liquid that was the same. This base liquid was a mixture of ethylene glycol and water with a mass proportion of 60/40, and it was used as a coolant in a vehicle radiator. They discovered that a nanofluid with a volumetric convergence of one percent of nanoparticles has more desirable properties than those with higher fixations: there was a 35.3 percent reduction in the syphoning power and a 7.4 percent reduction in the intensity move surface by using an Al_2O_3 nanofluid. The researchers Madhesh and Kalaiselvam (2015) used a rounded counter stream heat exchanger in their investigation of the intensity move capability of copper-titanium crossover nanofluids. They found that there was a 68 percent increase in the general intensity move coefficient. Researchers Nimmagada and Venkatasubbaiah (2015) investigated the heat transfer properties of half and half ($Al_2O_3 + Ag$) nanofluids in a small channel. They found that the normal convective intensity move coefficient was significantly greater. The performance of mixture nanofluid was evaluated by Allahyar et al. (2016) in a snaked heat exchanger at a constant divider temperature. They found that the largest intensity move improvement was 11.58 percent. In a chevron creased plate heat exchanger, Huang et al. (2016) did some preliminary research on the heat transfer properties of an (Al_2O_3 -MWCNT half and half nanofluid. They found that the crossover nanofluid combination presented the most raised heat transport coefficient at a given syphoning power. Involving half breed suspension for laminar power convection in constantly circular cylinder was shown to increase the Nusselt number 7.2 by percent, as reported by Takabi et al. (2016). In the study carried out by Elbadawy et al. (2018), two nanofluids ($\frac{Al_2O_3}{water}$ and $CuO/water$) were seen to be flowing in a radiator with a level container. Mathematical research was carried out to evaluate and analyze the flow of the nanofluids. In spite of the fact that the required syphoning power is considered to be a component of both the Reynolds number and the nanofluid fixation proportion, they were able to accomplish a significant reduction in the volume of the radiator by achieving a checked improvement in the performance of the intensity move. Goncalves et al. (2021) presented the super trial methods that analysts employ in order to measure the conductivity of nanofluids. They discussed the factors that could be affecting the accuracy of the results, as well as the roles that should be played by the concentration, temperature, consistency, heat limit, and surface strain of the succeeding nanofluid. Younes et al. (2022) investigated the hypothesis that the conductivity of a liquid might be affected by factors like molecule size, pH of the liquids, surfactant, dissolvable type and hydrogen holding, temperature, base liquids, and arrangement.





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Mathematical Formulation

The thermal conductivity of entire nanofluids is calculated by adding the conductivity of static weak suspension k_s to the thermal conductivity of the nanoparticles due to Brownian movement k_b . A few examples of the persuasive conductivity are as follows:

$$k_{eff} = k_s + k_b \tag{1}$$

$$\alpha = \frac{1}{\sqrt{3}} \left(\frac{4M_f}{\rho_f N_A} \right)^{\frac{1}{3}} \tag{2}$$

Where M_f =Molar Mass of the fluid

N_A =Avogadro's Number ($6.023 \times 10^{23} / Mol$)

According to Yu and Choi (2003) findings, the thermal conductivity of the nanofluid may be computed

$$\frac{k_s}{k_f} = \frac{k_p + 2k_f + 2(k_p - k_f)(1 + \alpha)^3 \varphi}{k_p + 2k_f - 2(k_p - k_f)(1 + \alpha)^3 \varphi} \tag{3}$$

Where k_p and k_f are the thermal conductivities of the particle and the fluid, respectively, and φ is the volume fraction of the nanoparticles that are present in the nanofluid.

The volume fraction of nanoparticles is

$$\varphi = \frac{V_s}{V_f} \Rightarrow V_s = V_f \varphi \tag{4}$$

where

V_s =Quantity total of nanoparticles in the sample

V_f =volume of the fluid being measured

The formula that can be used to calculate the volume of a spherical nanoparticle with a diameter of α_p is as follows:

$$V_p = \frac{4}{3} \pi \left(\frac{\alpha_p}{2} \right)^3 \tag{5}$$

From Eq. (4) and (5), we get

$$\frac{V_s}{V_p} = N_p \tag{6}$$

Where V_p =The volume of the nanoparticles relative to the number of particles included in a cluster (n_c)

The total number of clusters, denoted by (N_c), can be expressed as

$$\frac{N_p}{n_c} = \frac{V_s}{n_c V_p} \tag{7}$$

The formula for determining the total volume of clusters can be written as follows: where (N_c) is the number of clusters and V_c is the volume of a single cluster.

$$V_{cb} = N_c V_c \tag{8}$$

Where V_{cb} =Total bulk volume of the cluster

The formula that can be used to calculate the effective cluster volume fraction is:

$$\varphi' = \frac{V_{cb}}{V_f - V_{cf}} \tag{9}$$

V_{cf} =The total amount of fluid by volume that is contained within the cluster

$$\varphi' = \frac{N_c V_c}{V_f - (1 - \varphi_c) N_c V_c} = \frac{\left(\frac{V_s}{n_c V_p} \right) V_c}{V_f - (1 - \varphi_c) \left(\frac{V_s}{n_c V_p} \right) V_c} = \frac{\left(\frac{V_f \varphi}{n_c V_p} \right) V_c}{V_f - (1 - \varphi_c) \left(\frac{V_f \varphi}{n_c V_p} \right) V_c}$$





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$$\begin{aligned}
 &= \frac{\left(\frac{V_f \varphi}{n_c V_p}\right) V_c}{V_f - \left(\frac{V_f \varphi}{n_c V_p}\right) V_c + \left(\frac{V_f \varphi \varphi_c}{n_c V_p}\right) V_c} \\
 &= \frac{\left(\frac{\varphi}{\varphi_c}\right)}{1 - \frac{\varphi}{\varphi_c} + \varphi} \tag{10}
 \end{aligned}$$

Where $\varphi_c = \frac{V_{sc}}{V_c}$ and $n_c V_p = V_{sc}$

$$\begin{aligned}
 \frac{k_s}{k_f} &= \frac{k_p + 2k_f + 2(k_p - k_f(1 + \alpha)^3 \varphi' \varphi_c)}{k_p + 2k_f - 2(k_p - k_f(1 + \alpha)^3 \varphi' \varphi_c)} \\
 k_s &= \frac{k_p + 2k_f + 2(k_p - k_f(1 + \alpha)^3 \varphi' \varphi_c)}{k_p + 2k_f - 2(k_p - k_f(1 + \alpha)^3 \varphi' \varphi_c)} k_f \tag{11}
 \end{aligned}$$

k_p represents the thermal conductivity of the particles, and φ_c is the volume percentage of the particles that make up a cluster.

Because of the Brownian mobility (k_b) of the nanoparticles, Koo and Kleinstreuer (2004) are able to calculate the thermal conductivity of the material.

$$k_b = 5 \times 10^4 \beta \varphi \rho_f C_{p,b} \times \sqrt{\frac{k_B T}{\rho_p d_p}} f(T, \varphi)$$

$$f(T, \varphi) = (-134.63 + 1722.3\varphi) + (0.4705 - 6.04\varphi)T \tag{12}$$

$$\text{Where } \beta = \begin{cases} 0.0137(100\varphi)^{-0.8229} & \varphi < 1\%, Au - citrate, Ag - citrate, CuO \\ 0.0011(100\varphi)^{-0.7272} & \varphi > 1\%, CuO \\ 0.0017(100\varphi)^{-0.0841} & \varphi > 1\%, Al_2O_3 \end{cases} \tag{13}$$

The total k_{eff} of the system is

$$\frac{k_p + 2k_f + 2(k_p - k_f)(1 + \alpha)^3 \varphi' \varphi_c}{k_p + 2k_f - 2(k_p - k_f)(1 + \alpha)^3 \varphi' \varphi_c} k_f + 5 \times 10^4 \beta \varphi \rho_f C_{p,b} \times \sqrt{\frac{k_B T}{\rho_p d_p}} f(T, \varphi) \tag{14}$$

NUMERICAL RESULTS AND DISCUSSION

The variation in viable thermal conductivity with volume division for various advantages of the volume part of the particles in a bunch is illustrated in chart 1, which can be found here. Based on the findings of charts (2) to (6), it can be inferred that the newly developed model is more accurate than other models. The model was validated for use with a comprehensive selection of readily available nanofluid mixtures. The expansion in volume of the nanoparticles was accompanied by an increase in the conductivity of the nanofluids. The circular cluster is the one that deviates from the exploratory traits the least of all the bunches. Therefore, we anticipate that the shattered nanofluids will form a circular bunch, and that the Brownian movement and the nanolayer will conform to the group, the volume part of the bunch, and the nanofluid that is caught in the bunches will assist in increasing the conductivity of the nanofluids. The thickness of the nanolayer was taken into consideration as a basic boundary for the improvement of the thermal conductivity. The results for the nanolayer thickness of water and ethylene glycol were measured and calculated. It was determined that the thickness of the nanolayer for water, which was used as the base liquid, was 0.2884 nm. In the case where water was used as the base liquid, the advantages of the nanolayer thickness were increased from 0.01 nm to 1 nm. In the case of ethylene glycol, the thickness of the nanolayer was measured to be 0.414 nanometers. As part of the effort to finish the parametric review, the thickness was increased from 0.2 to 1 nm. The difference in the volume component ranged from 0.001 to 0.04. In the calculations of the thermal conductivity, round groups were taken into consideration. The benefits of conductivity for a variety of nanofluids were analyzed, and the resulting diagrams have been plotted and are presented in Graphs (7) to (10).

Closing Comments



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The bunching of nanoparticles, the thickness of the nanolayer, the Brownian movement of the nanoparticle, and the volume part of nanoclusters were all taken into consideration when developing a model for the practicable thermal conductivity of nanofluids. A portion of the thermal conductivities of the liquid and the nanoparticles, as well as the bunching impact, the nanolayer, and the volume component, are accounted for in the numerical model that was developed to calculate the thermal conductivity. Based on the results that were obtained and the confirmation that was given, it has been determined that the Brownian movement, the thickness of the nanolayer that surrounds the nanoparticles, and the grouping of nanoparticles within a nanofluid all play important roles in the enhancement of the thermal conductivity of nanofluids. When compared to the impact that nanoparticles have on grouping together, the commitment that occurs as a result of Brownian movement caused by moving nanoparticles in nanofluids is rather small. By resolving the numerical model utilising the various hypotheses, it was possible to have a better understanding of the factors that are responsible for the overall improvement in conductivity. The following is a list of conclusions that can be derived from this study: When it came to making sense of the conductivity conduct of nanofluids, the kinetic hypothesis was considered to be of little importance. The particles' ability to cluster together ended up being a substantial factor in the overall improvement of the nanofluids' conductivity. It was determined that the model that had been developed was applicable to virtually all of the nanofluids. The conductivity of nanofluids increases when the volume portion is expanded, as does the thickness of the nanolayer. The nanolayer thickness was addressed by the numerical model, which resulted in decreased conductivity for low volume divisions of 0.01, stayed fairly consistent for volume sections of 0.02 and 0.03, and expanded at volume part 0.04. In light of this result, it is possible that one of the topics for future research might be the investigation of the limiting variables. Therefore, this ground-breaking breakthrough, which consists of suspending nanoparticles in base liquids, may provide solutions to issues that have been worked on. Understanding of intricate nanofluids, which requires a lot of hard work, will have a significant impact on a far wider range of issues.

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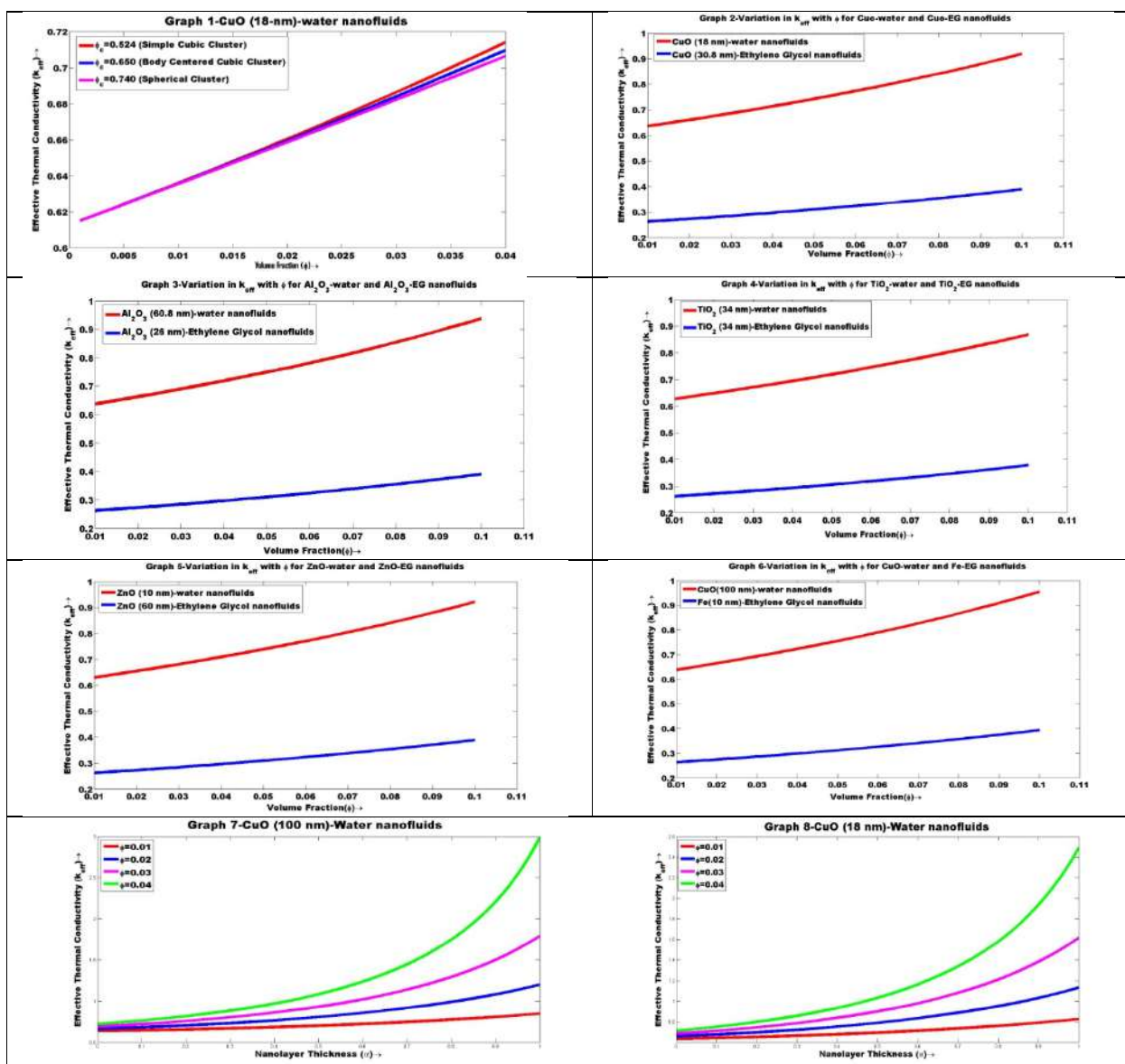
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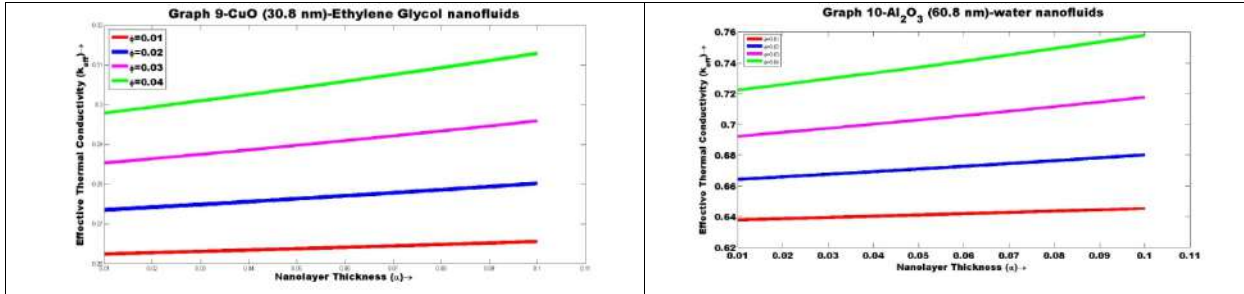
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Seed Disease Classification and Detection System Using Machine Learning

Nazia Hassan.B^{1*} and M. T. Somashekhar²

¹Assistant Professor and Research Scholar, Government First Grade College, Vijayanagar, Bangalore, Karnataka, India.

²Associate Professor, Department of Computer Science Applications, Bangalore University, Bangalore, Karnataka, India.

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*Address for Correspondence

Nazia Hassan.B

Assistant Professor and Research Scholar,
Government First Grade College,
Vijayanagar, Bangalore,
Karnataka, India.



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ABSTRACT

In a developing country like India agriculture plays a noteworthy role. Agricultural intervention in the livelihood of rural India indulges by about 58%. Among the agricultural products, chilli is one of the most used crops. Thus, preventing significant loss in quantity and yield of chilli is majorly dependent on recognition and classification of diseases a chilli plant might possess. Latest and fostering technologies like Image processing is used to rectify such issues using different types of techniques and algorithms. Initially, the seeds of a chilli plant get affected, when plant develops a particular type of disease. In this paper, four consecutive stages are used to discover the type of disease. The four stages include preprocessing, seed segmentation, feature extraction and classification. This paper imparts representation of seed disease detection employing image processing that can identify drawbacks in chilli plant from images, based on color, bound and texture to give the brisk and reliable results to the farmer.

Keywords: Image processing, chili seeds, feature extraction.

INTRODUCTION

In countries like India it is of utmost importance to bring technological advancement in the fields related to crop productivity. Research initiatives and tentative study process in the important domain of qualitative farming is focused towards improving the yield and food crop standard at low cost, with greater monetary outcome. Agricultural building model stands as a result of a compound interlinking of soil with seeds, and chemicals used to



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enhance growth. Vegetable and fruits exists as one of the present significant agricultural achieved output. In directive for getting surplus and effective worthy products, a product value examination and improvement has always been importantly imperative. Diseases are disablement to the conventional state of the plant that translates or hinders its important roles such as transpiration, photosynthesis, fertilization, pollination, germination etc. They distorting diseases are spawned by pathogens like, fungi, bacteria and viruses, because of unfavorable environmental situations. Accordingly, the preliminary stage for diagnosing of disease in seeds is a significant task. Farmers need periodic monitoring by professionals which might be prohibitively costly and time absorbing. Hence, looking for quick, less costly and precise ways to smartly detect the diseases from the indicators that look to be on the seed is of great pragmatic importance. In this study proposing a system which can be used to identify the particular type of disease a chili seeds might have. It is of major concern to identify the type of disease an important crop like chili can have, by implementing upbringing technologies like image recognition, which represent the application functioning visually and it is also an important reason for making digital technologies popular. Many people and technological groups are involved in the field of agriculture to increase the yield and throughput. There has been various techniques used in the past to solve problems related to disease spread in a chili plant. With the advancement in technology chili plant disease detection have become more easy and precise. In our system a different approach, i.e. KNN algorithm is used for the same. Various kind of methods have been used recently to determine the type of plant disease. Some of these involves analysis and study of chemical analysis method to determine plant diseases, and ways which are indirect by implementing physical techniques, like spectroscopy of the seeds, leaf and imaging, to get information related to properties of chili plant.

LITERATURE REVIEW

Machine learning in detecting and classifying diseases of a chili seeds, Identification of diseases is one of major area in agriculture which needs to be taken care of, though many practices have been done and implemented to cope up with this issue, rapid and quick identification of the diseases still remains in state of inchoate. The use of machine learning in facilitating the identification and detection helps to counter this problem to a much greater extent. Reviewing classification and detection on plants using ML. The paper gives an elaborate view about the techniques which can be implemented for detecting and classifying the various diseases caused by bacteria, viruses and fungi. Based on their morphology i.e., their particular form, shape, or structure the diseases detected through classification are categorized. The techniques used in classification aids in automatic detection of the diseases of chili seeds. Machine learning in detection of stem diseases of jute plant. In this paper detection of diseases of the stem plant is done, using the HSV algorithm, GLCM algorithm and SVM to perform and initiate the segmentation process, followed with feature extraction and classification respectively. It discusses the removal of noise, conversion from RGB to HSV and vice versa. Detection of abnormalities of the leaves of plants and training using papaya seeds. This paper talks about the detection and recognition of abnormalities of plants for training and study papaya seeds were taken. Random forest classifier was used for classification and it got trained using images of seeds with an almost seventy percent accuracy. Apple leaf disease detection. The common Apple leaf diseases like rust, grey spot, brown spot were discussed and found out with the help of deep learning algorithms and improved CNNs. The dataset for diseased leaves were generated, processed and collected. New deep CNN model designed to identify small diseased spots. In this study chili seeds, plant leaves are used for study, training, testing and detection of diseases. Study of diseases in seeds and use of digital image processing The digital image processing provides a vast area for identification of diseases through the various algorithms it supports.

The seed testing method is more than 100 years old. It was implemented in the parts of Australia and Africa. But only simple and easiest methods were used .Later on seed testing laboratories were developed all over the world. Seed pathogens may effect in different ways to crops. There are many diseases that affect the crops the reason behind this is unhealthy seeds and other environmental factors. Seed disease may affect many parts of plants and crops. Many methods were proposed few among them included the parts like roots, leaves, stems, etc. Image processing techniques in identifying diseases in seeds: The most common Diseases in Seeds 1. Yellow virus 2. Brown spot



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disease 3. Alternate 4. Bacterial diseases 5. Aster yellow cytoplasm 6. Bacterial Blight. Planting disease free seeds is a smart way to minimize the possibility of the diseases and losses associated with them. For this purpose Severity measurement using image processing techniques like Simple threshold methods and triangle threshold methods are used so that the lesion area and area of the seed can be segmented. Categorization is done calculating quotient of lesion and seed regions. Plants such as chili have various kinds of such diseases which can affect the amount and the quality of crop and its yield. To avoid this it's important to know the severity of the diseases so the appropriate amount of fertilizers can be used in time. Understanding the pain and efforts of the farmers and how much time is devoted to cultivate a crop for one season, in this study we employed the method which monitors the plants and its seeds from very beginning i.e., by using digital image processing. Early detection can save the farmers from huge losses hence our work focuses on early and correct detection of diseases in seeds using digital image processing so that neither the crop nor its yield is affected. Also the algorithms which are supported by image processing are quite useful in segmentation and in feature extractions which forms an essential part of the project. Selection of algorithms: In machine learning various algorithms are available for feature extraction, clustering, segmentation. Selecting the most suitable as per needs of the task can be tough at times. To reduce the complexity and improve the time of response selection of the most suitable algorithm is required. Pre-processing and filters are used to compare with previous studies. Before we start working on the image we need to smooth out the image and resize it for further working. Segmentation: The functioning and well known and significant are of image processing has to be segmentation as it derives useful and more appropriate to say meaningful data set from, from meaningless data by segmenting the parts of the image into several parts. It can be classified on the basis of region, edge threshold, feature and model. Out the above ours project deals with feature extraction so segmentation on such basis is important to simplify the further work and, we found that K-Mean algorithm which works well for feature extraction segmentation also is the one of the mostly widely used and easy to implement algorithm.

Classification: The algorithms used for classification are quite commonly used for almost all similar projects like SVM i.e., Support Vector Machine, CNN, KNN. The classification is a necessary step as it compares the values received after the feature extraction step is compared with a pre-calculated set of data here we went ahead with KNN algorithm though both are supervised algorithms the KNN is simple easy and flexible to implement. It is also quite robust to data containing noise. Improvisation in our work: Different plants require different algorithm depending upon various factors some even upon the morphology. We compared and contrasted each of the above algorithms before finally selecting it with test and trial methods.

PROPOSED METHODOLOGY

The proposed system consists of various stages including collection of images of agricultural seeds for creation of database image segmentation is performed. Features of segmented images are stored in database with respect to image of seeds using support vector machine. The shape feature extraction is used to solidly extent minor axis length and eccentricity. This feature is taken in order to extract the shape feature of the diseased region. Eccentricity is used which and where the rust or the decay has occurred. Eccentricity is used to measure the area of the diseased region.

Various Types of Diseases in Seeds 1. Yellow virus 2. Brown spot disease 3. Alternate 4. Bacterial diseases 5. Aster yellow cytoplasm 6. Bacterial Blight. Planting disease free seeds is a smart way to minimize the possibility of the diseases and losses associated with them. Diseases in seeds are a major concern to the farmers these days. Many a times, the farmers are not sure which pesticide or insecticide is needed to treat a particular diseased in seed because they are not sure of the type of disease. This results in spraying wrong pesticides, damaging the plants which affect the plant yield. To overcome with this problem, we have come up with a solution of developing a system that easily identifies some common diseases that occur in a chili plant by merely examining the seeds of the plants. This system is not only beneficial to the farmers in saving the crops, but also in saving money by buying only right kind of pesticides suitable to treat the particular disease. As the system does not involve any heavy machineries and electricity, the system proves to not only be a cost-effective solution, but also an environment friendly one.



**Nazia Hassan and Somashekhar****PROCEDURE**

The Digital Image Processing is a combination of a number of steps and algorithms that go together in a controlled flow manner. The flowchart as shown below depicts the various stages that the images goes through before the final result is produced.

PRE-PROCESSING

This step involves processing the test image in order to bring it to the size, colour and quality of the images comprising our dataset. This involves various stages through which the image goes. These stages are: 1. Image Resizing: The dimensions of the image are brought equal to the dimensions of the training images by using the „imresize ()“ method in MATLAB. Image resizing is a crucial step as the pixel values may change if the dimensions of all the training as well as the testing images are not the same.

Smoothing: The smoothing of the image renders the pixel values to gradually even out to all the points of the image so as to allow a smooth image. Along with this the image also gets converted from colored to grayscale image using the function „RGB2GRAY ()“.

Noise Filtering: The noise is the unwanted extras that are present in the images that make feature determination and extraction difficult. Thus the process of noise filtering involves removal or averaging of the pixel values that add noise to the image. The process used in our system to ensure noise removal is „Median Filter“.

FEATURE EXTRACTION

Feature Extraction is a method used for dimensionality reduction which helps in representing into a compact feature vector, the parts of the image which are interesting. This process results to be very helpful when the sizes of images are large and for the faster image matching and retrieval, reduced feature representations are required to complete tasks quickly.

CLASSIFICATION

The final stage of our Image Processing Phase is the training of the dataset and testing of the images against the trained model. The algorithm used in this classification model is the KNN. KNN algorithm can be explained as supervised machine learning algorithm as it can be implemented to find solutions of both the classification and regression problems. This algorithm begins with making an assumption that the things with more similarity are existing in close proximity, or we can also say that similar things are near to each other. In KNN algorithm we first start with the loading of the data and then initializing K to the selected number of neighbors, then for each example in the data we find the distance between the query example and the given current example from the given data. Then the data collected is sorted orderly from smallest to largest according to the distances, later we pick the first k entries from the sorted collection and take the labels of the selected k entries. If there is regression then the algorithm returns mean and in case for the classification the mode value is returned. Hence our images go through this algorithm and get classified according to the disease category they belong to. It is a very clean and precise process which produces accurate results.

Web Interface The complete process of model training and performance is performed in backend, so for the easy user interaction we use frontend application which helps us in analyzing the images that are uploaded from the sources like an external camera or downloaded from the internet. These test images are easily analyzed with help of backend processes and are represented using this user interface, as we test these images and represent the result soon after that. Thus the Web Interface is interlinked with our model at the backend and the user"s camera/phone in the frontend.





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CONCLUSION

The proposed methodology in the following chili seeds disease detection system focus on generating an advance and efficient system which makes the process of creating high yield of chili much more easier for the farmers. The project aims to detect the most common diseases occurring on a chili seeds, namely Yellow virus, Brown spot disease, Alternate, Bacterial diseases, Aster yellow cytoplasm, Bacterial Blight using image processing technique under upbringing technology i.e., machine learning. In easier terms, the farmer will be able to accurately detect the type of disease a particular plant is having using the image of the seed. The proposed system is based on four important modules namely: Pre-processing, Segmentation, Feature extraction, Classification using KNN. The proposed systems functionality is better than existing disease detection system as it is able to generate a more accurate and precise result with easier and faster implementation. It aims to make the life of farmers easier. The system can be a boon to the agricultural sector as it advances the crop production and management process, as agriculture is of the major reason to facilitate growth of per capita income of our country.

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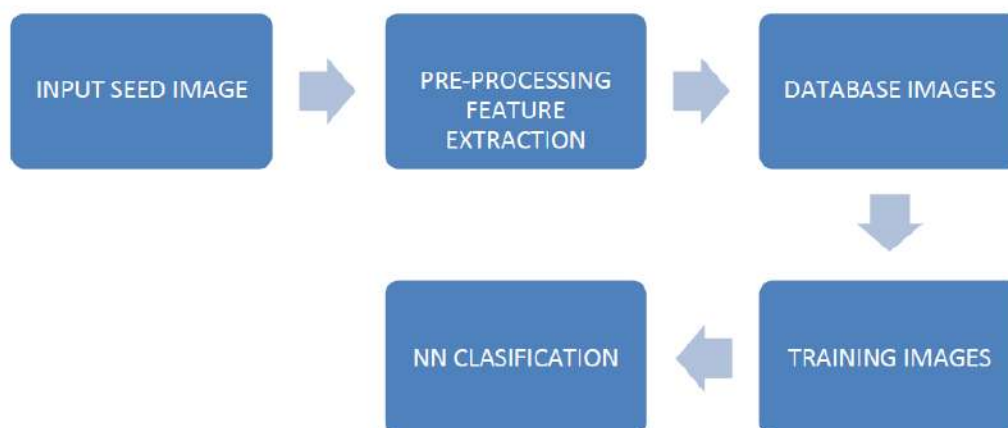


Fig.1. Procedure





A Study on Covering Extended Energy of Some Graphs

Y.Yogalakshmi^{1*}, U.Mary² and S.Sreeja³

¹Research Scholar, PG and Research, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Associate Professor and Head (Former), Dean – Student Affairs, PG and Research Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, , India.

³Assistant Professor, Department of Mathematics, PSGR Krishnammal College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

Y.Yogalakshmi

Research Scholar,

PG and Research Department of Mathematics,

Nirmala College for Women,

Coimbatore, Tamil Nadu, India.

E. Mail : yoga.goki@gmail.com



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ABSTRACT

The work of Extended Adjacency Matrix [1,6,7] inspired the concept of Covering Extended Matrix. In this manuscript, Covering Extended matrix (A_{ex}^C) is obtained using the degree of the nodes and hence energy is obtained using the sum of the latent values of the matrix (A_{ex}^C) . The Covering Extended Energy (E_{ex}^C) for Star graph, Complete graph, Complete Bipartite graph and Crown graph are estimated and few properties of covering extended energy are discussed.

Keywords: Determinantal equation, Covering set, covering extended matrix, Covering Extended energy, Latent values.

INTRODUCTION

The concept of energy of a graph was introduced by I. Gutman [3] in the year 1978. Let ψ be a graph with p nodes (M) and q lines (L). Let $A = (x_{ij})$ be the adjacency matrix of the graph. The latent values $\mu_1, \mu_2, \dots, \mu_p$ of A , assumed in non increasing order, are the latent values of the graph ψ . As A is real symmetric, the latent values of ψ are real with sum equal to zero. The energy $E(\psi)$ of ψ is defined to be the sum of the absolute values of the latent values of ψ . [2,4,5]





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i.e., $E(\psi) = \sum_{i=1}^p |\mu_i|$

Covering Set

Let ψ be a simple graph of order p and size q . A subset C of N is called a covering set of ψ if every edge of ψ is incident to atleast one vertex of C . [1]

Extended Energy

Extended matrix of ψ is the $p \times p$ matrix defined by $A_{ex}(\psi) = (x_{ij})$ where

$$x_{ij} = \begin{cases} \frac{1}{2} \left(\frac{d_i}{d_j} + \frac{d_j}{d_i} \right) & \text{if } a_i a_j \in L(\psi) \\ 0 & \text{Otherwise} \end{cases}$$

The latent values of $A_{ex}(\psi)$ are called extended latent values. The **extended energy** of ψ is described as

$$E_{ex} = \sum_{i=1}^p |\mu_i| \text{ where } \mu_1, \mu_2, \dots, \mu_p \text{ are the latent values of } A_{ex}(\psi). [7]$$

1.3 Covering Extended Energy:

Let ψ be a simple graph of order p and size q . Let C be the covering set of graph ψ . The covering extended matrix of ψ is a $p \times p$ matrix $A_{ex}^C(\psi) = (x_{ij})$ where,

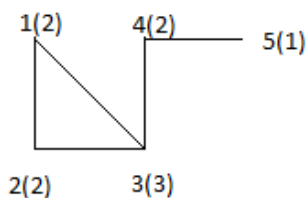
$$x_{ij} = \begin{cases} \frac{1}{2} \left(\frac{d_i}{d_j} + \frac{d_j}{d_i} \right) & \text{if } a_i a_j \in L(\psi) \\ 1 & \text{if } i = j \text{ \& } a_i \in C \\ 0 & \text{Otherwise} \end{cases}$$

The covering extended latent values of the graph ψ are the latent values of $A_{ex}^C(\psi)$. The covering extended

energy of ψ is defined as $E_{ex}^C(\psi) = \sum_{i=1}^p |\mu_i|$.

Illustration

Let ψ be the graph and $N = \{a_1, a_2, a_3, a_4, a_5\}$ be its node set. Its covering set $C = \{a_1, a_3, a_5\}$.





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$$A_{ex}^C(\psi) = \begin{bmatrix} 1 & \frac{1}{2}\left(\frac{2}{2} + \frac{2}{2}\right) & \frac{1}{2}\left(\frac{2}{3} + \frac{3}{2}\right) & 0 & 0 \\ \frac{1}{2}\left(\frac{2}{2} + \frac{2}{2}\right) & 0 & \frac{1}{2}\left(\frac{2}{3} + \frac{3}{2}\right) & 0 & 0 \\ \frac{1}{2}\left(\frac{2}{3} + \frac{3}{2}\right) & \frac{1}{2}\left(\frac{2}{3} + \frac{3}{2}\right) & 1 & \frac{1}{2}\left(\frac{2}{3} + \frac{3}{2}\right) & 0 \\ 0 & 0 & \frac{1}{2}\left(\frac{2}{3} + \frac{3}{2}\right) & 0 & \frac{1}{2}\left(\frac{2}{1} + \frac{1}{2}\right) \\ 0 & 0 & 0 & \frac{1}{2}\left(\frac{2}{1} + \frac{1}{2}\right) & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 1 & \frac{13}{12} & 0 & 0 \\ 1 & 0 & \frac{13}{12} & 0 & 0 \\ \frac{13}{12} & \frac{13}{12} & 1 & \frac{13}{12} & 0 \\ 0 & 0 & \frac{13}{12} & 0 & \frac{5}{4} \\ 0 & 0 & 0 & \frac{5}{4} & 1 \end{bmatrix}$$

The covering extended latent values are

$$\begin{aligned} \mu_1 &= -1.4154 & \mu_2 &= -0.6454 & \mu_3 &= 0.1775 \\ \mu_4 &= 1.8127 & \mu_5 &= 3.0707 \end{aligned}$$

The covering extended energy, $E_{ex}^C(\psi) = \sum_{i=1}^p |\mu_i| = 7.1217$

Few Properties on Covering Extended Energy

Theorem 3.1

Let $\psi = (p, q)$ be a simple graph and C be its covering set . Let $\mu_1, \mu_2, \dots, \mu_p$ be the latent values of $A_{ex}^C(\psi)$.

Then,

$$(i) \sum_{i=1}^p \mu_i = |C| \qquad (ii) \sum_{i=1}^p \mu_i^2 = |C| + \frac{1}{2} \sum_{i < j} \left(\frac{d_i}{d_j} + \frac{d_j}{d_i} \right)^2$$

Proof

(i) The totality of the latent values of $A_{ex}^C(\psi)$ is the trace of $A_{ex}^C(\psi)$

$$\therefore \sum_{i=1}^p \mu_i = \sum_{i=1}^p x_{ii} = |C|$$

(ii) The totality of squares of the latent values of $A_{ex}^C(\psi)$ is the trace of $(A_{ex}^C(\psi))^2$





$$\begin{aligned}
 \therefore \sum_{i=1}^p \mu_i^2 &= \sum_{i=1}^p \sum_{j=1}^p x_{ij} x_{ji} \\
 &= \sum_{i=1}^p (x_{ii})^2 + \sum_{i \neq j} x_{ij} x_{ji} \\
 &= \sum_{i=1}^p (x_{ii})^2 + 2 \sum_{i < j} (x_{ij})^2 \\
 &= |C| + 2 \sum_{i < j} \left[\frac{1}{2} \left(\frac{d_i}{d_j} + \frac{d_j}{d_i} \right) \right]^2 \\
 &= |C| + \frac{1}{2} \sum_{i < j} \left(\frac{d_i}{d_j} + \frac{d_j}{d_i} \right)^2
 \end{aligned}$$

Theorem 3.2

Let $\psi = (p, q)$ be a simple graph. Let C be the covering set of ψ and $g_x(\psi, \mu_x) = y_0 \mu_x^p + y_1 \mu_x^{p-1} + y_2 \mu_x^{p-2} + \dots + y_p$ be the determinantal equation of ψ . Then,

(i) $y_0 = 1$

(ii) $y_1 = -|C|$

(iii) $y_2 = \binom{|C|}{2} - \sum_{i < j} \left[\frac{1}{2} \left(\frac{d_i}{d_j} + \frac{d_j}{d_i} \right) \right]^2$

Proof

(i) From the definition of $g_x(\psi, \mu_x) = \det(\mu_x I - A_{ex}^c(\psi))$, follows that $y_0 = 1$.

(ii) Since the sum of diagonal elements of $A_{ex}^c(\psi)$ is equal to $|C|$,

$(-1)^1 y_1 = |C|$

$y_1 = -|C|$

(iii) The sum of the determinants of all 2×2 principal sub matrices of $A_{ex}^c(\psi) = (-1)^2 y_2$





$$\begin{aligned} \therefore y_2 &= \sum_{1 \leq i \leq j \leq p} \begin{vmatrix} x_{ii} & x_{ij} \\ x_{ji} & x_{jj} \end{vmatrix} \\ &= \sum_{1 \leq i \leq j \leq p} (x_{ii} x_{jj} - x_{ij} x_{ji}) \\ &= \sum_{1 \leq i \leq j \leq p} x_{ii} x_{jj} - \sum_{1 \leq i \leq j \leq p} x_{ij} x_{ji} \\ &= \sum_{1 \leq i \leq j \leq p} x_{ii} x_{jj} - \sum_{i < j} x_{ij}^2 \\ &= \binom{|C|}{2} - \sum_{i < j} \left[\frac{1}{2} \left(\frac{d_i}{d_j} + \frac{d_j}{d_i} \right) \right]^2 \end{aligned}$$

Covering Extended Energy of Star Graph, Complete Graph, Complete Bipartite Graph and Crown Graph

Theorem 4.1

For $p \geq 2$, covering extended energy of star graph $K_{1,p-1}$ is $\frac{\sqrt{p^5 - 5p^4 + 12p^3 - 15p^2 + 10p - 3}}{(p-1)}$.

Proof

Consider the star graph $K_{1,p-1}$ with node collection $N = \{a_0, a_1, a_2, \dots, a_{p-1}\}$. Covering set $C = \{a_0\}$. Then the covering extended adjacency matrix is

$$A_{ex}^C(K_{1,p-1}) = \begin{bmatrix} 1 & \frac{1}{2} \left[\frac{p-1}{1} + \frac{1}{p-1} \right] & \dots & \frac{1}{2} \left[\frac{p-1}{1} + \frac{1}{p-1} \right] \\ \frac{1}{2} \left[\frac{p-1}{1} + \frac{1}{p-1} \right] & 0 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ \frac{1}{2} \left[\frac{p-1}{1} + \frac{1}{p-1} \right] & 0 & \dots & 0 \end{bmatrix}$$

The determinantal equation is

$$\frac{\mu^{p-2} [4(p-1)\mu^2 - 4(p-1)\mu - ((p-1)^2 + 1)^2]}{4(p-1)} = 0$$

The covering extended latent values are

$$\mu = 0 [(p-2) \text{ times}]$$

$$\mu = \frac{(p-1) \pm \sqrt{p^5 - 5p^4 + 12p^3 - 15p^2 + 10p - 3}}{2p-2}$$

The covering extended energy,





$$\begin{aligned}
 E_{ex}^C(K_{1,p-1}) &= \sum_{i=1}^p |\mu_i| \\
 &= |0|(p-2) + \left| \frac{(p-1) + \sqrt{p^5 - 5p^4 + 12p^3 - 15p^2 + 10p - 3}}{2p-2} \right| + \left| \frac{(p-1) - \sqrt{p^5 - 5p^4 + 12p^3 - 15p^2 + 10p - 3}}{2p-2} \right| \\
 &= \frac{\sqrt{p^5 - 5p^4 + 12p^3 - 15p^2 + 10p - 3}}{(p-1)}
 \end{aligned}$$

Theorem 4.2

For $p \geq 2$, the covering extended energy of Complete graph K_p is $\sqrt{(p-3)(p-1)}$.

Proof:

Let K_p is a Complete graph with node collection $N = \{a_1, a_2, \dots, a_p\}$ and covering set $C = \{a_1, a_2, \dots, a_{p-1}\}$.

$$A_{ex}^C(K_p) = \begin{bmatrix} 1 & \frac{1}{2} \left[\frac{p-1}{p-1} + \frac{p-1}{p-1} \right] & \dots & \frac{1}{2} \left[\frac{p-1}{p-1} + \frac{p-1}{p-1} \right] \\ \frac{1}{2} \left[\frac{p-1}{p-1} + \frac{p-1}{p-1} \right] & 1 & \dots & \frac{1}{2} \left[\frac{p-1}{p-1} + \frac{p-1}{p-1} \right] \\ \vdots & \vdots & \ddots & \vdots \\ \frac{1}{2} \left[\frac{p-1}{p-1} + \frac{p-1}{p-1} \right] & \frac{1}{2} \left[\frac{p-1}{p-1} + \frac{p-1}{p-1} \right] & \dots & 0 \end{bmatrix}$$

The determinantal equation is

$$(\mu)^{p-2} (\mu^2 - (p-1)\mu - (p-1)) = 0$$

The covering extended latent values are

$$\mu = 0 \text{ [(p-2) times]}$$

$$\mu = \frac{(p-1) \pm \sqrt{(p+3)(p-1)}}{2}$$

The covering extended energy,

$$\begin{aligned}
 E_{ex}^C(K_p) &= \sum_{i=1}^p |\mu_i| \\
 &= |0|(p-2) + \left| \frac{(p-1) + \sqrt{(p+3)(p-1)}}{2} \right| + \left| \frac{(p-1) - \sqrt{(p+3)(p-1)}}{2} \right| \\
 &= \sqrt{(p+3)(p-1)}
 \end{aligned}$$

Theorem 4.3

For $p > q$, covering extended energy of a Complete Bipartite graph $K_{p,q}$ is

$$(p-1) + \frac{\sqrt{p^5q + pq^5 + 2p^3q^3 + p^2q^2}}{pq}$$

Proof





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Node collection of a complete bipartite graph $K_{p,q}$ be $\{a_1, a_2, a_3, \dots, a_p, b_1, b_2, \dots, b_q\}$. Then the covering set $C = \{a_1, a_2, \dots, a_p\}$. The covering extended matrix is,

$$A_{ex}^C(K_{p,q}) = \begin{bmatrix} 1 & 0 & \dots & 0 & \frac{1}{2}\left(\frac{p+q}{q-p}\right) & \frac{1}{2}\left(\frac{p+q}{q-p}\right) & \dots & \frac{1}{2}\left(\frac{p+q}{q-p}\right) \\ 0 & 1 & \dots & 0 & \frac{1}{2}\left(\frac{p+q}{q-p}\right) & \frac{1}{2}\left(\frac{p+q}{q-p}\right) & \dots & \frac{1}{2}\left(\frac{p+q}{q-p}\right) \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & 1 & \frac{1}{2}\left(\frac{p+q}{q-p}\right) & \frac{1}{2}\left(\frac{p+q}{q-p}\right) & \dots & \frac{1}{2}\left(\frac{p+q}{q-p}\right) \\ \frac{1}{2}\left(\frac{p+q}{q-p}\right) & \frac{1}{2}\left(\frac{p+q}{q-p}\right) & \dots & \frac{1}{2}\left(\frac{p+q}{q-p}\right) & 0 & 0 & \dots & 0 \\ \frac{1}{2}\left(\frac{p+q}{q-p}\right) & \frac{1}{2}\left(\frac{p+q}{q-p}\right) & \dots & \frac{1}{2}\left(\frac{p+q}{q-p}\right) & 0 & 0 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \ddots & \vdots \\ \frac{1}{2}\left(\frac{p+q}{q-p}\right) & \frac{1}{2}\left(\frac{p+q}{q-p}\right) & \dots & \frac{1}{2}\left(\frac{p+q}{q-p}\right) & 0 & 0 & \dots & 0 \end{bmatrix}$$

The determinantal equation is

$$\frac{\mu^{q-1}(\mu-1)^{p-1} [4pq\mu^2 - 4pq\mu - (p^2 + q^2)^2]}{4pq} = 0$$

The covering extended latent values are

$$\mu = 0 [(q-1) \text{ times}]$$

$$\mu = 1 [(p-1) \text{ times}]$$

$$\mu = \frac{pq \pm \sqrt{p^5q + pq^5 + 2p^3q^3 + p^2q^2}}{2pq}$$

The covering extended energy is

$$\begin{aligned} E_{ex}^C(K_{p,q}) &= \sum_{i=1}^p |\mu_i| \\ &= |0|(q-1) + |1|(p-1) + \left| \frac{pq + \sqrt{p^5q + pq^5 + 2p^3q^3 + p^2q^2}}{2pq} \right| + \left| \frac{pq - \sqrt{p^5q + pq^5 + 2p^3q^3 + p^2q^2}}{2pq} \right| \\ &= \frac{(p-1) + \sqrt{p^5q + pq^5 + 2p^3q^3 + p^2q^2}}{pq} \end{aligned}$$

Theorem 4.4

For $p \geq 3$, covering extended energy of a Crown graph S_p^0 is $(p-1)\sqrt{5} + \sqrt{4p-3}$.

Proof

For the crown graph S_p^0 with nodes setis $N = \{a_1, a_2, a_3, \dots, a_p, b_1, b_2, \dots, b_p\}$ and covering set $C = \{a_1, a_2, \dots, a_p\}$





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$$A_{ex}^c = \begin{bmatrix} 1 & 0 & \dots & 0 & 0 & \frac{1}{2}\left(\frac{p-1}{p-1} + \frac{p-1}{p-1}\right) & \dots & \frac{1}{2}\left(\frac{p-1}{p-1} + \frac{p-1}{p-1}\right) \\ 0 & 1 & \dots & 0 & \frac{1}{2}\left(\frac{p-1}{p-1} + \frac{p-1}{p-1}\right) & 0 & \dots & \frac{1}{2}\left(\frac{p-1}{p-1} + \frac{p-1}{p-1}\right) \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & 1 & \frac{1}{2}\left(\frac{p-1}{p-1} + \frac{p-1}{p-1}\right) & \frac{1}{2}\left(\frac{p-1}{p-1} + \frac{p-1}{p-1}\right) & \dots & 0 \\ 0 & \frac{1}{2}\left(\frac{p-1}{p-1} + \frac{p-1}{p-1}\right) & \dots & \frac{1}{2}\left(\frac{p-1}{p-1} + \frac{p-1}{p-1}\right) & 0 & 0 & \dots & 0 \\ \frac{1}{2}\left(\frac{p-1}{p-1} + \frac{p-1}{p-1}\right) & 0 & \dots & \frac{1}{2}\left(\frac{p-1}{p-1} + \frac{p-1}{p-1}\right) & 0 & 0 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \ddots & \vdots \\ \frac{1}{2}\left(\frac{p-1}{p-1} + \frac{p-1}{p-1}\right) & \frac{1}{2}\left(\frac{p-1}{p-1} + \frac{p-1}{p-1}\right) & \dots & 0 & 0 & 0 & \dots & 0 \end{bmatrix}$$

The determinantal equation is

$$(\mu^2 - \mu - 1)^{p-1} [\mu^2 - \mu - (p - 1)^2] = 0$$

The covering extended latent values are

$$\mu = \frac{1 \pm \sqrt{5}}{2} [(p - 1) \text{ times}]$$

$$\mu = \frac{1 \pm \sqrt{4p^2 - 8p + 5}}{2}$$

The covering extended energy is

$$\begin{aligned} E_{ex}^C(S_p^0) &= \sum_{i=1}^p |\mu_i| \\ &= \left| \frac{1 + \sqrt{5}}{2} \right| (p - 1) + \left| \frac{1 - \sqrt{5}}{2} \right| (p - 1) + \left| \frac{1 + \sqrt{4p^2 - 8p + 5}}{2} \right| + \left| \frac{1 - \sqrt{4p^2 - 8p + 5}}{2} \right| \\ &= (p - 1)\sqrt{5} + \sqrt{4p^2 - 8p + 5} \end{aligned}$$

CONCLUSION

In this Manuscript, the covering extended energy of Star graph, Complete graph, Complete Bipartite graph and Crown graph are estimated and few properties of covering extended energy are discussed. For future research, the bounds for the energy can be calculated. Extended adjacency matrices are used to calculate the electro negativity of the electrons [7]. This application can be extended for covering extended energy in as well.

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Fault Analysis of Transmission Line using Wavelet and ANN

M.Kondalu^{1*} and T.Umamaheswari²

¹Professor, Department of EEE, Malla Reddy Engineering College (Autonomous), Secunderabad, Hyderabad, Telangana, India.

²Assistant Professor, Department of EEE, Malla Reddy Engineering College (Autonomous), Secunderabad, Hyderabad, Telangana, India.

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*Address for Correspondence

M.Kondalu

Professor, Department of EEE,
Malla Reddy Engineering College (Autonomous),
Secunderabad, Hyderabad,
Telangana, India.



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ABSTRACT

This paper analyzes a review on responsibility finding and arrangement inside an extended communication line which is cycle remunerated using artificial neural networks (ANN) and wavelet transform. The future method makes utilize of one rotation post fault and one rotation pre fault and samples of the 3-phase current signals to get the view current signal. Daubechies is worn as the mother wavelet at the same time with the separate wavelet transform method. The degree of difference force, based on happening separate wavelet transform is useful to supply a scheme, planned calculated for the group of all fault types. Firstly the most select features which be the energies obtain from separate wavelet transform of the current signals preferred are feed to neural networks for the idea of responsibility arrangement. The dependability of the optional method is qualified in a 735-kV, 50 Hz power systems in changed operating settings using MATLAB. The fault was detected and confidential using separate wavelet transform in addition to ANN. The outcome indicates to the planned design know how to suitably categorize every potential fault with large variation into organization condition.

Keywords: Discrete wavelet transforms, Artificial neural networks faults, Fault, Power transmission lines

INTRODUCTION

The wavelet transform is definitely a useful instrument used for analyze the signal's superior frequencies. The Short Time Fourier transformation (STFT) is also another approach where the range of the window enclose is complex, but this method absorb knowledge of the range of the window and is not totally consistent to have enough decision.





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Wavelet transform solve these troubles of the Fourier transform. In Fourier transform, waveform can be experiential in the frequency area or the waveform does not contain time domain information. However, within wavelet transform inputs it is create in both the frequency and the point domain. WT’s attempt using it as method which associatedresearchers to estimate the transients in the power scheme. Available in different shapes and sizes, such as morel, coif lets, hair and Daubechies, wavelet selection is a major strength. Wavelet investigates consistent power interruption, the study process, called wavelets, modify with their time size by frequency, while the lesser frequency wavelet is wider and the superior frequency wavelets are especially narrow. Study for wavelets depend sin the equations below

Scaling equation

$$\phi(x) = \sum_n h\phi(n)\sqrt{2} \phi(2x - n) \tag{1}$$

Wavelet equation

$$\varphi(x) = \sum_n g\varphi(n)\sqrt{2}\varphi(2x - n) \tag{2}$$

Where $\phi(x)$ scaling equation $\varphi(x)$ are wavelet equation $h\phi(n)$ and $g\varphi(n)$ are separate filter. Theequations are choosing a mother wavelet for which the below condition have to be met

$$\sum_{n=-\infty}^{\infty} h\phi(n) z^{-n} = \sqrt{2} \tag{3}$$

$$\sum_{n=-\infty}^{\infty} h\phi(n) z^{-n} = \sqrt{2}$$

$$m=1$$

$$l$$

$$\sum_{n=-\infty}^{\infty} h\phi(n) \cdot h_{n+2m} = 1 \quad \text{If } z = 0 \tag{4}$$

$$l=1$$

$$=0 \text{ if } \in Z_l \ z \neq 0$$

It is set up that divide Wavelet Transform is useful in analyze a transient incident like this essential to compact with faults in the power line. The MRA is one of separate Wavelet Transform device. The non-stationary signals have been converted in to the small frequency and high frequency variables in this wavelet based system and these are called approximation and particulars coefficientswith such broad range decision level, which is between [12]. In the high-pass filter, wavelet transformation is being used to estimate high frequency in cycle of signal and low frequency. Low pass filter at ease analyzed. It performs two stages of disintegration. The indication through the first stage was decomposed into CA1 and CD1 with type of frequency band among $0-fs/4$ and $fs/4-fs/2$ all during which fs is called selection frequency. CA1 is broken behind toward present rise to CA2 and CD2 unconnectedly, in the second stage decomposition. The CD2 branch band frequency is $fs/8-fs/4$, and $0-fs/8$ for CA2 [12]. Upon breakdown the energy can be designed from the complete coefficients expressed in mathematical equations as below:

$$E(t_a, t_b) = \int_{t_a}^{t_b} |y(t)|^2 dt$$

Where Y(t) represents the signals



**Kondalu and Umamaheswari****Learning by ANN**

Error Back-Propagation typically includes a least amount of two neuron layers: the hidden layer and the output layer. The input layer is not occupied and as such was not incorporated structure. Training using procedure for error back-propagation needs a controlled difficulty, i.e. they be supposed to have a collection of pairs $\{X_s, T_s\}$ of r input and target. In many other terms, they should provide a collection of m -variable input items X_s (m -intensity range, m -component study m -consecutive observations of a time dependent variable, etc.) for the testing and the suitable n dimensional target (response) T_s (n structural fragments) should be associated with any X . Because of the mores technique, the breakdown back-propagation scheme has be established the name: the weights of neurons are fixed first in the output layer, then in the second hidden layer and at the ends during the first hidden layer, i.e. in the first layer that gets the input signals from the data. A variables h and m are called learning rate and momentum, which scope mostly 0.1 to 0.9. In view of the 1st layer output being identical to the 2layer input (Figure 2), we can see that the word y_1 is comparable to the term input i . Both quantities are equal to the elements x_1, x_2, \dots when the first sheet of weights is adjusted ($= 1$). Input vector.

Fault Classification by ANN

While its overall conception of relays continues the same, the technology age has a major outcome on how controllers operate, which has introduced numerous enhancements to conservative electrical apparatus. The entire data collected in ANN-based approach is divided into three configurations, including training and validation. Fault finding is the first part of the method. If they appreciate there has a fault on the power line, one more be in motion to organize the fault in a variety of groups based on the phases of fault. This paper has the purpose of implement system used for artificial neural networks to perform each of those tasks. Neural networks focused on Back propagation are used for error identification and the arrangement of faults. Different neural networks are used for each of various types of classification fault. The flowchart shown in Figure 3 depict every of these steps.

Flow Chart (Fig.3)

The flowchart describes the basic method used to implement the detection and diagnosis of faults is based on ANN. Three major input signals should be measured at a sampling rate of 1.0 MH all through data pre-processing or advance analyze by means of a low-pass filter [2] and for calculate the energy sense of balance of three currents, a maximum set DFT is used. To cause to be ANN input point between +1 or 0, the input signals were identical. Network design, a learning rule set, training method and ANN-based fault locator processing are the most critical aspects of flaw position systems. The four output of neural network correspond to a fault for every one of the 3 phases and 1 output is ground line. Thus, all outputs is either 0 or 1 suggesting a yes or no fault on the line (A, B, C or G, where A, B and C represents 3 phases of transmission line network and G indicates ground) [1]. Therefore, each of different faults be represented accordingly by the various possible permutations. The proposed neural network is able to precisely differentiate ten feasible kind of faults. The table 1 shows the truth value describing faults and efficient operation for each of faults.

SIMULATION AND RESULTS OF FAULTS

The Fourier transform is a valuable tool for measuring the signal's high frequencies. The Short Time Fourier transformation (STFT) is also approach at which scale of the window pane is complex, but this method involves awareness of the scale of the window and is not necessarily reliable to have sufficient resolution. The modern, DWT-based methodology for fault identification and transmission line diagnosis. For this system current values are transmitted from each step. Moreover, the standardized values approach reference values with in presence of irregular working conditions. MATLAB circuit for 3-phase transmission line method of 13.8 kV seen in figure 4, must have a generator at bus A and a load at bus B, its principal component study discrete wavelet Transform with MRA is being used for modeling. Power network is composed of a 13.8kV, 350 MVA generator, current transformers required by each step, 30 km variable distributed transmission lines for part, 90 km line length and a three-phase load. Power Grid block Used to simulate the method



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that enable for the collection of continuous, discrete and phasor come within reach of to solving electrical circuit. Faults of various types on transmission lines at different locations are simulated using the MATLAB / Simulink. In MATLAB work space, current signals of increasing step are captured as DWT is implemented for detection and diagnosis of faults on such current signals. This technique proposed has been recognized at Simulink. And at current signal increasing step, separate wavelet transform with multi resolution study was added to measure normalized values from detail coefficients typical up to 2nd stage. No fault voltage and current signals sine wave and Figure 5. shows phase to phase fault current and voltage signal waveforms. Figure 6. displays the uniform no fault values for all phases. Whenever the maximum peak of any normalized phase value will be less than the threshold value 0.380, a method is regarded strong system. Figures 7., 8., and 9, illustrate the process of ground faults including A-G, B-G, and C-G. In these figures it is evident that phase to ground faults arise while normalized phase values outpace the threshold value. Phase comparison of phase faults including A-B, BC, and C-A is shown in Figures 10, 11 and 12. A Strong system endures the phase-to - phase fault as per the suggested technique is when normalized values of each of the two phases reach the threshold value. Figure 12 shows the symmetric (three-phase) fault. For this situation normalized values approach the threshold value of all phases. The Frequency of Parameters faults table 2 shown in the figure.

Simulation of ANN

A present, 13.8 KV 3-phase transmission line devices exhibited in figure.13, with a generator at bus A and load at bus B was utilized mat lab using present system described based on discrete wavelet transform are ANN. Network can be made up of 13.8 KV, 350 MVA generator, current transformer utilized every one step, 30 km parameter dispersed transmission lines for each segment, 90 km line length and a three-phase load [4]. In MATLAB work space, current signals to each phase are recorded ANN is applied detection and diagnosis of faults on these current signals. The sampling frequency takes 20 kHz and base frequency of 50 Hz. The MATLAB circuit ANN- Based Simulation Platform for Detection and Classification of faults shown in the 5. This technique proposed has been recognized at Simulink. And at current sign increasing step, separate wavelet transform with multi resolution study was added to measure normalized values from detail coefficients typical up to 2nd stage. No fault voltage and current signals sine wave and Figure 14 shows phase to phase fault current and voltage signal waveforms. Figure 15 displays the uniform no fault values for all phases. Whenever the maximum peak of any normalized phase value will be less than the threshold value 0.380, a method is regarded strong system. Figures 15, 16, and 16 illustrate the process of ground faults including A-G, B-G, and C-G. In these figures it is evident that phase to ground faults arise while normalized phase values outpace the threshold value. Phase comparison of phase faults including A-B, BC, and C-A is shown in Figures 17, 18 and 19. A Strong system endures the phase-to - phase fault as per the suggested technique is when normalized values of each of the two phases reach the threshold value. Figure 21 shows the symmetric (three-phase) fault. For this situation normalized values approach the threshold value of all phases. The Frequency of Parameters faults table 3 shown in the figure.

CONCLUSION

Transmission lines are part of the power systems, but power systems are experience a large number of faults. A range of efforts to reduce transmission line faults have be formed in reaction to this . The function of this learning was to explore the viability of Artificial Neural Networks as a method for transmission lines to common sense faults. There are unusual techniques of protection for the transmission lines: detection of faults, organization of faults and determination of the location of faults. The focus of the study was on the application of Artificial Neural Networks to fault detection. This paper aimed to identify and recognize electrical faults in real time inside a simulated environment. For this paper we researched that operation of ANN on the three-phase transmission line network to detect & diagnose faults [9]. The industrial method uses of three phase currents and voltages as input to neural networks. Its variables have been regular in relation to their various pre- fault standards. A finding contained in this statement is for a field to ground only with the fault line. Both these types of faults, -for example Line to line, symmetrical three phase faults, has been recognized and artificial neural networks are being created for all of those



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faults. The neural network design of the back propagation was followed by any of the artificial neural networks which were analyzed

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Table 1 Values of Various Faults

Fault Types	Phase A	Phase B	Phase C	Ground
AG	1	0	0	1
BG	0	1	0	1
CG	0	0	1	1
AB	1	1	0	0
BC	0	1	1	0
CA	1	0	1	0
ABC	1	1	1	0
NO FAULT	0	0	0	0

Table 2 The Frequency of Parameters faults

S. No.	Types of faults	Settling time			Peak time (sec)			Maximum peak over shoot(%)		
		P-A	P-B	P-C	P-A	P-B	P-C	P-A	P-B	P-C
1	AG Fault	2.843	2.643	1.949	0.057	0.087	0.070	8.223%	29.574%	44.975%
2	BG Fault	2.843	2.643	1.949	0.033	0.056	0.070	33.386%	-1.994%	44.975%
3	CG Fault	2.843	2.643	1.949	0.033	0.087	0.045	33.386%	29.574%	39.291%
4	AB Fault	2.843	2.643	1.949	0.057	0.056	0.070	44.975%	30.027%	-8.223%
5	BC Fault	2.843	2.643	1.949	0.33	0.056	0.045	33.386%	-1.994%	18.743%
6	AC Fault	2.843	2.643	1.949	0.057	0.087	0.045	10.823%	29.574%	34.257%
7	ABC Fault	2.843	2.643	1.949	0.057	0.056	0.045	2.956%	5.947%	63.639%
8	No Fault	2.843	2.643	1.949	0.033	0.087	0.070	37.832%	29.574%	44.948%

Table 3 Parameters of The Frequency Response

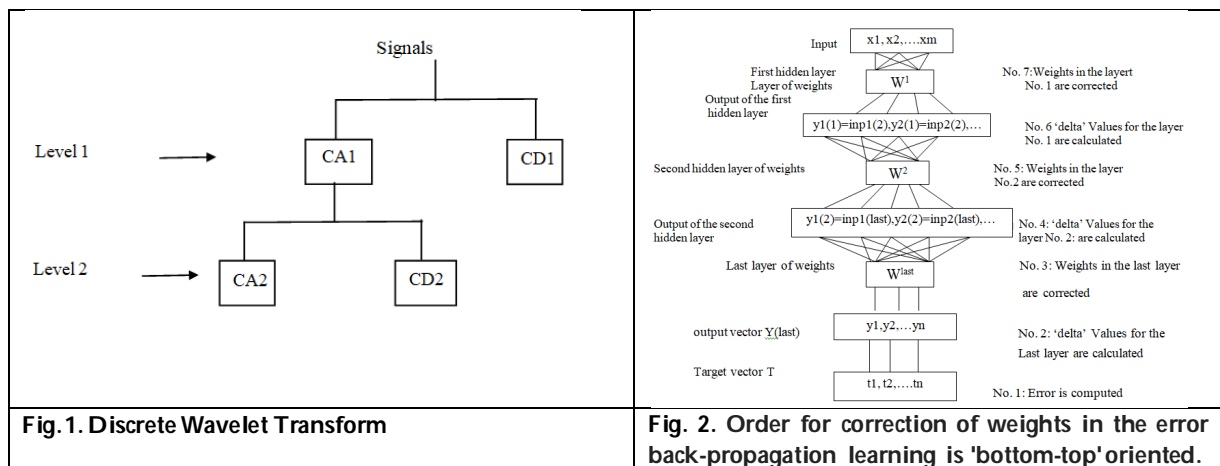
S. No.	Types of faults	Settling time			Peak time (sec)			Maximum peak over shoot(%)		
		P-A	P-B	P-C	P-A	P-B	P-C	P-A	P-B	P-C
1	AG Fault	1.672	1.315	1.332	0.056	0.007	0.087	35.720	38.735	244.741





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2	BG Fault	1.672	1.315	1.332	0.032	0.045	0.062	162.800	19.345	244.741
3	CG Fault	1.672	1.315	1.332	0.032	0.007	0.046	162.800	38.735	47.000
4	AB Fault	1.672	1.315	1.332	0.056	0.045	0.062	35.720	230.082	244.741
5	BC Fault	1.672	1.315	1.332	0.032	0.045	0.046	162.800	145.651	51.042
6	AC Fault	1.672	1.315	1.332	0.056	0.007	0.046	31.760	38.735	47.000
7	ABC Fault	1.672	1.315	1.332	0.056	0.045	0.046	27.977	14.912	33.607
8	No Fault	1.672	1.315	1.332	0.032	0.007	0.087	162.800	38.735	244.741





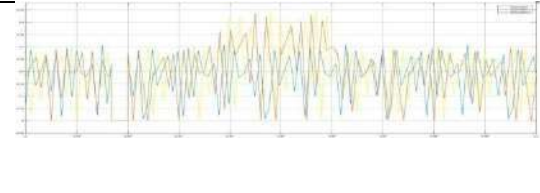
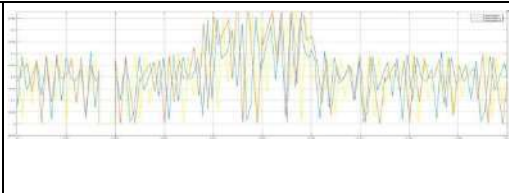
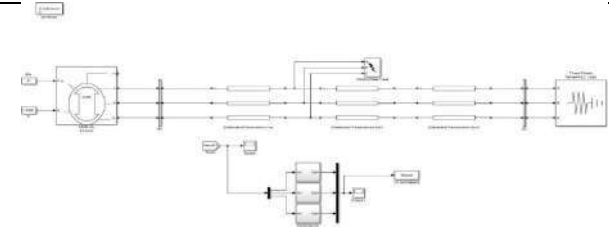
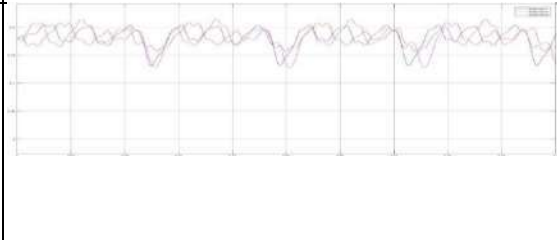
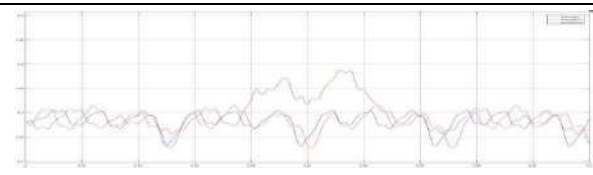
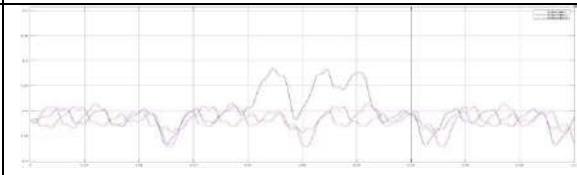
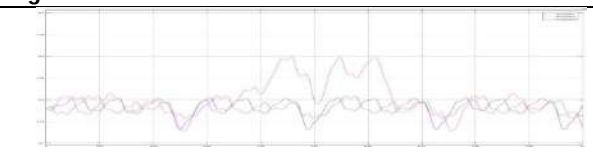
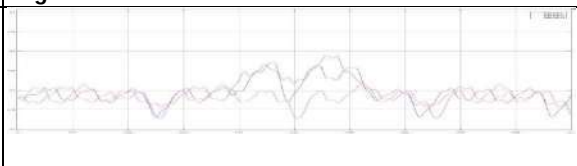
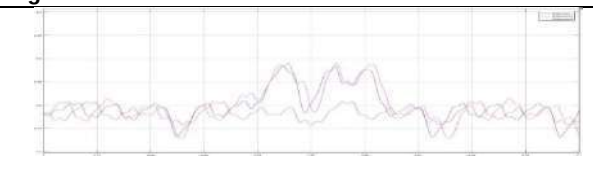
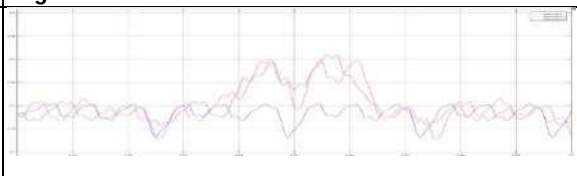
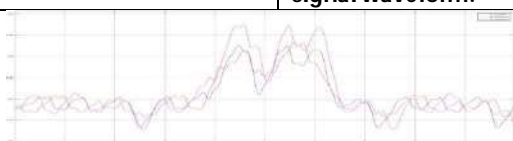
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<p>Fig. 3. Flow chart of Fault Classification on ANN Based</p>	<p>Fig. 4 MATLAB circuit for 3-phase transmission line method of 13.8 kV</p>
<p>Fig. 5. phase to phase (AB) fault current and voltage signal waveform</p>	<p>Fig. 6. No fault voltage and current signals waveform.</p>
<p>Fig. 7. phase to phase (AG) fault current and voltage signal waveform</p>	<p>Fig. 8. phase to phase (BG) fault current and voltage signal waveform</p>
<p>Fig. 9. phase to phase (CG) fault current and voltage signal waveform</p>	<p>Fig. 10. phase to phase (BC) fault current and voltage signal waveform</p>





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Fig. 11. phase to phase (AC) fault current and voltage signal waveform	Fig. 12. Three phase (ABC) fault current and voltage signal waveform
	
Fig. 13. MATLAB circuit ANN-Based Simulation Platform for Detection and Classification of faults	Fig. 14. No fault voltage and current signals waveform.
	
Fig. 15. phase to phase (AG) fault current and voltage signal waveform	Fig. 16. phase to phase (BG) fault current and voltage signal waveform
	
Fig. 17. phase to phase (CG) fault current and voltage signal waveform.	Fig. 18. phase to phase (AB) fault current and voltage signal waveform.
	
Fig. 19. phase to phase (BC) fault current and voltage signal waveform.	Fig. 20. phase to phase (AC) fault current and voltage signal waveform.
	
Fig. 21. Three phase (ABC) fault current and voltage signal waveform	





Data Envelopment Analysis to Study Efficiency and Productivity Change of Public and Private General Insurance Sector

K S Druva Kumar^{1,2*}, J P Senthil Kumar³

¹Research Scholar, Department of Finance, GITAM School of Business Gitam (Deemed University), Bengaluru, Karnataka, India.

²Asst. Professor, Department of Commerce, SFS Degree College, Bengaluru University, Karnataka, India.

³Department of Finance, GITAM School Of Business, Gitam (Deemed University) Bengaluru, Karnataka, India

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*Address for Correspondence

K S Druva Kumar

Research Scholar, Department of Finance,
GITAM School of Business Gitam (Deemed University),
Bengaluru, Karnataka, India.

E.Mail: druvakumarks@sfscollege.in



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ABSTRACT

This study aims to analyze and compare the efficiency and productivity changes of India's public and private non-life insurance companies from 2015 to 2022. The study will use Data Envelopment Analysis (DEA) to examine the technical, pure technical, and scale efficiencies of both sectors and Malmquist Index methods to explore the Total Factor Productivity (TFP) changes of the general insurance companies. The analysis data shows that the private general insurance sector is making more effort Than the Public Sector, and private companies or more efficient than the public Sector. Based on the analysis of the data provided, the study will provide a useful reference for policy makers and industry stakeholders interested in improving the insurance sector's Performance in India. The study is expected to contribute to the existing literature on insurance efficiency and productivity by providing a comparative analysis of the public and private sector non-life insurance companies in India. The study's results will provide valuable insights into the Performance of the public and private Sector non-life insurance companies in India. It will help identify the factors that contribute to their inefficiency and productivity. Originality the data indicates that all four companies, ICICI, Bajaj, United, and Oriental, have shown varying levels of efficiency in the insurance sector from 2015-2022. Overall, the data provides a glimpse into the efficiency and productivity of the four non-life insurance companies in India, based on the DEA and Malmquist Index methods.

Keywords: Data Envelopment Analysis (DEA), Total Factor Productivity (TFP), Malmqui



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INTRODUCTION

The insurance industry plays a significant role in economic development; (Ug- wuanyim, 2021). Any sector, for that matter, needs a lot of strategies and plans to establish its considerable impact on society. This paper aims to discuss or identify the factors which influence the Performance of general insurance in private and public Sectors. On-life insurance in India plays a very significant role in mitigating risk for many industrial sectors. In the non-life insurance business, India is ranked 14th in the world, which is an improvement of one rank compared to last year. The country also holds a 0.77% share of the global non-life insurance market. During 2020, the non-life insurance premium in India decreased by 1.3%, while the global non-life insurance premium increased by 2.8%. This highlights an efficiency and productivity gap in the general insurance industry(S, 2021). The general insurance industry recorded a total direct premium of 1.99 crores in India for 2020-21 against 1.89 crores in 2019-20 (ANNUAL REPORTS OF THE AUTHORITY, no date). There is a growth rate of 5.19%, but compared to last year, it was 11.49, so evidently proving that there is d-growth in 2020-21 over the previous year from the Public Sector, but in the private Sector, there is a tremendous growth rate of 8.1% registered. And if we see the penetration and density of general insurance compared to life insurance, penetration is 1% compared to 3.20 in life insurance. As well as, if we see the thickness of general insurance is 19% compared to 59% of life insurance (Mahapatra, 2017), although general insurance is mandatory in India, there has been a notable decline in both its penetration and density. This indicates a weakness in the development of the general insurance industry.

Additionally, when comparing the Performance of public and private insurers, the private insurers seem to be doing better. It's worth noting that private insurers have only recently been granted permission to operate. (Silver and Com, 2020) The study will use Data Envelopment Analysis (DEA) (Mandal and Dastidar, 2014; Zhao *et al.*, 2021) to examine the technical, pure technical, and scale efficiencies of both sectors and Malmquist Index methods to explore the Total Factor Productivity (TFP) change of the general insurance companies. Overall, the data provides a glimpse into the efficiency and productivity of the four non-life insurance companies in India, based on the DEA and Malmquist Index methods (Lovell, 2003; Barros *et al.*, 2005; Chakraborty, 2018). The study results will provide valuable insights into the Performance of the public and private Sector non-life insurance companies in India and will help identify the factors that contribute to their efficiency and productivity. Additionally, the study will provide a valuable reference for policymakers and industry stakeholders interested in improving India's insurance sector's performance. The study is expected to contribute to the existing literature on insurance efficiency and productivity by providing a comparative analysis of India's public and private Sector non-life insurance companies.

REVIEW LITERATURE

This study is a novel and groundbreaking comparison of the efficiency and productivity changes of India's public and private non-life insurance companies. We are not aware of any previous research that has examined this particular aspect of the industry. The findings of this study will address an essential gap in the literature, providing valuable Insights into the Performance of India's public and private non-life insurance sectors. These results will be of great significance to policymakers and industry stakeholders- ers, as they will offer guidance on ways to improve the efficiency and productivity of the insurance sector in India. This research represents a significant advance in our comprehension of the Performance of the insurance industry in India. It will be a crucial reference point for future studies in this area. Following will be the summary of research related to the studies DEA: Data Envelopment Analysis (DEA) model measures how well an organization utilises its available resources to produce output. In the insurance sector, technical efficiency can be calculated for an insurance company by using the DEA model to compare the company's actual work to the potential output that could be achieved if the company was operating at its maximum efficiency. (Oppong *et al.*, 2019; Li *et al.*, 2020; Lim *et al.*, 2021).

In a CRS model, the inputs and outputs of a DMU are assumed to be related by a fixed constant so that the relationship between inputs and outputs remains the same, regardless of the scale of production. This means that as the DMU increases its production levels, the ratio of inputs to outputs will remain constant. (Chakraborty, 2016;





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Benyoussef and Hemrit, 2019; Pervan *et al.*, 2021). In contrast, a VRS model allows for the possibility that the relationship between inputs and outputs may change as the scale of production changes. This means that the ratio of inputs to outputs may not be constant and may vary depending on the production level. (Luhnen, 2009)(Luhnen, 2009)

The Malmquist index is a productivity measure used in Data Envelopment Analysis (DEA) to assess changes in the efficiency of a set of decision-making units (DMUs) over time (Lovell, 2003; Chakraborty, 2018). The index is calculated based on two periods, and it captures changes in both the technological frontier and shifts in the Efficiency of individual DMUs over time (Cummins and Weiss, 2013; Cummins and Xie, 2016)

Technical Change: Technical change captures the change in the distance between the DMUs and the efficient frontier due to improvements in technology or other external factors. It reflects the shift in the efficient frontier over time and is calculated by Comparing the distance of DMUs to the efficient frontier between the two periods. (; Ndlovu, 2021a) (Cummins and Weiss, 2013; Biener *et al.*, 2016; Cummins and Xie, 2016; Chakraborty, 2016,?; Ilyas and Rajasekaran, 2020).

Pure Technical Efficiency Change: Pure technical efficiency change measures the change in the relative Efficiency of the DMUs in the same technology environment. It captures the change in the Efficiency of each DMU independent of changes in the production technology. It is calculated by dividing the distance to the efficient frontier of the second period by the product of the distance to the frontier of the first period and the technical change.

Scale Efficiency: Scale efficiency change reflects the change in the optimal scale of production. It captures the efficiency change resulting from changes in the scale of operations, which may lead to economies or diseconomies of scale. It is calculated by dividing the ratio of the distance to the efficient frontier between the two periods by the technical change. (Barros, Barroso and Borges, 2005; Luhnen, 2009; Chakraborty, 2018; Ilyas and Rajasekaran, 2019; Ndlovu, 2021).

OBJECTIVE OF THE STUDY

- I. TO EXAMINE AND COMPARE THE TECHNICAL EFFICIENCY, PURE TECHNICAL EFFICIENCY AND SCALE EFFICIENCIES OF THE PUBLIC and PRIVATE SECTOR OF GENERAL INSURANCE COMPANIES IN INDIA FOR THE PERIOD FROM 2015-2022
- II. TO EXAMINE THE TFP (TOTAL FACTOR PRODUCTIVITY) CHANGES OF THE GENERAL INSURANCE COMPANIES

HYPOTHESIS OF THE STUDY

1. H_0 = No significant difference in efficiency between public and private.
2. H_{01} = There is no significant change. In between the total factor of productivity among public and private general insurance companies

METHODOLOGY AND DATA

Data and Methodology Research Tools

The non-parametric Data Envelopment Analysis (DEA) model was employed to determine the relative efficiency scores of both the public and private non-life insurance firms in India. The output-oriented DEA approach was adopted in this study, using an input-output framework. In addition, the Malmquist index was utilized as an extension to the DEA model to evaluate the productivity changes of the public sector non-life insurers during the study period. (Brockett, 2007; Sinha, 2015; Yu, 2021; Zhao *et al.*, 2021) the value-based approach of data envelopment analysis (DEA) is used in common in that risk pooling and bearing (to decide on input and output) refer to the ways in which risk is managed and shared among the decision-making units (DMUs) being analyzed(J. Chakraborty, 2016, 2018) (Cummins and Weiss, 2013; Cummins and Xie, 2016; Chakraborty, 2016)



**Druva Kumar and Senthil Kumar****DATA SOURCES**

The data used in this study was obtained from the IRDA Annual Reports spanning the period of 2015-2022 and was further supplemented by the annual reports of individual companies for each respective year. In order to conduct the TFP (Total Factor Productivity) analysis, two private and two public general insurance companies were selected as the sample for this study. Summary of Input-Output Variables Used Table 2.

RESULTS AND DISCUSSION**Efficiency Analysis of the Sample Firms**

The data utilized in this study comprises a correlation matrix, which quantifies the degree of linear association between various variables. The values in this matrix range from -1 to 1 and indicate the strength of the relationship between the variables. A value of 1 represents a perfect positive relationship, while a value of -1 indicates a perfect negative relationship. A value of 0 signifies no correlation between the variables. From the matrix, we can see that there is a strong positive relationship between Operating Expenses and Net Premiums (0.85), as well as between Investments and Income from Investments (0.98). There is a moderate positive relationship between Operating Expenses and Investments (0.82) and between Net Premiums and Income from Investments (0.86). In conclusion, the data suggest that there is a strong association between Operating Expenses and Net Premiums, as well as between Investments and Income from Investments. However, the association between Operating Expenses and Investments and Net Premiums and Income from Investments is moderate. Table 3 The data provided is a descriptive statistics table for multiple variables for different years. The variables are Operating Expenses, Investments, Net Premiums, and Income from Investments. The statistics provided are mean, standard deviation (SD), minimum, and maximum.

Descriptive Statistics of inputs and Outputs variables. Note: Figures are in Rs000

we can see that the mean value of Operating Expenses has increased over the years, while the standard deviation has remained relatively stable. The mean value of Investments has also increased over the years, while the standard deviation has been more volatile. The mean value of Net Premiums has also increased over the years, while the standard deviation has remained relatively stable. The mean value of Income from Investments has increased over the years, while the standard deviation has been more volatile. In conclusion, the data shows that the mean values of all variables have increased over the years, indicating growth in the respective areas. The standard deviation of Investments and Income from Investments has been more volatile than the other variables, indicating a higher degree of variability in these areas.

Table 5 displays the technical efficiency scores of four non-life insurance companies (ICICI, Bajaj, United, and Oriental) for the period 2015-16 to 2021-22. The technical efficiency score measures how efficiently a company uses its inputs to produce outputs. A score of 1 indicates that the company uses its inputs to the maximum possible extent to produce outputs. In contrast, a score less than 1 indicates that the company has room for improvement in terms of efficiency. The scores in the table are calculated using the Constant Return to Scale (CCR) output orientation approach. This approach assumes that a company's inputs and outputs are linearly related and that an increase in inputs leads to proportional outputs. In this approach, the focus is on the outputs produced by the company and how efficiently the inputs are being used to produce those outputs. The table also shows the number of efficient and inefficient DMUs A DMU is considered efficient if its technical efficiency score is equal to 1, meaning that it uses its inputs to the maximum possible extent to produce outputs. A DMU is considered inefficient if its score is less than 1, indicating that it has room for improvement in terms of efficiency.

Here's an interpretation of the data:

- Based on the technical efficiency scores, ICICI has an average score of 0.96494437 over the period from 2015-16 to 2021-22, indicating that the company has been using its inputs efficiently to produce outputs. However, there have been some fluctuations in its efficiency score over the years.





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- Bajaj has an average technical efficiency score of 0.969744741, which is higher than ICICI's score, indicating that Bajaj has been consistently efficient in using its inputs to produce outputs over the entire period.
- United has an average technical efficiency score of 0.932797841, which is lower than the scores of ICICI and Bajaj. This indicates that United has not been as efficient in using its inputs to produce outputs as the other two companies. However, it has improved its efficiency score over the years.
- Oriental has an average technical efficiency score of 0.943754351, which is higher than United's score but lower than the scores of ICICI and Bajaj. This indicates that Oriental has been relatively efficient in using its inputs to produce outputs but still has room for improvement.
- The table also shows that there have been fluctuations in the number of efficient and inefficient DMUs over the years. At different times, there have been two to three efficient DMUs, while there have been one to four inefficient DMUs.

Overall, the data suggest that Bajaj has been the most efficient of the four companies in using its inputs to produce outputs over the period from 2015-16 to 2021-22, while United has the least efficiency. Under VRS, the average technical efficiency score for ICICI was 0.9891 and ranked 3rd among the four insurers. ICICI scored 1 in 2015-16, 2017-18, 2018-19, 2020-21, and 2021-22, indicating that it was technically efficient in those years. However, it scored 0.971 in 2016-17, indicating that it was technically inefficient. Bajaj had an average technical efficiency score of 0.993 under VRS and was ranked 2nd among the four insurers. Bajaj scored 1 in all the years except 2020-21, when it had a score of 0.955, indicating that it was technically inefficient. United had an average technical efficiency score of 0.995 under VRS and was ranked 1st among the four insurers. United scored 1 in all the years except 2021-22, when it scored 0.967, indicating that it was technically inefficient. Oriental had an average technical efficiency score of 0.979 under VRS and was ranked 4th among the four insurers. Oriental scored 1 in 2015-16, 2017-18, 2018-19, 2019-20, and 2021-22, indicating that it was technically efficient in those years.

Comparison of CRS and VRS

- The average technical efficiency score for all the insurers is higher under VRS as compared to CRS.
- The ranking of the insurers is different in both models. For example, Bajaj is ranked 2nd in VRS but 1st in CRS.
- The scores of the insurers show that most of the insurers were technically efficient in VRS compared to CRS.

The scale efficiency scores under the VRS model (Table 6) tell us about each non-life insurance company's ability to produce a given output level using the minimum number of inputs (scale efficiency). The average TE SE (2015-2022) gives us the average level of scale efficiency over time. The rank compares the companies in terms of their scale efficiency.

Based on the data, it can be seen that

- Bajaj and ICICI have consistently been among the top performers in scale efficiency.
- Oriental has also had a good level of scale efficiency over the years.
- United has had the lowest average scale efficiency over the period.

Hypothesis H0= Null hypothesis is rejected due to a significant change in efficiency between the Public Sector and Private Sector; above are the data indicating the details of the significant changes. This data suggests that the companies could focus on improving their scale efficiency by using their inputs more efficiently, improving their processes, and increasing their output while minimizing the use of inputs. Additionally, they could consider expanding their operations to increase their economies of scale, which could improve scale efficiency.

TOTAL FACTOR OF PRODUCTIVITY (MALMQUIST INDEX)

the Malmquist Index is a valuable tool for measuring productivity growth in the insurance sector and guiding insurance companies in their efforts to improve their competitiveness and Performance. In the insurance sector, TFP can be a valuable tool for evaluating the Performance of different insurance companies and identifying areas for



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improvement. The index provides a comprehensive picture of how each company is performing, taking into account both technical efficiency and technological advancements.

MALMQUIST INDEX SUMMARY OF FIRM MEANS

The above data shows the Total Factor Productivity (TFP) changes for the four non-life insurance companies ICICI, Bajaj, United, and Oriental Insurance. The data indicates the changes in technical efficiency, technological change, pure technical efficiency change, scale efficiency change, and overall TFP changes. Based on the data, ICICI has the highest increase in TFP at 1.17, followed by Bajaj at 1.085, United at 1.05, and Oriental Insurance at 0.976. The average TFP change is 1.068. To improve TFP, companies can focus on improving their technical efficiency, embracing technological changes, increasing their scale of operation, and improving their management practices. Companies can also focus on increasing their operational efficiency, improving customer service, and finding new market opportunities to grow their business. It's important to note that this is just a general suggestion, and the best approach for each company may vary based on their specific circumstances and goals. Further analysis and data would be needed to make more specific recommendations. Hypothesis H01 = Null hypothesis is rejected because there is a significant change in TOTAL FACTOR PRODUCTIVITY between the Public Sector and Private Sector; above are the data indicating the details of the significant changes.

Year-Wise Malmquist Index Summary of Annual Means

The above table represents the Total Factor Productivity (TFP) change in the insurance sector from 2016-17 to 2021-22. The TFP change is calculated using the Malmquist Index, which considers both technical and scale efficiency changes. The data shows that the average TFP change over the period is 1.068, which indicates that the overall productivity of the Sector has increased slightly over this time. However, there is some variability in the TFP change from year to year, with the highest increase of 1.175 observed in 2016-17, and the lowest increase of 0.977 observed in 2021-22. When analyzing the different components of TFP change, it is seen that technical change has an average value of 1.064, which suggests that the companies in the Sector have improved their processes and operations, leading to higher efficiency. (PTEC) Technological change, on the other hand, has an average value of 1, indicating that no major technological breakthroughs have significantly impacted the Sector. In terms of (TEC) technical efficiency change, the average value of 1.004 suggests that there has been a slight improvement in the way resources are utilized by the companies in the Sector. However, scale efficiency change, with an average value of 1.004, indicates that there has been a more significant improvement in the way the companies are managing their economies of scale.

Based on this data, I would suggest that companies in the insurance sector continue to focus on improving their processes and operations and utilizing their resources effectively to maintain or increase their productivity in the future. Additionally, it may be beneficial for companies to consider adopting new technologies and finding ways to manage their economies of scale better to remain competitive in a rapidly changing industry.

CONCLUSION

From the above data, it's clearly concluded that the private general insurance sector is making more effort than the public sector and private companies or more efficient than the public Sector. Based on the data analysis, it can be concluded that all four companies, ICICI, Bajaj, United, and Oriental, have shown varying levels of efficiency in the insurance Sector from 2015-2022. According to the fourth table, the technical efficiency change of these companies has fluctuated over the years, with the highest change of 1.175 in 2016-17 and the lowest of 0.977 in 2021-22. The technological change has also shown variation, with a highest value of 1.163 in 2020-21 and a lowest value of 0.96 in 2019-20.

In the fifth table, the VRS model shows that Bajaj has the highest average TE score of 0.975874, while United has the lowest average TE score of 0.936545. The remaining companies, ICICI and Oriental, have average TE scores of 0.974719 and 0.964136, respectively. In the seventh table, the Malmquist Index reflects the companies' Total Factor



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Productivity (TFP) change. The highest TFP change was seen in 2016-17 with 1.175, and the lowest in 2020-21 with 1.03. The overall TFP change has fluctuated from 2015-2022, with a mean TFP change of 1.068. In conclusion, all four companies have shown some level of efficiency over the years. Still, there is room for improvement regarding technical and scale efficiency, technological change and total factor productivity. The companies can focus on improving these aspects in order to be more competitive in the insurance sector.

LIMITATIONS

The above data provide information about the efficiency of the companies in the insurance Sector. However, the data only provides limited information and does not consider other factors that can impact the efficiency of a company. The data only considers technical Efficiency, technological change, pure technical Efficiency, scale efficiency, and total factor productivity (TFP). It does not consider other factors such as financial performance, market conditions, competition, regulatory environment, and other internal and external factors. Therefore, the data should be viewed as a starting point for understanding the efficiency of these companies and not as a comprehensive analysis. It is essential to consider other factors and gather more information before making any decisions or conclusions about the efficiency of these companies

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Table 1. Inputs and outputs: from the review literature

Author	Method	Units	Inputs	Output
(Pervan, Pavić Kramarić and Ćurak, 2021)	DEA	34	Operative expenses	Net premium and investment.
(Mandal and Ghosh Dastidar, 2014)	DEA	12	Operative expenses equity and share capital.	Premium claim processed
(Kaffash <i>et al.</i> , 2020)	DEA	Systematic review literature.	NA	NA
(Ilyas and S. Rajasekaran, 2022a)	DEA	15	Operating expenses equity and debt.	Net claims investment.
(Abdin, Mahelan Prabantarikso, <i>et al.</i> , 2022)	DEA	18	Capital expenses.	Premium. Gross investment
(Chakraborty, 2016)	DEA	4	Operating expenses	Net premium income from investment.
(Alhassan and Biekpe, 2015a)	DEA	80	Equity capital.	Income from investment.
(Cummins and Xie, 2016)	DEA	45	Labour financial capital material.	Premium investment on return.
(Chakraborty, 2018)	DEA/MI	12	Operating expenses investment	Net premium income from investment.
(Grmanová and Strunz, 2017)	DEW/TO BIT	15	Claims income operating expenses	Premium earned income from investment.
(Kozak, 2018)	SFA	29	Claims incurred operating expenses.	Premium earned income from investment
(Lim, Lee and Har, 2021)	RBCR	5	Labour business services material and capital.	Investment claims and PRIMIMUM
(Alhassan and Biekpe, 2015a)	DEA	35	Management epenses to liquidity total average.	Changes net premium climbing income from investment.
(Barros, Barroso and Borges, 2005)	DEA	27	Wages capital Investment.	Claims profit





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(Chawla and Sharma, 2017)	DEA	30	LABOUR COST commission broker financial capital.	TOTAL LOSS
(Huang and Eling, 2013)	DEA	BIBLOMATRI C ANALYSIS	NA	NA
(Luhnen, 2009)	DEA	295	LABOUR equity and debt.	Claims total investment.
(Eling and Luhnen, 2010)	DEA	52	LABOUR equity and debt.	Claims total investment.
(Lee <i>et al.</i> , 2019)	DEA	34	Number of employees, Total premium written	Net profit, Claims paid
(Krishnamurthy <i>et al.</i> , 2005)	DEA	45	Number of employees, Total premium written	Underwriting profit, Investment return
(J. chakjoy@gmail.com Chakraborty and Basu, 2018)	DEA	54	Number of policies issued; Total investments made	Claims ratio, Operating expenses ratio
(Garg and Garg, 2020a)	DEA	23	Number of claims processed, Total administrative expenses	Return on assets, Combined ratio
(Garg and Garg, 2020b)	SFA	34	Market share, Total assets	Return on equity, Loss ratio
(J. Chakraborty and Basu, 2018)	DEA	24	Premium growth rate, Total liabilities	Investment yield, Expense ratio
(Chakraborty and Sengupta, 2014)	DEA	5	Investment income, Underwriting expenses	Net income, Loss and expense ratio
(Yu <i>et al.</i> , 2021)	DEA	7	Premium earned, Total expenses	Policyholder surplus, Operating ratio
(Sinha, 2015)	DEA	8	Customer satisfaction, Customer retention rate	Risk-adjusted return on capital, Capital adequacy ratio
(Bakhouche <i>et al.</i> , 2020)	DEA	7	Underwriting risk, Investment risk	Average claim cost, Loss development factor
(Ghosh and Dey, 2018)	DEA	4	Claims frequency, Claims severity	Market power, Premium adequacy
(Brockett <i>et al.</i> , 2007)	DEA	12	Market concentration, Premium per policy	Overall profit margin, Gross written premium
(Sinha, 2017)	DEA	12	Underwriting profit margin, Investment profit margin	Reinsurance recoveries, Net reinsurance expense ratio
(Nourani <i>et al.</i> , 2022)	DEA	32	Loss adjustment expenses, Reinsurance expenses	Settlement rate, Claims settlement efficiency
(Alhassan and Biekpe, 2015b)	DEA	12	Claims processing time, Average settlement amount	Sales productivity, Expense per employee
(Eling and Jia, 2019)	DEA	10	Sales commission, Premium per employee	Customer retention rate, Customer acquisition efficiency





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(Siddiqui, 2020)	SFA	10	Customer acquisition cost, Customer lifetime value	Expense ratio, Policy acquisition cost
(Parida and Acharya, 2016)	SFA	9	Expense per policy, Premium per policy	Expense ratio, Combined ratio
(Al-Amri, Gattoufi and Al-Muharrami, 2012)	DEA	9	Loss adjustment expense ratio, Underwriting expense ratio	Revenue diversification, Market diversification
(Abdin, Prabantarikso, <i>et al.</i> , 2022)	DEA	8	Product diversity, Distribution channel diversity	Market segmentation, Target market penetration
(Peng and Lian, 2021)	DEA	14	Product diversity, Distribution channel diversity	Revenue diversification, Market diversification
(Medved and Kavčič, 2012)	DEA	13	Customer demographics, Product pricing	Market segmentation, Target market penetration
(Barros and Wanke, 2016)	DEA	15	Investment portfolio diversification, Investment portfolio performance	Investment portfolio yield, Investment portfolio volatility
(Leverty and Grace, 2010)	DEA	14	Claims severity distribution, Claims frequency distribution	Aggregate claims distribution, Loss distribution shape
(Hardwick, Adams and Zou, 2011)	DEA	18	Fraud detection rate, Fraud detection cost	Fraud detection efficiency, Fraud loss ratio
(Sinha, 2021)	DEA	17	Underwriting guidelines, Claims handling guidelines	Compliance rate, Regulatory fines
(Suvvari, 2019)	DEA	21	Risk exposure, Risk mitigation strategies	Risk management effectiveness, Risk appetite
(Alhassan and Biekpe, 2016)	DEA	31	Industry benchmarking, company benchmarking	Performance relative to industry, Performance relative to peers
(Savitha, Banerjee and Shetty, 2019)	DEA	41	Market competition, Product differentiation	Competitive advantage, Price elasticity of demand
(Biener and Eling, 2012)	DEA	12	Capital allocation, Capital utilization	Return on capital employed, Capital efficiency
(Bhatia and Mahendru, 2022)	DEA	6	Premium per customer, Loss per customer	Customer lifetime value, Customer profitability
(Naushad, Faridi and Faisal, 2020)	DEA	8	Sales volume, Marketing spends	Return on marketing investment, Market share growth rate





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(Yuengert, 1993)	DEA	14	Claims severity trend, Claims frequency trend	Loss trend, Reserve adequacy
(Bansal and Singh, 2021)	DEA	24	Premium pricing, Underwriting standards	Underwriting margin, Premium adequacy
(Tone and Sahoo, 2005)	DEA	45	Customer loyalty, Customer advocacy	Net promoter score, Referral rate
(Modi, 2008)	DEA	66	Customer service quality, Customer complaint ratio	Customer satisfaction, Customer loyalty
(Dutta, 2013)	DEA	7	Market growth rate, Market penetration rate	Revenue growth rate, Market share growth rate
(Ilyas and S Rajasekaran, 2022)	DEA	75	Customer lifetime value, Customer acquisition cost	Customer retention rate, Customer acquisition efficiency
(Anandarao, Durai and Goyari, 2019)	DEA	77	Claims frequency, Claims severity	Average claim cost, Loss development factor
(Ohene-Asare, Asare and Turkson, 2019)	DEA	74	Market concentration, Premium per policy	Market power, Premium adequacy
(Chen, Liu and Kweh, 2014)	DEA	47	Underwriting profit margin, Investment profit margin	Overall profit margin, Gross written premium
(Rahmaniet al., 2014)	DEA	44	Loss adjustment expenses, Reinsurance expenses	Reinsurance recoveries, Net reinsurance expense ratio
(Shetty and Basri, 2020)	DEA	32	Claims processing time, Average settlement amount	Settlement rate, Claims settlement efficiency
(Kuoet al., 2017)	DEA	43	Sales commission, Premium per employee	Sales productivity, Expense per employee
(Akhtar, 2018)	DEA	11	Expense per policy, Premium per policy	Expense ratio, Policy acquisition cost
(Kasman and Turgutlu, 2011)	DEA	11	Loss adjustment expense ratio, Underwriting expense ratio	Expense ratio, Combined ratio
(Biener and Eling, 2011)	DEA	22	Product diversity, Distribution channel diversity	Revenue diversification, Market diversification
(Sahoo and Tone, 2022)	DEA	33	Customer demographics, Product pricing	Market segmentation, Target market penetration
(Ilyas and S. Rajasekaran, 2022b)	DEA	12	Investment portfolio diversification, Investment portfolio performance	Investment portfolio yield, Investment portfolio volatility





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(Ghose and Kumar, 2019)	DEA	12	Claims severity distribution, Claims frequency distribution	Aggregate claims distribution, Loss distribution shape
(Varma, 2007)	DEA	33	Fraud detection rate, Fraud detection cost	Fraud detection efficiency, Fraud loss ratio
(sreedevi k, 2016)	DEA		Underwriting guidelines, Claims handling guidelines	Compliance rate, Regulatory fines

Table 2 Summary of Input-Output

VARIABLES USED	INPUT/OUTPUT
Operating Expenses	Input
Investments	Input
Net Premiums	Output
Income from Investments	Output

Table 3 Correlation Metric Between Inputs and Outputs.

	Operating Expenses	Investments	Net Premiums	Income from Investments
Operating Expenses	1	0.824038	0.853467	0.985218
Investments	0.824038	1	0.610702	0.828762
Net Premiums	0.853467	0.610702	1	0.860429
Income from Investments	0.985218	0.828762	0.860429	1

Table 4. Descriptive Statistics of inputs and Outputs variables. Note: Figures are in Rs 000

		Operating Expenses	Investments	Net Premiums	Income from Investments
2015-16	MEAN	20890185	115625186	70663935	12816240
	SD	8125055	67043980	27336709	5990849
	MIN	11407097	89346369	45723819	6201791
2016-17	MEAN	29240700	232382395	107145600	18226800
	MEAN	22834615	188197835	86161383	15437516
	SD	7528384	75693852	35506054	7910137
2017-18	MIN	13614489	102727526	53008839	7374934
	MAX	29691200	271252752	133464800	23256800
	MEAN	22019474	212930912	92489979	20963615
	SD	5890249	68093015	25020343	12666941
	MIN	14051321	139906917	67325358	8837656
	MAX	26929900	298151002	123904700	32923300





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2018-19	MAX	26929900	298151002	123904700	32923300
	MEAN	23365023	239206871	104877169	20902768
	SD	5548349	61855360	25371849	11236114
	MIN	18071090	167864429	77744606	9298583
2019-20	MAX	30594100	316566721	137924600	31844800
	MEAN	28722281	233088323	105963423	22005396
	SD	6531231	45628411	24226897	9773587
	MIN	22931019	183045594	80159624	11964950
2020-21	MAX	34425350	279307452	137400200	31787576
	MEAN	29361967	278216154	19146613	19146613
	SD	7669719	54786746	5931396	5931396
	MIN	20597713	224774302	11932977	11932977
2021-22	MAX	39080200	339320662	24103134	24103134
	MEAN	33539140	315507609	117471731	21528175
	SD	8908516	68812486	27123563	5385689
	MIN	21648278	242279567	77628213	13830525

TABLE 5
TECHNICAL EFFICIENCY SCORES UNDER CRS

DMUs/Non-	TE	TE	2017-	2018-	2019-	2020-	2021-	Avg.	RANK
Life Insurers	CRS 2015-16	CRS 2016-17	18	19	20	21	22	Te (15-22)	
ICICI	1	0.95	0.964	1	1	0.91	0.92	0.96	2
BAJAJ	1	1	1	0.94	0.93	0.91	1	0.96	1
UNITED	0.93	1	1	0.97	1	0.84	0.77	0.93	4
ORIENTAL	0.79	0.86	1	1	1	0.96	0.97	0.94	3
Number of Efficient-DMUs	2	2	3	2	3		1		
Number of Inefficient-	2	2	1	2	1	4	3	4	





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TABLE 6
TECHNICAL EFFICIENCY SCORES UNDER VRS

DMUs/Non-Life	2015-	2016-	2017-	2018-	2019-	2020-	2021-	avg.	RANK
Insurers	16	17	18	19	20	21	22	TE	
ICICI	1	0.971	0.982	1	1	0.975	1	0.9891	3
BAJAJ	1	1	1	1	1	0.955	1	0.993	2
UNITED	1	1	1	1	1	1	0.967	0.995	1
ORIENTAL	1	0.880	1	1	1	0.973	1	0.979	4
Number of Efficient DMUs	4	3	3	4	4	1	3		
Number of Inefficient DMUs	NIL	1	1				1		
Number of Efficient DMUs Exhibiting CRS	2	2	3	3	4	1	3		
Number of Efficient DMUs Exhibiting IRS	2	1	NIL	1					
Number of Efficient DMU Exhibiting DRS		1	1			3	1		

Table 7.

SCALE EFFICIENCY SCORES UNDER VRS

DMUs/Non-Life Insurers	TE SE 2015-16	TE SE 2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	avg. (15-22)	RANK
ICICI	1	0.98	0.98	1	1	0.93	0.92	0.97	2
BAJAJ	1	1	1	0.94	0.93	0.95	1	0.97	1
UNITED	0.93	1	1	0.97	0.84	0.79		0.93	5
ORIENTAL	0.79	0.97	1	1	1	0.99	0.97	0.96	3
MEAN	0.93	0.98	0.99	0.98	0.98	0.93	0.92	0.96	4
Number of SCALE efficient DMUs	2	2	3	3	3	NIL	1		





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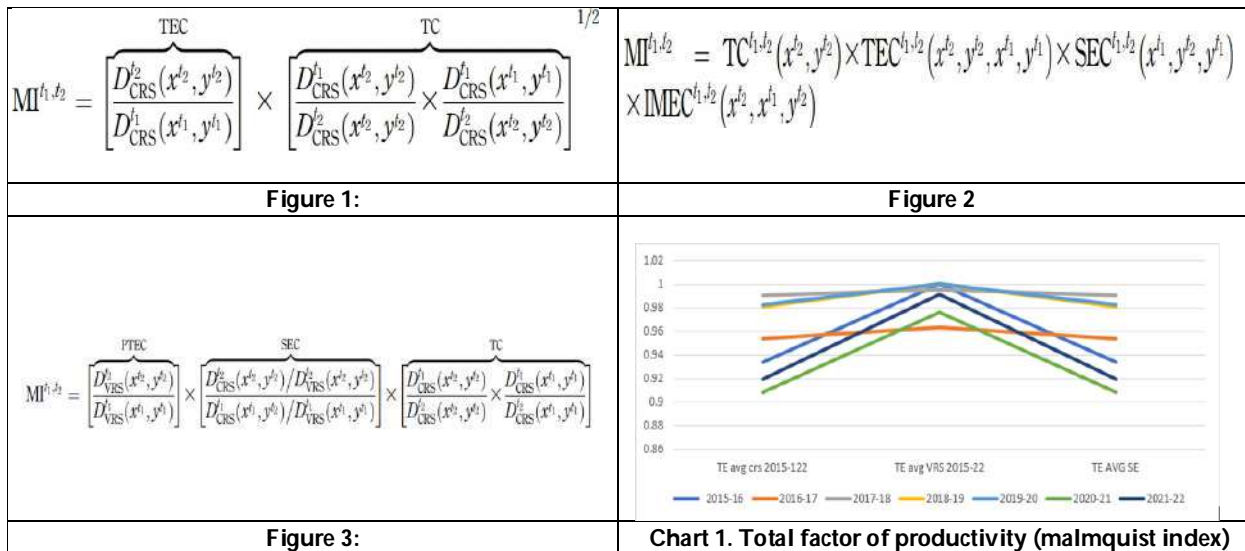
Table 8. technical efficiency and technological advancements

DMUs/	TEC	TC	PTEC	SEC	TFPC	Ranks(TFP)
ICICI	0.965	1.212	1	0.965	1.17	1
BAJAJ	1	1.085	1	1	1.085	2
UNITED	1.035	1.015	1	1.035	1.05	3
OrientalInsurance	1.016	0.961	1	1.016	0.976	4
Means	1.004	1.064	1	1.004	1.068	
Increase(in %)	0.4	0.64	0	0.004	0.68	
Decrease(in %)						

Table 9

Year of Operation	TEC	TC	PTEC	SEC	TFPC
2016-17	1.026	1.145	1	1.026	1.175
2017-18	1.074	1.063	1	1.074	1.141
2018-19	1.008	1.035	1	1.008	1.043
2019-20	1.076	0.96	1	1.076	1.033
2020-21	0.885	1.163	1	0.885	1.03
2021-22	0.966	1.032	1	0.966	0.977
Means	1.004	1.064	1	1.004	1.068

Year-Wise Malmquist Index Summary of Annual Means





A Comparative Study to Find Effectiveness of Dry Needling Technique Versus Strain-Counterstrain Technique on Cervical Function in Management of Myofascial Trigger Points Upper and Middle Trapezius in College Going Students: A Pilot Study

Keshmin Vesuna^{1*}, Prachi Shah² and Amir Hamza Chauhan¹

¹MPT Scholar, Parul Institute of Physiotherapy, Parul University, Vadodara, Gujarat, India.

²Assistant Professor, Parul Institute of Physiotherapy, Parul University, Vadodara, Gujarat, India.

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*Address for Correspondence

Keshmin Vesuna

MPT Scholar,
Parul Institute of Physiotherapy,
Parul University, Vadodara,
Gujarat, India.
E.Mail: keshminvesuna@yahoo.com



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ABSTRACT

The trapezius muscle is a superficial muscle of the back, who has shape like that of a trapezoid. The scapula is a triangle shaped bone that connects the upper limb with the collar bone and thorax. With a perspective of functionality, the structure of trapezius allows it to contribute to posture maintenance. Trigger points are discrete, focal, hyper irritable spot. Palpation of nodule of muscle fiber of harder than normal consistency is the physical finding typically associated with trigger point. Total 20 college going healthy individuals were recruited as per selection criteria, all subjects collected from Parul university. There were 24 candidates scanned for trigger point out of which there were 4 dropouts. Pain and Function was checked immediate pre and post treatment. Result and Conclusion: In the Dry needling (DN) group NPRS was significantly reduced after treatment and so was range of motion. In the Strain counter strain (SCS) group We can conclude that after treatment NPRS significantly reduced not much effect on ROM. In comparison of NPRS outcome between both groups, For DN and SCS, both the treatment had same effect on NPRS. In comparison of ROM outcomes between both groups, the treatment had different effect on ROM, in which the DN group showed major effect in improving ROM post treatment.

Keywords: Strain-counterstrain, Dry needling, Trigger points





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INTRODUCTION

A trigger point is a painful spot within a muscle. In simple words it is described as a ‘knot’ inside a muscle. Trigger points causes a muscle to become stressed, which in turn causes pain and limited movement. Myofascial trigger point is defined as a hyperirritable spot in the skeletal muscle which is associated with hyperirritable nodule in a taut band. There are two types of trigger points-active- which gives pain without palpation [1]. The trapezius is considered to be a postural muscle. The origin of trigger points in the trapezius is said to be related to wrong movements of the neck and prolonged periods of sustaining uncomfortable postures [2]. Neck pain and dysfunction is one of the highly prevalent musculoskeletal disorders which is usually observed more in women than men [3]. Considering the workload and type of work of college going students, mental, physical and psychosocial burdens could augment the activity of trapezius muscle [4]. The upper fibers originate from superior nuchal line and external occipital protuberance and inserts at lateral 1/3rd of clavicle. The middle fibers originate from the spinous process of 7th cervical and 1st, 2nd, 3rd, 4th thoracic vertebrae and inserts into acromion of scapula. The lower fibers originate from the spinous processes of the T5 to T12 and inserts into the spine of scapula. The function of trapezius is to stabilize and move the scapula. The upper fibers elevate, rotate the scapula upwards and extend the neck, whereas the middle fibers do the work of retracting the scapula [4].

Dry needling is a skilled intervention that is performed by a physiotherapist. In this technique, a thin filiform needle is used to get into the skin in order to stimulate the underlying muscles, nerves and connective tissues for the purpose of effective management of musculoskeletal pain and dysfunctions [5]. The formation of trigger point is due to excess acetylcholine release from motor end plates. The pain caused by trigger points is due to hypoxia and reduced blood flow inside the trigger point. Dry needling(DN) of trigger points in the trapezius causes an analgesic effect, the stimulation of which causes a local twitch response that indicates that the trigger point has been released [6].

Differences between trigger point and tender points [7]

	Tender point	Myofascial trigger point
Local tenderness	Yes	Yes
Location	Somatic tissues: Muscle, ligament, tendon, bone	Muscle and/or its fascia
Evoked referred pain	No	Yes
Presence of taut band	No	Yes
Presence of autonomic phenomena	No	Yes

Strain-counterstrain (SCS) technique is a kind of osteopathic manipulative soft tissue technique developed in 1955 to treat musculoskeletal pain, decreased range of motion and somatic dysfunction passively by bringing a difference in cellular function of the tissues being treated [8,9]. Strain-counterstrain uses palpation and the feedback of the therapist to manipulate the soft tissues or joints into a position of ease, in the direction away from the restrictive barrier. This is usually done by compressing or shortening the area of dysfunction, encouraging the body to relax the trigger point [9,10]

NEED OF STUDY

- Bad posture resulting in pain and reduced range of motion is a very prevalent problem seen in people of all ages and it is one of the main causes for trapezititis. Prolonged desk work or doing work in uncomfortable positions for long hours can cause muscle spasm and palpable tightening of taut band of muscle fibers which then form trigger points. This can be overcome by using strain-counterstrain and dry needling technique which helps to deactivate a trigger point.





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- There are many techniques to deactivate trigger points and the efficacy of dry needling and strain-counterstrain techniques has been proven through various studies.
- But there were only few studies done to identify the immediate effects of these techniques post treatment on cervical ROM.
- Also in the student population, which is much affected by this condition, not many studies are done to compare these two techniques. Hence there is paramount need of this study to take place.

METHODOLOGY

- Study design: Comparative study
- Study population: Students aged between 18 to 30 years with myofascial triggerpoints in upper and middle trapezius
- Study setting: Parul University
- Sampling methods: Random allocation method
- Sample size: Total of 20 samples. Divided into 2 groups by random allocation. 4 droupouts, 2 in each group.

Criteria Selection

Inclusion Criteria

- Subjects who are aged between age 18-30 years
- Subjects who participate with their own will
- Subjects in which trigger points are detected by the star palpation method.
- Subjects with trigger points in upper or middle fibers
- Subjects with unilateral or bilateral MTrPs involvement
- Presence of active or latent myofascial trigger points MTrPs in upper and middletrapezius

EXCLUSION CRITERIA

- Any cervical instability
- Any degenerative disorder
- Recent surgeries in neck, shoulder or cevical region
- Open wounds
- Any skin disease or allergic condition
- Any allergy to metals or needles
- Cervical radiculopathy
- Any history of fracture or whiplash injury in cervical area
- Infection, systemic disease or fibromyalgia.

Materials used

- Sterile disposable needles that are usually 0.16mm to 0.3mm thick and 1.5cm to2cm long in size with guided tube
- Gloves
- Cotton
- Alcohol for cleaning skin surface
- Stop watch



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- GROUP A: Subjects receive dry needling.
- GROUP B: Subjects receive strain counter strain
- Pre and post intervention range of motion (opposite side flexion) for both group A and B.

For Group A: Dry needling

Once the trigger point is located the skin is cleaned with alcohol. The needle will be then inserted through the skin 5-7mm into the MTrP and local twitch response is obtained.. Then the needle is withdrawn and the area was disinfected with alcohol again.

For Group B: Strain-counter strain

For this the subject is positioned in supine position with the neck in neutral position, the physiotherapist stands on the trigger point side. The head is then laterally flexed towards the side of the trigger point. Then the forearm is grasped and then shoulder is abducted till 90° and then add flexion or extension to fine tune the position. Contact is constantly maintained on the trigger point throughout the procedure and intermittent pressure over the trigger point is applied to monitor reduction in the tone of trigger point and pain associated with it. Position of minimum pain is determined.

This position is maintained for 90 secs and after that the participant is brought back to original position passively and gently NPRS and Range of Motion was checked pre treatment and post treatment for both the groups.

RESULT AND DISCUSSION

SPSS software version 26 (SPSS Inc, Chicago, IL, USA) was used for data analysis. A total of 24 participants were included in the assessment, out of which 4 were dropouts, hence, 20 participants took part in the study and were statically analyzed.

Significance tests

Parametric test (Paired sample t – test) for comparison between pre and post measure

DRY NEEDLING

Conclusion:

- NPRS: Before treatment mean NPRS was 4.60 with SD 1.043 which reduced to 1.8 after treatment with SD 1.135. Test statistic t was 8.573 with p – value 0.000, which is less than 0.05 (level of significance) which is significant. We can conclude that after treatment after treatment NPRS significantly reduced.
- ROM: Before treatment mean ROM was 21.10 with SD 2.601 which increased to 30.90 after treatment with SD 3.035. Test statistic t was -8.723 with p – value 0.000, which is less than 0.05 (level of significance) which is significant. We can conclude that after treatment after treatment ROM significantly increased.

Non – Parametric test (Wilcoxon Signed Ranks Test)

Conclusion:

- NPRS: Here negative ranks were 10, positive rank was 0 and there were no ties. At 5% level of significance, Z – value was -2.484 with p – value 0.004 (which is less than 0.05) which is significant. we can conclude on the basis of this data that value were significantly decreased after treatment.
- ROM: Here negative ranks were 0, positive ranks were 10 and there were no ties. At 5% level of significance, Z – value was -2.807 with p – value 0.005 (which is less than 0.05) which is significant. we can conclude on the basis of this data that value were significantly increased after treatment.



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Parametric test (Paired sample t – test) for comparison between pre and post measure

Conclusion:

- NPRS: Before treatment mean NPRS was 4.80 with SD 1.398 which reduced to 2.9 after treatment with SD 1.197. Test statistic t was 3.612 with p – value 0.006, which is less than 0.05 (level of significance) which is significant. We can conclude that after treatment after treatment NPRS significantly decreased.
- ROM: Before treatment mean ROM was 22.10 with SD 2.558 which increased to 27.40 after treatment with SD 2.875. Test statistic t was -9.485 with p – value 0.000, which is less than 0.05 (level of significance) which is highly significant. We can conclude that after treatment after treatment ROM significantly increased.

Non – Parametric test (Wilcoxon Signed Ranks Test)

Conclusion:

NPRS: Here negative ranks were 8, positive rank was 0 and there were 2 ties. At 5% level of significance, Z – value was -2.636 with p – value 0.008(which is less

- than 0.05) which is significant. we can conclude on the basis of this data that value were significantly decreased after treatment.
- ROM: Here negative ranks were 0, positive ranks were 10 and there were no ties. At 5% level of significance, Z – value was -2.81 with p – value 0.005(which is less than 0.05) which is significant. we can conclude on the basis of this data that value were significantly increased after treatment.

Unpaired tests for comparison between two groups**Parametric test (Unpaired sample t – test)**

Conclusion of table:

- NPRS PRE: Test statistic t value is -0.316 with p – value 0.755 which is more than 0.05 (Level of significance). We can conclude that in pre measure there is no significance difference in between two groups at 5% level of significance. i.e., before treatment applied both the groups had same NPRS.
- NPRS POST: Test statistic t value is -2.1089 with p – value 0.049 which is almost equal to 0.05 (Level of significance). We can conclude that in post measure there is no significance difference in between two groups at 5% level of significance. i.e., After treatment applied both the groups had same NPRS. i.e., both the treatments were equally effective on NPRS.
- ROM PRE: Test statistic t value is -0.867 with p – value 0.397 which is more than 0.05 (Level of significance). We can conclude that in pre measure there is no significance difference in between two groups at 5% level of significance. i.e., before treatment applied both the groups had same ROM.
- ROM POST: Test statistic t value is 2.647 with p – value 0.016 which is less than 0.05 (Level of significance). We can conclude that in pre measure there is significance difference in between two groups at 5% level of significance. i.e., both the treatment had different effect on ROM.

Non – Parametric test (Mann-Whitney Test)

Conclusion of table:

- NPRS PRE: Test statistic t value is -0.316 with p – value 0.755 which is more than 0.05 (Level of significance). We can conclude that in pre measure there is no significance difference in between two groups at 5% level of significance. i.e., before treatment applied both the groups had same NPRS.
- NPRS POST: Test statistic t value is -2.1089 with p – value 0.049 which is almost equal to 0.05 (Level of significance). We can conclude that in post measure there is no significance difference in between two groups at 5% level of significance. i.e., After treatment applied both the groups had same NPRS. i.e., both the treatments were equally effective on NPRS.
- ROM PRE: Test statistic t value is -0.867 with p – value 0.397 which is more than 0.05 (Level of significance). We can conclude that in pre measure there is no significance difference in between two groups at 5% level of significance. i.e., before treatment applied both the groups had same ROM.



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- ROM POST: Test statistic t value is 2.647 with p – value 0.016 which is less than 0.05 (Level of significance). We can conclude that in pre measure there is significance difference in between two groups at 5% level of significance. i.e., both the treatment had different effect on ROM.

Non – Parametric test (Mann-Whitney Test)

Conclusion of table:

- NPRS PRE: For DRY NEEDLING mean rank was 10.05 and for STRAIN COUNTER STRAIN was 10.95. z value was -0.349 with p – value 0.727 which is greater than 0.05 (level of significance). We can conclude that before treatment there is no significance difference in NPRS for both the groups. i.e., before treatment applied both the groups had same NPRS.
- NPRS POST: For DRY NEEDLING mean rank was 8.05 and for STRAIN COUNTER STRAIN was 12.95. z value was -1.903 with p – value 0.57 which is greater than 0.05 (level of significance). We can conclude that After treatment there is no significance difference in NPRS for both the groups. i.e., Both the treatment had same effect on NPRS.
- ROM PRE: For DRY NEEDLING mean rank was 9.50 and for STRAIN COUNTER STRAIN was 11.50. z value was -0.761 with p – value 0.447 which is greater than 0.05 (level of significance). We can conclude that before treatment there is no significance difference in ROM for both the groups. i.e., before treatment applied both the groups had same ROM.
- ROM POST: For DRY NEEDLING mean rank was 13.60 and for STRAIN COUNTER STRAIN was 7.40. z value was -2.368 with p – value 0.018 which is LESS than 0.05 (level of significance). We can conclude that there is significance difference in ROM for both the groups. i.e., Both the treatment had different effect on ROM, in which the DRY NEEDLING group showed major effect in improving ROM post treatment.

RESULTS

Therefore, In the DN group a significant difference of ($p < 0.05$) was observed in improving pain. was Before treatment mean 4.60 with SD 1.043 which reduced to 1.8 after treatment with SD 1.135. Test statistic t was 8.573. Thus NPRS was significantly reduced after treatment and so was range of motion. In the SCS group, NPRS was 4.80 with SD 1.398 which reduced to 2.9 after treatment with SD 1.197. Test statistic t was 3.612 with p – value < 0.05 (level of significance) which is significant. We can conclude that after treatment after treatment NPRS significantly decreased.

In comparison of NPRS outcome between both groups, For DRY NEEDLING mean rank was 8.05 and for STRAIN COUNTER STRAIN was 12.95. z value was -1.903 with p – value 0.57 which is greater than 0.05 (level of significance). We can conclude that after treatment there is no significance difference in NPRS for both the groups. i.e., Both the treatment had same effect on NPRS. In comparison of ROM outcomes between both groups, For DRY NEEDLING mean rank was 13.60 and for STRAIN COUNTER STRAIN was 7.40. z value was -2.368 with p – value 0.018 which is LESS than 0.05 (level of significance). We can conclude that there is significance difference in ROM for both the groups. i.e., Both the treatment had different effect on ROM, in which the DRYNEEDLING group showed major effect in improving ROM post treatment.

CONCLUSION

Both Dry needling and strain counter strain were shown to be equally and efficiently effective in reducing pain immediately after treatment. Both groups were showed effectiveness in improving range of motion. Whereas dry needling was shown to be more effective in improving functional range of motion post treatment as compared to strain counter strain group.

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Ethical approval

Ethical approval was obtained from The Institutional review board from Parul Institute of Physiotherapy, Parul University Waghodia, Vadodara.

Conflict of interest

None

Consent for publication

All individuals participating in this research signed an informed consent form prior to their inclusion in the study.

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Table – 1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
NPRS PRE	10	3	7	4.60	1.430
NPRS POST	10	0	4	1.80	1.135
ROM PRE	10	17	25	21.10	2.601
ROM POST	10	25	35	30.90	3.035





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Table 2: Age wise distribution of Students in the group of Dry Needling.

Age of the Students	No. of Students	%
21	4	40.0
22	3	30.0
23	1	10.0
24	1	10.0
29	1	10.0
Total	10	100.0

Table – 3:

Gender	No. of Students	%
F	6	60.0
M	4	40.0
Total	10	100.0

Table – 4:

NPRS PRE	No. of Students	%
3	3.0	30
4	2.0	20
5	2.0	20
6	2	20
7	1.0	10
Total	10.0	100

Table – 5

NPRS POST	No. of Students	%
0	1	10
1	3	30
2	4	40
3	1	10
4	1	10
Total	10	100

Table – 6:

ROM PRE	Frequency	Percent
17	1	10.0
18	1	10.0
19	1	10.0
20	1	10
21	1	10.0
22	2	20.0
23	1	10.0
24	1	10.0
25	1	10.0
Total	10	100.0





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Table – 7:

ROM POST	Frequency	Percent
25	1	10
28	1	10
30	3	30
31	1	10
32	1	10
34	2	20
35	1	10
Total	10	100

Table 8: Descriptive statistics:

	N	Minimum	Maximum	Mean	Std. Deviation
NPRS PRE	10	3	7	4.80	1.398
NPRS POST	10	1	4	2.90	1.197
ROM PRE	10	18	26	22.10	2.558
ROM POST	10	24	32	27.40	2.875

Table – 9:

Age of the participant	No. of Participants	%
18	1	10.0
20	2	20.0
21	1	10.0
22	1	10.0
23	1	10.0
24	2	20.0
29	1	10.0
30	1	10.0
Total	10	100.0

Table – 10:

Gender	No. of Participants	%
F	6	60.0
M	4	40.0
Total	10	100.0

Table – 11:

NPRS PRE	No. of Participants	%
3	2.0	20
4	3.0	30
5	1.0	10
6	3	30
7	1.0	10
Total	10.0	100





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Table – 12:

NPRS POST	No. of Participants	%
1	2	20
2	1	10
3	3	30
4	4	40
Total	10	100

Table – 13:

ROM PRE	No. of Participants	%
18	1	10.0
20	2	20
21	2	20.0
22	1	10.0
24	2	20.0
25	1	10.0
26	1	10.0
Total	10	100

Table – 14:

ROM POST	Frequency	Percent
24	3.0	30
26	1.0	10
27	1.0	10
28	1.0	10
29	1.0	10
30	2	20
32	1	10
Total	10.0	100

Table 15 DRY NEEDLING

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	NPRS PRE	4.60	10	1.430	0.452
	NPRS POST	1.80	10	1.135	0.359
Pair 2	ROM PRE	21.10	10	2.601	0.823
	ROM POST	30.90	10	3.035	0.960

Pair		Paired Differences				t statistic	df	P - value	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
1	NPRS PRE - NPRS	2.800	1.033	0.327	2.061	3.539	8.573	9	0.000





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2	POST ROM PRE - ROM POST	-9.800	3.553	1.123	-12.342	-7.258	-8.723	9	0.000
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Table 16. Non – Parametric test (Wilcoxon Signed Ranks Test)

		N	Mean Rank	Sum of Ranks	z - value	p - value
NPRS POST - NPRS PRE	Negative Ranks	10	5.50	55.00	-2.848	0.004
	Positive Ranks	0	0.00	0.00		
	Ties	0				
	Total	10				
ROM POST - ROM PRE	Negative Ranks	0	0.00	0.00	-2.807	0.005
	Positive Ranks	10	5.50	55.00		
	Ties	0				
	Total	10				

Table 17. Parametric test (Paired sample t – test) for comparison between pre and post measure.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	NPRS PRE	4.80	10	1.398	0.442
	NPRS POST	2.90	10	1.197	0.379
Pair 2	ROM PRE	22.10	10	2.558	0.809
	ROM POST	27.40	10	2.875	0.909

		Paired Differences					t	df	P - value
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	NPRS PRE - NPRS POST	1.900	1.663	0.526	0.710	3.090	3.612	9	0.006
Pair 2	ROM PRE - ROM POST	-5.300	1.767	0.559	-6.564	-4.036	-9.485	9	0.000

Table 18. Non – Parametric test (Wilcoxon Signed Ranks Test)

		Ranks	N	Mean Rank	Sum of Ranks	z – value	p - value
NPRS POST - NPRS PRE	Negative Ranks	8	4.50	36.00	-2.636	0.008	
	Positive Ranks	0	0.00	0.00			
	Ties	2					
	Total	10					
ROM POST - ROM PRE	Negative Ranks	0	0.00	0.00	-2.81	0.005	
	Positive Ranks	10	5.50	55.00			





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	Ties	0			
	Total	10			

Table 19. Parametric test (Unpaired sample t – test)

Group		N	Mean	Std. Deviation	Std. Error Mean
NPRS PRE	DRY NEEDLING	10	4.60	1.430	0.452
	STRAIN COUNTER STRAIN	10	4.80	1.398	0.442
NPRS POST	DRY NEEDLING	10	1.80	1.135	0.359
	STRAIN COUNTER STRAIN	10	2.90	1.197	0.379
ROM PRE	DRY NEEDLING	10	21.10	2.601	0.823
	STRAIN COUNTER STRAIN	10	22.10	2.558	0.809
ROM POST	DRY NEEDLING	10	30.90	3.035	0.960
	STRAIN COUNTER STRAIN	10	27.40	2.875	0.909

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t statistic	df	P - value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
NPRS PRE	Equal variances assumed	0.000	1.000	-0.316	18	0.755	-0.200	0.632	-1.529	1.129
	Equal variances not assumed			-0.316	17.991	0.755	-0.200	0.632	-1.529	1.129
NPRS POST	Equal variances assumed	0.105	0.750	-2.108	18	0.049	-1.100	0.522	-2.196	-0.004
	Equal variances not assumed			-2.108	17.949	0.049	-1.100	0.522	-2.196	-0.004
ROM PRE	Equal variances assumed	0.001	0.973	-0.867	18	0.397	-1.000	1.154	-3.424	1.424
	Equal variances not assumed			-0.867	17.995	0.397	-1.000	1.154	-3.424	1.424





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ROM POST	Equal variances assumed	0.019	0.891	2.647	18	0.016	3.500	1.322	0.723	6.277
	Equal variances not assumed			2.647	17.948	0.016	3.500	1.322	0.722	6.278

Table 20. Non – Parametric test (Mann-Whitney Test)

	Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Wilcoxon W	Z - value	p - value
NPRS PRE	DRY NEEDLING	10	10.05	100.50	45.5	100.5	-0.349	0.727
	STRAIN COUNTER STRAIN	10	10.95	109.50				
	Total	20						
NPRS POST	DRY NEEDLING	10	8.05	80.50	25.5	80.5	-1.903	0.057
	STRAIN COUNTER STRAIN	10	12.95	129.50				
	Total	20						
ROM PRE	DRY NEEDLING	10	9.50	95.00	40	95	-0.761	0.447
	STRAIN COUNTER STRAIN	10	11.50	115.00				
	Total	20						
ROM POST	DRY NEEDLING	10	13.60	136.00	19	47	-2.368	0.018
	STRAIN COUNTER STRAIN	10	7.40	74.00				
	Total	20						

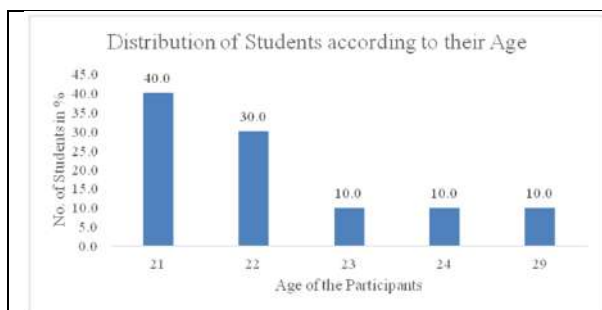


Fig.1. Distribution of Students according to their Age

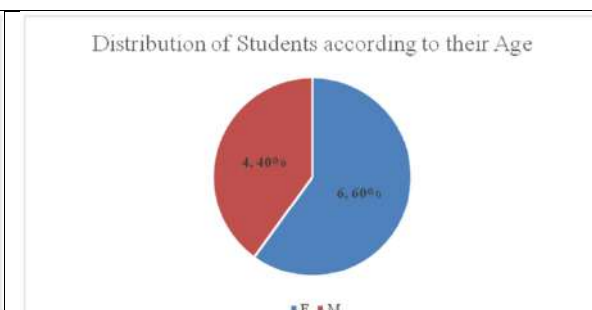


Fig.2. Distribution of Students according to their Age





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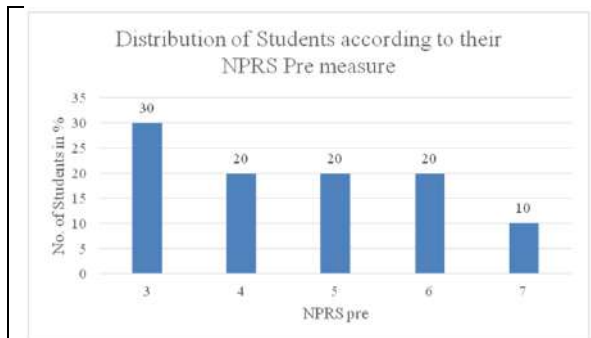


Fig.3. Distribution of Students according to their NPRS Pre measure

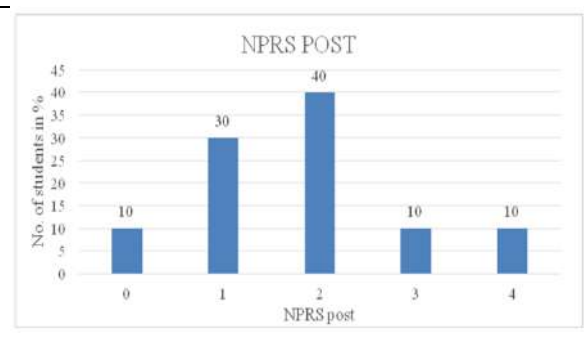


Fig.4. NPRS POST

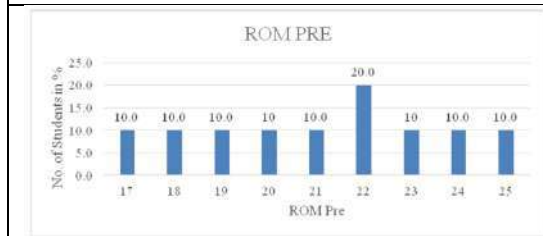


Fig.5. ROM PRE

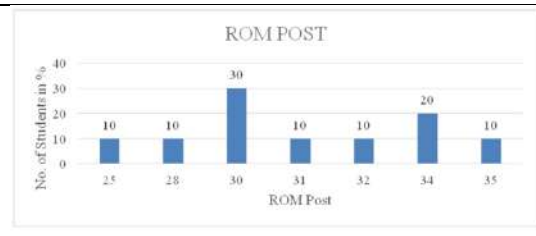


Fig.6. ROM POST

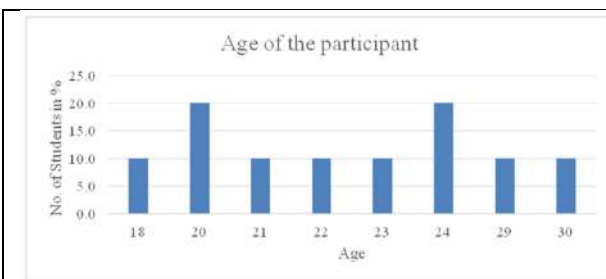


Fig.7. Age of the Participant

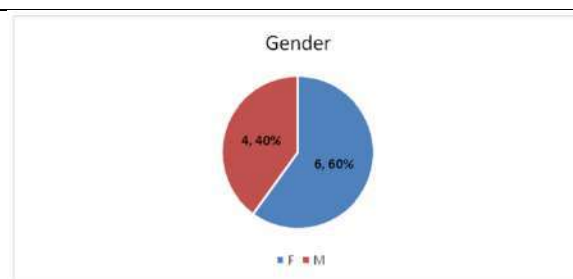


Fig.8. Gender

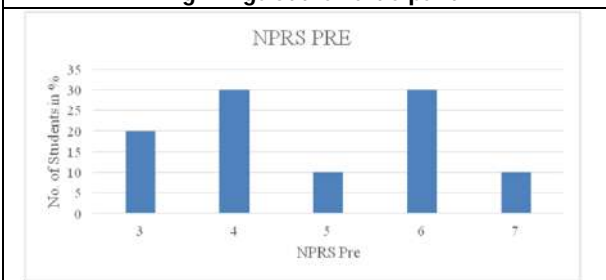


Fig.9. NPRS PRE

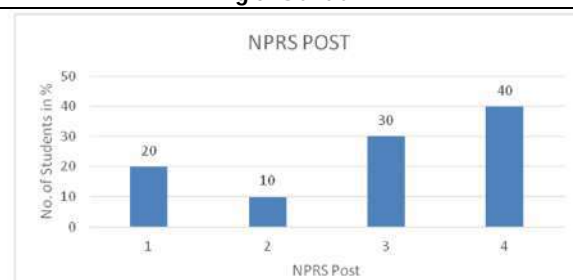


Fig.10. NPRS POST





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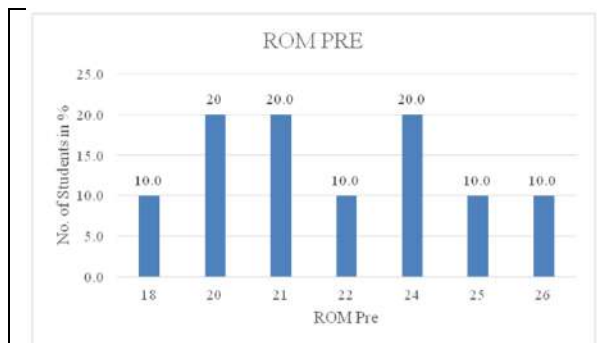


Fig.11. ROM PRE

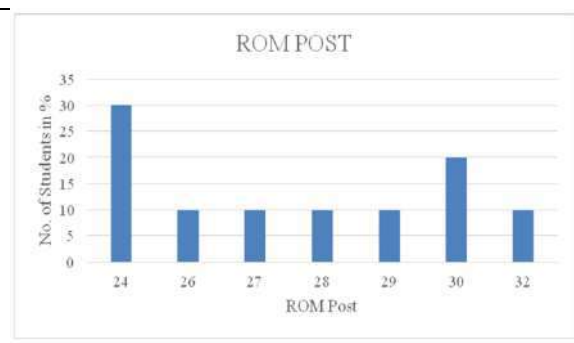


Fig.12. ROM POST





Finding Potential Phytocompounds from the Indian Medicinal Plants for the Treatment of Canine Distemper – An *In silico* Approach

Umabarathi.V¹, Karthikeyan.G², Jamuna.S³, Logeshwaran.A⁴ and Ravikumar.P^{5*}

¹Scientific officer, Iyarvi Research Center for Bioinformatics, Erode – 638 452, Tamil Nadu, India.

²Assistant Professor, Department of Biochemistry, Kongu Arts and Science College, Erode, Tamil Nadu, India.

³PG Student, Department of Biochemistry, Kongu Arts and Science College, Erode, Tamil Nadu, India.

⁴Research Assistant, Iyarvi Research Center for Bioinformatics, Erode – 638 452, Tamil Nadu, India.

⁵Senior Scientist and Head, Iyarvi Research Center for Bioinformatics, Erode – 638 452, Tamil Nadu, India.

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*Address for Correspondence

Ravikumar.P

Senior Scientist and Head,
Iyarvi Research Center for Bioinformatics,
Erode – 638 452, Tamil Nadu, India.
Email: headircb@gmail.com



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ABSTRACT

The canine distemper virus (CDV), a member of the Morbillivirus genus in the Paramyxoviridae family, causes a highly infectious disease in dogs. The present study was aimed to find the potential phytocompounds from the Indian medicinal plants against Canine Distemper (CD) using *in silico* studies. The 3D structure of the phytocompounds was obtained using IMPPAT and PubChem database. The Lipinski rule of five for all the phytocompounds was tested using SwissADME. The sequence of the target protein was retrieved from the UniProt database and modelled using Swiss-Model. The docking studies were performed using PyRx and the results were analyzed using Discovery Studio 2021. From the results, the phytocompounds such as Diosgenin, Agapanthagenin, and beta - Amyrin exhibited very good binding affinity of -8.9, -8.7 and -8.5 Kcal/mol, respectively. Toxicity studies were done for the best - interacted phytocompounds and the results showed that the compounds had very less toxicity. Hence, the present study concludes that Diosgenin and beta - Amyrin from *Allium cepa* and Agapanthagenin from *Allium sativum* may have a potential effect in the treatment of Canine Distemper.

Keywords: Canine distemper virus, Phytocompounds, Docking, PyRx, Discovery Studio, ADMET properties.





INTRODUCTION

Canine distemper is a contagious disease which was caused by a member of the Morbillivirus genus, which infects a wide range of terrestrial and aquatic carnivores. Canine distemper virus (CDV) is a non-segmented single-stranded negative-sense RNA genome that encodes six structural (nucleocapsid N, matrix M, fusion F, hemagglutinin H, phospho-P, and large-L proteins) and two non-structural (C and V proteins) proteins [1]. Morbilliviruses are members of the Paramyxoviridae family and include a number of highly pathogenic viruses that cause catastrophic infections in humans and animals, such as measles, rinderpest, canine distemper virus (CDV), and peste-des-petits-ruminants virus. Morbilliviruses have been linked to a number of major extinctions in marine mammals in recent decades [2,3]. The CDV genome is 15,690 nucleotides (nt) long and has a single-stranded negative RNA that encodes six non-overlapping transcriptional units that produce eight proteins [4,5]. The nucleocapsid (N) protein encases genomic RNA, which is used as a template for transcription and replication by the viral polymerase (L) protein and also its cofactor phosphoprotein (P). The ribonucleoprotein (RNP) [6], is made up of the N, P, and L proteins, as well as viral RNA, and it guides the synthesis of capped and polyadenylated mRNAs from six transcriptional units or the replication of full-length encapsulated antigenomes [7]. The viral envelope contains two membrane proteins, fusion (F) and hemagglutinin (H), as well as a membrane-associated protein (matrix (M)) that make contact with the RNP [8]. The H glycoprotein aids in the virus's attachment to the cell membrane, while the F protein aids in the fusing of the two membranes, allowing the viral RNP to enter the cytoplasm [9].

CD is most common among unvaccinated puppies and dogs during their first year of life, although it can also affect adults [10]. Canine distemper has one of the worst fatality rates of any infectious disease that affects dogs [11,12]. After Rabies, the case fatality rate is far too high as compared to other canine diseases [13]. Mizoram's canine population has a high prevalence of CD. Canine distemper was found to be present in 1.11% of dogs (10/900). Clinical symptoms and antigen detection can both be used to detect it. Canine Distemper virus antigen can be detected in a variety of samples using the Antigen Rapid CDV Ag Test Kit. The haematological alterations caused by CD are significant. The values of Hb, Hct, TEC, TLC, Lymphocytes, and Monocytes in CD infected dogs were considerably ($p < 0.01$) lower. CD can be prevented with vaccination [14]. Direct contact with infected dogs is the most common mechanism of illness transmission [15]. Canine distemper has a wide range of symptoms that might mimic those of other diseases, making clinical identification difficult. As a result, having a quick and sensitive diagnostic test for confirming the disease is critical in order to take the required precautions to avoid infection transmission. As a result, nested PCR can be used to detect canine distemper virus [16]. Subclinical CDV infections are thought to account for 50–70% of CDV infections in domesticated dogs [17].

In animals with a weak or non-existent immune response, two clinical variants of CDV can be distinguished: an acute systemic type and a chronic neurological form [18,19]. Acute systemic illness develops two to three weeks after infection [20]. Fever, mucopurulent oculonasal discharge, coughing, dyspnoea, depression, anorexia, vomiting, and diarrhoea are among the severe clinical manifestations caused by the virus as it continues to replicate and spread throughout the body (which may be bloody) [21,22]. The virus is detected in every bodily secretion and excretion during this stage of infection [19]. Within 2–3 weeks, neurological indications may be present or follow systemic disease. Odd behaviour, convulsions or seizures, chewing-gum movements of the mouth, blindness, cerebellar and vestibular symptoms, paresis or paralysis, incoordination, and circling are common indicators [20]. Acute demyelination occurs following infection in the central nervous system, and most animals die 2–4 weeks later [23]. Clinical symptoms are frequently aggravated by secondary bacterial infections of the skin and respiratory tract due to CDV's immune weakening nature [17].

Because no specific antiviral medicine is approved for therapeutic use against CDV infection in any species, includes domestic dogs, most CDV infections are treated with symptomatic and supportive therapy. Antiviral compounds' *in vitro* effect in the treatment of CDV is still being studied, and numerous more tests are necessary to determine their efficacy and safety in treating CDV in different species [24]. They discovered that treating CDV-infected ferrets with





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the inhibitor at the commencement of viraemia results in ferrets having low-grade viral levels that remained asymptomatic and recovered from the infection. Other substances, like as fucoidan, a sulfated polysaccharide found in brown algae, also have been studied for their antiviral properties against CDV [25]. Fucoidan inhibited the first phases of the viral replication cycle *in vitro*, effectively reducing the formation of syncytia in infected cells. Carvalho and colleagues [26] looked explored the antiviral activity of flavonoids (quercetin, morin, rutin, and hesperidin) as well as phenolic acids (cinnamic, trans-cinnamic, and ferulic acids), focusing on their potential to suppress phases of the CDV replication cycle *in vitro*. Against CDV infection, all flavonoids and phenolic acids showed antiviral activity. Mesenchymal stem cell treatment [27] and use of a veterinary pharmaceutical preparation of silver nanoparticles are two further ways for treating CDV infection that have been investigated [28]. Acute widespread CDV infection in domestic dogs can often be identified clinically, especially whereas if animal is unvaccinated. Clinical diagnosis, on the other hand, might be complicated by use of modified live vaccinations, because clinical distemper can arise in puppies who have only recently been vaccinated. In nondomestic specoes, the disease must be distinguished from rabies, feline panleukopenia, toxoplasmosis, parvovirus infection, lead poisoning, canine hepatitis, leptospirosis, and a range of other viral infections, which all have similar clinical symptoms [29]. Treatments for CDV includes broad-spectrum antibiotics, electrolyte solutions that are balanced, Antipyretics, analgesics, and anticonvulsants, as well as parenteral feeding and excellent nursing care [30].

Moreover, there is currently no effective treatment for CDV infections. The pyrazine derivative favipiravir (T-705), which acts on RNA-dependent RNA polymerase, has been demonstrated to be an efficient antiviral treatment against RNA viruses (RdRp). At doses ranging from 2.441 g/ml to 1250 g/ml, T-705 effectively reduced CDV-3 and CDV-11 replication in Vero and DH82 cells [31]. *In vitro*, ribavirin inhibits CDV replication in a dose- and time-dependent fashion. In VERO cell cultures infected with the canine distemper virus, propolis ethanolic extract from *Plebeia frontalis* demonstrated a statistically significant antiviral activity, which was equivalent whether administered an hour before and simultaneously to the infection. As a result, it's a good idea to include it in antiviral therapy for both domestic animals and humans [32]. Sulfated polysaccharides work primarily by preventing enveloped viruses from entering host cells [33-35]. By interfering with virus adsorption process, marine polysaccharides from various sources can prevent virus infection. Fucoidan appears to have antiviral properties by blocking virus particle attachment to the host cell or interfering with the adsorption process [36].

Fucoidan is a sulfated polymer found in brown algae's cell walls. Fucoidan, which is produced from *Cladosiphonokamuranus*, was previously tested *in vitro* for anti-CDV action. Fucoidan suppresses viral infection by interfering in the early steps and blocking CDV-mediated cell fusion in Vero cells at a 50 percent inhibitory concentration (IC50) of 0.1 g/ml, according to the researchers [25]. In the present study, the Indian medicinal plants like *Allium cepa*, *Allium sativum* [37], *Curcuma longa* [38], *Ocimum tenuiflorum* [39], *Origanum vulgare*[40] and *Zingiber officinale* [41] were taken to find the potential phytochemicals for the treatment of Canine Distemper.

MATERIALS AND METHODS

Ligand selection

Using literature, IMPPAT database [42] around 345 phytochemical compounds were selected from the different Indian medicinal plants like *Allium cepa*, *Allium sativum*[37], *Curcuma longa* [38], *Ocimum tenuiflorum*[39], *Origanum vulgare*[40] and *Zingiber officinale* [41] for treating Canine Distemper. The 3D structure of these compounds was retrieved from the PubChem database [43] and using SwissADME [44] they were subjected to test Lipinski Rule of Five. From the results, 296 compounds obeyed Lipinski Rule of Five and these compounds were taken for the study.

Target protein selection and preparation

The sequence of target protein Nucleoprotein was taken from the UniProt database [45]. It was modelled using SWISS-MODEL [46] to predict the 3D structure of target protein and the best model was taken, evaluated using





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SAVES online server [47] and Ramachandran plot was taken. The modelled 3D structure of target protein was prepared using Discovery Studio 2021 for *in silico* docking studies.

Docking studies

Docking studies for the modelled target protein Nucleoprotein and the phytochemicals (ligands) were done using PyRx 0.8 software [48]. The target protein was further prepared for docking studies using this software. All the ligands were uploaded using Open Babel option in the PyRx 0.8. The grid was generated and the docking studies were performed using Vina wizard option in the PyRx 0.8. The values of binding affinity were saved in XL file. The results were analysed using Discovery Studio 2021 and the 2D and 3D docked images were taken. In the results, the lowest binding affinity indicates good result.

ADMET and CYP properties

ADMET and CYP properties were tested for all the best-interacted phytochemicals using Swiss ADME [44]. Lipinski, BBB (Blood - Brain Barrier), HIA (Human Intestinal Absorption), PGP (P-glycoprotein), XLogP3, TPSA (Topological Polar Surface Area), LogS, Fraction Csp3, Rotatable bonds, CYP enzyme inhibitor properties, Skin permeation and Bioavailability score were evaluated for all the best-interacted compounds.

RESULTS AND DISCUSSION

Ligand and Target protein selection

The 3D structure of the ligands (phytochemicals) was retrieved from the PubChem database. The sequence of the target protein Nucleoprotein was taken from the UniProt database and its UniProt ID is P04865. It was modelled using SWISS-MODEL and PDB ID: 7OI3 was used as a template to predict the 3D structure of the target protein and the sequence identity is 82.31 %. The modelled target protein was evaluated using Ramachandran plot. In the results, 89.7% of residues are located in the most favoured regions which confirms that predicted model is good. The 3D structure of the modelled target protein and the Ramachandran plot are shown in figure 1 and 2.

Docking studies

Docking studies for the target protein Nucleoprotein and the phytochemicals (ligands) were done using PyRx 0.8 software, the binding affinity value was noted and the results were analysed using Discovery studio 2021. From the results, 10 compounds showed very good interaction with the target protein and the results are shown in table 1. The 2D and 3D interaction of phytochemicals and the synthetic drug with the target protein are shown in figures 3-9. From the results (Table 1), among the 296 Phytochemicals which were obeyed the Lipinski Rule of Five, 10 compounds had the best results with the target protein. In which, the phytochemical Diosgenin showed the best binding affinity (-8.9 Kcal/mol) with the amino acid residues PRO 248 and ASN 164 of the target protein Nucleoprotein. The phytochemical Agapanthagenin also showed a very good binding affinity of -8.7 Kcal/mol with the amino acid residues ILE 240 and ASN 164. The binding affinity -8.5 Kcal/mol was observed between the phytochemical beta -Amyrin and the amino acid residue ASP 239 of the target protein. The phytochemical Oleanolic Acid showed a good binding affinity (-8.3 Kcal/mol) along with the amino acid residues LYS 180 and THR 187 of target protein and the binding affinity of phytochemical Ursolic acid was -8.2 Kcal/mol and its amino acid residues are LYS 180 and THR 187. Besides, the Synthetic drug Favipiravir with the target protein has the lowest binding affinity of -4.8 Kcal/mol and it interacted the amino acid residues were PRO 106, ASN 109, THR 115, ALA 121 and ASP 124.

Moreover, in the results of the present study, all the 10 phytochemicals showed the best binding affinity when compared to the Synthetic drug Favipiravir. Wherein, the phytochemicals Diosgenin, Agapanthagenin and beta - Amyrin showed the highest binding affinity among the other phytochemicals. Further, in the previous study, *Conium maculatum* was taken on a regular basis to minimize the neurological signs of distemper. *Conium maculatum* was recommended for dogs with canine distemper because of its efficacy in cases of posterior paralysis, neurological





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dysfunction, and weakness [49]. In VERO cell cultures infected with the canine distemper virus, propolis ethanolic extract from *Plebeia frontalis* demonstrated a statistically significant antiviral activity [32]. A study reported that a sulfated polysaccharide has been found to have antiviral properties against CDV [25]. Fucoidan has been found to have a high selectivity of antiviral effect. Another study found that proanthocyanidin A2 isolated from *Aesculus hippocastanum* has greater *in vitro* antiviral activity (CDV) than Ribavirin [50]. Curcumin has been proven to suppress a wide range of species, including bacteria, fungi, and viruses such as HBV, HCV, and HIV [51-53]. Fresh garlic extract contains the greatest thiosulfinate, which acts favorably against non-enveloped viruses by inhibiting their adsorption or penetration [54]. Essential oils from Tulsi leaves, such as Eugenol, have antiviral properties [55]. In the same way, the present *in silico* docking studies identified that the phytochemicals Diosgenin and beta -Amyrin from *Allium cepa* and Agapanthagenin from *Allium sativum* showed very good binding affinity with the target protein Nucleoprotein and they may have the potential ability to act as a drug for the treatment of infection caused by Canine Distemper Virus.

ADMET and CYP Properties

In the present study, ADMET properties were tested for the best interacted phytochemicals and Synthetic drug Favipiravir using SwissADME and the results were tabulated (table 2). From the results, all the best interacted phytochemicals and also the synthetic drug Favipiravir obey the Lipinski rule of five. Most of the compounds did not cross Blood – Brain Barrier (BBB). Only five phytochemicals such as Diosgenin, Agapanthagenin, Protopine, Gibberellin A7, Gibberellins and the synthetic drug Favipiravir had High Intestinal Absorption (HIA). Many phytochemicals predicted to be effluated from the CNS by P-glycoprotein. Only four phytochemicals predicted not to be effluated from the CNS by P-glycoprotein. Among the 10 compounds, XLogP3 value of seven compounds were within the range and remaining compounds were above the range. TPSA (Topological Polar Surface Area) and Log S value of the most of the compounds were within the limit. In all the phytochemicals, Fraction Csp3 value of one phytochemical ((-)-Epicatechin gallate) was less than 0.25 and the value of other compounds were above this limit. Rotatable bonds of all the compounds were within the limit.

From the results of the Boiled egg image of the phytochemicals (Figure 10), the compounds Diosgenin and Protopine are located in the Egg-yolk region, which means the compounds can passively permeate through the blood-brain barrier. The compounds Agapanthagenin, Gibberellin A7 and Gibberellins are located in the Egg-white region, which means they are passively absorbed by the gastrointestinal tract. Moreover, the compounds Diosgenin, Oleanolic Acid, Ursolic acid, and (-)-Epicatechin gallate are predicted not to be effluated from the Central Nervous System by the P-glycoprotein. The compounds Protopine, Agapanthagenin, Gibberellin A7, Gibberellins and Apigenin-7-O-glucoside are predicted to be effluated from the Central Nervous System by the P-glycoprotein. In the results of CYP properties (table 3), the most of the compounds does not inhibit the CYP450 enzymes and does not give any adverse reactions. Only, the phytochemical Protopine inhibits CYP1A2, CYP2C9, CYP2D6 and CYP3A4. The value of log K_p(Skin Permeation) is good for all the compounds and A Bioavailability Score (ABS) is also good for the most of the compounds.

CONCLUSION

In the present study, the phytochemicals from the different Indian medicinal plants and the target protein Nucleoprotein were subjected for *in silico* docking analysis to find the potential phytochemicals for treating Canine Distemper Virus. In the results, when compared to Synthetic drug Favipiravir, all the 10 best interacted phytochemicals showed very good interaction with the target protein Nucleoprotein. In which, the phytochemicals Diosgenin, Agapanthagenin and beta -Amyrin showed the highest binding affinity among the other phytochemicals. Toxicity studies were also done for the 10 best-interacted phytochemicals and the results showed that all the compounds had very less toxicity. Hence, the present study concludes that the phytochemical





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Diosgenin and beta –Amyrin from *Allium cepa*, and Agapanthagenin from *Allium sativum* may have the potential ability to act as a drug for treating the Canine Distemper disease.

Abbreviations

CDV: canine distemper virus; CD: Canine Distemper; RNP: ribonucleoprotein; HA: haemagglutination assay; PCR: Polymerase Chain Reaction; NPO: Nil per Os; CPE: cytopathic effect; FDA: Food and Drug Administration; BBB: Blood - Brain Barrier; HIA: Human Intestinal Absorption; GPG: P-glycoprotein; TPSA: Topological Polar Surface Area; PPV: Plum Pox Virus;

Conflict of Interests

Authors declare that there is no conflict of interest regarding publication of the current research work.

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Table.1: Interaction of Phytochemicals with the target protein Nucleoprotein

S.No.	PubChem(CID)	Compound Name	Plant Name	Binding Affinity (Kcal/mol)	No. of Bonds	Interacting Residues	Bond Length (Å)
1.	99474	Diosgenin	<i>Allium cepa</i>	-8.9	2	PRO 248 ASN 164	5.39 1.46
2.	15558507	Agapanthagenin	<i>Allium sativum</i>	-8.7	2	ILE 240 ASN 164	4.60 1.97
3.	225689	beta-Amyrin	<i>Allium cepa</i>	-8.5	1	ASP 239	2.72
4.	10494	Oleanolic Acid	<i>Allium cepa</i>	-8.3	2	LYS 180 THR 187	2.75 2.05
5.	64945	Ursolic acid	<i>Ocimum tenuiflorum</i>	-8.2	2	LYS 180 ARG 354	2.75 2.66
6.	107905	(-)-Epicatechin gallate	<i>Allium cepa</i>	-8	11	ARG 354 GLY 349	2.52 2.13





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						THR 187 ALA 184 ALA 179 VAL 262 GLU 263 GLY 265 ALA 267 ALA 267 ALA 264	2.39 4.17 2.10 2.58 2.64 2.42 4.04 5.05 5.14
7.	12304093	Apigenin-7-O-glucoside	<i>Origanum vulgare</i>	-8	11	SER 328 THR 295 LEU 299 ASN 322 LYS 323 LYS 323 ARG 15 ARG 15 ARG 15 PHE 11 LYS 12	2.19 3.91 5.48 3.69 5.08 3.44 5.10 5.17 3.84 5.26 5.38
8.	4970	Protopine	<i>Allium sativum</i>	-7.4	6	THR 183 ARG 354 ASN 351 LEU 350 LEU 350 ALA 267	3.95 4.80 3.58 3.50 3.86 5.05
9.	122130381	Gibberellin A7	<i>Allium sativum</i>	-7.2	6	SER 328 THR 295 PHE 11 LYS 12 LYS 12 LYS 12	3.11 2.52 4.76 2.49 3.36 4.48
10.	102004933	Gibberellins	<i>Allium sativum</i>	-7.2	4	ASN 164 PHE 80 ILE 250 ILE 250	2.41 2.44 2.49 5.40
Synthetic Drug							
11.	492405	Favipiravir	Synthetic drug	-4.8	5	PRO 106 ASN 109 THR 115 ALA 121 ASP 124	2.53 2.01 2.25 2.48 2.04

Table.2: ADMET Properties of Phytocompounds

S. No.	Pub Chm (CID)	Compound Name	Lipinski	BBB	HIA	PGP-	XLOGP3	TPSA (Å)	Log S (ESOL)	Fraction Csp3	Rotatable Bonds
1	99474	Diosgenin	Yes	Yes	High	Yes	5.67	38.69	-5.98	0.93	0
2	15558507	Agapanthagenin	Yes	No	High	No	4.09	79.15	-5.20	1.00	0





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3	225689	beta-Amyrin	Yes	No	Low	NA	9.15	20.23	-8.25	0.93	0
4	10494	Oleanolic Acid	Yes	No	Low	Yes	7.49	57.53	-7.32	0.90	1
5	64945	Ursolic acid	Yes	No	Low	Yes	7.34	57.53	-7.23	0.90	1
6	107905	(-)-Epicatechin gallate	Yes	No	Low	Yes	1.53	177.14	-3.70	0.14	4
7	12304093	Apigenin-7-O-glucoside	Yes	No	Low	No	1.81	170.05	-3.78	0.29	4
8	4970	Protopine	Yes	Yes	High	No	2.79	57.23	-4.13	0.35	0
9	122130381	Gibberellin A7	Yes	No	High	No	2.01	83.83	-2.89	0.68	1
10	102004933	Gibberellins	Yes	No	High	No	1.50	104.06	-2.07	0.68	1
Synthetic drug											
11	492405	Favipiravir	Yes	No	High	No	-0.56	88.84	-0.80	0.00	1

Note: Obey Lipinski: Yes means 0 violation and good, BBB (Blood - Brain Barrier): Yes means good, HIA (Human Intestinal Absorption): High means good, PGP- (Molecules predicted not to be effluated from the CNS by P-glycoprotein): Yes means good, Lipophilicity: XLOGP3 value between -0.7 and +5.0 means good, Polarity: TPSA between 20 and 130 Å² means good, Water Solubility (Log S scale: Insoluble < -10 < Poorly < -6 < Moderately < -4 < Soluble < -2 < Very < 0 < Highly): Log S value not higher than 6 means good, Saturation (Fraction Csp3): Fraction of carbons in the sp³ hybridization not less than 0.25 means good, and Flexibility (Rotatable bonds): No more than 9 rotatable bonds means good.

Table.3: CYP properties of phytochemicals


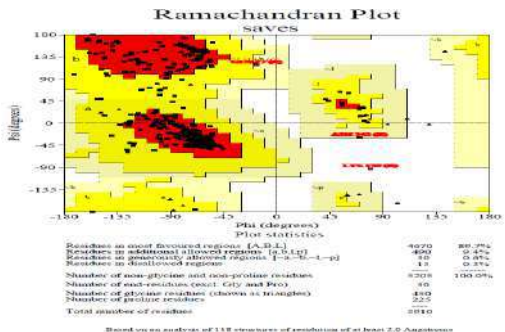
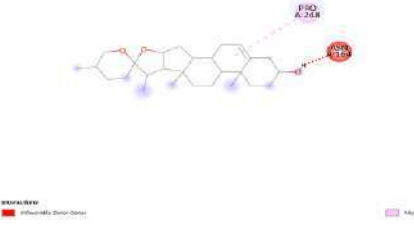
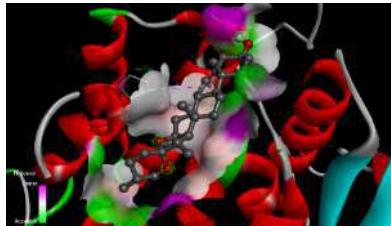

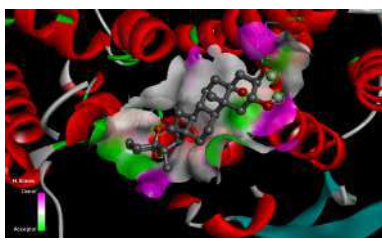
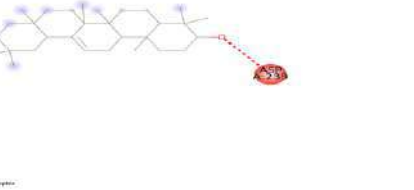
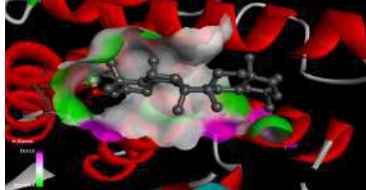
S. No.	Pub Chm (CID)	Compound Name	CYP1A2 inhibitor	CYP2C19 inhibitor	CYP2C9 inhibitor	CYP2D6 inhibitor	CYP3A4 inhibitor	Log K _p (Skin permeation)(cm/s)	A Bioavailability Score (ABS)
1	99474	Diosgenin	No	No	No	No	No	-4.80	0.55
2	15558507	Agapanthagenin	No	No	No	No	No	-6.13	0.55
3	225689	Beta -Amyrin	No	No	No	No	No	-2.41	0.55
4	10494	Oleanolic Acid	No	No	No	No	No	-3.77	0.85
5	64945	Ursolic acid	No	No	No	No	No	-3.87	0.85
6	107905	(-)-Epicatechin gallate	No	No	No	No	No	-7.91	0.55
7	12304093	Apigenin-7-O-glucoside	No	No	No	No	No	-7.65	0.55
8	4970	Protopine	Yes	No	Yes	Yes	Yes	-6.47	0.55
9	122130381	Gibberellin A7	No	No	No	No	No	-7.12	0.56
10	102004933	Gibberellins	No	No	No	No	No	-8.24	0.56
Synthetic drug									
11	492405	Favipiravir	No	No	No	No	No	-7.66	0.55

Note: No means good, the compound does not inhibit the CYP450 enzymes and does not give any adverse reactions; Yes means the compound inhibits the CYP450 enzymes and gives unanticipated adverse reactions; The more





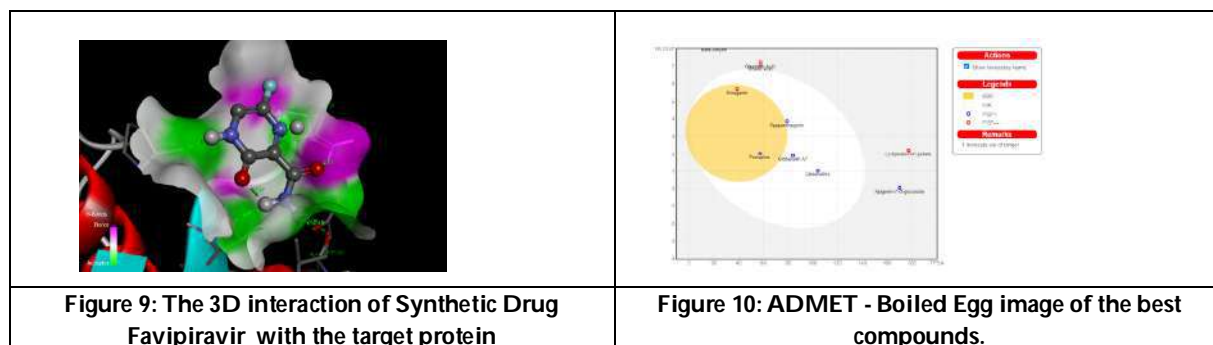
negative the log K_p , the less skin permeant is the molecule; ABS 0.55 means it passes the rule of five and 0.17 means it fails the rule of five.

	 <table border="1"> <thead> <tr> <th colspan="2">Statistics on model Ramachandran regions [A-D-E]</th> <th>90%</th> <th>95%</th> </tr> </thead> <tbody> <tr> <td>Residues in disallowed allowed regions [A-D-E]</td> <td>46/20</td> <td>80.0%</td> <td></td> </tr> <tr> <td>Residues in disallowed allowed regions [F-H-L]</td> <td>46/2</td> <td>97.8%</td> <td></td> </tr> <tr> <td>Residues in disallowed regions [F-H-L]</td> <td>1/3</td> <td>0.2%</td> <td></td> </tr> <tr> <td>Number of non-glycine and non-proline residues</td> <td>20/20</td> <td></td> <td>100.0%</td> </tr> <tr> <td>Number of non-glycine and non-proline residues</td> <td>46</td> <td></td> <td></td> </tr> <tr> <td>Number of glycolic residues (shown as triangles)</td> <td>1/19</td> <td></td> <td></td> </tr> <tr> <td>Number of proline residues</td> <td>2/2</td> <td></td> <td></td> </tr> <tr> <td>Total number of residues</td> <td>20/20</td> <td></td> <td></td> </tr> </tbody> </table> <p>Search for an analysis of 138 structures of resolution of at least 2.0 Angstroms and produce in general less than 20% of good quality model would be expected to have more than 90% in the most favoured regions.</p>	Statistics on model Ramachandran regions [A-D-E]		90%	95%	Residues in disallowed allowed regions [A-D-E]	46/20	80.0%		Residues in disallowed allowed regions [F-H-L]	46/2	97.8%		Residues in disallowed regions [F-H-L]	1/3	0.2%		Number of non-glycine and non-proline residues	20/20		100.0%	Number of non-glycine and non-proline residues	46			Number of glycolic residues (shown as triangles)	1/19			Number of proline residues	2/2			Total number of residues	20/20		
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<p>Figure 1: The 3D structure of target protein Nucleoprotein</p>	<p>Figure 2: The Ramachandran plot for the modelled target protein Nucleoprotein</p>																																				
																																					
<p>Figure 3: The 2D interaction of phytochemical Diosgenin with the target protein</p>	<p>Figure 4: The 3D interaction of phytochemical Diosgenin with the target protein</p>																																				
																																					
<p>Figure 5: The 2D interaction of phytochemical Agapanthagenin with the target protein</p>	<p>Figure 6: The 3D interaction of phytochemical Agapanthagenin with the target protein</p>																																				
																																					
<p>Figure 7: The 2D interaction of phytochemical beta - Amyrin with the target protein</p>	<p>Figure 8: The 3D interaction of phytochemical beta - Amyrin with the target protein</p>																																				





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Note:

BBB: Points located in BOILED-Egg's yolk are molecules predicted to passively permeate through the blood-brain barrier.

HIA: Points located in BOILED-Egg's white are molecules predicted to be passively absorbed by the gastrointestinal tract.

PGP+: Blue dots are for molecules predicted to be effluated from the central nervous system by the P-glycoprotein.

PGP-: Red dots are for molecules predicted not to be effluated from the central nervous system by the P-glycoprotein.





Smart Garden Monitoring and Irrigation Based on IoT

Sugumaran A¹ and Ashok B P^{2*}

¹Student, MCA III Sem, The Oxford College of Engineering, Bommanahalli, Bengaluru, Karnataka, India

²Associate Professor, MCA Department, The Oxford College of Engineering, Bommanahalli, Bengaluru, Karnataka, India

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*Address for Correspondence

Ashok B P

Associate Professor, MCA Department,
The Oxford College of Engineering,
Bommanahalli, Bengaluru, Karnataka, India
E.Mail: sugumaranamca2023@gmail.com



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ABSTRACT

Garden will make the peace in everyone life make in peace. Green is often described as a refreshing and tranquil color. Green has made the mind relax or cool. Oxygen is necessary for every human being. So, to make it we should make it green always by irrigating to the plants in the garden. By using Humidity sensor and soil moisture sensor to get know about the soil moisture level and temperature level. If the soil moisture level is less, we will irrigate to the plants by turn on the motor by using the relay. We can change the part to irrigate to plants by using Solenoid valve. We have another choice to irrigate to the garden by using RTC in everyday without human interaction. In this system we can customize the timer for irrigation to garden.

Keywords: ESP3266, LoRa, Relay, Soil moisture sensor, Humidity sensor, solenoid valve, RTC (Real Time Clock).

INTRODUCTION

Smart Garden Monitoring and Irrigation Based on IoT is a system that uses Internet of Things (IoT) technology to automate the process of monitoring and irrigating plants in a garden or farm. The system consists of sensors, actuators, and a central controller that work together to ensure optimal growing conditions for plants. The sensors are used to measure different environmental parameters such as soil moisture, temperature and humidity. The data collected by these sensors is transmitted through wire to the central controller which processes it to make decisions on when and how much to irrigate the plants. The actuators are responsible for carrying out the irrigation process based on the decisions made by the central controller. In summary, Smart Garden Monitoring and Irrigation Based on IoT is a modern and efficient solution for managing gardens and farms, providing real-time monitoring and control of growing conditions.



**Sugumaran and Ashok****Literature Survey**

"Design and Implementation of an IoT-based Smart Agriculture Monitoring and Control System" by Abdulazeez Abdulrauf *et al.* (2020). This paper presents a comprehensive IoT-based smart agriculture monitoring and control system that utilizes sensors, actuators, and a central controller to automate the irrigation process and monitor plant growth. "Smart Irrigation System Based on IoT for Agriculture" by Shubham Tayal *et al.* (2019). This paper proposes a smart irrigation system based on IoT that uses a combination of soil moisture sensors and weather data to optimize irrigation scheduling. The system was tested on a cotton field, and the results showed a 44% reduction in water consumption and a 25% increase in yield. "Smart Irrigation System Based on IoT and Cloud Computing for Precision Agriculture" by M. S. Islam *et al.* (2020). This paper proposes a smart irrigation system based on IoT and cloud computing that uses a combination of sensors, actuators, and machine learning algorithms to optimize irrigation scheduling. The system was tested on a maize farm, and the results showed a 32% reduction in water consumption and a 22% increase in yield.

Problem Statement**Existing system**

In an existing system, a smart garden monitoring system that uses soil moisture sensors, light sensors, and other environmental sensors to monitor the growing conditions of plants. The data collected by the sensors is sent to a web server, where users can view real-time information about their garden and receive recommendations on when and how much to water their plants. The system can be controlled through a web server, which allows users to monitor water usage and receive real-time alerts about any issues with their irrigation system.

Proposed System

Drawback of the existing system is that it collects data and sent to a mobile app, surely user should be there to control the system. A proposed Smart Garden Monitoring and Irrigation Based on IoT system would consist of several components working together to automate the process of monitoring and irrigating plants in a garden or farm. This system would use various sensors to monitor environmental conditions such as soil moisture, temperature, humidity, and light intensity. A central controller would receive data from the sensors and use it to make decisions on when and how much to irrigate the plants. The actuators in the system would control the irrigation process based on the decisions made by the central controller. The proposed system would provide an automated and efficient solution for managing gardens and farms, providing real-time monitoring and control of growing conditions while reducing the workload and increasing productivity.

System Requirements**Node MCU**

The ESP32 Node MCU is an enhanced version of the Node MCU board that is based on the ESP32 Wi-Fi and Bluetooth module. It is a powerful development board that is widely used for building IoT applications, including smart garden monitoring and irrigation systems. The ESP32 Node MCU features a dual-core processor, which allows it to handle multiple tasks and processes simultaneously. The ESP32 Node MCU supports both Wi-Fi and Bluetooth connectivity, which allows it to communicate with other devices and services. The ESP32 Node MCU offers more GPIO pins than the original Node MCU board, which provides more flexibility for connecting sensors, actuators, and other components to the board. ESP32 Node MCU offers a powerful and flexible platform for building IoT applications, including smart garden monitoring and irrigation systems.

Soil Moisture Sensor

A soil moisture sensor is an electronic device that is used to measure the amount of moisture in the soil. It is commonly used in agriculture to determine when crops need to be watered. The sensor works by measuring the electrical resistance of the soil, which changes as the moisture level changes.



**Sugumaran and Ashok****Humidity Sensor**

A humidity sensor is an electronic device that measures the amount of moisture in the air. It is commonly used in a variety of applications, including weather monitoring, HVAC systems, and industrial processes. The sensor works by measuring the changes in electrical capacitance or resistance caused by the absorption or release of moisture.

LoRa

LoRa (short for Long Range) is a low-power, long-range wireless communication protocol used for Internet of Things (IoT) applications. It is designed for sending small amounts of data over long distances with low power consumption. LoRa operates in the unlicensed spectrum (typically 868 MHz in Europe, 915 MHz in North America, and 433 MHz in Asia) and can achieve ranges of up to 10 kilometers in rural areas and up to several kilometers in urban areas. LoRa is particularly well-suited for outdoor, battery-powered applications where low data rates and long battery life are required, such as smart agriculture, smart cities, and asset tracking.

Relay

A relay is an electrically operated switch that uses an electromagnet to mechanically open or close contacts in order to control the flow of electricity. Relays are commonly used in a variety of applications, including industrial automation, home automation, automotive systems, and telecommunications. The basic components of a relay include a coil, a set of contacts, and a housing. When an electrical current flows through the coil, it generates a magnetic field that pulls a set of contacts together or pushes them apart, depending on the design of the relay. This allows the relay to switch a high voltage or current circuit on or off with a low voltage or current signal. Relays can be designed for a wide range of voltages and currents, and can be configured as normally open (NO), normally closed (NC), or changeover (CO) contacts. They are often used to isolate one circuit from another, to switch between different power sources, or to control the timing of events in a circuit.

Solenoid Valve

A solenoid valve is an electromechanical device that is used to control the flow of fluids or gases in a system. It consists of a coil of wire that produces a magnetic field when an electrical current is passed through it, and a movable plunger or armature that is attached to a valve orifice. When the coil is energized, the magnetic field pulls the plunger into the valve orifice, allowing fluid or gas to flow through. When the coil is de-energized, a spring or other mechanism returns the plunger to its original position, shutting off the flow of fluid or gas. Solenoid valves are commonly used in a variety of applications, including industrial automation, HVAC systems, irrigation systems, and medical equipment.

Wires

Wires are electrical conductors that are used to transmit electrical signals or power from one point to another. They consist of a metal conductor, typically copper or aluminum, surrounded by an insulating material, such as rubber, plastic, or Teflon. Wires can be classified based on several factors, including their diameter, insulation type, and maximum voltage and current ratings. Wires are used in a wide range of applications, including building wiring, automotive wiring, electronic circuits, and power distribution systems.

Implementation

Smart Garden Monitoring and Irrigation based on IoT implementation is a system that uses various sensors, controllers, and IoT technologies to manage and monitor the growth and health of plants in a garden. This system can be used for both indoor and outdoor gardens, including home gardens, urban gardens, and commercial gardens.

Hardware design

Sensors: Sensors are placed in the soil or in the surrounding environment to collect data on temperature, humidity, light, and soil moisture levels.





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Controller: The Node MCU is used to receive data from the sensors and to control the irrigation system. It is programmed to activate the irrigation system when the soil moisture level is low, and to turn off the system when the soil is sufficiently moist.

Irrigation System: The irrigation system is used to water the plants in the garden. The system can be set up to water the plants automatically based on the data collected by the sensors and controllers.

IoT Technologies: IoT technologies such as Wi-Fi, Bluetooth, and cellular data connections are used to connect the sensors, controllers, and irrigation system to the internet. This allows the system to be remotely monitored by a web-based interface.

Software Design

The software design for a smart garden monitoring and irrigation system based on IoT implementation typically involves the following components:

Sensor interface: The system will need sensors to measure environmental factors such as soil moisture, temperature, and humidity. The software design should include an interface to connect and communicate with these sensors.

Data collection: The system should collect data from the sensors and store it in a database for further analysis and decision-making.

Control logic: The system should have control logic that determines when to activate the irrigation system based on the data analysis. This logic should also take into account factors such as weather patterns and crop types.

User interface: The system should have a user interface that allows gardeners to monitor and control the system remotely. The user interface can be a web-based dashboard.

Firmware: The system should have a firmware that allows to control, collect data and automate the system by itself. Overall, the software design for a smart garden monitoring and irrigation system should be flexible, scalable, and easy to use.

RESULT ANALYSIS

Smart Garden Monitoring and Irrigation based on IoT is a reliable and useful for garden monitoring and maintaining.

Increased Efficiency: Smart garden systems can help save water and reduce the workload associated with maintaining a garden by automating the irrigation process.

Improved Plant Health: By monitoring the environment and adjusting the irrigation system accordingly, the system can help ensure that plants receive the appropriate amount of water and nutrients for optimal growth.

Remote Monitoring: With IoT technologies, gardeners can monitor and control their gardens from anywhere, using a mobile app or web-based interface.

Sustainable Gardening: By using smart garden systems, gardeners can reduce their environmental impact by using water and other resources more efficiently.

Future Enhancements

User Interface: The mobile app is used to monitor and control the system remotely. The user can view real-time data from the sensors, control the irrigation system, and receive alerts if the system detects any problems in the garden.

Integration with AI and Machine Learning: With the integration of artificial intelligence and machine learning, the system can learn from past data and optimize irrigation schedules and amounts to maximize crop yield.

Integration with weather forecasting: The system can be enhanced by integrating weather forecasting data, allowing it to adjust irrigation schedules and amounts based on upcoming weather conditions.

Integration with virtual and augmented reality: Virtual and augmented reality can be used to provide a more immersive experience for gardeners, allowing them to visualize and interact with their garden in new ways.

Overall, the future enhancements of a smart garden monitoring and irrigation system based on IoT implementation are limitless, and the possibilities are exciting for gardeners and farmers alike.





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CONCLUSION

In conclusion, a smart garden monitoring and irrigation system based on IoT implementation can provide several benefits to gardeners, including increased crop yields, water conservation, time savings, and cost savings. The system can monitor environmental factors such as soil moisture and temperature and automatically adjust irrigation schedules and amounts to optimize resource usage.

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7. Sensors details are get from their datasheets.





On I_ξ open sets in Ideal Topological Space

T. Sankili¹ and R. Asokan^{2*}

¹Research Scholar, School of Mathematics, Madurai Kamaraj University, Madurai, Tamil Nadu, India

²Head and Chairperson, School of Mathematics, Madurai Kamaraj University, Madurai, Tamil Nadu, India.

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*Address for Correspondence

R. Asokan

Head and Chairperson,
School of Mathematics,
Madurai Kamaraj University,
Madurai, Tamil Nadu, India.
E.Mail: asokan.maths@mkuniversity.org



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ABSTRACT

The main aim of this paper is to introduce and study a new type of open sets namely I_ξ open sets in ideal topological space. The topological elementary properties of I_ξ interior, I_ξ closure, I_ξ limit point, I_ξ derived set, I_ξ boundary, I_ξ frontier and I_ξ exterior are also studied using I_ξ open sets. Moreover, some of its basic properties, note and remarks are relate to them.

Key words: Ideal topological space, I_ξ interior, I_ξ closure, I_ξ limit point, I_ξ derived set, I_ξ boundary, I_ξ frontier and I_ξ exterior.

INTRODUCTION

The term ideal in topological space was first studied by Kuratowski and Vaidyanathaswamy [3,5]. Jankovic and Hamlett [1] were introduced the concept of I open sets in ideal topological spaces. An ideal I on a non empty collection of subsets of X which satisfies the following axioms:

- (i) $S_1 \in I$ and $S_2 \subseteq S_1 \Rightarrow S_2 \in I$,
- (ii) $S_1 \in I$ and $S_2 \in I \Rightarrow S_1 \cup S_2 \in I$ [3,5].

Applications of this to various fields investigated by Jankovic and Hamlett [2]. Given a topological space (X, τ) together with an I on X and if $P(X)$ is the power set of X , a set operator $(.)^*: P(X) \rightarrow P(X)$, called a local function [3] of S with respect to an τ and ideal I is defined as follows:





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For $S \subseteq X$, $S^*(I, \tau) = \{s \in X \mid U \cap S \notin I \text{ for every } U \in \tau(s), \text{ where } \tau(s) = \{U \in \tau \mid s \in U\}\}$. Furthermore $cl^*(S) = S \cup S^*(I, \tau)$ defines a Kuratowski [3] Closure operator for the topology τ^* is finer than τ . If $S \subseteq X$, then $int(S)$, $cl(S)$, $d(S)$, $b(S)$, $fr(S)$ and $ext(S)$ are interior, closure, derived, boundary, frontier and exterior respectively.

Throughout this paper (X, τ, I) (simply X) represent an ideal topological space for which there is no chance of confusion. We have used the symbols " \Leftrightarrow " for "if and only if" and " \Rightarrow " it means "implies". The rest of the paper is organized as follows: Section 2 gives the preliminaries, Section 3 represents the I_ξ open sets in ideal topological spaces. The conclusion of the present study is set forth in Section 4.

Preliminaries

Definition 2.1. [3, 4] Let (X, τ) be a topological space. Then

- (i) A subset S is said to be interior of S if the union of all open sets contained in S .
- (ii) A subset S is said to be closure of S if the intersection of all closed sets containing S .
- (iii) A point $s \in X$ is called limit point of S if for all G and $s \in G$ such that $G \cap (S - \{s\}) \neq \emptyset$.
- (iv) The set of all I_ξ limit point of S is called I_ξ derived set $I_\xi d(S)$.
- (v) A subset S is said to be boundary of S if $b(S) = S - int(S)$.
- (vi) A subset S is said to be frontier of S if $fr(S) = cl(S) - int(S)$.
- (vii) A subset S is said to be exterior of S if $ext(S) = int(X - S)$.

On I_ξ open sets in Ideal Topological Spaces

Here, we have introduced and studied a new type of open sets namely I_ξ open sets in ideal topological space. The topological elementary properties of I_ξ interior, I_ξ closure, I_ξ limit point, I_ξ derived set, I_ξ boundary, I_ξ frontier and I_ξ exterior are also studied using I_ξ open sets.

Definition 3.1 A subset S of an ideal topological space (X, τ, I) is called I_ξ open set if there exists a closed set $F \neq \emptyset, X \in \tau^c$ such that $S \cap F \subseteq int^*(S)$.

The opposite of I_ξ open set is I_ξ closed set. The family of every I_ξ open sets in an ideal topological space (X, τ, I) is denoted by τ^{int^*} .

Example 3.2 Let $X = \{s_1, s_2, s_3\}$, $\tau = \{\emptyset, \{s_1\}, \{s_2\}, \{s_1, s_2\}, X\}$ with ideal $I = \{\emptyset, \{s_2\}\}$. Then $\tau^{int^*} = \{\emptyset, \{s_1\}, \{s_2\}, \{s_1, s_2\}, \{s_1, s_3\}, X\}$.

Note. $\tau \subseteq \tau^{int^*}$.

Theorem 3.3 Every open set in an ideal topological space (X, τ, I) is I_ξ open set.

Proof. Let (X, τ, I) be an ideal topological space and let $S \subseteq X$ be any open set. Then there exists a closed set $F \neq \emptyset, X \in \tau^c$ such that $S \cap F \subseteq int^*(S)$. Therefore S is I_ξ open set.

Remark 3.4 The converse of theorem 3.3, need not be true in general as we shown in the following example.

Example 3.5 In example 3.2, $\{s_1, s_3\}$ is I_ξ open set but not an open set in (X, τ, I) .

Theorem 3.6 Let (X, τ, I) be an ideal topological space and let S_1, S_2 be two I_ξ open sets. Then

- (i) $S_1 \cup S_2$ is I_ξ open set,
- (ii) $S_1 \cap S_2$ is I_ξ open set.





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Proof. (i) Let S_1 and S_2 be two I_ξ open sets. Then by definition 3.1, $S_1 \cap F \subseteq \text{int}^*(S_1)$ and $S_2 \cap F \subseteq \text{int}^*(S_2)$. Then $(S_1 \cap F_1) \cup (S_2 \cap F_2) \subseteq \text{int}^*(S_1) \cup \text{int}^*(S_2) = \text{int}^*(S_1 \cup S_2)$ where F_1 and F_2 are closed sets in τ^c . Therefore $S_1 \cup S_2$ is I_ξ open set.

(ii) Let S_1 and S_2 be two I_ξ open sets. Then by definition 3.1, $S_1 \cap F \subseteq \text{int}^*(S_1)$ and $S_2 \cap F \subseteq \text{int}^*(S_2)$. Then $(S_1 \cap F_1) \cap (S_2 \cap F_2) \subseteq \text{int}^*(S_1) \cap \text{int}^*(S_2) = \text{int}^*(S_1 \cap S_2)$ where F_1 and F_2 are closed sets in τ^c . Therefore $S_1 \cap S_2$ is I_ξ open set.

Definition 3.7 Let (X, τ, I) be an ideal topological space and let $S \subseteq X$. Then the I_ξ interior of S is defined as the union of every I_ξ open contained in S and it is denoted by $I_\xi \text{int}(S)$.

Remark 3.8 For any subset S of an ideal topological space (X, τ, I) , $I_\xi \text{int}(S)$ is I_ξ open set.

Proposition 3.9 Let (X, τ, I) be an ideal topological space and let $S_1, S_2 \subseteq X$ and $S_1 \subseteq S_2$. Then

- (i) $I_\xi \text{int}(S_1) \subseteq I_\xi \text{int}(S_2)$,
- (ii) $I_\xi \text{int}(S_1) \subseteq S_1$,
- (iii) S_1 is I_ξ open if and only if $S_1 = I_\xi \text{int}(S_1)$.

Definition 3.10 Let (X, τ, I) be an ideal topological space and let $S \subseteq X$. Then the I_ξ closure of S is defined as the intersection of every I_ξ closed sets containing S and it is denoted by $I_\xi \text{cl}(S)$.

Remark 3.11 For any subset S of an ideal topological space (X, τ, I) , $I_\xi \text{cl}(S)$ is I_ξ closed set.

Proposition 3.12 Let (X, τ, I) be any ideal topological space and let $S_1, S_2 \subseteq X$ and $S_1 \subseteq S_2$. Then

- (i) $I_\xi \text{cl}(S_1) \subseteq I_\xi \text{cl}(S_2)$,
- (ii) $S_1 \subseteq I_\xi \text{cl}(S_1)$,
- (iii) S_1 is I_ξ closed if and only if $S_1 = I_\xi \text{cl}(S_1)$.

Definition 3.13 Let (X, τ, I) be an ideal topological space and let $S \subseteq X$. A point $s \in X$ is called I_ξ limit point of S if for every $G \in \tau^{\text{int}^*}$ and $s \in G$ such that $G \cap (S - \{s\}) \neq \emptyset$. The set of every I_ξ limit point of S is called I_ξ derived set and it is denoted by $I_\xi d(S)$.

Note. For any subset S of an ideal topological space (X, τ, I) , a point s is not I_ξ limit point of S if and only if there exists $G \in \tau^{\text{int}^*}$ and $s \in G$ such that $G \cap (S - \{s\}) = \emptyset$.

Theorem 3.14 Let (X, τ, I) be an ideal topological space and $S \subseteq X$. Then the following conditions are equivalent.

- (i) for all $G \in \tau^{\text{int}^*}$ and $s \in G$ such that $G \cap (S - \{s\}) \neq \emptyset$
- (ii) $s \in I_\xi \text{cl}(S)$.

Proof. (i) \Rightarrow (ii) is clear.

(ii) \Rightarrow (i) Suppose $s \notin I_\xi \text{cl}(S)$, then there exists a I_ξ closed set $F \in \tau^{\text{int}^*c}$ such that $S \subseteq F$ and $s \notin F$. Hence $G = X - F$ is I_ξ open set such that $s \in G$ and $G \cap (S - \{s\}) = \emptyset$. Which gives a contradiction and hence (ii).

Theorem 3.15 Let (X, τ, I) be an ideal topological space and let $S_1, S_2 \subseteq X$ and $S_1 \subseteq S_2$. Then

- (i) $I_\xi \text{cl}(S_1) = S_1 \cup I_\xi d(S_1)$,
- (ii) S_1 is I_ξ closed if and only if $I_\xi d(S_1) \subseteq S_1$,
- (iii) $I_\xi d(S_1) \subseteq d(S_1)$,
- (iv) $I_\xi \text{cl}(S_1) \subseteq \text{cl}(S_1)$.

Proof. (i) Suppose $x \notin I_\xi \text{cl}(S_1)$, then there is a I_ξ closed set $F \in \tau^{\text{int}^*c}$ such that $S_1 \subseteq F$ and $x \notin F$. Hence $G = X - F$ is I_ξ open set such that $x \in G$ and $G \cap (S_1 - \{x\}) = \emptyset$. Therefore $x \notin S_1$ and $x \notin I_\xi \text{cl}(S_1)$, then $x \notin S_1 \cup I_\xi d(S_1) \subseteq I_\xi \text{cl}(S_1)$. On the other side, $x \in S_1 \cup I_\xi d(S_1)$ which implies that there is a I_ξ open set G such that $x \in G$ and $G \cap (S_1 - \{x\}) = \emptyset$.





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Hence $F = X - G$ is an I_ξ closed such that $S_1 \subseteq F$ and $s \notin F$. Hence and $s \notin I_\xi cl(S_1)$. Thus $I_\xi cl(S_1) \subseteq S_1 \cup I_\xi d(S_1)$. Therefore, $I_\xi cl(S_1) = S_1 \cup I_\xi d(S_1)$.

For (ii), (iii) and (iv) are obvious.

Theorem 3.16 Let (X, τ, I) be an ideal topological space and let $S_1, S_2 \subseteq X$. If S_1 is I_ξ closed, then $I_\xi cl(S_1 \cap S_2) \subseteq S_1 \cap I_\xi cl(S_2)$.

Proof. Let S_1 be I_ξ closed. Then $I_\xi cl(S_1) = S_1$ and $I_\xi cl(S_1 \cap S_2) \subseteq I_\xi cl(S_1) \cap I_\xi cl(S_2) = S_1 \cap I_\xi cl(S_2)$.

Definition 3.17 Let (X, τ, I) be an ideal topological space and let $S \subseteq X$. Then the I_ξ boundary of S denoted by $I_\xi b(S)$ and it is defined by $I_\xi b(S) = S - I_\xi int(S)$.

Definition 3.18 Let (X, τ, I) be an ideal topological space and let $S \subseteq X$. Then the I_ξ frontier of S is denoted $I_\xi fr(S)$ and it is defined by $I_\xi fr(S) = I_\xi cl(S) - I_\xi int(S)$.

Remark 3.19 If S is I_ξ closed in an ideal topological space (X, τ, I) . Then $I_\xi b(S) = I_\xi fr(S)$

Example 3.20 Let $X = \{s_1, s_2, s_3\}$, $\tau = \{\emptyset, \{s_1\}, \{s_1, s_2\}, X\}$ with ideal $I = \{\emptyset, \{s_2\}\}$. Then $\tau^{int^*} = \{\emptyset, \{s_1\}, \{s_1, s_2\}, \{s_1, s_3\}, X\}$. Let $S = \{s_3\}$, then $I_\xi int(S) = \emptyset$, $I_\xi b(S) = \{s_3\}$, $I_\xi cl(S) = \{s_3\}$ and $I_\xi fr(S) = \{s_3\}$. Consider $S = \{s_2, s_3\}$, we get $I_\xi int(S) = \emptyset$, $I_\xi b(S) = \{s_2, s_3\}$, $I_\xi cl(S) = \{s_2, s_3\}$ and $I_\xi fr(S) = \{s_2, s_3\}$.

Theorem 3.21 Let (X, τ, I) be an ideal topological space and let $S \subseteq X$. Then

- (i) $S = I_\xi int(S) \cup I_\xi b(S)$,
- (ii) $I_\xi int(S) \cap I_\xi b(S) = \emptyset$,
- (iii) S is I_ξ open if and only if $I_\xi b(S) = \emptyset$,
- (iv) $I_\xi b(I_\xi int(S)) = \emptyset$,
- (v) $I_\xi int(I_\xi b(S)) = \emptyset$,
- (vi) $I_\xi b(I_\xi b(S)) = I_\xi b(S)$,
- (vii) $I_\xi b(S) = S \cap I_\xi cl(X - S)$,
- (viii) $I_\xi b(S) = S \cap I_\xi d(X - S)$.

Proof. (i) and (ii) are obvious.

(iii) Since $I_\xi int(S) \subseteq S$, it follows from the proposition 3.9(iii) that S is I_ξ open $\Leftrightarrow S = I_\xi int(S) \Leftrightarrow I_\xi b(S) = I_\xi int(I_\xi b(S)) = \emptyset$.

(iv) Since $I_\xi int(S)$ is I_ξ open, it follows from (iii) $I_\xi b(I_\xi int(S)) = \emptyset$.

(v) Assume that $s \in I_\xi int(I_\xi b(S))$, then $s \in I_\xi b(S) \subseteq S$ and $s \in I_\xi int(S)$. Since $I_\xi int(I_\xi b(S)) \subseteq I_\xi int(S)$. Thus $s \in I_\xi b(S) \cap I_\xi int(S) = \emptyset$, which is a contradiction to our assumption. Therefore $I_\xi int(I_\xi b(S)) = \emptyset$.

(vi) Using (v) we get, $I_\xi b(I_\xi b(S)) = I_\xi b(S) - I_\xi int(I_\xi b(S)) = I_\xi b(S) - \emptyset = I_\xi b(S)$.

(vii) $I_\xi b(S) = S - I_\xi int(S) = S - (X - I_\xi cl(X - S)) = S \cap I_\xi cl(X - S)$

(viii) Applying condition (vii) and theorem 3.21, we have $I_\xi b(S) = S \cap I_\xi cl(X - S) = S \cap ((X - S) \cup I_\xi d(X - S)) = S \cap I_\xi d(X - S)$.

Proposition 3.22 Let (X, τ, I) be an ideal topological space and let $S \subseteq X$. Then S is I_ξ closed if and only if $I_\xi fr(S) \subseteq S$.

Definition 3.23 Let (X, τ, I) be an ideal topological space and let $S \subseteq X$. Then the I_ξ exterior of S is denoted by $I_\xi ext(S)$ and it is defined by $I_\xi ext(S) = I_\xi int(X - S)$.





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Example 3.24 Let $X = \{s_1, s_2, s_3\}$, $\tau = \{\emptyset, \{s_1\}, \{s_1, s_3\}, X\}$ with ideal $I = \{\emptyset, \{s_2\}\}$. Then $\tau^{int^*} = \{\emptyset, \{s_1\}, \{s_3\}, \{s_1, s_2\}, \{s_2, s_3\}, X\}$. Let $S = \{s_3\}$, then $I_\xi ext(S) = \{s_1, s_2\}$.

Theorem 3.25 Let (X, τ, I) be an ideal topological space and let $S_1, S_2 \subseteq X$ and $S_1 \subseteq S_2$. Then

- (i) $I_\xi ext(S_1)$ is I_ξ open,
- (ii) $I_\xi ext(S_1) = X - I_\xi cl(S_1)$,
- (iii) $S_1 \subseteq S_2 \Rightarrow I_\xi ext(S_2) \subseteq I_\xi ext(S_1)$,
- (iv) $I_\xi ext(S_1 \cup S_2) \subseteq I_\xi ext(S_1) \cap I_\xi ext(S_2)$,
- (v) $I_\xi ext(S_1 \cap S_2) \supseteq I_\xi ext(S_1) \cup I_\xi ext(S_2)$,
- (vi) $I_\xi ext(X) = \emptyset$,
- (vii) $I_\xi ext(\emptyset) = X$,
- (viii) $I_\xi ext(S_1) = I_\xi ext(X - I_\xi ext(S_1))$,
- (ix) $X = I_\xi int(S_1) \cup I_\xi fr(S_1) \cup I_\xi ext(S_1)$.

Proof. (i) and (ii) are obvious.

(iii) Let $S_1 \subseteq S_2$. Then $I_\xi ext(S_2) = I_\xi int(X - S_2) \subseteq I_\xi int(X - S_1) = I_\xi ext(S_1)$.

(iv) $I_\xi ext(S_1 \cup S_2) = I_\xi int(X - (S_1 \cup S_2)) = I_\xi int((X - S_1) \cap (X - S_2)) \subseteq I_\xi int(X - S_1) \cap I_\xi int(X - S_2) = I_\xi ext(S_1) \cap I_\xi ext(S_2)$.

(v) $I_\xi ext(S_1 \cap S_2) = I_\xi int(X - (S_1 \cap S_2)) = I_\xi int((X - S_1) \cup (X - S_2)) \supseteq I_\xi int(X - S_1) \cup I_\xi int(X - S_2) = I_\xi ext(S_1) \cup I_\xi ext(S_2)$.

(vi) $I_\xi ext(X) = I_\xi int(X - X) = I_\xi int(\emptyset) = \emptyset$

(vii) $I_\xi ext(\emptyset) = I_\xi int(X - \emptyset) = I_\xi int(X) = X$

(viii) $I_\xi ext(X - I_\xi ext(S_1)) = I_\xi ext(X - I_\xi int(X - S_1)) = I_\xi int(X - S_1) = I_\xi ext(S_1)$

(ix) is clear.

CONCLUSION

In this paper, we have discussed I_ξ open sets in ideal topological space and also investigated some of its basic properties are discussed. In future, We will make dense, nowhere dense, continuity, homeomorphism, compactness, connectedness, Separation axioms, weaker, stronger form and generalization of I_ξ closed sets.

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Plant based HMG-Co-A Reductase Inhibitors as Therapeutic Molecules for AD Amyloidopathy

D Divya¹ and D Dineshvaran², Amrita Babu¹, S Arun Kumar³, S K Meheronnisha¹, and Dithu Thekkekkara^{4*}

¹Master of Pharmacy, Department of Pharmacology, JSS College of Pharmacy, Mysuru, Karnataka, India

²Bachelor of Pharmacy, Department of Pharmacology, JSS College of Pharmacy, Mysuru, Karnataka, India

³Master of Pharmacy, Department of Pharmaceutical Chemistry, JSS College of Pharmacy, Mysuru, Karnataka, India

⁴Lecturer, Department of Pharmacology, JSS College of Pharmacy, Mysuru, Karnataka, India

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*Address for Correspondence

Dithu Thekkekkara

Lecturer,

Department of Pharmacology,

JSS College of Pharmacy,

Mysuru, Karnataka, India

E.Mail: dithuthekkekkara@jssuni.edu.in



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ABSTRACT

Alzheimer's disease is one of the most common neurodegenerative diseases that is prevalent and rapidly escalating in the present global scenario. The exact etiology of AD is idiopathic but a certain population of affected AD patients were observed to have genetic causes behind the onset of disease. The two potential markers for Alzheimer's is presence of β -amyloid plaques and neurofibrillary tau tangles. Current treatment strategies are symptomatic and provide no cure. Statins are a class of anti-hyperlipidemic drugs that prevent the biosynthesis of cholesterol by inhibiting an enzyme HMG CoA reductase which is important in the rate limiting step. Various studies suggested that cholesterol plays a role in the amyloidogenic pathway, by increasing the activity of γ -secretase. Furthermore, it is suspected to play a role in phosphorylation of tau protein. Therefore, use of statins could be one strategy in the treatment of AD. For this study, we have considered phytoconstituents known to have HMG CoA reductase inhibitor activity and determined their usefulness in AD.

Keywords: Alzheimer's disease, β -amyloid plaques, Neurofibrillary tau tangles, Statins, Phytoconstituents





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INTRODUCTION

Alzheimer's disease (AD) is characterised by increasing memory loss and deficits in cognitive ability. The global AD patient population is anticipated to be above 46 million, which is expected to reach 131.5 million by 2050[1]. AD affects roughly 3% of all adults aged 65 to 74, 19% of those aged 75 to 84, and 47% over 85. Women are somewhat more affected than males by AD; this may be due to women's longer life expectancy, leaving a more significant percentage of women in the most affected age groups[2].

Role of cholesterol in Alzheimer's disease pathogenesis

Alzheimer's disease is characterised by progressive neurodegeneration, leading to dementia and digressive behaviour. The pathological indications of AD are neurofibrillary tangles and senile plaques resulting in neuronal degeneration and loss of synapses, where the extracellular Amyloid plaques are composed of amyloid β peptide, and intracellular neurofibrillary tangles comprised of hyperphosphorylated microtubule-stabilizing protein tau which is shown in Figure I[3]. An in-depth correlation between cholesterol metabolism and AD was recognised when Apolipoprotein E (APOE) gene was identified as a threat to AD. APOE allele ϵ 4 is a lipid metabolism regulator; it's logical to anticipate that lipids like cholesterol play an essential role in Alzheimer's disease pathogenesis[4]. Astrocytes and oligodendrocytes produce a high proportion of cholesterol in the brain. Apolipoprotein E transports cholesterol produced by astrocytes, which is then deposited into the extracellular matrix through ATP-binding cassette transporter A1 (ABCA1) and ATP-binding cassette transporter G1 (ABCG1). After that, the cholesterol adheres to the nerve cell membrane's LDL receptor, which endorses dendrites' growth and synapse formation [5]. The research of *Xeusong Chen et al* unveiled that the permeability of the Blood Brain Barrier (BBB) is altered due to the intake of high cholesterol-induced diet in New Zealand rabbits, thereby affecting the integrity of the Central Nervous System[6]. Disturbance in the integrity of BBB results in elevated A β in the brain resulting in AD pathogenesis. There have been several targets discovered for lowering AD levels. The enzymes β - and γ -secretase are essential for A β synthesis. The secretase complex appears to comprise multiple proteins, including β -secretase (Beta-Site APP Cleaving Enzyme), γ -secretase, and Nicastrin being the most prevalent[7, 8]. Amyloid Precursor Protein (APP), which is expressed in all cells, is connected to the same family as APLP1 and APLP2 in mammals[9].

Two pathways metabolise APP, when it is cleaved by α -secretase, α -sAPP (soluble APP) is formed, and the C-terminal fragment is cleaved at its intramembranous region by γ -secretase, releasing the peptide p3. This pathway is known as the non-amyloidogenic since it does not create A β . The Amyloid precursor protein (APP) is also cleaved by β -secretase to generate a membrane-bound, 99-residue carboxyl-terminal fragment, which is denoted as APP C99, subjected to additional, sequential fractionation by γ -secretase at the ϵ sites to produce amyloid- β peptides including A β 40 and A β 42. This pathway is known as amyloidogenic pathway as there is a formation of A β . Amyloid β is thought to cause cytotoxic effect by interacting with cellular membranes and proteins, which regulate the folding of this peptide into higher-order complexes with varied cytotoxic potential[10, 11]. Alzheimer's disease is postulated to be caused by a spike in the ratios of A β 42 over A β 40[11, 12]. The cholesterol content can directly affect the activity of β and γ secretases. Lipid rafts are dynamic microdomains comprising the outer exoplasmic region of sphingolipids and cholesterol, connected to phospholipids and cholesterol in the inner cytoplasmic region of the lipid bilayer. That can float independently within the plasma membranes or congregate to create bigger, organised platforms[13]. According to many studies, having a higher baseline total cholesterol level in serum throughout middle age increases the chance of developing AD. As well as poor cognition in old age[14]. An increase in membrane cholesterol content increases the number of lipid rafts. As a result, there is more APP in rafts and the interface between APP and β -secretase increases. As a result, β and γ secretase cleave APP, resulting in enhanced A β production. The amyloidogenic and non-amyloidogenic pathways are represented in Figure II. Low levels of HDL-cholesterol were linked to an increased risk of dementia, whereas high levels were linked to a bigger hippocampus volume and protection against dementia and AD. HDL's primary lipoprotein in the human brain reduces A β toxicity by preventing it from aggregating. High levels of low-density lipoprotein and total cholesterol, on the other hand, are linked to cognitive impairment. Although epidemiological research has been unclear, genetic and biochemical



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investigations have supported the concept that high cholesterol levels are a risk factor for AD[15]. The neuropil tangles or NFT comprised of hyperphosphorylated tau protein. Instead of binding to tubulin and facilitating microtubule assembly, AD cytosolic abnormally hyperphosphorylated tau (AD P-tau) hinders group and breaks microtubules which eventually results in failing of neuronal synapse ultimately resulting in neuronal degeneration[16, 17].

Role of HMG-CoA reductase inhibitors in AD

Cholesterol is an essential component in our body which serves as a fundamental component of the cell membrane. For example, Cholesterol helps in the production of vitamin D. It serves as an essential element of bile salts required for digestion and proper absorption of several vitamins such as A, D, E, and K[18, 19]. The overall process of cholesterol synthesis and the amyloid plaque formation is represented in Figure III. Cholesterol synthesis is a complicated process tightly controlled at various points throughout the production. A set of enzymatic processes produces cholesterol from acetate. The formation of 3-hydroxy-3-methylglutaryl CoA (HMG-CoA) from acetyl-CoA units is the initial step in cholesterol biosynthesis. The action of HMG-CoA reductase on the endoplasmic reticulum membrane converts HMG-CoA to mevalonate. Statins target this reaction because it is the primary limiting rate step in cholesterol production. Following that, mevalonate is transformed into the bioactive isoprenoids isopentenyl pyrophosphate and dimethylallyl pyrophosphate, out of which farnesyl pyrophosphate (PP) and squalene are produced. Cyclization and oxygenation reactions of squalene produce lanosterol. Where enzymes such as DHCR7 or DHCR24 help in the synthesis of cholesterol by the reduction of lanosterol intermediates[20]. The CNS is where the central part of the cholesterol required by the brain is synthesised. One of the organs with enormous cholesterol levels in the body is the brain. Cholesterol is crucial for organising neuronal components and supporting their functions[21].

In contrast to free APOE, which has been demonstrated to encourage A β aggregation, APOE-containing HDL-like particles prevent the formation of A β . LDL receptor-related protein (LRP) functions as a neuronal receptor for APOE-containing lipid particles generated by astrocytes, facilitating their internalisation into neurons where they are broken down. It has been demonstrated that the cholesterol efflux regulator ABCA1(ATP-binding cassette sub-family A member 1) also controls the amounts of A β in neurons. Neuronal organelles of the late secretory and endolysosomal systems generate A β in their lumen, and only for easier understanding it is drawn as free-floating in the cytoplasm. According to the research of *J.D. Buxbaum et al.*, it is proven that the cells (Chinese hamster Ovary cells, MDCK cells, H4 cells) incubated with medium containing lipid-depleted serum and LA (lovastatin acid) significantly decreased the production of A β , and a decrease in cholesterol accompanied this where it is also indicated that LA had a negligible impact on a generation of secreted A β PP and maturation of A β PP which rule out the harmful effect of LA as a root cause for the reduction of A β formation[22].

In a prospective study conducted by *Haag MD et al.* with the help of 6992 participants free from Alzheimer's disease at the baseline who were administered with both lipophilic and hydrophilic statins. Of the total 6992 participants, 739 participants developed AD with the progress of time. Statin use was related to a decreased incidence of AD compared to never using cholesterol-lowering medications. The use of cholesterol-lowering medications other than statins did not show any neuroprotective effects, and in this study, it is concluded that regardless of how lipophilic they are, statin use is linked to a lower incidence of AD[23]. In the twelve-week prospective pilot study carried out by *K.P. Padala et al.*, 18 older age participants went through the phases of withdrawal of statins and rechallenge for a span of 6 weeks each. The cognition capacity of the participants was measured by the Mini-Mental State Examination, CERAD (Consortium to Establish a Registry for Alzheimer's Disease), Activities of Daily Living, International Activities of Daily Living etc. In this pilot trial, it was discovered that quitting the statins improved cognition but the rechallenge phase caused worsening of cognition. In individuals who have dementia, statins may hurt cognition[24]. In the research of *Li et al.*, 110 cognitively normal subjects brain autopsies were performed, and it is concluded that statins have been shown to dramatically decrease Neurofibrillary tangles compared to amyloid plaques in normal subjects, which implicates statins may be able to prevent tau deposition more easily than A β buildup[25]. In the research of *Boimel et al.*, using tauopathy induced mouse model, it is found that simvastatin



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treatment in young rats for eight months dramatically reduced NFTs and enhanced T-maze performance and BBB impermeable atorvastatin therapy for 5 months significantly lowered lectin-positive microglia and considerably reduced the NFT load in hypercholesterolemic mice. This research also implied that microglial and Neurofibrillary tangles load had a positive connection[26]. There are some proposed possible mechanisms outlined by several researchers based on *in-vitro*, *in-vivo*, preclinical and clinical experiments in identifying the action of the HMG-Co-A reductase inhibitors. In the study of *Buxbaum et al.*, several feasible mechanisms of statins are compiled together, which includes reduced levels of cholesterol may affect the biogenesis of Amyloid Precursor Protein which in turn decreases the production of amyloid β , The Beta-Site APP cleaving enzyme (typically confined to lipid rafts along with APP), β -secretase, is thought to be redistributed as a result of cholesterol deprivation using methyl- β -cyclodextrin[22]. Also, in the study of *Shinohara et al.* few mechanisms of action of statins were gathered, which comprises of, Amyloid β degradation is regulated by $\alpha/\beta/\gamma$ -secretase shedding and metabolism of Amyloid Precursor Protein C-terminal fragments by isoprenoid-controlled agency [27]. Some of the evidences imply that the use of statins for the treatment in AD has proven to decrease its prevalence described in Table I. It is yet unclear how statins control the metabolism of A β in the brain.

Phytoconstituents as a rich source of HMG-CoA reductase inhibitors

Plant and plant-based products have been extensively used in the treatment of various diseases and disorders since ancient times. The current therapeutic approaches for Alzheimer's are symptomatic treatments with no permanent cure. The present-day pharmacotherapy for AD include Accetylcholineesterase inhibitors Tacrine, Donepezil, Rivastigmine and Galantamine. Tacrine is rarely prescribed today because of its hepatotoxic effects. A number of studies have shown that plant-based remedies with phytoconstituents can heal and manage AD[28]. Biochemical and genetic investigations identify a potential link between hyperlipidemia and an increased risk of AD. Furthermore, there were reports suggesting the use of hypolipidemic drugs and decreased risk of AD. Thus lipid lowering phytoconstituents could potentially act as a source of medication for AD[29].

Phytoconstituents that act as a HMG CoA reductase inhibitors otherwise known as statins are shown to reduce the onset and advancement of AD. Some of the phytochemicals of class flavonoids that includes rutin, quercetin, kaempferol; polyphenols, alkaloids, triterpenoids have proved effective in the treatment of AD[30].

Role of HMG-CoA reductase inhibitors in other neuronal complications**Parkinson's Disease:**

Parkinson's disease is a degenerative condition of the motor control system caused by the destruction of nigrostriatal dopaminergic neurons. Distal resting tremor, postural instability and bradykinesia are the hallmark signs of Parkinson's disease[31]. There are some supporting evidences which describes the effect of statins in ameliorating the progression of PD. In the research conducted by *Bar-On et al.*, on transfected neuronal cell line treated using lovastatin, pravastatin and simvastatin it is found that statins reduced the build-up of α -synuclein in the detergent insoluble portions of the neuronal cells expressing α -synuclein and lessened the effects of PD[32]. By reducing plasma cholesterol levels, statins could help prevent the formation of a-synuclein aggregation in the brain, according to the study by *G. Hu et al.* [33]. According to clinical evidence, statins' ability to lower cholesterol prevents the build-up of a-synuclein in some brain regions in people with Parkinson's disease[34, 35]. Statin therapy clearly correlates with a lower incidence of Parkinson's disease (PD), particularly in Asian populations when compared to western populations, according to a meta-analysis by *Sheng et al.*, using a number of clinical trials and observational studies. This finding supports the use of statins as adjuvant therapy for PD patients[36]. In contrast, Simvastatin treatment in 6-hydroxydopamine-induced rats with Parkinson's disease revealed an upsurge in dopaminergic receptor expression; however, further evidence indicates statins might not be beneficial in Parkinson's disease[37]. Some potential mechanisms for statin-induced neuroprotective properties in Parkinson's disease have been identified by few available experimental research data. Through regulation of neuro-inflammatory effects, statins may guard the dopaminergic neurons of the substantia nigra against neurodegeneration. Other studies have shown that statins exhibit neuroprotection through a number of mechanisms, including the prevention of oxidative stress-induced damage by inhibiting lipid peroxidation and nitrite concentration, the depletion of mitochondrial enzyme complexes



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I and III and the cytoprotective radical scavenger glutathione peroxidase, and the ensuing aggregation of α synuclein[38].

Epilepsy

A non-communicable disease associated with the brain characterized by recurrent seizures, with brief episodes of muscle movement that is involuntary which may be a part of the body (tonic) or the whole body (generalized) accompanied by loss of consciousness. Defined as the two or more unprovoked seizures within a time span of 24 hours, are caused due to excessive and uncontrolled electrical discharge in the brain[39]. According to the research by Lee *et al.*, atorvastatin, a potent HMG CoA inhibitor, when administered as a pre-treatment in KA (kainic acid) induced status epilepticus significantly reduced the severity of the convulsions in rats[40]. The neuroprotective effects of statins have been attributed to several mechanisms such as decreased excitotoxicity due to marked reduction in the glutamate uptake by the cells, upregulated expression of anti-apoptotic protein and suppression of the reactive astroglial cell so as to increase the life-span of neurons and lastly reduced permeability of the Blood-Brain-Barrier. Some of the statins have specific pharmacological effect such as inhibition of neuronal damage induced by NMDA by simvastatin. Decrease in the production of pro-inflammatory cytokines by lovastatin. Increased production of endothelial nitric oxide synthase by atorvastatin and rosuvastatin[41].

Multiple sclerosis

A severe, recurring, inflammatory condition of the CNS is known as multiple sclerosis. The oligodendrocytes, and axons, are damaged as a consequence of this immune-mediated disease[42]. Statins are supposedly a novel therapeutic approach for multiple sclerosis, and this appears to be related to the immunomodulatory effects of statins. Statins are thought to exhibit immunomodulatory effects by reducing the other downstream metabolites of cholesterol production and blocking the mevalonate pathway. Statins may reduce geranylgeranylation of Rho small GTPase and Rho kinase, improving cell processes[38]. Simvastatin oral high-dosage (80 mg/day) treatment for six months decreased the number of degenerative neurological lesions in patients suffering from multiple sclerosis by 43%[43]. Clinical evidence suggests that administering lovastatin on a regular basis may help individuals with multiple sclerosis who have brain lesions that are exacerbated by gadolinium[44]. Patients with relapsing-remitting multiple sclerosis receiving long-term statin therapy experienced functional progress and a decrease in the mean annual recurrence rate[45]. Intriguing evidence suggests that the immunomodulatory effects of statins are regulated by the mevalonate pathway since L-mevalonate has the ability to counteract the statin-induced immunomodulation[46]. Simvastatin prevented the IFN γ -induced transcription of MHC class II in cultured astrocytes isolated from neonatal Wistar rats. The positive benefits of statins on multiple sclerosis may be attributed to astrocytes' decreased antigen-presenting ability[47].

MATERIALS AND METHODS**Computational Docking and Molecular Dynamics**

Molecular docking is a digital technique for computationally determining the framework of compounds made up of 2 or more different molecules predicting intended three dimensional structures. The molecular docking method allows us to characterise how small molecules interact in the binding site of protein targets and to better understand basic biological processes by simulating the interaction between a small molecule and a protein at the atomic level[48, 49]. Prediction of the ligand geometry as well as its location and orientation among these sites, as well as an evaluation of the binding affinity, are the two fundamental steps in the docking process. The efficiency of docking procedures is greatly improved by knowing the precise position of the binding site prior to docking actions. The docking procedure entails two fundamental steps: estimation of the binding affinity and prediction of the ligand structure, as well as its location and position among these sites [50]. Biovia discovery studio version 2019 was used for determining the binding energies and interaction analysis.





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Protein Structure

The enzyme HMG-CoA reductase (HMGR) as shown in Figure IV, plays a rate-limiting role in the cholesterol biosynthesis pathway, and is in charge of converting 3-hydroxymethylglutaryl CoA to mevalonate, a crucial intermediary in the production of cholesterol, and statins are well-known for targeting its catalytic domain. Layers of negative feedback loops affect HMGR; high levels of cholesterol prevent the gene from being transcribed, while lanosterols and oxysterols hasten the protein's decomposition[51]. Statins, which successfully lower serum cholesterol levels and are frequently used to treat hypercholesterolemia, are HMGR inhibitors which has a nanomolar range of inhibition constant values. The HMG-binding pocket and a portion of the CoA binding surface of the HMG-CoA enzyme are both occupied by the hydrophobic components of statins. Therefore, when statins are bound, accessibility of the HMG-CoA substrate to HMGR is inhibited. The numerous van der Waals interactions between blockers and HMGR are undoubtedly the basis of the statins' strong affinity. Only when the COOH-terminal residues of HMGR are disordered can a shallow non-polar groove accept the dense, structurally varied hydrophobic groups of the statins[52].

RESULTS AND DISCUSSION

The docking results can be interpreted in the following fashion. Higher the negative binding energy, the better the interaction between the target protein and ligand which can be observed in Table III. Various plant products were found to have an active role as HMG-CoA reductase inhibitors. 15 such phytochemicals were selected based on a review of the literature listed in Table II. The required structures of the bioactive compounds were obtained from PubChem. Protein HMG CoA reductase – PDB ID:1HW8 was used as the receptor protein. The structure was downloaded from Protein Data Bank. Each structure was docked with the macromolecule to the binding energy, interactions and types of bonds formed. Most of the phytochemicals improved the cognitive impairment which is the major problem associated with AD. Certain phytochemicals had the highest negative binding energies, meaning the ligand binds spontaneously to the protein without the consumption of energy. It also implies that it forms a stable complex. This study also highlighted the potential use of plant based HMGR inhibitors and the possible correlation between lipid metabolism and Alzheimer's disease through its interactions with the enzyme. Figure V showed five phytochemicals that have good binding energy with the protein. Their respective 2D and 3D structures are depicted along with their interactions and types of bonds.

CONCLUSION

The primary focus of this study was to understand the interactions between HMG CoA reductase enzyme and the phytoconstituents selected. Currently available HMG CoA reductase inhibitors have known to have numerous side effects thereby, encouraging plant-based research. Compounds that are known to inhibit cholesterol biosynthesis by inhibiting HMG CoA reductase and its interactions with the protein has been reported through the computational docking analysis. Based on the docking studies performed Salvianolic Acid A, Rutin, Ganoderic Acid A, Gingerol and Apigenin were found to have high binding energy with the HMGR protein. The mentioned phytochemicals needs to be further studied and analysed for their potential activity of HMG CoA Reductase inhibition.

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Table I: Some of the Clinical Evidence Implying The Use Of Statins In Patients With Ad Are Mentioned

Reference	Number of participants	HMG-Co-A reductase inhibitors employed	Outcomes of the study
Wolozin et al.[53]	57,104	Lovastatin, Pravastatin sodium, Simvastatin	For people treated either with pravastatin sodium or Lovastatin corresponded to a 60-73% decreased prevalence of AD
Sparks et al.[54]	98	Atorvastatin calcium	Showed beneficial outcomes in patients when assessed using Geriatric Depression Scale, ADAS-cog, NIS and CGIC
Jick H et al.[55]	60,901	Simvastatin, Cerivastatin, Atorvastatin, Fluvastatin, Pravastatin	Dementia prevalence were significantly lower in 50 years and older individuals.
Parale et al.[56]	110	Atorvastatin	It was implied that when contrasted to the placebo group, the atorvastatin-treated patients had a significant improvement in the neurocognitive assessments.
Haag MD et al.[57]	6992	Atorvastatin, simvastatin fluvastatin, cerivastatin, rosuvastatin, pravastatin,	Administration of statins indicated a reduced risk of Alzheimer's disease

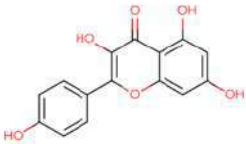

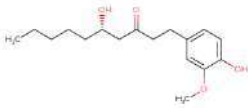
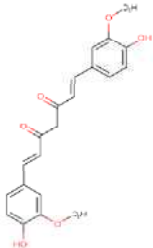
TABLE II: Characteristics Of Phytoconstituents Used As Hmg Coa Reductase Inhibitors.

Phytochemical	Chemical structure	Botanical source	Pharmacological effect	Therapeutic effect
Rutin[58, 59]		<ul style="list-style-type: none"> • <i>Morus alba</i> • <i>Ruta graveolens</i> 	Enhances the phagocytosis of A β plaques by up-regulation of the microglial phagocytic receptor	Improved spatial memory impairment in AD
Quercetin[60]		<ul style="list-style-type: none"> • <i>Cichorium intybus</i> • <i>Solanum lycopersicum</i> • <i>Malus domestica</i> 	Inhibits the Acetylcholinesterase enzyme, thereby inhibiting the hydrolysis of Acetylcholine.	Improvement in the cognitive and memory function In AD patients





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<p>Kaempferol[61–64]</p>		<ul style="list-style-type: none"> • <i>Ginkgo biloba</i>, • <i>Tilia</i> spp, • <i>Equisetum</i> spp, • <i>Moringa oleifera</i>, • <i>Sophora japonica</i> and <i>propolis</i> 	<p>Inhibits the generation of free radicals precisely the Reactive Oxygen Species (ROS) induced by Aβ plaques. It further prevents neuronal damage caused by apoptosis, acts as an Acetylcholinesterase enzyme</p>	<p>Improves Aβ induced memory impairment by acting as a potential anti-oxidant, disrupting the oxidative stress caused by ROS</p>
<p>Epigallocatechin gallate[65]</p>		<ul style="list-style-type: none"> • <i>Camellia sinensis</i> 	<p>Acts as an α- secretase agonist which upregulates Amyloid Precursor Protein (APP) proteolysis and inhibits Aβ accumulation, inhibits Tau hyperphosphorylation by inhibiting Glycogen synthase kinase- 3β (GSK-3β) activation and thereby relieving Aβ induced neurotoxicity</p>	<p>Improved cognitive function and facilitated adaptive behaviour</p>
<p>Gingerol[66–68]</p>		<ul style="list-style-type: none"> • <i>Zingiber officinale</i> 	<p>Increases cell viability and Superoxide Dimutase (SOD) levels an enzyme that breaks down reactive oxygen species, suppresses Aβ-induced apoptosis via Akt/ GSK-3β pathway</p>	<p>Improves cognitive impairments and memory dysfunctions</p>
<p>Curcumin[69, 70]</p>		<ul style="list-style-type: none"> • <i>Curcuma longa</i> 	<p>Inhibits the accumulation of amyloid plaques by downregulating the expression of BACE1 an enzyme responsible for the breakdown from AβPP to Aβ, Inhibits the expression of Aβ-induced Egr-1 peptide which is responsible for cytochemokine gene expression in monocytes thereby preventing neuroinflammation, potent anti-oxidant that decreases free radical</p>	<p>Indicates potent anti-oxidant, anti-inflammatory and anti-amyloid activity</p>





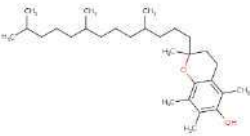
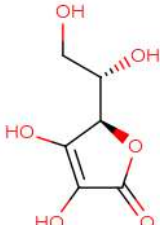
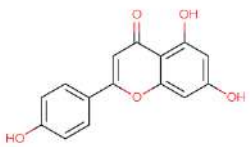
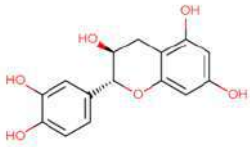
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			formation and increases the levels of Superoxide Dimutase	
Myrcene[71]		<ul style="list-style-type: none"> • <i>Bene hullec</i> • <i>Pistacia atlantica</i> • <i>Commiphoramukul</i> 	Enhances the levels of SOD and decreases the levels of MDA (malondialdehyde) in AD-induced rats, destabilises the Aβ fibrils, inhibits Acetylcholineesterase enzyme	Improves memory functions and learning, reduced Aβ plaques and showed anti-fibrillation effect
Trilinolein[72]		<ul style="list-style-type: none"> • <i>Panax Notoginseng</i> • <i>Acalypha indica</i> 	Downregulates the expression of gene responsible for the transcription of APP, modifies the gene expressions of α and β secretase activities thereby increasing the levels of α-secretase and decreasing the levels of β-secretase enzymes, showed decline in serum LDL-cholesterol and triglycerides, a potent antioxidant inhibiting the generation of ROS	Improves memory impairments and cognitive functions
Squalene[73, 74]		<ul style="list-style-type: none"> • <i>Acalypha indica</i> 	Increases the levels of Acetylcholine by inhibiting AchE enzyme, inhibits Tau phosphorylation thereby blocking the progression of Aβ plaque formation	Reversal of memory and cognitive impairments in AD patients
Stigmasterol[75]		<ul style="list-style-type: none"> • <i>Ophiopogon japonicus</i> • <i>Mirabilis jalapa</i> • <i>Ecliptaprostrata</i> 	Inhibits AchE, activation of NMDA receptor via (Extracellular signal-regulated kinase) ERK – (cAMP response element-binding protein) CREB pathway in the hippocampus	Improves learning and memory functions






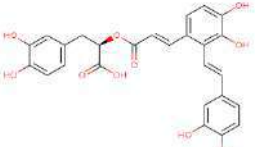
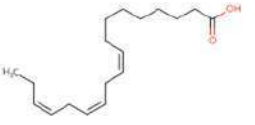
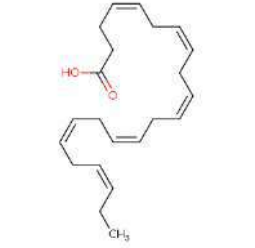
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<p>α-tocopherol[76]</p>		<ul style="list-style-type: none"> • <i>Basbella alba</i> 	<p>Potent antioxidant that prevents oxidative stress by reducing the levels of ROS and other free radicals, shows cognitive benefits in the presence of certain genes such as APOE ϵ4, ABCA1, ABC transporter-2 gene etc</p>	<p>Improvement in cognitive deficits</p>
<p>Ascorbic acid[77]</p>		<ul style="list-style-type: none"> • <i>Terminalia ferdinandiana</i> • <i>Myrciariadubia</i> • <i>Malpighia emarginata</i> • <i>Basbella alba</i> 	<p>Prevents the formation of Aβ oligomers hence prolonging the time needed for Aβ accumulation, reduces oxidative stress by scavenging free radicals in the brain</p>	<p>Improved memory, cognitive and learning functions, improved recognition and vocabulary</p>
<p>Apigenin[78]</p>		<ul style="list-style-type: none"> • <i>Elsholtziarugulosa</i> • <i>Carduus crispus</i> • <i>Basbella alba</i> 	<p>Reduces insoluble Aβ in the cerebral region by decreasing the deposition of fibrillar amyloid plaques, downregulating the enzymatic activity of BACE1 protein, possess antioxidant effect by scavenging the ROS and superoxide anions, restores the ERK/CREB pathway</p>	<p>Improved spatial memory impairment, learning deficits and slowed down AD associated cognitive impairments</p>
<p>Catechin[79]</p>		<ul style="list-style-type: none"> • <i>Cosmos caudatus</i> • <i>Camellia sinensis</i> 	<p>Reduces the lipid peroxidation and ROS levels by scavenging effect, chelation of Iron(III) and Copper(II) which is accumulated in the brain tissues of AD patients, acts as AchE inhibitor</p>	<p>Improved memory and learning functions</p>





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<p>Ganoderic acid A[80]</p>		<ul style="list-style-type: none"> • <i>Ganoderma lucidum</i> 	<p>Enhanced the Axl receptor tyrosine kinase (Axl)- activated kinase 1 (Pak1) signalling pathway in the microglial cells leading to increased autophagy of Aβ plaques</p>	<p>Improved cognitive function</p>
<p>Salvianolic acid A[81]</p>		<ul style="list-style-type: none"> • <i>Salvia miltiorrhiza</i> 	<p>Inhibits the accumulation of Aβ by preventing the conversion of α-helix to β-sheets at the C-terminal of Aβ, inhibits metal ion induced Aβ aggregation by chelating with Cu and Fe, reduces the levels of ROS</p>	<p>Anti-amyloid activity</p>
<p>α-linolenic acid [ALA][82, 83]</p>		<ul style="list-style-type: none"> • Flaxseeds and flaxseed oil. • Canola (rapeseed) oil. • Soybeans and soybean oil. • Pumpkin seeds and pumpkin seed oil. • Perilla seed oil. • Tofu. • Walnuts and walnut oil 	<p>Prevents the aggregation of tau protein which is responsible for the formation NeuroFibrillary Tangles (NFTs)</p>	<p>Reversal of cognitive impairment in AD patients</p>
<p>Omega-3-fatty acids[84]</p>		<ul style="list-style-type: none"> • Fish and other seafood (especially cold-water fatty fish, such as salmon, mackerel, tuna, herring, and sardines) • Nuts and seeds (such as flaxseed, chia seeds, and walnuts) • Plant oils (such as flaxseed oil, soybean oil, and canola oil) 	<p>Facilitating the interaction between APP and α-secretase to inhibit Aβ formation, blocks the binding site of γ-secretase on the APP preventing Aβ formation, directly inhibit fibrils and Aβ formation</p>	<p>Improves cognitive and memory decline in patients in the early stages of AD</p>





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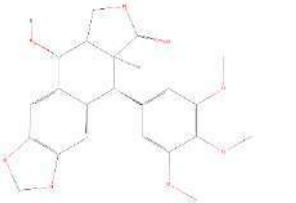
Lignans[85]		<ul style="list-style-type: none"> • <i>Schisandra chinensis</i> 	<p>Induces autophagy in the microglial cells and reduces the accumulation of Aβ, inhibits the release of Nitric oxide from the microglial cells, downregulates 4-hydroxynoneal in AD patients that is responsible for increased accumulation of Aβ plaques and tau phosphorylation, lowers uric acid levels which is often associated with alleviated cognitive impairment in AD patients</p>	Improves cognitive function
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TABLE III: Docking Results Between The 15 Bioactive Constituents And Hmg Coa Reductase Was Obtained As Follows

SI. No.	Compound	Binding Energy (Kcal/mol)	-CDOCKER Energy	-CDOCKER Interaction Energy
1	Salvianolic Acid A	-136.654	60.9438	65.7294
2	Rutin	-132.878	9.77215	67.9684
3	Ganoderic Acid A	-121.963	-36.7922	48.6979
4	Gingerol	-95.3909	37.1294	39.3183
5	Apigenin	-92.4847	31.3081	37.8027
6	Kaempferol	-74.1808	33.5802	38.6274
7	Trilionelin	-71.8396	15.3199	51.3519
8	Ascorbic Acid	-65.8215	10.6223	30.8223
9	Quercetin	-59.0937	35.9037	39.7146
10	Omega-3-Fatty Acid	-52.548	-40.5519	46.2192
11	Alpha-Linolenic Acid	-46.8066	-1.0488	38.4248
12	Curcumin	-43.363	35.231	45.9234
13	Squalene	-42.7571	-85.9463	41.8978
14	Alpha-tocopherol	-25.4199	35.1243	47.5071
15	Myrcene	-23.9403	-10.486	19.3946





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<p>Figure I: The above image shows the presence of Amyloid beta plaques and neurofibrillary tangles in the brain which are the pathological indicators of Alzheimer's disease.</p>	<p>Figure II: There are two main mechanisms by which the integral membrane protein known as an amyloid precursor protein (APP) might be metabolised. The α-secretase enzyme cleaves APP within the $A\beta$ domain in the nonamyloidogenic pathway. But in the amyloidogenic pathway, APP is initially broken down by β-secretase (BACE1) at the N-terminus of the $A\beta$ domain rather than α-secretase, and this is then accompanied by γ-secretase cleavage at the C-terminus. The pathogenic $A\beta$ amylogenic peptides are produced as a result of these events, and they have the potential to aggregate together into oligomers and form extracellular neurotoxic plaques in the brain.</p>
<p>Figure III: The endoplasmic reticulum produces the majority of the cholesterol in the brain by de novo synthesis. High-density lipoproteins (HDLs) may penetrate the blood-brain barrier (BBB) and transfer small amounts of cholesterol to the brain from the periphery, whereas larger lipoproteins like low-density lipoproteins and very low-density lipoproteins (LDL/VLDL) cannot. The rate-limiting step in the de novo cholesterol production is mediated by HMG-CoA reductase. ACAT converts excess free cholesterol into cholesterol ester.</p>	<p>Figure IV: HMG CoA Reductase (PDB Id:1HW8)</p>





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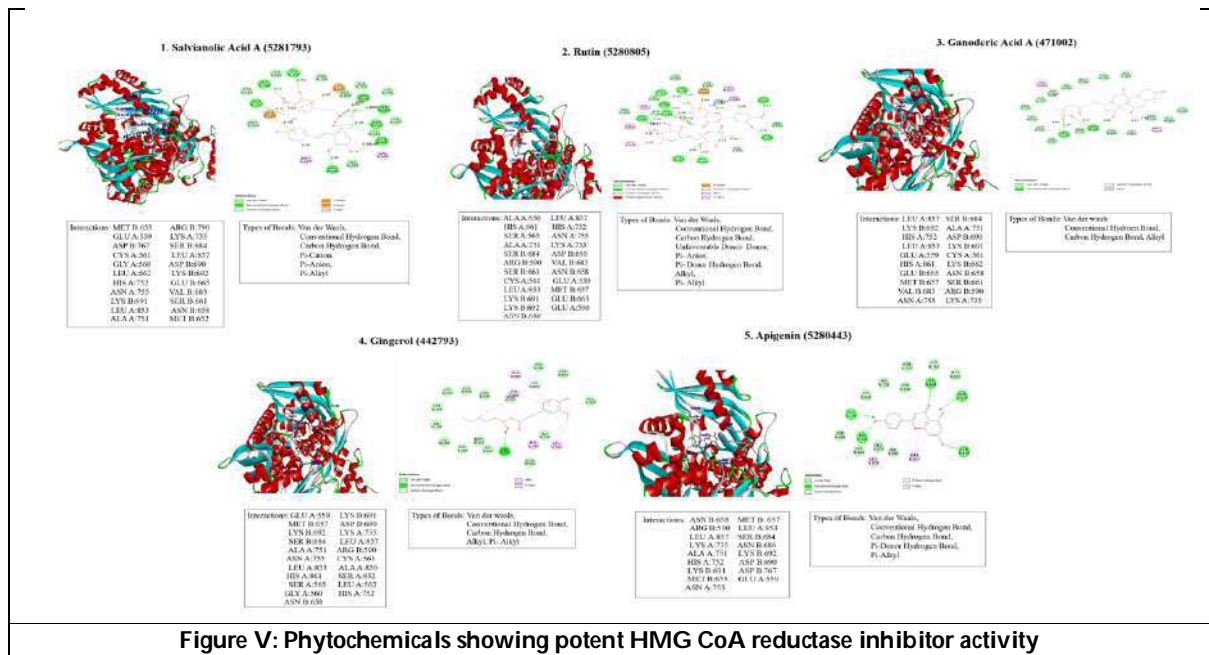


Figure V: Phytochemicals showing potent HMG CoA reductase inhibitor activity





Screening and Isolation of Lipase Producing Culturable Heterotrophic Prop Root Bacteria of *Rhizophora apiculata* from the Ayiramthengu Mangrove Ecosystem of Kerala Coast

Mintu Ann Varghese^{1*}, Anit M Thomas² and Sunil Kumar.R³

¹Research Scholar, PG and Research Department of Zoology, Catholicate College (Affiliated to MG University, Kottayam), Pathanamthitta, Kerala, India.

²Assistant Professor, Department of Zoology, Baselius College (Affiliated to MG University, Kottayam), Kottayam, Kerala, India.

³Associate Professor, PG and Research Department of Zoology, Catholicate College (Affiliated to MG University, Kottayam), Pathanamthitta, Kerala, India.

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*Address for Correspondence

Mintu Ann Varghese,

Research Scholar,

PG and Research Department of Zoology,

Catholicate College (Affiliated to MG University, Kottayam),

Pathanamthitta, Kerala, India.

Email: mintuvar@gmail.com



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ABSTRACT

The present study focusses on the screening and isolation of lipolytic culturable bacteria from the prop root surface of *Rhizophora apiculata* from Ayiramthengu mangrove. Samples from three distinct regions of the prop root were studied namely, upper, middle and lower. About 84% of the isolated bacteria tested for lipase enzyme showed positive results. The tested bacteria with positive result were identified as *Acinetobacter* sp., *Micrococcus* sp., *Beijerinckia* sp., *Bacillus* sp., *Alteromonas* sp., *Pseudomonas* sp., *Rhizobacter* sp., *Azotobacter* sp., *Staphylococcus* sp., *Xanthomonas* sp., *Alcaligenes* sp., *Acetobacter* sp., *Derxia* sp., *Streptococcus* sp., *Salmonella* sp., *Moraxella* sp., *Proteus* sp. and *Vibrio* sp. The enzyme study revealed that a comparatively increasing enzyme production was observed on both middle and lower region of mangrove prop root than the upper region. This new insight gives the importance of lipolytic bacteria in organic matter decomposition, detritus food chain operation and nutrient recycling in mangrove ecosystem. Also, these potentially active lipase producers have novel importance in various medicinal and industrial fields.

Keywords: Mangrove, Bacteria, Prop root, Lipase





INTRODUCTION

Mangroves are highly productive ecosystem that lies as an interface between marine and terrestrial ecosystem (Thatoi *et al.*, 2013). The diverse and complex mangrove ecosystem fosters the growth of diverse group of organisms as well as play important role in shoreline stabilization, reduction in the impact of natural disasters and provide food, medicine, fuel and building material (Tomilson, 1986 and Giri *et al.*, 2011). Mangroves are specially adapted to grow themselves in the adverse environmental condition like high and changing salt concentration, anaerobic sediment, high temperature and low relative air humidity (MacFarlane *et al.*, 2007 and Agoramoorthy *et al.*, 2008). Mangrove root adaptation also helps the plant to withstand the harsh environment. Prop roots are typically adapted roots found in *Rhizophora apiculata*, that descends from the trunk and branches of the plant. These aerial roots help the plant to facilitate oxygen supply, anchor the plant in place and collect water-borne silt and debris to build soil beneath it (Bayas *et al.*, 2011; Ohira *et al.*, 2013 and Mendez-Alonzo *et al.*, 2015). Microbial diversity is reflected as an important community found in the mangrove ecosystem. This unique ecosystem holds wide growth of microorganisms by providing specific niche (Kathirvel, 1996). Amongst the different mangrove microorganisms, bacteria are much greater than those of fungi population (Kathiresan and Qasim, 2005). Primarily, bacteria take part in the decomposition and nutrient recycling of this ecosystem (Friesen *et al.*, 2018). Hence-forth the study of bacteria helps to understand the geochemical nature and the underlying mechanism within the mangrove ecosystem. Bacteria are well known for its production of hydrolytic enzymes (Kachiprath *et al.*, 2019). Owing towards their increased production capacity, low cost and susceptibility to genetic manipulation, microbial enzymes have strong biotechnological interest (Castro *et al.*, 2014).

Lipases are the third largest group of enzymes based on the commercial sales volume due to their significant application in various industries (Andulema and Amare, 2012). Microbial lipases are more appreciated in the market because of their variability in catalytic activities, increased yield, simplicity of genetic manipulation, absence of seasonal variation, continuous supply, stability, convenience and the high growth rate of microbes (Mendes, 2012 and Reetz, 2013). Due to the advantages of microbial lipases upon animal and plant lipases, they are influencing the market growth. Lipase were used in food industry, cosmetics, biosensors, agriculture, pharmaceuticals and medical industry, bioenergy production and environmental field for effluent treatment, bioremediation, biodegradation of oil, leather degreasing, plastic biodegradation, detergent manufacturing and so on (Chandra *et al.*, 2020). The present study focusses on the screening and isolation of lipolytic bacteria from the three distinct regions of prop root surface of *Rhizophora apiculata* from Ayiramthengu mangrove ecosystem.

MATERIALS AND METHODS

Study area

The study was conducted at Ayiramthengu mangrove ecosystem of Kerala coast (90° 7' 30" N to 90° 7' 40" N latitude and 76° 28' 40" E to 76° 28' 50" E longitude). Three stations were selected for the study and named as Station 1 (near to the land area of mangrove), Station 2 (middle of the mangrove) and Station 3 (found near to the estuary). The study was carried out from October 2018 to January 2019.

Sampling

The samples were collected from the prop root surface of *Rhizophora apiculata* prior to the removal of surface contaminants through washing the surface with sterilized sea water. Biofilms were collected using sterile knife and aseptically transferred to the sterile bottles. Three distinct regions of prop root were taken as upper (above the tidal range), middle (within the tidal range) and lower layer (above the root cap and within the tidal range). The samples were immediately preserved at -20°C and analysed in the laboratory.



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Isolation of bacteria

The samples were serially diluted and standard plate method using Zobell Marine Agar (Hi-Media) was done. The plates were incubated for 48 hours at 28±2°C. The bacterial colonies were isolated and purified using saline nutrient agar medium.

Lipase enzyme study

The purified bacterial isolates were studied for lipase enzyme by agar diffusion method (Gerhardt *et al.*, 1981). Nutrient agar medium in saline (10%) supplemented with 1% tributyrin was used and the cultures positive for lipase showed a clear zone around the spot of inoculation after 2-3 days. A semi quantitative approach was used for the determination of Enzymatic index (EI) using the value obtained by the ratio of halo size and bacterial colony (Lima *et al.*, 2005; Soares Junior *et al.*, 2013). The cultures showing positive results were identified upto generic level as per Bergey's Manual of Determinative Bacteriology (2000).

Statistical Study

One-way ANOVA was used to find out and compare the means of bacterial enzymatic index at three different regions of prop root with $p < 0.05$ represents the significance and post hoc analysis was done to identify which layer have least significant difference. Box Whisker Plot was also constructed with enzymatic index at three regions of prop root. Statistical study was done using SPSS software (Version 21).

RESULT AND DISCUSSION

The present study revealed that about 84% of the isolated bacteria were lipase producers (Fig. 1). Paul *et al.* (2020) reported the occurrence of highest lipase producing bacteria during post monsoon from mangrove sediments of North Kerala. In addition to that, Varghese *et al.* (2020) reported lipase producing bacteria from pneumatophores of Ayiramthengu mangrove. The lipolytic bacteria isolated from the study were *Acinetobacter* sp., *Micrococcus* sp., *Beijerinckia* sp., *Bacillus* sp., *Alteromonas* sp., *Pseudomonas* sp., *Rhizobacter* sp., *Azotobacter* sp., *Staphylococcus* sp., *Xanthomonas* sp., *Alcaligenes* sp., *Acetobacter* sp., *Derxia* sp., *Streptococcus* sp., *Salmonella* sp., *Moraxella* sp., *Proteus* sp. and *Vibrio* sp. Kathiresan *et al.* (2011) described lipase producing bacteria strains including *Bacillus* sp. and *Azotobacter* sp. from mangrove forest of Vellar estuary. *Bacillus* sp., *Acinetobacter* sp., *Staphylococcus* sp. and *Pseudomonas* sp. were observed from mangrove's sediment of Jaguaribe by Santos *et al.* (2016). Bibi *et al.* (2017) noticed lipase enzyme production in *Vibrio* sp. from the mangroves of Saudi Arabia. Thangaraj *et al.* (2018) reported lipase production by *Pseudomonas* sp. from mangrove forest of Vellar estuary. The enzymatic index study revealed that the production of lipase enzyme varied at different regions of prop root by the various isolated bacteria (Fig. 2). Kathiresan *et al.* (2011) reported variation in lipase production by different bacteria. According to Lechuga *et al.* (2016) enzymes were classified into four groups based on enzymes production as no enzyme activity with value upto 1, low activity with value up to 2, medium activity with value up to 3 and high activity with value up to 4. During this study high enzymatic index (3.7) was found in *Alcaligenes* sp. at the middle region whereas the least production (1.2) was observed at the upper region of the prop root. An overall increase in enzymatic index was noticed in the middle region followed by lower and upper region of the prop root (Fig. 3).

One-way ANOVA analysis concluded that there is significant difference in the bacterial enzyme production between the various prop root regions namely, upper, middle and lower ($p < 0.05$). Statistical study using Post Hoc test was used to identify which region of prop root showed least significant difference in enzyme production (Table 2). From the post hoc analysis, it is evident that bacterial enzyme production between upper root layer and middle root layer showed significant difference (p -value = 0.009 which is less than 0.05) and also there is significant difference in the bacterial enzyme production between upper root region and lower root region (p -value = 0.041 which is less than 0.05). But there is no significant difference in the bacterial enzyme production between middle region and lower region of prop root since the p -value is greater than 0.05 ($p = 0.580$). Thus, the bacterial enzyme production is significantly lower in the upper root region than middle root region and lower root region. Also, the bacterial



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enzyme production in the middle root layer and lower root layer are equivalent statistically. The decreased enzymatic index at the upper region of the prop root is supposed to be due to the less influence of tide on that region and the dryness resulted to the particles that adhered to the prop root surface may hinder the bacterial enzyme production. Tides and water current might bring about silt and debris to the prop root that may attach to its surface (Srikanth *et al.*, 2015). The middle and lower region were submerged regions, where there will be more interaction with the organic debris. The persistent submergence of the middle and lower region that accounts for the maximum bacterial enzyme production in those regions of prop root. The present study clearly revealed a rich consortium of culturable prop root lipolytic bacteria and majority of the isolated bacteria showed noticeable enzymatic index. Mangrove ecosystem supports rich source of organic matter and the diverse microbes found in this ecosystem take part in organic matter decomposition, detritus food chain and nutrient recycling. As the lipase enzyme was an important industrial enzyme, hence further investigation is required for their potential usage and also to improve future omics studies.

ACKNOWLEDGEMENT

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Table 1: Analysis of variance (one way ANOVA) for enzyme production at different regions of proprop

ANOVA					
Bacterial Enzyme Production					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.852	2	1.426	4.259	.023
Within Groups	11.048	33	.335		
Total	13.900	35			

Table 2: Post Hoc Analysis for least significant difference among various regions of prop root

Multiple Comparisons						
Dependent Variable: Bacterial Enzyme Production						
LSD						
(I) Root Regions	(J) Root Regions	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Upper	Middle	-.639679*	.231630	.009	-1.11093	-.16843
	Lower	-.504755*	.237041	.041	-.98702	-.02249
Middle	Upper	.639679*	.231630	.009	.16843	1.11093
	Lower	.134924	.241526	.580	-.35646	.62631
Lower	Upper	.504755*	.237041	.041	.02249	.98702
	Middle	-.134924	.241526	.580	-.62631	.35646

*. The mean difference is significant at the 0.05 level.





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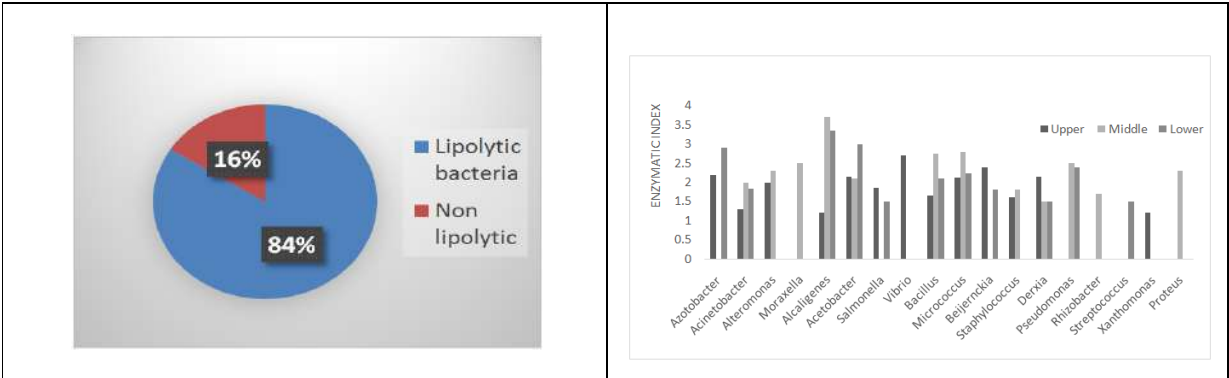


Fig. 1 Percentage composition of lipase enzyme production of culturable prop root bacteria

Fig. 2. Enzymatic index of isolated bacteria at different regions of prop root

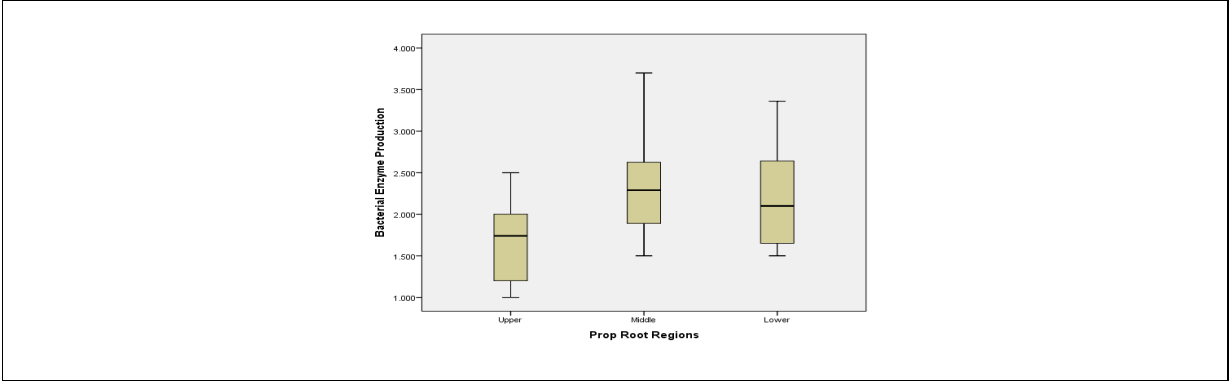


Fig. 3. Whisker Box Plot showing variation in bacterial enzyme production at three regions of prop root





A Review on Fibrinolytic Activity of Marine Microbes

V. Poorna Pushkala^{1*}, H. Subhashree², K. Yazhini² and S. Mathukumar³

¹Professor, Department of Microbiology, Sri Sairam Siddha Medical College and Research Centre, Chennai, Tamil Nadu, India.

²Second Profession BSMS, Sri Sairam Siddha Medical College and Research Centre, Chennai, Tamil Nadu, India

³Principal, Department of Paediatrics, Sri Sairam Siddha Medical College and Research Centre, Chennai, Tamil Nadu, India.

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*Address for Correspondence

V. Poorna Pushkala

Professor,

Department of Microbiology,

Sri Sairam Siddha Medical College and Research Centre,

Chennai, Tamil Nadu, India.

E.Mail: poorna.mku@gmail.com



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ABSTRACT

A clot that forms and stays in a blood vessel is called a thrombus. Inherited and acquired deadly hypercoagulable conditions like cancer, cardio-vascular diseases, factor V leiden, ischemic heart disease, high blood pressure etc., is the result of restriction of blood flow to vital organs due to thrombus formation. Drugs such as Streptokinase are administered to overcome thrombolytic complications; yet it has significant limitations such as re-obstruction, low specificity to fibrin, bleeding complications and also not economically feasible. Currently there is a steady demand for a highly effective, safe thrombolytic agent. Microbes and their natural products have been making significant contributions to mankind. Marine ecosystems house a plethora of microorganisms capable of producing clinically important metabolites, but remain largely unexplored. Earlier there was a widespread misconception that high saline concentration of marine ecosystems is unfavourable for conspicuous bacterial growth. However this field has garnered interest in recent times as the salinity of seawater was observed to be quite close chemically to that of blood plasma. This review focuses on establishing the most effective fibrinolytic enzymes against hyper-coagulable disorders in the near future.

Keywords: fibrinolytic enzymes, fibrinolysis, thrombolytic complications, thrombolytic prophylaxis, marine microbes.





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INTRODUCTION

The formation of blood clot and its presence in blood vessel is referred to as “Thrombosis” and it is the body’s first line of defence against bleeding but sometimes clots form inappropriately or fail to dissolve after an injury[1]. Such a clot that forms and stays in a blood vessel is called a thrombus. Inherited and acquired deadly hypercoagulable conditions like cancer, cardio-vascular diseases, factor V leiden, ischemic heart disease, high blood pressure etc, is the result of restriction of blood flow to vital organs due to thrombus formation[2]. Medications are employed to cleave such blood clots and this is known as fibrinolysis also called thrombolytic therapy; administered in complications such as ST elevation, myocardial infarction, stroke and in cases of severe venous thromboembolism.

Thrombolytic therapy in current use

Currently thrombolytic therapy involves the use of drugs such as Streptokinase, Reviparin [low molecular weight heparin], Bivalirudin [Hirudin- based direct thrombin inhibitors], Reteplase etc.[3]. Since 8 decades, from the discovery of Penicillin to till date, microbes and their natural products have been making significant contributions to mankind. Clinically used thrombolytic enzymes are of microbial origins. The first drug approved by FDA for thrombosis treatment since 1950s is Streptokinase - a bacterial protein obtained from beta-hemolytic Streptococci of Lancefield groups A,C and G. Other effective thrombolytic agents in current use are Staphylokinase from *Staphylococcus aureus*, Nattokinase (Serine protease) from *Bacillus subtilis*[2]. Serine proteases like Tissue plasminogen activator (TPA) exert fibrin specific thrombolytic activity. Different forms of tPA including Alteplase, Reteplase, Tenecteplase and Desmoteplase have been developed using recombinant-DNA technology.

Limitations

Drugs in use to overcome thrombolytic complications itself has significant limitations including re-obstruction, low specificity to fibrin, bleeding complications and high cost. Currently there is a steady demand for highly effective and safe thrombolytic drug.[2]. The side effects of some currently used fibrinolytic drugs are mentioned in Table-1.

AIM

The aim of this study is to establish the potential of marine microbes in producing thrombolytic enzymes which are cost effective, fibrin specific, stable at a physiological pH, temperature and exhibiting both anticoagulant/ thrombolytic effects *in vitro*. This review is based on various microbes isolated from marine ecosystem subjected to screening assays to determine the potential of their novel fibrinolytic enzymes.

METHODOLOGY

In the process of writing this review article, we have done searches on journal websites like science direct, mdpi, ncbi, frontiers in, pubmed providing access to scholarly articles and indexed journals and acquired the results for the present review.

REVIEW FINDINGS

In the process of writing this review article we could find that many marine microbes can serve as highly potent sources of thrombolytic enzymes in the near future.

The key findings of this review include:

- i. Marine Microbial Fibrinolytic Drugs Production would definitely be a huge milestone in the treatment of thrombolytic complications.
- ii. Production of effective fibrinolytic drugs with less or no side effects.
- iii. Enzymes of marine microbial sources can be used in effective treatment of thrombolytic complications in the near future.
- iv. Marine microbes including various bacteriae, fungi and algae serve as potent sources of fibrinolytic enzymes.





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***Streptomyces radiopugnans* VITSD8**

It is a fibrinolytic protease producing microbe isolated from brown marine tube sponges *Agelas conifera* collected from Rameshwaram sea coast. The specimen was subjected to serial dilutions. It was then inoculated in starch casein agar plate. The fibrinolytic activity of *Streptomyces sp* was screened by casein plate assay. Protein content was determined by Lowry's method using bovine serum albumin. By employing tyrosine as the standard, the activity of protease was determined by Folin–Ciocalteu method. This enzyme degrades the clot by direct fibrinolysis more efficiently than the positive control-streptokinase. The enzyme is highly active and stable in the medium at pH 7 and 33°C. The protease showed 567U/mL and 587 U /mL activity. Among the eight species screened for caseinolytic activity, VITSD8 isolate showed promising results representing 12mm zone of hydrolysis. The fibrinolytic activity of protease was increased by 35-fold after purification and the final yield was 22.36%. In the near future, this strain will serve as a potential source for the commercial production of fibrinolytic enzymes.[14]

Streptomyces venezuelae

It is a thrombinase producing microbe. For strain improvement it was exposed to UV radiation and EMS for different time intervals (0-10 min), incubated for 2 days at 37°C and their survival percentage was calculated. The fibrinolytic activities of the plates which showed least survival percentage were selected and were tested by fibrinolytic assay. The mutant which showed higher fibrinolytic activity was selected for further studies. Such mutated strains were employed for the production of thrombolytic enzymes. The enzymes produced by mutant strains confer stability by making it tolerant to a broad range of pH and temperature. It was noted that the wild strains exhibited maximum thrombolytic activity and biomass production at a pH of 8 and temperature of 40°C[15].

***Serratia marcescens* RSPB11**

Inhibitory analysis revealed that the enzyme produced by this strain is metalloprotease. Much attention has been focused on Serralysin production by *Serratia marcescens* due to its potential for higher enzyme yields. By the addition of Co²⁺, Cu²⁺, Fe²⁺, Mg²⁺ and Zn²⁺ this enzyme activity could be regained after chelation of ions with EDTA. This enzyme has both fibrin and fibrinogenolytic property. This protein macromolecule was found to be more stable over a wide range of pH 6-10 and temperature upto 60°C. It exhibited optimum activity at pH 9 and at a temperature of 37°C. This enzyme showed the Km (1.261 mg/ml) for its substrate, casein and the observed maximum attainable velocity was Vmax (24,842 U/min). Much attention has been focused on Serralysin production by *Serratia marcescens* due to its potential for higher enzyme yields. Serralysin acts like plasmin in human body. It was concluded that Serralysin is having potential application in thrombolytic therapy.[17]

Serratia marcescens* subsp. *sakunensis

Fibrinolytic enzyme produced by this microbe appears to be a potential candidate for thrombolytic therapy due to its high specific fibrinolytic, high ratio of fibrinolytic to fibrinogenolytic activity at the physiological pH, anticoagulant and thrombolytic effects. Further attempts were made to enhance enzyme activity by medium optimisation. 1 mL of fresh human whole blood was added to equal volume of cell free crude enzyme solutions in a sterile glass test tube, mixed gently and incubated at 37°C for 6 hours. Upon incubation for 6 hours the supernatant liquid was decanted and the extent of clot formed was observed visually. The dialysed protein solutions were incubated with the respective buffers ranging from pH 4 to 9[19]. Based on a study among eight strains the strain C7 was chosen and identified as *Serratia marcescens* subsp. *sakunensis*. The ratio of specific fibrinolytic to specific fibrinogenolytic activity was 8:1 for C7 isolate. This indicated that it is a potential fibrinolytic enzyme.

Serratia rubidaea

Serratia rubidaea KUAS001 is a marine bacterium with potent fibrinolytic activity. Optimization of process parameters were done under submerged fermentation using one factor at a time method. This resulted in the enhancement of enzyme production. Growing microorganisms as a suspension in liquid (commercial) medium consisting of various nutrients either in dissolved form or as particulate solids is referred to as Submerged Fermentation [21]. Optimization of process parameters like incubation time of 48 hours, inoculum size - 0.8% v/v, pH-6.0, temperature

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30 °C, concentration of nutrient sources like maltose 1.5% w/v, yeast extract 1.5% w/v, NaCl (1.5% w/v) and skimmed milk powder (0.15% w/v) enhanced the thrombolytic activity(394.9IU/mL) of the enzyme 2.57 times higher than the value observed in unoptimized conditions. The optimum temperature and pH of the enzyme was found to be 6 and 30°C respectively. Thus it is a source of potent fibrinolytic drug.

***Bacillus subtilis* ICTF-1**

On the basis of 16S rRNA gene sequencing and biochemical properties, a novel thrombolytic enzyme of the bacterium *Bacillus subtilis* ICTF-1 was isolated from marine niches. For the enhanced production of fibrinolytic enzyme the media optimization was done using L18-orthogonal array method. The enzyme activity was found to be 2.6 folds higher (8814U/mL) than in unoptimized medium[3420U/mL]. This enzyme was found to be stable at a pH range of 5.0-11.0 and temperature of 25-37°C. The optimum pH and temperature of the enzyme was found to be 9 and 50°C respectively. Ca(2+) activated the enzyme. Zn(+2), Fe(+3), Hg(2+) and PMSF showed inhibitory effect on enzyme action. To determine the class of enzyme produced the complete genome of *Bacillus subtilis* ICTF-1 was sequenced and compared with those in NCBI. On the basis of the results observed it was found to be a Subtilisin like serine protease[23]. Based on the study of invitro assays, it was found that the enzyme could catalyze blood clot lysis effectively. Hence it was concluded that this enzyme could be a useful thrombolytic agent.

***Bacillus subtilis* A26**

It is a fibrinolytic enzyme producing bacterium isolated from sea water in Sfax city and identified on the basis of the 16S rRNA gene sequence. In order to obtain optimal yield the key ingredients were found using Plackett-Burman statistical design. By using Response Surface Methodology (RSM) the optimal concentrations and conditions were determined [24]. Fibrin zymography was performed to screen fibrinolytic enzymes. Development of clear zones indicated the presence of protease activity. Casein zymography of the crude enzyme preparation suggest the presence of at least seven proteases. The optimization of the medium resulted in about a 4.2-fold higher protease production than that of the unoptimized medium. The fibrinolytic activity of the crude protease enzyme prepared in the presence of an artificial fibrin clot in a glass test tube was established by evaluating with fresh human blood plasma. It was found that the clot was completely solubilized after 3 hours of incubation at pH 7.4 and 37°C proving the potential of fibrinolytic enzyme.

***Bacillus subtilis* HQS-3**

It is a fibrinolytic enzyme producing marine microbe. The enzyme was found to be a monomeric protein by SDS-PAGE and gel filtration chromatography. By using alkaline solution treatment, dialysis, ammonium sulphate precipitation, gel filtration chromatography, membrane concentration and ion exchange, the enzyme was purified to electrophoretic homogeneity. It was found that this marine-derived enzyme is a serine metalloprotease showing plasmin like activity. The purified enzyme was found to be stable at a pH of 8 and a temperature range of 25-37°C. The enzyme was found to be active at a pH range of 6 -10 and a temperature range of 45 -50°C. This enzyme was found to have the highest isoelectric point of 9-9.2 on comparing with all known fibrinolytic enzymes of other *Bacillus* sp. Results of in vitro studies showed that this enzyme did not undergo hemolysis but rather preferred direct degradation of fibrin unlike the other fibrinolytic enzymes of the genus *Bacillus* conferring uniqueness to the strain [25].

Bacillus flexus

It is a microbe obtained from marine sediments whose enzyme exhibits strong fibrinolytic activity. The bacterial strain was sourced from South West coast of India. SSF [Solid State Fermentation] was employed in optimization of enzyme production which enhanced the yield 3.5 fold than unoptimized medium. In this process RSM was used and fish meal was taken as SSF substrate. By taking Urokinase as the standard, measurement of enzyme activity was done based on the zone of clearance observed around the sample well. Enzyme stability was performed for 1 h at pH 8. Impact of pH on enzyme activity was analyzed using buffers at ranges between 3 and 10. The fibrinolytic enzyme was highly active at alkaline pH 8 and temperature 50°C. By substituting 1-5 mM phenylmethylsulfonyl fluoride (PMSF) the influence of inhibiting properties exerted by the enzyme was analyzed and studied. The frequent





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methods employed for optimization are Central Composite Design and Response Surface Methodology. The present study indicates that this fibrinolytic enzyme can be used efficiently in Thrombolytic prophylaxis.[27].

***Fictibacillus* strain SKA27**

The sand, seashells, and marine water from the Kozhikode beach area situated on the Malabar Coast of India were screened for bacterial sources of fibrinolytic enzymes. A highly potent thrombolytic enzyme was obtained from marine *Fictibacillus* species close, yet distinct relative of *Bacillus* sp. Optimization of medium components plays a vital role in enhancing enzyme production. Enzymes of interest can be produced cost-effectively by using cheap agro-industrial residues [29]. The fibrinolytic activity of the enzyme was qualitatively detected by analyzing the binding ability of Congo red dye to fibrin. Strong fibrinolytic activity and higher specificity for fibrin can be demonstrated by measuring the diameter of the clear zone of degradation. It was found to be 33% more than plasmin. Optimization of fibrinolytic enzyme production is done using statistical methods such as RSM and artificial neural network (ANN)-linked genetic algorithm (GA). Active fibrinolysis during enzyme's blood clot degradation indicates its high potential as a fibrinolytic agent.

***Pseudomonas aeruginosa* KU1**

Pseudomonas aeruginosa KU1-a potent fibrinolytic enzyme producing bacteria, was isolated from marine sediments of Ezhara beach, Kannur, Kerala. Maximal production of enzyme was achieved by a mechanism resembling the activity projected by RSM. This was done in shake flask culture which resulted in a 3.25 fold increase over the activity prior to any optimization. For picking key factors like Tryptone, skimmed milk and inoculum size Placket-Burman factorial design was employed. It influenced fibrinolytic enzyme production of the isolate. Box-Behnken design was used for optimizing the enzyme action further. 0.72% w/v tryptone, 0.09% w/v skimmed milk and 3.95% v/v inoculum size were identified as the optimal concentrations required in the medium. Using one factor at a time method, optimization was done and enzyme activity showed a 1.32 fold increase that was found to be maximum. Thus the new isolate yielded an enzyme showing significantly higher thrombolytic activity [31].

***Ulva pertusa* [Green alga]**

Ulva pertusa- a green alga was found to be a source of enzyme showing both direct-acting fibrinolytic and plasminogen-activating properties and hence a bifunctional thrombolytic serine protease. At optimal temperature of 40 °C and pH 7.0 maximum fibrinolytic activity of Ulvease[serine protease] was observed. Cu^{2+} and Zn^{2+} were found to exert inhibitory effect on the enzyme. The γ -chain was apparently unaffected while the $\text{A}\alpha$ - and $\text{B}\beta$ -chains of fibrinogen was preferentially hydrolyzed by Ulvease. Activated Partial Thromboplastin Clotting Time (APTT) and Prothrombin time physical therapy (PT) was prolonged by Ulvease. This enzyme delayed the closure times of citrated whole human blood and this was demonstrated by PFA-100 assay. Fibrin plate assay revealed that the activity of ulvease was higher than that of plasmin and u-PA. This enzyme displayed both plasmin and plasminogen activator-like activities. It showed protective effect on mice from collagen and epinephrine induced pulmonary thromboembolism[33]. It showed stronger thrombolytic ability and safety in vivo than u-PA. These results suggest that Ulvease may have a potential clinical application for the treatment and prevention of thrombosis.

***Costaria costata* [Brown sea weed]**

A direct acting antithrombotic serine protease [CCP-*Costaria costata* protease] was purified from brown seaweed *Costaria costata*. Anticoagulant, antiplatelet and prophylactic antithrombotic effects are exhibited by this enzyme. PMSF and APMSF have inhibitory action towards proteolytic activity. The direct degradation of fibrin clots by CCP was demonstrated by fibrin plate and fibrin zymography. This enzyme exhibits specific hydrolyzation of human fibrinogen and fibrin in the sequence - $\text{A}\alpha$ and α , $\text{B}\beta$ and β chains followed by γ and γ - γ chains respectively. The alteration of secondary structure was observed using FTIR spectroscopy in order to emphasize cleavage of fibrin clot and fibrinogen. In vitro studies showed that CCP reduced the thrombus effectively[35]. Fluorescent microscopic observation was done to establish the morphological alterations of fibrin clot. These data suggest that CCP could have therapeutic potential for the treatment of thrombosis.





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Codium intricatum

Two fibrinolytic enzymes, namely, CIP-I and CIP-II were obtained from the extract of *Codium intricatum*. These enzymes showed the highest activity in both assays. They were purified to homogeneity by gel filtration. Gel filtration is often used to give an indication of the suitability of different detergents for a particular protein. Separation with gel filtration is thus an important tool for qualifying the membrane protein preparation for further analysis and it was followed by ion-exchange chromatography. Ion exchange chromatography is a technique used to separate molecules according to their charge, for example, it can be used to purify charged molecules such as proteins, amino acids and nucleotides. These two enzymes hydrolyzed fibrinogen with preference to the A α chain over B β or γ chains. They were identified as serine proteases and their activities peaked between pH 8 and 9; which was completely inhibited by diisopropyl fluorophosphate (DFP). Thus, *Codium intricatum* is a source of novel thrombolytic protease[37].

***Codium fragile* [green alga]**

Codium fragile, a green alga is a source of a new bi-functional fibrinolytic serine protease Codiase having thrombolytic, anticoagulant, and antiplatelet activities. Hydrolyzation of fibrin clot by the enzyme was done either directly or by activation of plasminogen and this was revealed by fibrin plate assays. Effective fibrin and fibrinogen hydrolyzation was exhibited by Codiase following the sequence of A α and α - chains, γ - γ and γ chains and preferred slower degradation of B β and β -chains. FTIR-ATR spectroscopy analysis was employed to detect the structural change caused by enzyme on fibrin clot and fibrinogen. At a temperature of 30 °C and pH 6.0 maximal activity of Codiase was observed and the activity was inhibited by Zn²⁺ and Fe²⁺ ions. PFA-100 studies showed that Codiase prolonged the closure time (CT) of citrated whole human blood[38]. These favourable antithrombotic profiles together with its anticoagulant and platelet disaggregation properties, lack of toxicity to mice and NIH-3T3 cells, make it a potential agent for fibrinolytic therapy.

***Sargassum fulvellum*-Brown alga**

Sargassum fulvellum specimens was sourced from the East Sea and dried in natural environment. Chloroform-methanol (2:1) was used in the extraction of compounds from the specimen and isolation was done by repeated chromatography using silica gel columns. With the usage of a round-bottomed 96-well plate the fibrinolytic activities were determined at a temperature and pH of 37°C and 7.4 respectively. This brown alga was found to be a source of two bioactive natural products whose molecular structures were analyzed by NMR spectroscopy and GC-mass spectroscopy following their isolation and purification. Those two compounds were identified to be 1-O-palmitoyl-2-O-oleoyl-3-O-(α -D-glucopyranosyl)glycerol (POGG) & 1-O-myristoyl-2-O-oleoyl-3-O-(α -D-glucopyranosyl) – glycerol (MOGG)[40]. The extracts of *S. fulvellum* have been reported to have many biological roles; including anti-inflammatory effects. It was discovered that POGG and MOGG enhanced reciprocal activation of pro-u-PA and plasminogen *in vitro*. POGG and MOGG showed potent fibrinolytic activity in the plasminogen.

***Stachybotrys longispora*:**

FGFC1 (Fungi fibrinolytic compound 1), was isolated from a rare marine microorganism strain, *Stachybotrys longispora* FG216. The structure of FGFC1 was elucidated by ¹H NMR, ¹³C NMR, [Nuclear magnetic resonance spectroscopy, most commonly known as NMR spectroscopy or magnetic resonance spectroscopy, is a spectroscopic technique to observe local magnetic fields around atomic nuclei] IR, and MS data. It was evaluated for fibrinolytic activity *in vitro* and *in vivo*. The results showed that it could stimulate generation of plasmin activity and exhibited an increase in action by 2.05–11.44 folds. FITC-fibrinogen degradation indicated that the effect of enzyme on fibrinolytic activity was mediated by plasminogen and scuPA. By measuring Glu-plasminogen and Lys-plasminogen activation *in vitro*, *S. longispora* produces a potential thrombolytic agent FGFC1 which could dissolve most of the pulmonary thrombus of Wistar rat *in vivo*. Thus FGFC1 isolated from *Stachybotrys longispora* would be a potent fibrinolytic agent[42].





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SUMMARY AND CONCLUSION

This review elaborates about 17 diverse marine microbes that can produce enzymes having potent thrombolytic/fibrinolytic effect. The review focuses on establishing the potential of marine microbes and the efficacy of the enzymes produced. Marine ecosystems are being largely unexplored despite housing a plethora of microorganisms which can efficiently produce clinically important metabolites. Earlier there was a widespread misconception that high saline concentration of marine ecosystems is unfavourable for conspicuous bacterial growth. However this field has garnered interest in recent times as the salinity of seawater was observed to be quite close chemically to that of blood plasma. Thus marine enzymes can be employed as biocatalysts in order to enable metabolic processes as they result in fewer side effects[44]. Hence from this review it is quite evident that the above said fibrinolytic enzymes are highly effective. Thus it can be concluded that the forementioned microbes undoubtedly act as potent sources of drugs for thrombolytic prophylaxis in the upcoming years[45].

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S.No	Fibrinolytic Enzyme	Adverse effects
1	Streptokinase	Chest pain, Hypotension, Coughing, Echinymosis, Haemorrhagic stroke, Erythematous rash, Bradycardia. (4,5,6)
2	Reviparin	Anaemia, Peripheral edema, Hematuria, Thrombocytopenia, Congestive heart failure, Elevated liver transaminases, Pneumonia, Spinal/Epidural hematoma (7)
3	Bivalirudin:	Hypotension, Nausea, Backache, Coronary artery stent thrombosis, Renal failure, Fetal risk in pregnancy, Hypersensitivity. (8,9)
4	Tenecteplase:	Intra cerebral haemorrhage, Major bleeding and limb associated complications. (10,11)
5	Alteplase:	Over bleeding, angioedema, anaphylaxis, and fever (12)
6	Nattokinase:	Acute cerebellar haemorrhage, Multiple microbleeds, Potential carcinogenic effects, Cardiotoxicity, Susceptible to chemical oxidation, inactivation, denaturation in GIT (13)

Table-1: Adverse effects of some fibrinolytic drugs in current use





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S.No	Marine-microbial source	Thrombolytic enzyme
1	<i>Streptomyces radiopugnans</i> VTSD8	Protease [14]
2	<i>Streptomyces venezuelae</i>	Thrombinase [15]
3	<i>Serratia marcescens</i> RSPB11	Metalloprotease (Serratysin) [17]
4	<i>Bacillus subtilis</i> ICTF-1	Subtilisin like serine protease [23]
5	<i>Bacillus subtilis</i> A26	Protease [24]
6	<i>Bacillus subtilis</i> HQS-3	Serine metalloprotease [25]
7	<i>Ulva pertusa</i>	Serine protease (Ulvease) [33]
8	<i>Costariacostata</i>	<i>Costaria costata</i> protease (CCP) [35]
9	<i>Codium intricatum</i>	CIP-I and CIP-II [37]
10	<i>Codium fragile</i>	Serine protease (Codiase) [38]
11	<i>Sargassum fulvellum</i>	POGG and MOGG [40]
12	<i>Stachybotrys longispora</i>	Fungi fibrinolytic compound 1 (FGFC1) [42]

Table-2. Some Fibrinolytic enzymes and their Marine microbial sources.





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Fig-1 : Marine Microbial sources of Fibrinolytic Enzymes





A Study on Algebraic Structures of Groups and Rings

Muddsar Yaseen Malik^{1*} and D.Sivakumar²

¹Research Scholar, Department of Mathematics, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India .

²Professor, Department of Mathematics, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu , India.

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*Address for Correspondence

Muddsar Yaseen Malik

Research Scholar,
Department of Mathematics,
Annamalai University, Annamalai Nagar,
Chidambaram, Tamil Nadu, India .
E.Mail: muddsarmalik807@gmail.com



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ABSTRACT

The aim of this paper is to present the basic concepts of abstract algebra like groups, rings, integral domain (ID,) & also to study about the properties of these concepts. But the main focus is to study about the relationship, generalization of these concepts. Throughout this paper we considers ring it may be both commutative as well as non-commutative as the case may be & group it may be abelian or non-abelian as required.

Keywords: Binary operation, Group, Ring, Ideals & Integral domain etc.

INTRODUCTION

It covers very basic concepts & relationship between some algebraic structure of ring theory like ring of Integers, Rationals, Real numbers etc. We begin with some basic definitions of ring theory. As we study that group theory stands only on the study of one Binary operation, while ring theory involves two Binary operations with additional elementary properties. There are many mathematical structures to study having two binary operations, one is addition and the other is multiplication. In ring theory there is a very interesting concept of "division", division algorithm from the ring of integers \mathbb{Z} to an arbitrary commutative integral domain \mathbb{R} with unity. We will study & present the relation of groups rings which [1] & [4] has discussed. Also we will study characteristic of ring which [2] has discussed & we will prove some main results on characteristic of ring with help of additive order of element of groups. Also we will study ideal, sub- ring of ring & its types, zero divisors, principal ideal domain, and Euclidean domain along with their properties discussed by [3] & [5] have discussed & will prove some result. The





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notion of structure of ring has been introduced by so many mathematicians. But the conceptualization was first given by David Hilbert, Franklin & Noether.

**PRELIMINARIES
GROUP**

Definition [7]: A binary operation $*$ on a set G is a function $*$: $G \times G \rightarrow G$.

i.e. $*$ assign an element (x, y) in G to each ordered pair (x, y) in G .

Examples are " $+$ " is a binary operation on set of natural numbers " $+$ " is binary operation on Z the set of integers & " \times " means multiplication is binary operation on $Z, N, \text{Retc.}$

Definition [7]: A Group is a set G equipped with a binary operation $*$ such that

- (i) Associative law holds: for every $x, y, z \in G$ $x * (y * z) = (x * y) * z$
- (ii) there is an element $e \in G$ called the identity with $e * x = x = x * e \forall x \in G$
- (iii) Every $x \in G$ has an inverse; there is $x' \in G$ with $x' * x = e = x * x'$.

Definition [7]: A Group G is called abelian if it satisfies commutative law

i.e. $x * y = y * x$ holds for all $x, y \in G$

Now we can say that G is Group under the operation ' $*$ ' we write $(G, *)$ is Group.

Examples of groups are $(Z, +)$ $(R, +)$ $(R - \{0\}, \times)$ $(Q, +)$ etc.

Note: Group contains only one operation.

Definition [5]: Let G be some non-empty set with some binary operation ' $'$ '. If o satisfies associativity than G is semi group.

Definition [5]: If a semi-group has identity element than it is said to be monoid. i.e. if it has following properties.

- 1 Closure property
- 2 Associativity
- 3 Existence of identity

MAIN RESULTS

Theorem 1.0 $\forall a, b \in G$ such that $(ab)^k = a^k b^k$ where $k > 1$ is a fixed integer than $(ab)^{k-1} = b^{k-1} a^{k-1}$ & $a^k b^{k-1} = b^{k-1} a^k$ by [1].

$\forall a, b \in G$ such that $(ab)^k = a^k b^k$ where $k > 1$ is fixed integer where G is group than We will show that suppose there exist two relatively prime positive integer m & t such that $\forall a, b \in G$ $a^t b^t = b^t a^t$ & $a^m b^m = b^m a^m$. We will show that group G is abelian?

Proof: Since m & n are relatively prime than there exist integers x & y such that $mx + ny = 1$ (Bezout's identity).

Now for any a, b we have

$$\begin{aligned} (a^m b^n)^{mx} &= (a^m b^n)(a^m b^n) \dots (a^m b^n) \quad (mx \text{ times}) \\ &= a^m (b^n a^m b^n \dots b^n a^m) b^n = a^m (b^n a^m)^{mx-1} b^n \\ &= a^m (b^n a^m)^{mx} (b^n a^m)^{-1} b^n \\ &= a^m c^m (b^n a^m)^{-1} b^n \quad \text{where } c = (b^n a^m)^x \\ &= c^m a^m (b^n a^m)^{-1} b^n \end{aligned}$$





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$$\begin{aligned}
 &= c^m a^m a^{-m} b^{-n} b^n = c^m = (b^n a^m)^{mx} \\
 &\text{Similarly } = (a^m b^n)^{ny} = (b^n a^m)^{ny} \\
 &\text{Giving } = (a^m b^n)^{mx+ny} = (b^n a^m)^{mx+ny} \\
 &\Leftrightarrow a^m b^n = b^n a^m \quad \forall a, b \in G \dots\dots\dots (1) \\
 &\text{Now } \quad ab = a^{mx+ny} b^{mx+ny} \\
 &= a^{mx} \cdot (a^{ny} b^{mx}) b^{ny} \\
 &= a^{mx} (a^m k^m) b^{ny} \quad \text{where } d = a^y, k = b^x \\
 &= a^{mx} (k^m d^m) b^{ny} \quad \text{by (1)} \\
 &= a^{mx} \cdot b^{mx} \cdot a^{ny} \cdot b^{ny} \\
 &= (a^x)^m \cdot (b^x)^m \cdot (a^y)^n \cdot (b^y)^n \\
 &= (b^x)^m \cdot (a^x)^m \cdot (b^y)^n \cdot (a^y)^n \\
 &= b^{mx} \cdot (a^{mx} \cdot b^{ny}) \cdot a^{ny} = b^{mx} \cdot (b^{ny} \cdot a^{mx}) \cdot a^{ny} \\
 &= b^{mx+ny} \cdot a^{mx+ny} = ba
 \end{aligned}$$

Hence G is abelian.

GROUP HOMOMOPHISM

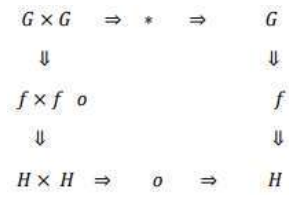
It studies about the form & structure of group ('Homo' meaning same & 'Morphism' meaning form or structure) that is it tells about the similarity of the two structures which are connected by a function & this function fulfils some conditions under the map f than f is called as homomorphism from one group to another group.

Definition. Let $(G,*)$ & (H,o) be two groups and $f: G \rightarrow H$ is said to be homomorphism if the group operations are preserved .i.e. $\forall a, b \in G$ such that $f(a * b) = f(a) o f(b)$

The study which has been done by [4] by calling functions between groups as an application We will study & give diagrammatic representation about the applications or function between groups which are homomorphism. Also we will prove some main results.

Definition [4]. Let $(G,*)$ & (H,o) be two groups and $f: G \rightarrow H$ be an application than f is called group homomorphism if $\forall a, b \in G f(* (a, b)) = o(f(a), f(b))$.

\Leftrightarrow the diagram:



\Leftrightarrow Diagrammatic representation is commutative .i.e. two paths are equivalent We usually say that f is compatible with both laws $*$ & o as they preserve the structure of groups, homomorphism map the input identity to the identity of codomain & inverse element to the inverse of image of element. We are interested to see the preservation of operation which leads to similarity of two structures. Note: $*$: $G \times G \rightarrow G$ & o : $H \times H \rightarrow H$ are respective binary operations of group G & group H .

Theorem 1.1 The application $f: G \rightarrow G$ defined by $f(x) = x^2$ is a group homomorphism $\Leftrightarrow G$ is commutative..

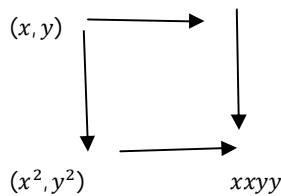
Proof:- Since f is homomorphism we can write the two paths of the diagram as follow.



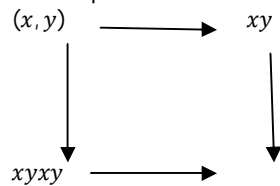


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First path



Second path



It is clear from the diagrammatic representation that there is commutativity we have $xyxy = xxyy \Leftrightarrow yx = xy$ hence G is commutative

If G is commutative $xyxy = xxyy$ then which makes the above diagram commutative and proves that f is group homomorphism.

Proposition 1.0:- Let D be a subgroup of Z (set of integral values) then $\exists a$ unique number $a \in N$ such that $D = aZ$

Proof:- If D is trivial subgroup then the statement follows obviously

If D is not trivial then there exist $b \in D$ (where $b \neq 0$) consequently $\exists c > 0 \in D$ as if $b < 0$ then $-b \in D$ & $-b > 0$.

Let $a = \min(b \in N \cap D)$ Because $a \in D, na \in D, \forall n \in Z$.

If $n > 0, na = (a + a + a \dots + a) \in D$

If $n = 0, 0.a = 0 \in D$

If $n < 0, -na = -(na) \in D$

Let $b \in D$; we divide (Euclidean) b by a to obtain $b = aq + r$ where $r \in (0, 1, 2, 3 \dots a - 1)$

and $r = b - qa \in D$.

Because a is the minimum, necessarily $r = 0$. We therefore have $D = aZ$.

Hence the result.

This allows us to define the order of an element of a group which will help us in defining characteristic of ring in later part.

Definition [7]: It is defined as a least positive integer $n > 0$ such that $n.a = e$ for some $a \in G$ where e is additive identity. If no such n exist we say a has infinite order.

Definition [1]: Order of an element of multiplicative group: It is defined as a least positive integer $n > 0$ such that $a^n = e$ for some $a \in G$ where e is multiplicative identity.

Permutation group or symmetric group of degree n where n is number of elements of a set on which permutation is defined studied by [1] & [6] we will give diagrammatic representation of this group for $n = 3$ which has order $n!$ & will show that it is special case of symmetric group S_n over n symbols having n reflection symmetries & n rotational symmetries like D_3 where D_3 has order $2n = |S_3|$ & D_3 is dihedral group defined over 3 sided polygon.

Definition [6]: It is defined as a bijective map from a set to itself.

If L is some set then set of permutations of L is denoted by $A(L)$.

Let us have a set $L = \{a, b, c\}$ let us define a set of bijective maps from $L \rightarrow L$ which is denoted by $A(L)$

$A(L)$ Contains all possible bijective maps on L i.e $A(L) = \{f \mid f: L \rightarrow L \text{ is bijective map.}\}$





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Now the possible bijective maps are as follow in form of graphs or diagram

$$f_1 = \begin{pmatrix} a & b & c \\ a & b & c \end{pmatrix} \quad f_2 = \begin{pmatrix} a & b & c \\ a & c & b \end{pmatrix} \quad f_3 = \begin{pmatrix} a & b & c \\ c & a & b \end{pmatrix}$$

$$f_4 = \begin{pmatrix} a & b & c \\ b & c & a \end{pmatrix} \quad f_5 = \begin{pmatrix} a & b & c \\ c & b & a \end{pmatrix} \quad f_6 = \begin{pmatrix} a & b & c \\ b & a & c \end{pmatrix}$$

We will give diagrammatic representation of these maps with the help of rotations and reflections and then this group will be same as group D_3 .

This D_3 is special case of symmetric group of S_n for $n = 3$ having same order & it contains only reflections & rotations. Diagrammatic representation will be shown on 3-sided regular polygon i.e equilateral triangle.

Like wise D_4 can be represented with the help of square.

Figures represent reflections & rotations which are bijective functions too.

First 3 figures are obtained by fixing each of the three vertices once & than reflect remaining two vertices.

Figures which represent rotation are rotated by an angle of 120°

Now we have above a regular polygon of three sides so for rotations we will find an angle of rotation by $\frac{2\pi}{3} = 120^\circ$
 $0^\circ, 120^\circ$ & 240° also instead of 0° we can use 360° which represents the same element

Ring

Ring is an extended structure of group under additive binary operation. As group has only one binary operation but ring has two binary operation i.e. addition as well as multiplication. In this [2] has shown some result we will generalise these result & will present relationship between structures.

Definition [1], [4]: - It is defined as an additive abelian group under addition & semi group under multiplication also properties of distribution of multiplication over addition holds.

We represent ring with $(R, +, \cdot)$. Here R is some set which we named by choice

i.e. $(R, +, \cdot)$ is said to be ring if $(R, +)$ is abelian group & (R, \cdot) is semi group where (\cdot) represents multiplication. By distributivity we mean as given below

$$\forall a, b, c \in R.$$

$$\text{We will have a. } (b + c) = a \cdot b + a \cdot c \quad \& \quad (b + c) \cdot a = b \cdot a + c \cdot a.$$

Examples of ring are as below

- (1) Set of integers = Z (2) Set of rationals = Q (3) Set of reals = R

Definition [1]:-A ring R is called commutative if $ab = ba \forall a, b \in R$. Also if $\exists e \in R$ s.t. $ae = ea = a \forall a \in R$ than we say R is commutative ring S with unity.

Z, R, Q are all examples of commutative ring with unity. Unity means multiplicative identity.

Different structures may have different unity .In general unity is denoted by 1

In the above definition of unity e may or may not be 1 it may be any element depends

Upon operation of structure.

We will give an example of commutative ring with unity having no 1.

Let $S = \{0, 2, 4\}$ be any set under operation modulo 6 we will show that S is commutative ring with unity 4 but having no 1

$+_6$	0	2	4
0	0	2	4
2	2	4	0
4	4	0	2





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·6	0	2	4
0	0	0	0
2	0	4	2
4	0	2	4

Clearly S under modulo 6 operation is commutative ring with unity 4.

$0 \cdot_6 4 = 0$, $2 \cdot_6 4 = 2$ & $4 \cdot_6 4 = 4$ We have seen that every element remains unchanged after operating with 4. So 4 is the unity of this ring. Clearly $S = \{0, 2, 4\}$ under modulo 6 is subring of Z_6 but with different unity. Therefore we conclude that a subring may or may not have same identity element.

Definition [1]: - Characteristic of a ring: It is defined as a least non negative integern such that $n \cdot a = 0 \forall a \in S$. If \nexists such a non-negative integer then we say ring has no characteristic or ring has zero characteristic. It is denoted by $Char(S)$, $Ch(S)$ or by $\Psi(S)$ where S is some ring.

Examples: - Z is a ring which has no characteristic or it has characteristic zero
 R (Set of reals) is a ring which has no characteristic.

Definition [2]: - The additive order of an element d denoted by $O^+(d)$ in the ring $(R, +, \cdot)$ we mean the order of an element d in the group $(R, +)$. An element $d \in R$ is said to be of maximal additive Order element if $O^+(d) \geq O^+(b) \forall b \in R$.

RESULTS ON CHARACTERISTIC OF RING PROVEN IN CONNECTION WITH GROUPS

We will make use of Lagrange's theorem in proving the corollary. [1]

Lagrange's theorem: - If G is a finite group & H is subgroup of G then $O(H) | O(G)$.

Corollary 1: - If G is a finite group and a be any element of G then $O(a) | O(G)$ where $O(a)$ and $O(G)$ represent order of element a & order of group G .

Proof: - Let $a \in G$ be any element. Let $D = \{a^n \mid n \in Z\}$ then D is cyclic subgroup of G generated by a .

Let $r, s \in H \Rightarrow r = a^n, s = a^m$
 Therefore $rs^{-1} = a^n \cdot a^{-m} = a^{n-m} \in D$.

Now by Lagrange's theorem $O(D) | O(G)$ but $O(D) = O(a)$ hence $O(a) | O(G)$.

Theorem 1.2: - For a finite ring F $\Psi(F) | O(F)$ where $\Psi(F)$ represents characteristics of F .

Proof: - Assume that $O(F) = m$ using corollary 1 to each element y of additive group $(F, +)$

We have $m \cdot y = 0$ for any $y \in F$. particularly it states us that $\Psi(F)$ is finite & exist hence $\Psi(F) \neq 0$. Now Suppose $\Psi(F) = n > 0$ then by division algorithm $\exists q, r \in Z$ with $0 \leq r < n$ s.t $m = nq + r$, for any $y \in F$ we have that $0 = m \cdot y = (nq + r) \cdot y = nq \cdot y + r \cdot y = q \cdot 0 + r \cdot y$.

Thus $r \cdot y = 0 \forall y \in F$. But n is the least non negative integer with this property & $r < n$. So it follows that $r = 0$. Hence $m = nq = \Psi(F) \cdot q$. So $\Psi(F) | O(F)$. This result is the modified form of 'order of an element divides order of group'.

Definition of unit element of a ring:

Unit element [7]: It is defined as a non-zero element c of a commutative ring R if $c | 1$ in R i.e if \exists element d such that $d \cdot c = 1$ then we say that c & d are units in a ring or inverse to each other.

In the ring of integer the only units are 1 & -1.

Note: - Unity is a unit but unit element is not unity

Theorem 1.3: - Let R be a ring with unity. If 1 is of additive order n then $Char(R)$ is n . If 1 is of additive order infinity then $Char(R)$ is 0.

Proof: - Let additive order of 1 be n . By this we mean order of 1 in the group $(R, +)$ is n then $n \cdot 1 = 0$ & n is such least positive integer. Now for any $x \in R$ we have $n \cdot x = x + x + x + \dots + x = 1 \cdot x + 1 \cdot x + 1 \cdot x + \dots + 1 \cdot x = (1 + 1 + 1 + \dots + 1)x = 0 \cdot x = 0$
 $1 + 1 + 1 + \dots + 1 = 0$ Because of additive order of 1. which shows that $Ch(R)$ is n .





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If 1 will have infinite order under addition then \nexists any n s.t, $n \cdot 1 = 0$ Thus $\text{Ch}(R) = 0$

Lemma: –Let S be a ring with 1. If $\Psi(R) \neq 0$, then $O^+(a) | O^+(1) \forall a \in S$.

Proof: -Suppose $\text{Ch}(S) \neq 0$ then clearly $\text{Ch}(S) = n$ where $n \in \mathbb{Z}^+$ and n is least

Now we have given that S is a ring with unity then obviously unity is the maximal element of additive order then by above theorem $O^+(1)$ is n and is same as $\text{Ch}(S) \Rightarrow O^+(a) = n \forall a \in S$ & hence $O^+(a) | O^+(1)$.

Theorem 1.3: Suppose that T be a ring with unit element d . If $O^+(d)$ does not exist then $\Psi(T) = 0$ otherwise $\text{Ch}(T) = O^+(d)$.

Proof: -If $O^+(d)$ is infinite then \nexists any least $n \in \mathbb{Z}^+$ such that $n \cdot d = 0 \Rightarrow \Psi(T) = 0$

Now we consider $O^+(d)$ is finite let it be n i.e $O^+(d) = n$ then clearly

$n \cdot d = 0 \Rightarrow (n \cdot d) d^{-1} = 0 \cdot d^{-1} = 0$. Thus from this $n \cdot x = 0 \cdot x = 0 \forall x \in T$.

Since $O^+(d) | \Psi(T)$, last equality gives $\Psi(T) = n = O^+(1)$ hence follows. & n

Note: By the above results we concluded that the characteristic of a ring with unity is additive order of multiplicative identity in a group under addition?

It should be understood clearly that if a ring has unit then definitely it contains 1

Characteristic of ring can be extended to direct product of rings

In the beginning of this section we will present a definition of product of rings & then relation among characteristic of two rings $\Psi(M), \Psi(S)$ & $\Psi(M \times S)$ for any two rings M & S . After this we will present some relation between characteristic of ideal of ring, characteristic of ring & then characteristic of quotient ring.

Product of rings:- Let M & S be two rings then their product is $M \times S = \{(a, b)\}$

Where $a \in M$ & $b \in S$ then it forms a ring under the addition & multiplication below

$$(a_1, b_1) + (a_2, b_2) = (a_1 + a_2, b_1 + b_2)$$

$$(a_1, b_1) \cdot (a_2, b_2) = (a_1 a_2, b_1 b_2)$$

Here the rings M & S are called components of product $M \times R$.

Theorem based on characteristic of direct product of rings

Theorem 1.4: -If R & S are two rings then $\text{Ch}(M \times S) = 0$ if $\text{Ch}(M) = 0$ or $\text{Ch}(S) = 0$

And $\text{Ch}(M \times S) = r$ where $r = \text{l.c.m}\{\text{ch}(M), \text{ch}(S)\}$, otherwise.

Proof: -Let $\text{Ch}(M) = 0$ & suppose $\text{Ch}(M \times S) = t \neq 0$ then $t(a, b) = (0, 0) \forall a \in M$ & $b \in S$

$\Rightarrow (ta, tb) = (0, 0)$

$\Rightarrow ta = 0 \forall a \in M$ Which is a contradiction as $\text{Ch}(M)$ is 0

Thus $\text{ch}(M \times S) = 0$

Similarly if $\text{Ch}(S) = 0$ then $\text{Ch}(R \times S) = 0$

Now let us suppose that $\text{Ch}(M) = m$ & $\text{Ch}(S) = n$ & $k = \text{l.c.m}\{m, n\}$

then $k(a, b) = (ka, kb) = (0, 0) \forall a \in M$ & $b \in S$ as $m | k$ and $n | k$

Assume $p(a, b) = (0, 0)$ then $(pa, pb) = (0, 0)$.

$\Rightarrow pa = 0 = pb \Rightarrow m | p$ & $n | p$

$\Rightarrow k | p \Rightarrow k \leq p \Rightarrow \text{Ch}(M \times S) = k$. Hence follows result.

Conclusion of this result leads to generalization of this result for only finite characteristic of rings

i.e. For the rings $Z_1, Z_2, Z_3, \dots, Z_k$ $\Psi(\prod_{k=1}^m Z_k) = \text{l.c.m}\{\Psi(Z_1), \Psi(Z_2), \Psi(Z_3) \dots \Psi(Z_k)\}$ if each $\Psi(Z_k)$ is finite otherwise $\Psi(\prod_{k=1}^m Z_k) = 0$ where $\Psi(Z_1), \Psi(Z_2), \Psi(Z_3) \dots \Psi(Z_k)$ are finite characteristics of rings $Z_1, Z_2, Z_3, \dots, Z_k$.

Sub structures, properties & some basic definitions of elements of ring.

In this section we will elaborate the properties & some sub structures of ring which [5] & [6] have mentioned & we will prove some beautiful results

Sub -ring of a ring [6], [7]: A sub-ring of the ring R is subgroup of the ring R that is closed under multiplication.

Some examples of subring are as given below.

$\{0\}$ Is subring of $n\mathbb{Z}$ $n \in \mathbb{Z}$

$n\mathbb{Z}$ Is subring of \mathbb{Z}

\mathbb{Z} is subring of \mathbb{Q}

\mathbb{Q} is subring of \mathbb{R}

\mathbb{R} is subring of \mathbb{C}





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$\{0\} \subseteq nZ \subseteq Z \subseteq Q \subseteq R \subseteq C$. This is chain of subsets which are also subrings
 The beauty of this chain is it satisfies reflexive relation, antisymmetric relation & transitive relation
 Note the relation defined is ' \subseteq ' for above beauty.

Trivial & non-trivial subrings

Trivial subrings mean ring S itself & zero ring. Non-Trivial means not S & not zero ring. Where S is some ring.

Definition [3]: An element $p \in R$ (R is ring) is said to be left zero divisor if $\exists q \neq 0$ in R s.t $pq = 0$. Similarly p is right zero divisor if $\exists r \neq 0$ in R s.t $rp = 0$. An element $p \in R$ is zero divisor if is both left & right zero divisor .we also call it two sided zero divisor.

Ring with zero divisors [6] : –An element $(a \neq 0) \in R$ is said to be zero divisor if $\exists (b \neq 0)$ in R such that $a.b = 0$ or $b.a = 0$ than a & b are zero divisors in ring R.

Ring without zero divisors [6],[7]: – If $a . b = 0$ in S than either $a = 0$ or $b = 0$ in another way if $a . b \neq 0$ than neither $a = 0$ nor $b = 0$.

Definition [7]:– Ring having no zero divisors is called an integral domain.

Z is an integral domain.

Q is an integral domain.

R is an integral domain.

Likewise subrings we have a chain $Z \subseteq Q \subseteq R$.

IDEAL

It is sub-structure of a ring which plays an important role in defining other structures Like principal ideal ring, principal ideal domain & Euclidean domain etc.

Definition [6]: It is defined as a subgroup K under addition of a ring $(S, +, \cdot)$ which is closed from the right and left under multiplication by all the elements of a ring $(S, +, \cdot)$.

If K is closed under multiplication only from right than it is called right ideal if K is Closed only from left then it is called left ideal.

If k is closed from both side than K is called ideal or both sided ideal or two sided ideal. By [5]

Some examples of ideals and right ideal

Suppose we have a ring S than clearly zero ideal & R itself are trivial ideals of ring S

Let the ring of 2×2 matrices over Z be denoted by X .Let $A = \left\{ \begin{bmatrix} a & b \\ 0 & 0 \end{bmatrix} \right\}$ where $a, b \in Z$ be subset of X & is right ideal of X but not left ideal of X as shown below.

Let $\begin{bmatrix} a & b \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} c & d \\ 0 & 0 \end{bmatrix} \in A$ & let $\begin{bmatrix} x & y \\ z & u \end{bmatrix} \in X$ be arbitrarily than we have

$$\begin{bmatrix} a & b \\ 0 & 0 \end{bmatrix} - \begin{bmatrix} c & d \\ 0 & 0 \end{bmatrix} = \begin{bmatrix} a-c & b-d \\ 0 & 0 \end{bmatrix} \in A \text{ \& } \begin{bmatrix} a & b \\ 0 & 0 \end{bmatrix} \begin{bmatrix} x & y \\ z & u \end{bmatrix} = \begin{bmatrix} ax+ bz & ay+ bu \\ 0 & 0 \end{bmatrix} \in A$$

So A is right ideal of X

Note X is ring so the general element of X is $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ where $a, b, c, d \in Z$.

But A is not left ideal as shown below

$$\begin{bmatrix} 0 & 2 \\ 0 & 0 \end{bmatrix} \in A \text{ \& } \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix} \in X \text{ But } \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 2 \\ 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 2 \end{bmatrix} \notin A .$$

Definition [7]: Prime ideal: Let S be a commutative ring .An ideal K is said to be prime ideal of S if

$K \neq S$ and $p, q \in S, pq \in K \implies$ either $p \in K$ or $q \in K$.

Example of prime ideal is given as

Z is ring and consider $2Z$ an ideal in Z than clearly $2Z$ is prime ideal in Z

Definition [7]:An ideal M of a commutative ring S where $(M \neq S)$ is called maximal ideal whenever A is an ideal of S s.t $M \subseteq A \subseteq S$ then either $A = M$ or $A = S$.

Example of maximal ideal is given as





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$n\mathbb{Z}$ where n is prime and is maximal ideal in \mathbb{Z} or simply principal ideal generated by prime are maximal ideals in \mathbb{Z}

Definition [1]: An ideal I of a commutative ring R is called semi prime ideal if $x^2 \in I \implies x \in I \forall x \in R$

Example of semi prime ideal is given as

Consider the ring of integer \mathbb{Z} choose ideal $H = \{6n | n \in \mathbb{Z}\}$ suppose $a^2 \in H$ then a^2 is multiple of 6

i.e. $6|a^2$ since $2|6$, we find $2|a^2 \implies 2|a$ (as 2 is prime) similarly $3|a$

$\implies 6|a$ as g.c.d(2,3) = 1 $\implies a \in H$ Hence H is semi prime ideal of ring \mathbb{Z} .

As in group theory we study quotient group on the basis of normal subgroup of parent group likewise we will study & prove some results on characteristic of quotient ring in relation to integral domain as [1],[7] has shown quotient ring is integral domain, characteristic of integral domain is either prime or 0.

Theorem 1.5: Suppose ring B has finite characteristic & K be an ideal in B then $\Psi(B/K) = n \cdot \Psi(B)/\Psi(K)$ where n is positive integer satisfies $1 \leq n \leq \text{g.c.d}(\Psi(K), \Psi(\frac{B}{K}))$.

Proof:- Clearly $\Psi(B)$ is finite & K is ideal in B , $\Psi(K)$ is also finite and $\Psi(K)|\Psi(B)$. Now for all $b \in B$.

$O^+(b+K)|O^+(b)$ & so $\Psi(\frac{B}{K})$ is finite & $\Psi(\frac{B}{K})|\Psi(B)$. Let p, q, r be $\Psi(B), \Psi(K), \Psi(\frac{B}{K})$ respectively. Then $q \cdot b = 0 \forall b \in K$ & $r(y+K) = K \forall y \in K$. Again $r(y+K) = K \implies l \cdot y + K = K$

Thus we have $\forall y \in B \ q \cdot (r \cdot y) = (qr) \cdot y = 0 \forall y \in B$. Thus $p|q \cdot r$ and hence $\frac{p}{q} \leq r$. Again since $\Psi(K)|\Psi(B)$ and $\Psi(\frac{B}{K})|\Psi(B)$, l.c.m(q, r) $|p$ and hence $r \leq \text{gcd}(r, q) \cdot \frac{p}{q}$. On replacing the values p, q, r we get the result.

Theorem 1.6: Assume X be a ring having finite characteristic & C be an ideal in X . If X/C is an integral domain then $\Psi(\frac{X}{C}) = \frac{\Psi(X)}{\Psi(C)}$ or $\Psi(X) = \Psi(C)$

Proof: Given that $\frac{X}{C}$ is a commutative ring without zero divisors & $\Psi(X)$ is finite, $\Psi(\frac{X}{C})$ is prime say p . By the reasoning in the proof of above result we got $\Psi(C)|\Psi(X)$ & $\Psi(X)|p \cdot \Psi(C)$ and $\Psi(X) = k_1 \Psi(C)$
 $p \Psi(C) = k_2 \Psi(X)$ for some positive integers k_1 and k_2 . On combining these two equations we have $p \Psi(C) = k_1 k_2 \Psi(C)$ and so $p = k_1 k_2$. Since p is prime exactly one of k_1 and k_2 must be 1.

Thus $\Psi(X) = \Psi(C)$ and if $k_2 = 1$ then $\frac{\Psi(X)}{\Psi(C)} = p = \Psi(\frac{X}{C})$. Hence result follows.

Definition [6], [7]: - An ideal is said to be principal ideal if it is generated by single element.

Example $2\mathbb{Z}$ is principal ideal in \mathbb{Z} which is generated by 2.

More generally we can say $n\mathbb{Z}$ is principal ideal in \mathbb{Z} .

Definition [6]:- An integral domain is said to be principal ideal domain if every ideal of integral domain is principal ideal.

Example \mathbb{Z} is principal ideal domain

Definition [6]:-A map $N: D \rightarrow \mathbb{Z}^+ \cup \{0\}$ with $N(0) = 0$ is called a norm on integral domain D if $N(a) > 0$ for $a \neq 0$ here N is positive norm on D .

Definition [6]:- The integral domain D is said to be Euclidean domain if there is a norm N on D s.t for any two elements a, b of D with $b \neq 0 \exists$ elements q & r in D with $a = bq + r$ with $r = 0$ or $N(r) < N(b)$ where q is quotient & r is remainder.

Theorem 1.7: -Every Euclidean domain is principal ideal domain

Proof: -We will show that every ideal of Euclidean domain is principal ideal.

Let S be an Euclidean domain and let J be any arbitrary ideal of S

Case 1:- if J is zero ideal then there is nothing to prove.

Case 2:- Suppose $j \neq (0)$ let $(d \neq 0) \in J$ be any element of minimum norm then such d will exist and the set $\{N(a) | a \in J\}$ will have a minimum element by well ordering of \mathbb{Z} . This will imply that $(d) \subseteq J$.





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Now to show that $J \subseteq (d)$. Let $a \in J$ be arbitrarily. Now applying division algorithm $a = qd + r$ with $r = 0$ or $N(r) < N(d)$ than $r = a - qd$ where both a and qd are in $J \Rightarrow r \in J$
 Now by the minimality of the norm of d this will imply that $r = 0$. Thus $a = qd \in (d) \Rightarrow a \in (d)$.
 Hence $J \subseteq (d)$. Therefore by these two inclusions we get $J = (d)$
 Since J is arbitrary \Rightarrow every ideal of S is principal ideal.
 Hence S is principal ideal domain. So statement follows

CONCLUSION

In this paper we have studied about the properties, relationship of algebraic structures like groups, rings and ideals we have also given diagrammatic representation of some structures by using reflection & rotation. As in future we will develop the concept to higher structures.

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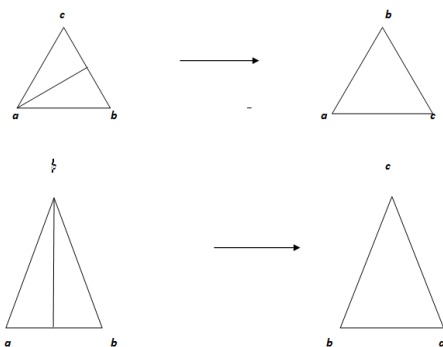
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CONFLICT OF INTEESTS

The author(s) declare that there is no conflict of interests.

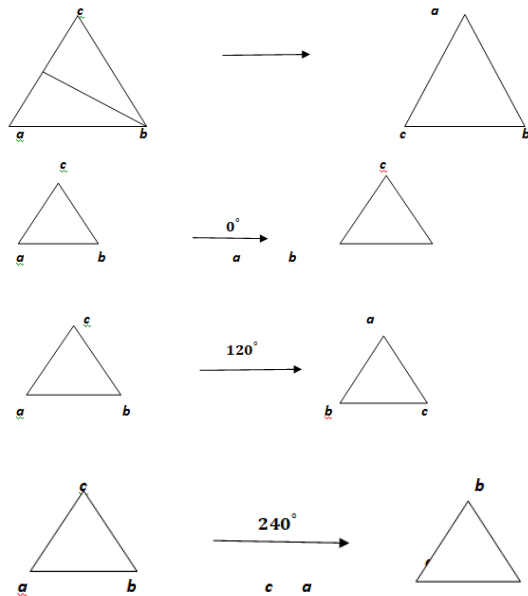
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These figures represent the diagrammatic representation of definition [6].





Evaluation of Osteogenic Differentiation Capability and Antimicrobial Effect of Graphene- Dexamethasone Coated PMMA Craniofacial Implants: The Protocol

Ishita Jakhanwal^{1*}, Sweta Kale Pisulkar², Preeti Prakash Kale³, Rashmi Rajendra Pagare⁴, Paulami Bagchi⁵ and Sonal Jain⁶

¹Assistant Professor, Department of Prosthodontics and Crown and Bridge, D Y Patil Dental School, Pune, Maharashtra University of Health Sciences, Maharashtra, India.

²Professor, Department of Prosthodontics, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Medical Sciences, Deemed to Be University, Sawangi (Meghe), Wardha, Maharashtra, India.

³Lecturer, Department of Periodontology, Pravara Rural Dental College and Hospital, Loni: 413736, Dist: Ahmednagar, Maharashtra, India.

⁴Consultant, Oral Medicine, Diagnosis and Radiology, Ayucare Diagnostic Centre and Dental Clinic, Viman Nagar, Pune, Maharashtra, India.

⁵Professor, Department of Prosthodontics and Crown and Bridge, D Y Patil Dental School, Pune, Maharashtra University of Health Sciences, Maharashtra, India.

⁶Senior Lecturer, Department of Prosthodontics and Crown and Bridge, Madha Dental College and Hospital, Chennai, Tamil Nadu, India.

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*Address for Correspondence

Ishita Jakhanwal,

Assistant Professor,

Department of Prosthodontics and Crown and Bridge,

D Y Patil Dental School, Pune, Maharashtra University of Health Sciences,

Maharashtra, India.

Email: isitapublication12345@gmail.com



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ABSTRACT

Craniofacial defects represent alternations in the anatomy and morphology of the cranial vault and the facial bones as a result of trauma, tissue necrosis associated with infections, or a sequel following surgical procedures. Nowadays the most used alloplastic material by surgeons for this rehabilitation is the polymethyl methacrylate (PMMA), which is an acrylic based resin, biocompatible, non degradable material. However, its still a challenge to develop an ideal PMMA implant that can effectively promote osseointegration while suppressing bacterial biofilm formation and activity. Consequently, the current study will be performed to evaluate the antimicrobial properties along with the osteogenic potential of PMMA implants modified with Graphene-Dexamethasone (G-DEX) surface coatings. The aim of this study is to evaluate the osteogenic differentiation capability and antimicrobial effect of Dexamethasone



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coated PMMA implants and Graphene-Dexamethasone coated PMMA implants against that of non-coated PMMA implants. To comparatively evaluate the surface adhesion, osteogenic differentiation and antimicrobial effect of Dexamethasone coatings and Graphene-dexamethasone coatings on PMMA implants. The proposed In-Vitro, Observational-Retrospective Cohort study will be conducted within 18 months from now, at Sharad Pawar Dental college and Hospital, Datta Meghe Institute Of Medical Sciences, Sawangi (Meghe), Wardha. The study has received the ethical clearance by Institutional Ethical Committee, Datta Meghe Institute Of Medical Sciences via Certificate No. EC-CT-2019-0129 and reference No. DMIMS (DU)/IEC/2021/458. 1620 circular PMMA discs will be prepared and divided into 3 groups of 540 samples each. Group A will act as control (non-coated PMMA implants), Group B will be spin coated with dexamethasone (DEX) solution and Group C will be spin coated with Graphene-Dexamethasone (G-DEX) solution. Further each group will undergo Adhesion test, Osteoblastic proliferation test and Antimicrobial test to comparatively evaluate the effects of Graphene-Dexamethasone coatings on PMMA implants.

Keywords: Cranial vault reconstruction, Osteogenic Differentiation, Antimicrobial Effect.

INTRODUCTION

Graphene modified PMMA (Polymethyl methacrylate) implant has become a core area of research, mainly because of its ability to modify the thermal, mechanical and biological properties of implant. Studies demonstrate that PMMA – based bone cements can be mixed with inorganic ceramics or bioactive glass to modulate curing kinetics and enforce mechanical properties. Additions of antibiotics within the cement have shown to reduce the risk for prosthesis – related infection [1]. In the recent past, graphene has raised wide interest due to its thermal, mechanical, electrical and biological properties. It is characterized by a carbon-based material with mono-atomic layer thickness, considered as the first two-dimensional crystal. This structure offers graphene an exceptionally high mechanical stiffness and extraordinary high thermal and electrical conductivity. It is used as coating of materials and biomaterials that usually lack these characteristics, hence, is ideal for improving the performance of autopolymerising acrylic resins. Graphene Doped Pmma implants have showed enhanced osseointegration in rabbit femurs [2]. Robert Di Carlo *et al*, through his study confirmed graphene to be a non toxic biomaterial which was able to induce osteogenic differentiation better around titanium discs. [3] Besides endowing implants with a non toxic biocompatible and osteogenic induction potential, providing antibacterial ability also plays an important role in preventing post –operative bacterial contamination. Ouyang L. *et al*, through his study has confirmed that Graphene oxide and Dexamethasone loaded substrate showed impressive biocompatibility and certain antibacterial properties [4]. However, it is still a challenge to develop an ideal PMMA implant that can effectively promote osseointegration while suppressing microbial biofilm formation and activity.

Objectives

To comparatively evaluate the surface adhesion, osteogenic differentiation capability and antimicrobial effect of graphene-dexamethasone coated PMMA implants as against non coated PMMA implants.

Null hypothesis

Null Hypothesis states that Graphene – Dexamethasone surface coating on PMMA implants show same antimicrobial effect and osteogenic differentiation capability as non coated PMMA implants.





Alternate hypothesis

Alternate Hypothesis states that Graphene – Dexamethasone surface coating on PMMA implants show improved antimicrobial effect and osteogenic differentiation capability around the implant surface as compared to non coated PMMA implants.

MATERIALS AND METHODOLOGY

1620 Standardized heat cured PMMA (DPI, manufactured by Dental Products of India, a div. of The Bombay Burmah Trading Corporation Ltd.) discs of 3 mm thickness and 10 mm diameter will be prepared with the help of custom made stainless steel die, following manufacturer's specifications. Discs will be polished with polishing paper and will be divided into 3 groups (Group A, B and C) of 540 each. Group A discs will remain uncoated and act as control, Group B discs will be spin coated with 1% Dexamethasone solution (DEX) (purchased from Adnano Technologies private limited, Shimoga, Karnataka, India) and Group C discs will be spin coated with 1% Graphene-Dexamethasone (G-DEX) solution (purchased from Adnano Technologies private limited, Shimoga, Karnataka, India). The total sample required per group for the study to be significant is 90 (Derived from the formula below). Out of 540 discs from each group (A, B and C), 90 will be used to test the Adhesion of the coatings (Test 1) (Subgroup A1, B1 and C1). Further, 90 discs from each group (A, B and C) will be used to perform Osteoblastic Proliferation test (Test 2) (Subgroup A2, B2 and C2). Remaining 360 discs from each group (A, B and C) will be used to perform Antimicrobial Test on 4 most commonly identified microbes in maxillofacial/craniofacial regions, i.e. *S. mutans*, *S. aureus*, *E. coli* and *C. albicans*. (Test 3) (Subgroup A3, B3 and C3). Out of 360 discs from each Subgroup (A3, B3 and C3), 90 discs will be utilized for each of the 4 species testing, thereby maintaining the sample size at 90 as derived from the formula.

Formula;

$$n = \{(r+1) (Z_{\alpha/2} + Z_{1-\beta})^2 \delta^2\} / r d^2$$

where,

r = ratio of the each group's sample size

d = difference of means

$Z_{\alpha/2}$ - indicates the critical table value when conducting a two-tailed Z test

$Z_{1-\beta}$ - Power is obtained as one minus type two error, which means probability of accepting null hypothesis when the alternative hypothesis is true.

$$n = (1+1) (1.96+0.84)^2 (9.36)^2 / 1 * (19.10 - 15.19)^2 = 1373.7248 / 15.2881 = 89.86 \approx 90$$

The total sample size for each group required for the study is 90.

Evaluation tests to be performed

Scratch test will be performed to evaluate an effective coating over the discs. In this a rounded stylus or loop will be loaded in increasing amounts until the coating is removed from the surface of the discs. The load needed to remove the coating will be calculated. Procedure – MC3T3 cells will be cultured on the discs for 6 hours (cell attachment) and 5 days (cell proliferation) after which the cells will be fixed with 2.5% glutaraldehyde for 2 hours and washed with PBS twice. Fixed samples will be dehydrated in series of alcohol concentrations, following which, samples will be dried for SEM (Scanning electron microscope) observation. [5] SEM observations will confirm cell viability assay for extent of cell (Osteoblast) attachment and cell (osteoblast) number after 6 hours and 5 days. [5] Procedure – 4 species of micro-organisms (*S. mutans*, *S. aureus*, *E. coli* and *C. albicans*) will be cultured on the discs and fluorescent nucleic acid staining will be performed to quantify the living and dead microbes on the discs. The living microbes will be stained green while the dead will take up the red stain. [5] Further ELISA will be performed to measure the optical density of the discs signifying the amount of microbial growth in each group for each species. [5]

Statistical Analysis

The collected data will be organized and tabulated. The data will be analyzed by appropriate statistical tools. After appropriate inferential study and analysis, conclusions regarding adhesive strength of the G-Dex solution coatings



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on PMMA implants will be derived. Further, the conclusions will be given regarding the Osteogenic differentiation capability of the surface modified PMMA implants and hence, provide results regarding improvement in the biological properties, cell growth and differentiation around the hybrid implants. Antimicrobial effects of the G-Dex Coated PMMA implants will be tested, thereby, concluding about the effect on the post-surgical infection rate and improved biocompatibility of the implants.

REVIEW OF LITERATURE

Polymethyl methacrylate (PMMA) is a lightweight, economical, synthetic polymer that is used in reconstructive surgeries where extremely high strength is not necessary. It is a non biodegradable polymer utilized in applications that require permanent, mechanically stable structures such as bone tissue regeneration [6]. Both Titanium and PMMA are the most widely used materials for implants in the correction of large bony defects, however, PMMA, because of its reduced surgical time, use of simple technique and excellent long term esthetic results along with being less expensive, more readily accessible and easier to handle and contour for specific craniofacial defects, have still kept it as a more reliable and acceptable option. Despite the excellent PMMA bulk properties, its surface inherited hydrophobic nature limits its compatibility when used as implant bio-material. Thus, surface modification of PMMA is necessary to improve its biocompatibility and to reduce implant complications [7]. Also, although PMMA allows a fast primary fixation to the bone, it does not guarantee a mechanically and biologically stable interface with bone, mainly because it is prone to bacteria adhesion and infection development [8]. Additions of antibiotics within the cement have shown to reduce the risk for prosthesis – related infection.[9] In the recent past, graphene has raised wide interest due to its thermal, mechanical, electrical and biological properties. It is characterized by a carbon-based material with mono-atomic layer thickness, considered as the first two-dimensional crystal. This structure offers graphene an exceptionally high mechanical stiffness and extraordinary high thermal and electrical conductivity. It is used as coating of materials and biomaterials that usually lack these characteristics, hence, is ideal for improving the performance of autopolymerising acrylic resins. [10]

Graphene modified PMMA implant has become a core area of research in the recent past mainly because of its ability to modify thermal, mechanical and biological properties of the implant. One of its highly studied properties includes the osseoblastic differentiation and tissue regeneration capability around the bone-implant interface. Antonio Scarano *et al*, in 2021, evaluated osseointegration of Graphene Doped (GD) PMMA compared with PMMA as potential material for dental implant, and concluded that GD-PMMA surfaces enhanced osseointegration in rabbit femurs.⁴ Roberta Di Carlo *et al*, in his study, confirmed that the graphene oxide functionalization provides a non cytotoxic biomaterial that is able to stimulate cell viability and induces osteogenic differentiation better with respect to titanium discs.[3] Furthermore, the study on the effect of graphene substrate on osteoblast cell adhesion and proliferation by Ashkan Aryaei *et al*, showed that graphene does not have any toxic effect on osteoblasts and also cell adhesion is improved with graphene coated substrate than the substrate alone. Moreover, the study concluded that a layer of graphene on bone implants will be beneficial for osteoblastic attachment and proliferation.[11] Davies proposed an ideal osseointegration period of 3-6 months after a successful implant operation. However, the soft tissue and bone are more susceptible to periodontitis during this time, which stimulates inflammation and bone loss, requiring antibiotic treatment. Lindhe and Meyle revealed that the risks of peri-implant mucositis are about 80% in patients and the risks of peri-implantitis are about 28-56% in patients, following dental implant surgery [2].

Sunho Park *et al*, developed a graphene-chitosan (GC) hybrid dental implant using various concentrations of graphene and concluded that the GC hybrid implant under optimal condition (1% GC hybrid implant) could significantly promote osteoblast proliferation while reducing biofilm formation and bacterial activity.[5] Apart from chitosan, various other drugs such as simvastatin, vitamin D, ascorbic acid and amethasone have been proved to be good options for improving biocompatibility and osteogenic activity. Among them, dexamethasone (DEX) has already been widely used to upgrade the osteogenic activity and biocompatibility of biomaterials[8,12]. It has also been proved that active bone formation and strong osseointegration occurs at the interface between DEX/ Growth



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and Differentiation Factor-5 Surface modified titanium implants and the host bone, as evaluated by micro computed tomography analysis, by Dae Hyeok Yang *et al.* [12]. Furthermore, Ouyang L. *et al.*, through his study has suggested that modified graphene oxide and dexamethasone loaded substrates are endowed with impressive biocompatibility and certain antibacterial qualities. [4] Thorough and systematic literature review suggests that only limited data have been published regarding inclusion of graphene in PMMA implants for improving its osteoblastic differentiation capability, which can thereby improve its osseointegration and biocompatibility [12]. Moreover, it is still a challenge to develop an ideal PMMA implant that can effectively promote osseointegration while suppressing bacterial biofilm formation and activity.

Limitations

Being an in vitro study, the exact simulation of craniofacial bone defect surface would be difficult. Thus, animal studies would be required to give a statistically stronger results. Further, only 4 microbial species are being tested for anti-microbial effects and results will be limited for only the selected microbial categories.

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Author's contribution

1. Ishita Jakhanwal: Concepts, Design, Definition of intellectual content, Literature search, Clinical studies, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review, Guarantor.
2. Sweta Kale Pisulkar :Concepts, Design, Definition of intellectual content, Literature search, Clinical studies, Data acquisition, Data analysis, Statistical analysis, Manuscript review
3. Preeti Prakash Kale: Concepts, Design, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review
4. Rashmi Rajendra Pagare: Concepts, Manuscript preparation, Manuscript editing, Manuscript review.
5. Paulami Bagchi: Definition of intellectual content, Literature search, Clinical studies, Manuscript editing, Manuscript review.
6. Sonal Jain: Concepts, Manuscript editing, Manuscript review, Guarantor

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Conflict of Interest

The authors declare that there are no conflicts of interests.

Ethical approval

The study has received the ethical clearance by Institutional Ethical Committee, Datta Meghe Institute Of Medical Sciences via Certificate No. EC-CT-2019-0129 and reference No. DMIMS (DU)/IEC/2021/458.

Data and materials availability

All data associated with this study are present in the paper.

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Table.1:

PMMA Uncoated Discs - Control (Group – A)	Dex Solution Coated Discs (Group – B)	G-DEX solution coated discs (Group – C)
n = 540	n = 540	n = 540

Table.2: Subgroup 1 will be prepared to confirm an effective coating by Adhesion Test (Test 1 : SubGp 1)

(SubGp – A1) PMMA uncoated Discs	(SubGp – B1) Dex Coated Discs	(SubGp – C1) G-Dex Coated Discs
n = 90	n = 90	n = 90

Table.3: Subgroup 2 will be prepared to perform Osteoblastic Proliferation Test (Osteogenic Differentiation Capability of the surface modified discs) (Test 2 : SubGp 2)

(SubGp – A2) PMMA uncoated Discs	(SubGp – B2) Dex uncoated Discs	(SubGp – C2) rG-Dex Coated Discs
n = 90	n = 90	n = 90

Table.4: Subgroup 3 will be prepared to perform the Antimicrobial Test (Test 3 : SubGp 3)

(SubGp – A3) PMMA uncoated Discs	(SubGp – B3) Dex coated Discs	(SubGp – C3) G-Dex coated Discs
n = 360	n = 360	n = 360

Table.5:

	<i>S.mutans</i>	<i>S.aureus</i>	<i>E.coli</i>	<i>C.albicans</i>
SbGp A3 (360) (Non –Coated Discs)	n = 90	n= 90	n= 90	n= 90
SbGp B3 (360) (Dex Coated Discs)	n=90	n= 90	n= 90	n= 90
SbGp C3 (360) (G-Dex Coated Discs)	n= 90	n= 90	n= 90	n= 90





Promising Role of Nano Cosmeceuticals in Skin Aging – an Updated Review

Aiswarya.S^{1*}, Reshma Fathima.K², Amrutha.C U¹, Asna Khalid.V K¹ and Shafin.P¹

¹M.Pharm Pharmaceutics, Grace College of Pharmacy, Palakkad, Kerala 678 004, India.

²Associate Professor, Grace College of Pharmacy, Palakkad, Kerala. 678 004, ,India.

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*Address for Correspondence

Aiswarya.S

M.Pharm Pharmaceutics,

Grace College of Pharmacy,

Palakkad, Kerala 678 004, India.

E.Mail: aiswaryasreedharan01@gmail.com



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ABSTRACT

Aging is a natural biological phenomenon that occurs with all the human beings, which often results in a decline of normal physiological systems of the body. Skin aging is a slow and irreversible process. Photo aging occurs due to the exposure to UV radiations which leads to skin damage. Cosmeceuticals are the cosmetic products with cosmetic and therapeutic effects and intended to have a beneficial effect on the skin health and beauty. The two sorts of skin aging have distinct sources: the intrinsic and extrinsic; however, their results become synergistic, leading to the aged look of the skin. The different theories related to skin aging includes Oxidative Stress, Cellular Senescence and Telomeres, Diet, Smoking etc.

Nanocosmeceuticals are the emerging promising Anti-aging approach with various benefits including enhanced skin permeation, less toxicity, and site specificity. This review emphasis on aspects of skin aging, its types, explores the miraculous role of various Nanocosmeceuticals in skin aging and on their safety regulations.

Keywords: Skin aging, Theories of skin aging, Nanocosmeceuticals, Management of skin aging, Regulatory aspects of Nanocosmeceuticals.

INTRODUCTION

The skin is an ecosystem composed of 1.8 m² of diverse habitats with an abundance of folds, invaginations and specialized niches that support an outsized range of microorganisms. The primary role of the skin is to function as a physical barrier, protecting our bodies from potential assault by foreign organisms or toxic substances [1]. Besides protecting the body from water loss and microorganism infection, it is a vital cosmetic role. Young and exquisite

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appearance may have a positive influence on people's social behaviour and reproductive status [2] . Aging may be a process perhaps best defined as decreased maximal function and reserve capacity altogether body, organs, resulting in an increased likelihood of disease and death [3] . The harbingers of our lost youth is most readily seen in our skin as we age; including skin wrinkling (rides), hair graying (canities) and for several men and some women the tendency for scalp hair thinning/baldness. These changes may confer only small losses in function, but as our expectations for the extension of optimal functioning still grow well into our 70s, 80s and beyond, these changes are unwelcome [4] . Cosmeceutical is that the term is attributed to Dr. Albert Kligman, who identified it as a hybrid category of products lying on the spectrum between drugs and cosmetics. The difference between a drug and a cosmeceutical is that the previous is defined by having a biological effect on living tissue. Another important distinction is that cosmeceuticals aren't regulated by the U.S. Food and Drug Administration (FDA) and, therefore aren't subject to premarket requirements for the proof of safety or efficacy [5] . Samples of popular cosmeceuticals include moisturizers, retinoids, antioxidants, and depigmentation agents [6] .

Nanoparticles are the sub-micron sized particles within the dimensions range of 1–100 nm [7] . Nanotechnology solves most issues with higher protective and skin health-enhancing efficiency. Various nanotechnology methods are involved in active roles in beauty enhancement, like Nano emulsions, liposomes, solid lipid nanoparticles, smaller sized nanoparticles, hydrogels, and dendrimers [8] . Nanocosmeceuticals have a widespread research interest among the researchers as they possess various benefits like occlusive properties, enhance permeation within the skin, less toxicity, and site-specificity [9] .

Skin Aging

The skin is a unique organ that reflects the inevitable changes that occur in the body's aging process. It is usually conceptualized as an irreversible progressive loss of homeostatic capacity, ultimately incompatible with life [11] . The "biological clock" affects both the skin and the internal organs in a similar way, causing irreversible degeneration [12] . Signs of aging become evident as life progresses, and skin changes constitute the first obvious evidence of the aging process. Most changes in aging skin result from a combination of endogenous (e.g., gene mutations, cellular metabolism, hormone environment) and exogenous (e.g., chemicals, toxins, pollutants, UV, and ionizing radiation) factors [13] .

Intrinsic Aging

Intrinsic skin aging is characterized primarily by functional alterations rather than by gross morphologic changes in the skin [3] . Intrinsic skin aging represents the biological clock of the skin cells per se and reflects the reduction processes that are common in internal organs [13] .

Extrinsic Aging

Exogenous factors will impact skin physiology permanently (e.g., pro oxidant and antioxidant influences on cell turnover via neuro-endocrine-immune biological response modifiers). By far the greatest source of extrinsic aging is accumulated and unprotected sun exposure (i.e., photo-aging) [4] . Among harmful environmental factors that contribute to the extrinsic aging of the skin, exposure to UV light (photo aging) is considered to be the most significant and well recognized [16] .

Mechanism of Photo aging

Photo aging could be a multisystem degenerative process that involves the skin and also the skin web. In skin with long-term sun exposure, the ratio of melanocyte density is approximately twice that of non-exposed skin [17] . When skin is exposed to sunlight, UV radiation is absorbed by skin molecules which will generate harmful compounds, called reactive oxygen species (ROS), which then cause "oxidative damage" to cellular components like cell walls, lipid membranes, mitochondria, and DNA [18] . It is a cumulative process and depends totally on the degree of sun exposure and skin pigment. The epidermis and dermis are both tormented by UVB, but the dermis is additionally affected to a major extent by UVA. Photo aged skin displays thickened basement membrane [17] .



**Aiswarya et al.,****Theories Concerning Skin Aging**

Oxidative Stress-The atom or oxidative stress theory of aging proposes that the build-up of oxidative cellular damage could be a major contributor to the aging process and a key determinant of longevity of the species [19].

Role of Mitochondria-Another target for ROS is mitochondrial DNA (mtDNA). MtDNA is susceptible for oxidative stress induced damage and contains a higher mutation frequency than genomic DNA because of the shortage of a repair mechanism and histones [20].

a. Cellular Senescence and Telomeres-Telomeres are the ends of linear chromosomes, several thousand bases long that comprises tandem repetitive DNA sequences. The presence of telomeric repeats protects the chromosome from degradation or fusion. It's also been determined that the length of telomeres decreases by up to 150 base pairs with every biological process, as determined in cultured human cells; and telomere length in cells obtained directly from tissues in vivo is inversely associated with the individual's physiologic age, being shorter in cells derived from older versus younger adults. When telomeres become 'critically short,' cells enter proliferative senescence and thus telomeres appear to function the biologic clock, informing cells that they're young or old [21].

b. Apoptosis- Apoptosis is that the rapid, highly conserved process of controlled, programmed necrobiosis [22]. Evidence has been accumulating to suggest that dysregulation of apoptosis may contribute to age-associated changes like progressive decline of physiologic function and significant increases within the incidence of cancer and degenerative diseases [23].

c. Diet-Vitamins, carotenoids, tocopherols, flavonoids and extracts from a spread of plants seem to possess potent antioxidant properties and are widely utilized in the skin care industry or as an agent applied topically or oral supplements in an effort to prolong the looks of young skin. Thus, nutrition and skin aging are closely related [19].

Effect of smoking- In a very recent study, tobacco smoking, but not ultraviolet exposure, made up our minds to be a powerful predictor of skin aging [24].

Pollution- Considerable effects mediated by air pollutants on the human skin may contribute to skin aging, dermatitis, carcinoma, psoriasis, and acne [25].

Nanocosmeceuticals

Nanocosmeceuticals have a widespread research interest among the researchers as they possess various benefits like occlusive properties, enhance permeation in the skin, less toxicity, and site-specificity [9]. Nano-cosmeceuticals are the strongest generation of skin care products using Nano-sized systems for the delivery of active ingredients to the skin cells for better penetration [27].

Mechanism of Action of Nanocosmeceuticals

The stratum (SC) layer of human skin as a permeation barrier offers an exclusive delivery pathway for the therapeutic agents in addition because the cosmeceuticals. The Nano-sized carriers either can translocate without degradation inside the skin or is degraded near the skin surface wherein the encapsulated therapeutic moieties would penetrate into the skin layers. Additionally, cutaneous penetration of the inorganic and polymeric nanoparticles may be facilitated using various passive and active permeation enhancement methods [2].

Advantages of Nanomaterial in Cosmetic Industry [28]

- I. Increased efficiency of the products;
- II. Superior penetration to deeper skin layers (due to their minute size and precise optical properties);
- III. Reduced amounts of the constituents utilised;
- IV. Reduced toxicity (some Nano-materials have antioxidant property);
- V. Improved stability of the active ingredients.





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Nano materials in Cosmetics

Organic Nanoparticles-Organic NPs are usually described as solid tiny pieces made of organic compounds ranging in size from 10 nm to 1 mm.

a. Lipid Nanoparticles (SLN, NLC)- Nanostructured lipid carrier (NLC) allow precise and accurate release of drug over a predetermined period of your time, provide protection to compounds with low stability and high entrapment and loading efficiency [29].

b. Liposomes- The property of those carrier includes high biocompatibility, bioavailability, non-hazardous and might encapsulate both lipophilic and hydrophilic drugs. "Capture" was the primary anti-ageing cream supported liposomal formulation [28].

c. Nanosomes –They are smaller than liposomes and are ready to permeate deeply to skin. Once having penetrated, they will integrate themselves in larger molecules [30].

d. Niosomes- Niosomal formulations with proper preparation techniques together with selection of fine non-ionic surfactant, cholesterol content and nature of incorporated drug can sway be a possible consideration within the field of cosmetics which could help within the treatment of skin ageing and wrinkles [31].

e. Ethosomes - Topically applied Ethosomes can increase the continuance of medicine or cosmetic chemicals within the horny layer and epidermis and reduce the systemic absorption of medication or cosmetic chemicals, these properties allow them to penetrate easily into the deeper layers of the skin and circulation [32].

f. Transferosomes- Transferosomes can deform and pass throughout skin layers without measurable depletion. They overcome the skin permeation difficulties with the assistance of compacting themselves along the intracellular lipids of the SC.

g. Cubosomes- They need great internal extent, simple preparation method, biodegradable lipids and also the potential of encapsulating hydrophobic, hydrophilic, and amphiphilic compounds, targeting and controlled release of bioactive agents.

Inorganic Nanoparticles

a. Nanosilver – Skin cleanser soap containing Nano silver exhibit antibacterial and antifungal properties and was found effective in treating acne and sun-damaged skin.

Polymeric Nanoparticles-

Nano capsules – Nano capsules are employed in cosmetics to guard sensitive actives, decrease unwanted odors, and take away incompatibility between formulation components.

Nano particulate Systems-

a. Nano spheres-Nano spheres are microscopic particles that are accustomed deliver active components into deep layers of skin. The natural Nano-sized lipid nanoparticles in Nano spheres improve drug penetration into the skin and cause enhanced stability and better activity in makeup components.

Carbon based Nanoparticles-

a. Fullerene-Fullerenes demonstrate brightening effect by inhibiting free radicals as a results of UV exposure and also control melanin production [33].

b. Nano diamond - Nano diamond shows important properties like biocompatibility, tailor able surface chemistry, which facilitate bio conjugation and accessibility.

Other Nanoparticles-

a. Dendrimers-Dendrimers are highly recommended by various firms like L'Oreal, and also the Dow Chemical for various skin and hair based products [26]. Table 3-Applications of nanomaterial in cosmetics industry [30]





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The role of Nano cosmeceuticals in the management of aging

- I. Herbal based Nano formulation.
- II. Phytochemical based Nano formulation.
- III. Drug based Nano formulation
- I. Herbal based Nano formulations [9]

a. *Phyllanthus urinaria* extract was utilized by the researcher to formulate a Nano emulsion based formulation using oil. These formulations were useful in anti- ageing property, reducing the effect of reactive oxygen species by preventing the oxidation through ultraviolet.

b. Nano emulsion using flavones *Eysenhardtia platycarpa* increase the anti-ageing process of the formulation additionally as enhancing the bioavailability of the merchandise. c. Another researcher used herbal extract of plant *Dracocephalum moldavica* and formulated solid lipid nanoparticles to enhance the therapeutic effect of the formulation [38].

d. Researchers have compared different Nano formulations using herbal extract of turmeric. Cream based these formulations were successful in healing the damage skin [39].

Phytochemical based Nano formulation [8]

a. **Solid lipid Nanoparticles-** Sesamol loaded solid lipid nanoparticle was formulated with the particle size of 127 nm for usage in skin cream, which increased the apoptotic nature of the skin.

b. **Nanostructured lipid carriers-** Quercetin-loaded nanostructured lipid carrier showed improved topical delivery of bioactive compounds with increased antioxidant activity.

c. **Nano single or multi emulsions-** Retinyl palmitate was employed within the assembly of Nano emulsions within the dimensions range of but 275 nm and showed enhanced skin penetration with increased inner skin protection.

d. **Nano Phytosomes -** Extracts from the *Citrus auranticum* and herb were used for the event of phytosomes and for the skin aging studies.

e. **Nano liposomes-** Curcumin-loaded 80 nm Nano liposomes were formulated and showed skin protection.

f. **Nano niosomes-** Tavano et al produced a rather larger Niosome within the dimensions range of 471–565 nm containing Phyto -derived antioxidants like resveratrol, alpha- tocopherol, and curcumin showed better antioxidant activity to the skin with increased skin permeation activity for cosmeceutical applications.

Drug based Nano formulation

a. Telomere attrition is believed to be the primary hallmark of aging or the explanation for age-associated damage resulting in cellular senescence. Telomere shortening can drive aging through cellular senescence. Ergocalciferol may reduce telomere shortening through anti- inflammatory and anti-cell proliferation mechanisms [34]. Liposomes increased the retention amount of VD 3 within the skin by transdermal absorption compared to the VD 3 solution. VD 3 liposomes could significantly improve skin appearance and repair damage within the histology of photoaging [35].

b. Drug like metformin, resveratrol are used as an anti-ageing agent. These drugs exhibit anti- oxidant property.

c. Gold-based nanoparticle with the use of muco polysaccharide for the delivery of metformin for the treatment of carcinoma has antioxidant property and show high bioavailability in biological system.

Safety, quality and regulatory aspects of nanocosmeceuticals There is a continuous, rapid growth in the novel technologies and pharmaceutical preparations related to the nanoparticles. Along with these advances, there is also a risk factor associated with the development procedure and use of the Nano-based products in society [8]. In recent years, the safety and quality of Nano-cosmeceuticals remained a topic of debate. Table 4 -The major aspects regarding safety, quality and regulation of Nano- cosmeceuticals used in cosmetics for different parts of the world [28].





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CONCLUSION

Skin aging could be a complex process that's caused by internal and external factors or their association and a few 80-90 which there's caused by UV light [37]. Cosmeceutical research may be a rapid growing area in tending sectors, which extends from facial products to skin and body products [8]. Nanocosmeceuticals refers to cosmetics embedded with active pharmaceutical agents. These products have various advantages like higher bioavailability, occlusive properties, enhance permeation within the skin, less toxicity, and site-specificity. Major applications of the nanocosmeceuticals are within the anti-ageing creams, different hair product, ultraviolet protection cream, moisturisers [26]. Continuous recent development in cosmetic products and nanotechnology has led to the evolution of cosmeceuticals into Nanocosmeceuticals [40]. The utilization of nanotechnology in cosmetics is increasing tremendously. However, few toxic events were reported with these Nanocosmeceuticals. Thus, the protection and efficacy of those Nanocosmeceuticals must be evaluated before their marketing. Various guidelines from diverse countries to control such products must be harmonized. There's a necessity for precise, harmonized guidelines and strict regulations over the long run use and therefore the advertisements of Nanocosmeceuticals [7].

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Table 1 -Morphologic and Functional Changes in Intrinsically Aged Skin [15]

Atrophy of the stratum spinosum	Increased vulnerability, fragility
Decreased mitotic activity, increased duration of cell cycle and migration time	Decreased desquamation, delayed wound healing
Flattening of the dermoepidermal junction	Decrease in surface contact area, increased risk of separation by shearing forces
Decrease of Langerhans cells	Diminished cutaneous immune function
Atrophy of the extracellular matrix	Reduced strength and resiliency





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Table 2-Glagou's Photo aging Classification [12]

TYPE	CHARACTERISTICS
a. No wrinkles	1. Typical age 20s to 30s 2. Early photo aging 3. Mild pigmentary changes 4. No keratosis
b. Wrinkles in motion	1. Typical ages late 30s to 40 s. 2. Early to moderate photo aging 3. Early senile lentiginos 4. Palpable but not visible keratoses
c. Wrinkles at rest	1. Typical age 50 or older 2. Advanced photo aging 3. Visible keratosis
d. Only wrinkles	1. Typical age 60 or older 2. Severe photo aging 3. Yellow-grey skin 4. Precancerous lesions

Table 3-Applications of nanomaterial in cosmetics industry [30]

PRODUCT	PROPOSED USE	MANUFACTURER	MARKETING CLAIMS
Hydra Flash Bronzer Daily Face moisturizer	Moisturizer	Lanco`me	Nano capsules of pure Vit E provide powerful antioxidant protection and ensure a natural, healthy glowing skin.
Lanco`me Renergie Micro lift	Anti-wrinkle	Lanco`me	Formulated with colloidal silica and soy protein NPs to provide the best possible face-lift effect.
Eye Contour Nano lift	Anti-wrinkle, Antiaging	Euoko	They provide instant and long term smoothness, give the eye area more radiance, and diminish the appearance of dark circles
Clearly It! Complexion Mist	Antiacne	Kara Vita	This Nanosphere-based product tackles acne conditions and balances sebum production.
Fresh As A Daisy Body Lotion	Body lotion	Kara Vita	This lotion uses Nano spheres to quickly penetrate, moisturize, and nourish all types of skin

Table 4-The major aspects regarding safety, quality and regulation of Nano-cosmeceuticals used in cosmetics for different parts of the world [28]

S. No	COUNTRY	REGULATORY AUTHORITY	REMARKS
1	United States	Food and Drug Administration (FDA)	Regulatory guidelines for industries released in June, 2014 for safety aspects of various Nano-cosmeceuticals. FDA informs industries about unsafe Nano- cosmeceuticals to control their use in Nano-cosmetics.
2	European Countries	European Union (EU)	In 1976, EU framed its regulatory guidelines for safety of cosmetics and amended in 2007; and pre- market evaluation is required for cosmetics. EU regulatory guidelines for safety of Nano-cosmetics were released





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			in 2009 and amended in 2012. As per EU regulatory guidelines, unstable molecules (such as liposomes) are not considered Nano-cosmeceuticals. It is mandatory to provide safety data of 6 months in advance of getting approval for any new Nano- cosmetic.
3	Australia	National Industrial Chemicals Notification and Assessment Scheme (NICNAS)	NICNAS guidelines implemented in Jan, 2011 and the main objective of these guidelines is the identification of Nano-materials (either nanomaterial of an existing compound or a novel compound). Nano-materials of novel compounds require approval followed by evaluation performed by NICNAS and self-analysis carried out by producers are not acceptable.
4	Japan	Ministry of Economy, Trade and Industry (METI) and National Institute of Occupational Safety and Health Japan (JNIOSH)	METI observes safety assessment of nanomaterial at industrial level in Japan, since 2008.
5	Canada	Health Canada and Environment Canada	Delivered a working definition of Nano-materials; means of collecting information on use, characteristics and safety issues of the nanomaterial reaching market.
6	Brazil	Committee of Nanotechnology	National Agency for Sanitary Vigilance carried out a debate on the increasing usage of nanotechnology in Oct 2012 and an Ordinance was passed in July 2013 and Committee of Nanotechnology was framed.
7	China	National Steering Committee for Nano science and Nanotechnology (NSCNN)	NSCNN was established in 2010 by Ministry of Science and Technology for the regulation of nanotechnology products in China.

<p>Fig.1:Skin Aging</p>	<p>Fig. 2: Nano cosmeceuticals</p>





Introduction to Computer Graphics Technology: An Overview

A.V. Radhika*

Lecturer, Department of Computer Science and Engineering, Government Polytechnic, Hosadurga-577527, Karnataka, India

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*Address for Correspondence

A.V. Radhika

Lecturer,

Department of Computer Science and Engineering,

Government Polytechnic,

Hosadurga- 577527, Karnataka, India



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ABSTRACT

The present study focused on basics of computer graphics is reviewed based on the published literature as carried out by different researchers. Computer graphics technology has become widely used as computer technology has advanced. The advancement of graphics technology in computer software systems is especially aided by the success of multimedia technology and object-oriented technology. As a result, computer graphics theory and technology have grown in importance in the field of computer science, and computer graphics technology is expanding into more and more application areas. The traditional method of resource management communication has become ineffective in recent years due to the growth of the social economy and, in particular, the rapid advancement of information technology. In this instance, the current communication resource management is still utilizing the original management tools and methods, as well as equipment management and maintenance for resource management, which caused numerous issues. In communication resource management, it is very hard for non-professionals to understand the equipment and the situation. Managers are unable to quickly and accurately comprehend the resource conditions, which results in a relatively low utilization of resources. This review paper proposes incorporating computer graphics technology into communication resource management to address the aforementioned issues. Computer graphics not only make resource management communication more vivid, but they also lower resource management costs and make work more efficient.

Keywords: Computer graphics, Technology; communication resource management; Applications.





INTRODUCTION

Computer graphics combines art, technology, and creativity, it is frequently regarded as a fascinating and enjoyable field. New consumer-level devices (like head-mounted displays) and media (like 3D videos on YouTube) have enabled a much larger segment of the population to experience and produce 3D content over the past few years. But teaching computer graphics can be hard because it requires a lot of different skills, like math, physics, programming, spatial reasoning, solving problems, and art and design. This issue has been recognized by a number of researchers, who have attempted to simplify and improve computer graphics instruction. However, according to Thomas Suselo et al (2017), there does not appear to be any agreement regarding the primary difficulties that educators must overcome or the concepts and approaches that could assist them in doing so. Any sketch, drawing, or special network that visually conveys some significant information is considered a graphic. When a set of images needs to be manipulated or when an image made of pixels is drawn on a computer, computer graphics is used. Digital photography, film, entertainment, electronic gadgets, and all other core technologies that are required can all benefit from computer graphics. (www.geeksforgeeks.org,2022) It is a vast area of computer science research. The art of using programming to draw images onto computer screens is known as computer graphics. Data creation, manipulation, and computation are all part of it. To put it another way, a rendering tool for the creation and manipulation of images is what computer graphics is.

Communication resource management has also evolved as a result of information technology, particularly in light of the rapid evolution of the current resource management. Equipment was stuffed into a lot of rooms by various departments. The system structure is becoming increasingly complex as a result of system equipment upgrades on a regular basis. The requirements for efficient management of all communication resources cannot be met by the conventional method of resource management. In the field of communication resource management, the original artificial separation, non-real, fragmented, manual site maintenance, and query management is still followed by the proportion of intelligent equipment. Utilization of resources is relatively low. Managers, operation and maintenance, and scheduling all receive a lot of repeating work. Communication resource management is significantly affected by staff turnover, and new employees cannot immediately assume management responsibilities. In resource management, it is extremely challenging for non-professionals to comprehend the equipment and circumstances. Managers are unable to quickly and accurately comprehend the resource situation due to the relatively low utilization of resources. The system fault handling, system resource query, and resource allocation processes are enhanced by this traditional approach (Olson, 2016; Jing Li et al.,2017). The difficulties associated with resource search, communication management, and maintenance have emerged as current hot topics.

Computer graphics encompasses a variety of activities, including image or data manipulation and graphical representation. Digital synthesis and its manipulation necessitate a variety of technologies. Its applications include object design, animation, simulation, and more. However, computer graphics gained prominence after monitors were introduced. These are a few more important input and output devices for the idea of computer graphics. Light pens and color monitors with high resolution are among them. The fundamentals of joysticks, mice, and other similar devices will be explained. Identifying which areas of the screen should be illuminated and which should not is all that computer graphics is about. The majority of regular figures, such as circles, straight lines, and so on, are represented by equations in math. The first step in computer graphics is to convert such equations into a sequence of points, such as picture cells or pixels that need to be illuminated (in the case of raster graphic display) or simply covert it into a curve that needs to be traced on the screen. Because many times these jobs need to be done quickly and efficiently, you will be introduced to a number of such algorithms as well as their limitations. We also look at the idea of transformations. When an existing drawing needs to be moved to a new For various operations, simple transformation matrices are also introduced. In addition, it's possible that we'll draw pictures that are larger than what can be seen on the screen. We have a method for "clipping" it to the required dimensions in these situations. Additionally, we have plans for fitting a particular image into a "window" of a suitable size and location.





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There are essentially two categories of computer graphics:

- 1) Interactive computer graphics that allow users to interact with the image displayed on a computer screen. Here, the user and the image communicate in both directions. The user has complete control over the image. Example. When playing a computer game, the user has complete control over the image. The image moves on the screen based on the user's wishes.
- 2) In Non-interactive computer graphics, the user has no control over the image in any way. Image is merely the output of a static stored program and will operate linearly in accordance with the program's instructions. The program's instructions, not the user, have complete control over the image. Screen savers, for instance (Sharada Vikas Trust, 2008).

History of Computer Graphics

People were interested in having computers draw pictures from the beginning of computing. On line printers, spaces and symbols were meticulously printed on successive lines to create data graphs. Whirlwind's output included computer-driven cathode ray tube (CRT) displays (4.v.). PC (1950) and the Wise Air Protection Framework (mid-1950s). Early computer systems included input devices that predated the light pen and mouse. When Ivan Sutherland created the "Sketchpad" drawing system in 1963, he set the standard for interactive computer graphics. Input and interactive methods for creating line drawings, such as pointing, dragging, and icons, are still utilized in this system. Software is still influenced by this system's use of a hierarchical approach to building objects from simpler components.

Computer graphics were being used in manufacturing and design by the middle of the '90s. The realization that the computer could assist with these drawing-intensive activities led to the development of computer-aided design (CAD) and computer-aided manufacturing (CAM). Projects were created to assist with lens design (Itek) and car design. Graphics had great potential, but there were limitations that prevented its widespread use. Hardware for graphics was extremely specialized and pricey. Programs for these devices were difficult to write because there were no standards, and the results could not be transferred to other systems. In addition, it was challenging to create interactive systems with reasonable and consistent response times due to the slow speed of graphics hardware.

The hardware used to control a graphics display in the past was very different from the hardware used today. Displays were vector-based and monochrome in the 1960s, with every image drawn as a collection of lines. A CRT, a display list, and a display processor made up a complete display system. The display processor's sole responsibility was to repeatedly draw the lines on the CRT, which were stored as a series of points in the display list. The points in the display list had to be altered in order to change the image that was displayed on the screen. Using an electron beam and a phosphor, CRTs of the past and present produce an image. The electron beam is deflected along the line's path in order to draw a line on the screen. The phosphor is energized when the electrons strike it. The phosphor then releases this additional energy as light. As more energy is released, this light diminishes over time. The viewer will be able to see the phosphor dimming and the image will appear to be flickering if the phosphor's energy is not refreshed at least 30 times per second.

The fact that it takes longer to return to the beginning of the list to begin redrawing the image is one issue with vector-based displays when the image becomes more complex. The phosphor's energy may have depleted to the point where the image begins to flicker if this period lasts long enough. An image didn't have to be very complicated for this to become a problem due to the limitations of early computers in terms of speed. The direct-view storage tube (DVST) was Tektronix's alternative strategy in the latter part of the 1960s. A special mesh near the phosphor could store the image being displayed in this technology. As a result of this mesh constantly attracting electrons to the phosphor necessary to display the image, it was refreshed. The mesh would be "erased" whenever a new image





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was to be displayed, prompting the screen to flash before the new image was drawn (McConnell, Jeffrey & Carson George, 2003).

Data Collection

Secondary data is collected on various issues of computer graphics technology by referring journals, monographs and web references. This data is useful for computer science students.

Types of Computer Graphics

Raster Graphics: Pixels are used for an image to be drawn and also known as a bitmap image in which a sequence of images is into smaller pixels. A bitmap indicates a large number of pixels .

Vector Graphics: In this, mathematical formulae are used to draw different types of shapes, lines, objects, and so on.

Cathode Ray Tube

The video monitor is a graphical system's primary output device. The Cathode Ray Tube (CRT), as depicted in the following illustration, is the primary component of a video monitor. The electron gun produces a beam of electrons and cathode rays, and focusing and deflection systems direct the electron beam to specific positions on the phosphor-coated screen. CRT's operation is straightforward. At each position where the electron beam comes into contact with the screen, the phosphor emits a tiny light. In a raster scan system, the electron beam is sweep crossways the screen one row at a time. This method quickly redraws the image (www.tutorialspoint.com). There are two ways Random scan and Raster scan by it can display an object on the screen.

Raster Scan

In order to produce a pattern of illuminated spots, the intensity of the electron beam is toggled on and off as it moves across each row. The Refresh Buffer or Frame Buffer is a memory area where picture definitions are stored. The set of intensity values for each screen point is stored in this memory area. In the next illustration, stored intensity values are retrieved from the refresh buffer and "painted" on the screen one row scan line at a time. A pixel picture element, or pel, is the name given to each point on the screen. The electron beam returns to the left side of the screen at the conclusion of each scan line to begin displaying the subsequent scan line (www.tutorialspoint.com).

Random Scan Vector Scan

Instead of scanning from left to right and top to bottom as in raster scan, the electron beam in this method is focused only on the area of the screen where the image is to be drawn. Calligraphic display, stroke-writing display, and vector display are all other names for it. In a memory area known as the refresh display file, picture definition is saved as a collection of line-drawing commands. The system draws each component line in turn using the set of commands in the display file to display a particular picture. The system returns to the first line command in the list after processing all line drawing commands. Displays with random scans are made to draw all of a picture's lines 30 to 60 times per second.

Communication Resource Management and Computer Graphics Technology

The utilization of computer graphics technology in resource management is made possible. This topic uses communication resource management as an example to explain this technology because it covers a wide range of topics. A wide range of equipment has always been a hallmark of communication resource management. The manager experiences a significant amount of inconvenience as a result of the large quantity of equipment. This issue is addressed by utilizing computer graphics display and room equipment for communication resource management. Additionally, it fully embodies the advantages of graphics technology in resource management and can be represented in a variety of ways (Moreira et al., 2016).

With the rapid growth of information these days, resource management in communication has taken on a newfound significance. Communication resource management is a huge idea that covers a lot of ground. The transmission room, the wiring room, and the outside line are the three primary components of the data entities in transmission





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that are referred to. The communication resource management system, on the other hand, is a typical complex project because of the system's complex data types. System data can come from a variety of sources, including communication, databases, geographic information systems (GIS), networks, and other technical fields. Communication station equipment maintenance and duty management issues brought on by an increase in communication traffic can now be addressed by implementing a communication resource management system, particularly through the use of computer graphics technology. Additionally, this application improves the operational efficiency of the staff and reduces the difficulty of management as well as the strength of system resources (Matsushita et al.,2016; Jing Li and others ,2017). The staff of the department are able to achieve management on a paperless office, digital management, and graphical management on the basis of this technology, which meets the requirements of communication users for the communication resource management system.

Computer Graphics Technology

As a result of the aforementioned issues, resource management must be effective. As a result, resource management naturally incorporates computer graphics technology. The aforementioned issues can be resolved and communication resource management greatly simplified if graphics are incorporated into a resource management system, particularly communication resource management in the form of a graphical representation of communications room equipment. Simply put, the use of computer graphics makes resource management for users easier. The following highlights the significance and benefits of incorporating computer graphics technology into resource management systems (Samdanis and Rost, 2016; Jing Li and others ,2017):

- (1) The equipment room can be visualized through the use of graphic technology in resource management. The graphical display greatly facilitates communication resource managers because of the variety and complexity of communications equipment. In the meantime, the graphical technology makes it easy to check and complete work.
- (2) Graphics is a display that is easier to use. The computer display shows the resource management equipment with graphics, making it easy for new employees to familiarize themselves with the entire communication room and its equipment. This technology unquestionably boosts productivity at work (Zdarsky et al.). ,2016; Jing Li et al., 2017).
- (3) The computer-generated equipment in the communication room encourages resource sharing. The competent leadership will be able to quickly comprehend the situation through computer graphics without having to appear in person. Computer graphics technology is quickly being integrated into communication resource management as a result of the aforementioned benefits. This will significantly reduce the workload of communication resource managers, increase work efficiency, and have positive social and economic effects.

Computer Graphics Surfaces

Polygon Surfaces

The illustration of things is as a collected works of surface. There are 2 types of representations for three-dimensional objects. Boundary representations concept depicts a three-dimensional object as a collection of surfaces that divide the interior of the object from the surrounding environment. Space-partitioning representations: This type of boundary representation divides the object's spatial region into a collection of small, non-overlapping, contiguous solids, typically cubes, to describe the object's interior properties. The most common boundary representation for a 3D graphics object is a collection of surface polygons that enclose the object's interior. For the purpose of object description, a set of polygons is stored. Since all surfaces can be described by linear equations, this makes surface rendering and display easier and faster. Because their wireframe display can be done quickly to provide a general indication of surface structure, the polygon surfaces are frequently used in applications for design and solid modeling. The illumination is then used to create realistic scenes by interpolating shading patterns across the surface of the polygon.

Polygon Tables

The set of vertex coordinates and associated attributes defines the surface in this approach. From v1 to v5, there are five vertices, as depicted in the following figure. The information about the x, y, and z coordinates that is stored at each vertex is shown in the table as v1: x1, y1, z1. Polygon edge information is stored in the Edge table. Edge E1 is





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shown in the figure below to be located between vertex v_1 and v_2 , and it is denoted as E_1 in the table: v_1, v_2 . The polygon's number of surfaces is stored in the polygon surface table. Edges E_1, E_2 , and E_3 cover surface S_1 in the figure below, which can be represented as S_1 in the polygon surface table: E_1 through E_3 .

Polygon Meshes

A set of polygonal and line elements can approximate 3D surfaces and solids. Polygonal meshes are names for such surfaces. Each edge in a polygon mesh can only be shared by two polygons. The "skin" of the object is the collection of polygons or faces. Graphics can be used to represent a wide range of solids and surfaces using this technique. Utilizing algorithms for hidden surface removal, a polygonal mesh can be rendered. There are three ways to represent the polygon mesh: explicit representation, points to a vertex list, and points to an edge list.

Merits

It can be used to model virtually any object

- As a collection of vertices, it is simple to represent them.
- They are simple to alter.
- On a computer screen, drawing them is simple.

Demerits

- Curved surfaces are difficult to accurately describe.
- It is challenging to imitate certain kinds of things, like liquid or hair.

Visible Surface finding

When look at a picture with non-transparent objects and surfaces, we can't see the behind-the-objects, closer-to-the-eye ones. To get a screen image that looks real, we need to get rid of these hidden surfaces. The term "hidden-surface problem" refers to the process of locating and removing these surfaces. The Image-space method and the Object-Space method are the two methods used to eliminate issues with hidden surface areas. The physical coordinate system is used to implement the object-space method, while the screen coordinate system is used to implement the image-space method. When want to show a 3D object on a 2D screen, need to find the parts of the screen that can be seen from a certain angle.

Depth Buffer Z-Buffer Method

Cut Mull developed this method. It takes into account image space. The fundamental idea is to test each surface's Z-depth to identify the closest visible surface. This technique processes each surface individually, one pixel position at a time, across the surface. The color that will be displayed in the frame buffer is determined by comparing the depth values of each pixel and selecting the closest and smallest surface. It works great when applied to polygonal surfaces. It is possible to process surfaces in any order. Two buffers, the frame buffer and the depth buffer, are utilized in order to distinguish the far-away polygons from the closer ones. As surfaces are processed, depth values for the x and y positions are stored in the depth buffer. The intensity value of the color at each position x,y is stored in the frame buffer. Typically, the z -coordinates are normalized to the $[0, 1]$ range. The back clipping pane is indicated by the z -coordinate value 0 and the front clipping pane by the z -coordinate value 1.

Advantages:

- If implemented in hardware, it alleviates the speed issue.
- Each object is processed at a time.

Disadvantages

- It calls for a significant amount of memory.
- It takes a long time to complete.





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The scan-line method

It is an image-space approach for determining the visible surface. A single scan-line's depth information is provided by this method. We need to group and process all polygons that intersect a given scan-line simultaneously before processing the next scan-line in order to only require one scan-line with depth values. For this, two crucial tables—the edge table and the polygon table—are maintained.

The Edge table contains pointers into the polygon table that connect edges to surfaces, as well as the coordinate endpoints of each scene line and its inverse slope.

The plane coefficients, surface material properties, and other surface data are all contained in the polygon table, which may also serve as pointers to the edge table.

An active list of edges is generated to make the search for surfaces crossing a particular scan-line easier. In addition, a flag is set for each surface to indicate whether a position along a scan-line is inside or outside the surface. The active list only stores edges that cross the scan-line in order of increasing x .

Each scan-line's pixel positions are processed from left to right. The surface flag is on at the intersection with a surface on the left, and it is off at the intersection with a surface on the right. Only when multiple surfaces have their flags activated at a particular scan-line position are depth calculations required.

Area-Subdivision Method

The area-subdivision method makes use of this by locating the view areas that are a portion of a single surface. Divide the entire viewing area into increasingly smaller rectangles until each increasingly smaller area projects either a portion of a single visible surface or none at all. Maintain this procedure until the subdivisions are reduced to the size of a single pixel or until they can be easily analyzed as a single surface. At each step, sequentially divide the area into four equal parts is an easy method. A surface can have four different relationships with a particular area boundary.

- A surface that completely surrounds the area
- An overlapping surface is one that is both inside and outside the area at the same time.
- An inside surface is one that is entirely contained within the area.
- A surface that is completely outside the area is an outside surface.

These four categories can be used to describe the tests that are used to determine surface visibility within a given area. If one of the following conditions holds true:

- All surfaces are outside surfaces in relation to the area, then no further subdivisions of a particular area are required.
- The area only has one interior, overlapping, or surrounding surface.
- All other surfaces within the area's boundaries are obscured by the surrounding surface.

Back-Face Detection

The "inside-outside" tests serve as the foundation for a quick and straightforward object-space approach to determining the polyhedron's back faces. When an inside point is along the line of sight to the surface, the polygon must have a back face because we are inside that face and cannot see the front from our viewing position. Points x , y , and z are "inside" polygon surfaces with plane parameters A , B , C , and D . In a right-handed viewing system with viewing direction along the negative ZV axis, the polygon is a back face if $C < 0$. Also, we cannot see any face whose normal has z component $C = 0$, since viewing direction is towards that polygon. Thus, in general, label any polygon as a back face if its normal vector has a z component value $-C \leq 0$

Packages that use a left-handed viewing system can make use of similar strategies. In contrast to the dinaright-handed system, these packages enable the calculation of plane parameters A , B , C , and D from polygon vertex coordinates specified in a clockwise direction. Additionally, when the viewing direction is along the positive Zv axis,





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back faces have normal vectors that point away from the viewing position and are indicated by $C \geq 0$. We are able to immediately identify each of the back faces by looking at parameter C for each of the various planes that make up an object.

A-Buffer Method

The depth-buffer method is complemented by the A-buffer method. The Lucas Film Studios-developed A-buffer method is a visibility detection method for the rendering system *Renders Everything You Ever Saw RE Yes*. The A-buffer method extends the depth buffer method to allow for transparency. The accumulation buffer is the A-buffer's most important data structure. A-buffer has 2 fields –Depth field stores either a positive or negative real number

Intensity field stores a pointer value

The depth of a single surface that covers the corresponding pixel area is the value stored at that position if depth is greater than or equal to zero. The intensity field then stores the percentage of pixel coverage and the RGB components of the surface color at that point. Multiple surface contributions to the pixel intensity are indicated if depth is less than zero. A pointer to a linked list of surface data is then stored in the intensity field. The RGB intensity components, the opacity parameter, the depth, the percentage of the area covered, and the surface identifier make up the A-buffer's surface buffer. The algorithm works in the same way as the depth buffer algorithm. The final color of a pixel is determined by using the depth and opacity values.

Depth Sorting Method

The depth sorting method makes use of both operations in object space and image space. The depth-sorting technique has two fundamental components: First, the surfaces are sorted in decreasing depth order. Second, the scan-converted surfaces are arranged in order, beginning with the deepest surface. In image space, the scan conversion of the polygon surfaces takes place. The painter's algorithm is a term used to describe this approach to resolving the hidden-surface problem. The depth effect is depicted in the below figure: The depth sort is the first step in the algorithm. For instance, the closest z value of any polygon vertex can be used as the initial "depth" estimate. Let us select the polygon P at the list's end. Take into account all Q-polygons with z-extents that overlap P. We run the following tests before drawing P. We can assume that P can be drawn before Q if any of the following tests are positive:

- Do the x and y extents not overlap?
- From the perspective of Q, is P entirely on the opposite side of the plane?
- Is Q entirely on the same plane as the viewpoint as P?
- Do the polygons' projections not overlap?

Split either P or Q using the plane of the other if all tests fail. The process continues as the new cut polygons are inserted into the depth order. In theory, this partitioning could result in $O(n^2)$ distinct polygons; however, in practice, the number of polygons is much lower.

Binary Space Partition (BSP)Trees

Visibility is determined through the use of binary space partitioning. Start with polygons and label all edges before building the BSP trees. Extend each edge so that it divides the plane in two, working with just one edge at a time. As the root, insert the tree's first edge. Based on whether they are inside or outside, add subsequent edges. Edges that extend beyond an existing edge in the tree are divided in half and added to the tree as two new edges.

- Take A as the first root from the previous illustration.
- Make a list of all the nodes, as shown in figure a.
- Place all of the nodes that are in front of root A on the left side of node A and all of the nodes that are behind root A on the right side, as shown in figure b.
- Process all of the nodes that are in front of the root first, then the nodes that are behind the root.





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- As depicted in figure c, the node B will be processed first; because there is nothing in front of the node B, NIL has been placed there. However, since node C is behind node B, it will move to the right of node B.
- Perform the same procedure for node D.

Computer Graphics Fractals

Fractals were discovered by Dr. Benoit Mandelbrot, a French-American mathematician. The Latin word fractus, which means broken, is where the term fractal comes from. Fractals are extremely intricate images that are produced by a computer from a single formula. Iterations are used to create them. This indicates that the outcomes of the previous iteration are taken into account each time a single formula is applied with slightly different values.

Among the many applications of fractals are:

- The study of galaxies and the Saturnian rings, among other things
- For depicting bacteria cultures, chemical reactions, human anatomy, molecules, and plants;
- For depicting clouds, coastlines, and borders; fractal art, fractal music, landscapes; special effects, data compression, and diffusion;

Generation of Fractals

As can be seen in the following figure, a fractal can be created by repeatedly utilizing the same shape. An equilateral triangle is depicted in a figure. We can see in figure b that the triangle is repeated to form a star-shaped shape. As in figure c that the star shape from figure b is repeated multiple times to create a new shape. To get the shape to want, can iterate indefinitely. Recursion is the programming term for creating such shapes.

Geometric Fractals

Shapes found in nature with non-integer or fractal dimensions are the focus of geometric fractals. We begin with a particular geometric shape known as the initiator to geometrically construct a deterministic non-random self-similar fractal. The generator is the pattern that replaces the subparts of the initiator. Construct a good pattern by repeating the initiator and generator shown in the preceding figure. At each step, the initiator replaces each straight-line segment with four equal-length line segments. The fractal measurement is 1.2619 and the scaling factor is $1/3$. In addition, the length of each line segment in the initiator increases by a factor of $4/3$ at each step, so the fractal curve tends to be infinite as more details are added, as shown in the below figure.

Animation

In computer graphics, animation refers to giving life to any object. It has the ability to give even the most inanimate objects life and emotion. There are two types of computer animation: computer-generated animation and computer-assisted animation. It can be shown in the film. The fundamental idea behind animation is to play back recorded images at a rate that fools the human eye into thinking they are moving in a continuous loop. A series of dead images can come to life through animation. Computer-aided design (CAD), scientific visualization, training, education, e-commerce, and computer art are just a few of the many applications of animation. Techniques for Animation have developed and utilized numerous animation techniques. In essence, there are six animation techniques, each of which will be discussed individually in this section.

Frame by frame: Traditional animation In the past, most of the animation was done by hand. It was necessary to manually draw each frame in an animation. It can take a lot of work to make even the shortest of movies because 24 frames are needed for each second of animation.

Procedural: In a procedural animation, the objects are animated not by keyframing but rather by a procedure a set of rules. Rules and initial conditions are set by the animator, and the simulation is run. Mathematical equations often serve as the basis for rules that are based on real-world physical rules.





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Behavioral: In behavioral animation, an autonomous character has some control over its actions. This frees the animator from having to specify every aspect of each character's movement and gives the character some improvisational ability.

Performance-Based Motion Capture

It is another method that uses magnetic or vision-based sensors to record the three-dimensional actions of a human or animal object. The data are then used by a computer to animate the object. A number of well-known athletes can now play the roles of characters in sports video games thanks to this technology. Because some common human actions can be captured with relative ease, motion capture is quite popular among animators. However, problems with precise execution may arise if there are significant inconsistencies between the subject's shapes or dimensions and the graphical character.

Physically Based Dynamics

In contrast to key framing and motion pictures, simulation generates motion for pictures and other objects by utilizing the laws of physics. While maintaining physical realism, simulations can easily be used to produce slightly different sequences. Second, real-time simulations enable a greater level of interactivity, allowing the player to control the simulated character's actions. Key-framing and motion select and modify applications, on the other hand, create a pre-computed library of motions. The expertise and time required to handcraft the appropriate controls systems is one limitation of simulation.

Key Framing

An animation change is defined in a keyframe. When we create animation frame by frame, each frame is a keyframe. When making a computer-generated 3D animation, it is common practice to not specify the precise position of any given object on each frame. Keyframes are made by them. An important frame in which an object alters its size, direction, shape, or other properties is known as a keyframe. The animator saves a significant amount of time by letting the computer figure out all of the frames in between. The frames drawn by the user and the frames created by the computer are shown in the following illustrations.

Purpose of Computer Graphics Technology

The computer equipment in the communication resource management is taken as an example to analyze and give details the application of computer graphics technology. The purpose is to use computer graphics technology and combine the actual needs of the equipment in the communication resource management. The room equipment is displayed graphically on a computer. Various communications departments put into a large number of room and communications equipment. Due to the continuous upgrading of system equipment, the system structure is more and more complex (Lynch et al.,2017). The traditional way of resource management has been unable to meet the effective management of the entire communication resource needs. The proportion of intelligent equipment is growing, but it is still following the original site maintenance and query management in the resource management. The task is very heavy, and it is also inconvenient in the management and viewing. In addition, it improves the efficiency of resource managers and puts forward a new idea of resource management (Schultz et al.,2016; Jing Li et al.,2017). Computer Graphics are used for a design for engineering and architectural system- These are used in electrical automobiles, mechanical, electronic devices such as in gears and bolts.

- Useful in MS Paint.
- It is used in statistical scientific or economic data like Bar chart, Line chart.
- Helpful in motion pictures, videos, television and games.
- It is also used for framing captains, pilots and so on.
- To analyzing satellite photo of the earth.

In Multimedia applications the idea of virtual reality, in which one can experience an unreal experience, was inspired by the use of sound cards on computers to produce sound effects. The ability of computers to convert electronic



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signals (0 and 1) into data and then on to figures and pictures has made it possible for us to get photographs of distant planets like Mars being reproduced here on the earth in almost real time, just like going through an un built house to see how it feels inside once it is built. In Simulation the availability of easily interactive devices (the mouse is one of them; we will see a few more later in the course) made it possible to construct simulators, such as flight simulators, in which the trainee participates. Simulation is essentially a mockup of an environment elsewhere to study or experience it. Sitting in front of a computer, he can use interactive devices in the same way as if he were controlling a flight. The changes expects to see outside s window are shown on the screen, so one can learn how to operate a flight before trying his hand at flying. Computers' graphic capabilities are utilized in a wide range of fields, including criminology (to recreate the faces of victims, assailants, and so on). fields of medicine (reproducing images of internal cavities). Using signals from miniature cameras), recapturing images from satellites (Sharada Vikas Trust,2008).

CONCLUSION

Computer graphics technology has become widely used as computer technology has advanced. The computer can be used to implement graphical management of communication resources by the management system. Additionally, the system makes it possible to accurately and punctually determine the communication network's current state in real time. Digitization of resource management for the communication network is also accomplished. Resource management does come with some drawbacks, however. Numerous issues have arisen as a result of the traditional approach to resource management's failure to meet the requirements of all social resources. In order to create a more vivid picture of resource management, this review paper proposes the utilization of computer graphics technology in resource management. Utilizing this brand-new technology, a number of realistic issues are resolved, the expense of resource management is decreased, and work efficiency is enhanced.

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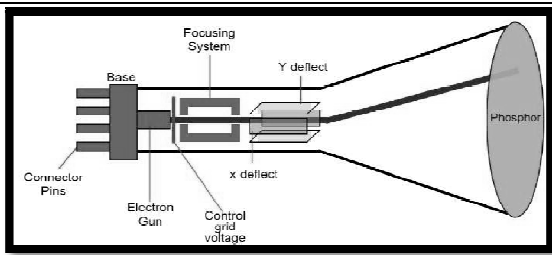


Fig.1. Cathode Ray Tube

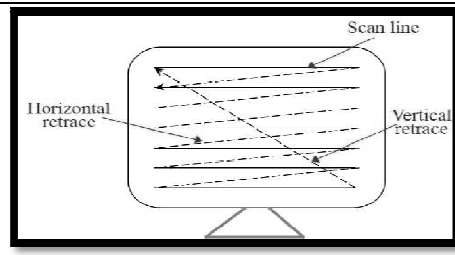
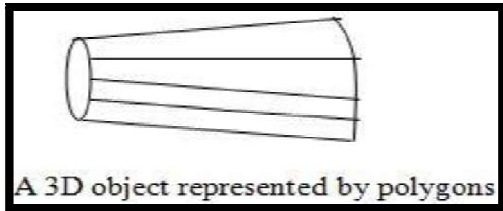


Fig.2. Raster Scan



A 3D object represented by polygons

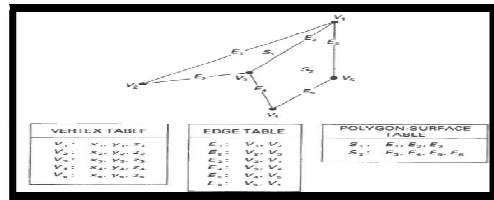


Fig.4. Polygon Tables

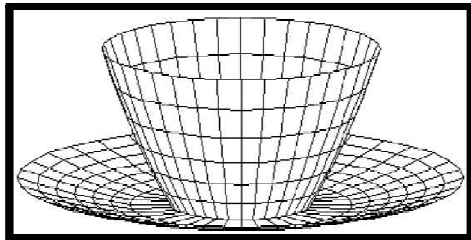


Fig.5. Polygon Meshes

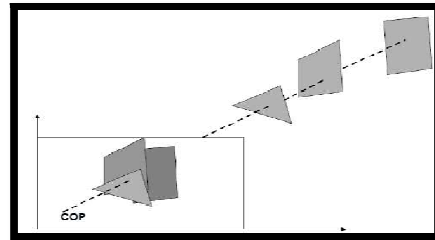


Fig. 6. Depth Buffer Z-Buffer Method

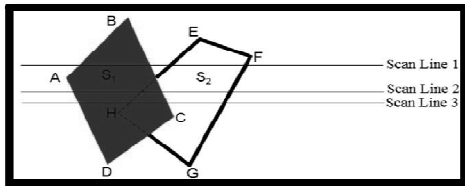


Fig.7. The scan-line method

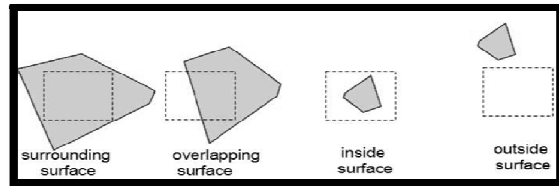


Fig.8. Area-Subdivision Method

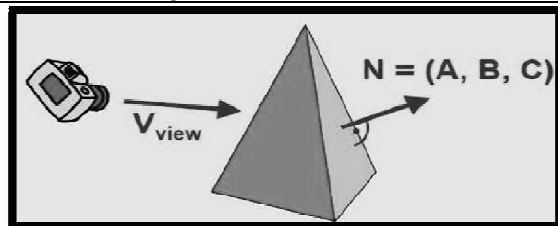
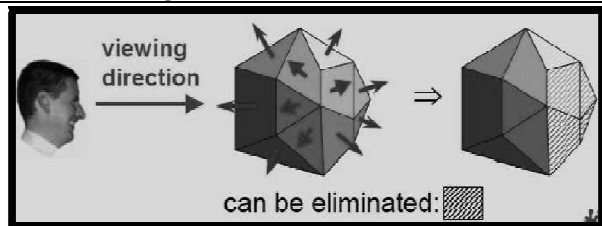


Fig.9. Back-Face Detection





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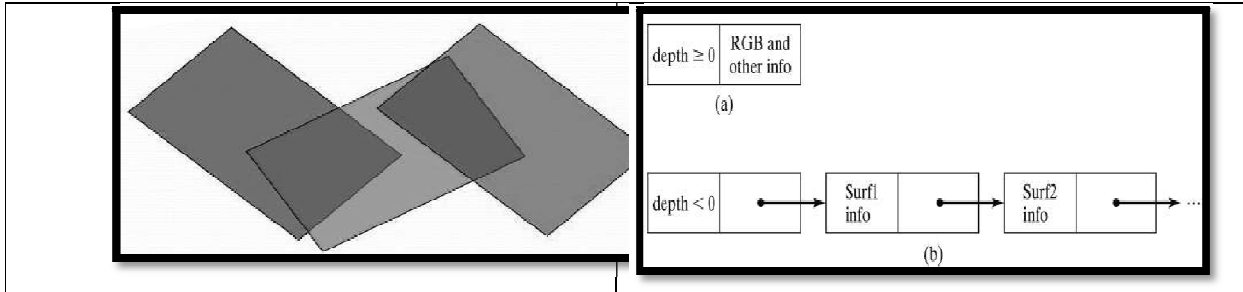


Fig.10. A-Buffer Method

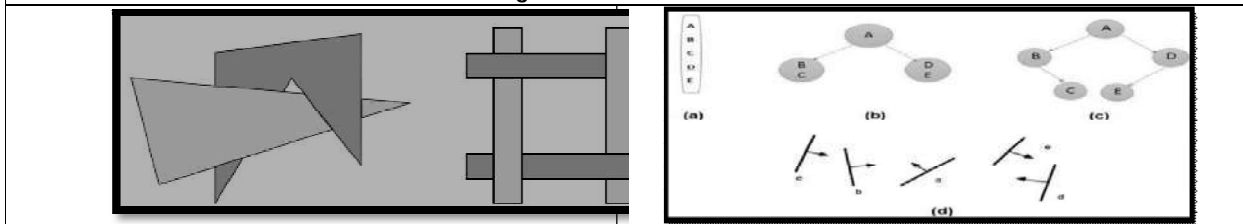


Fig .11 .Depth Sorting Method

Fig.12. Binary Space Partition (BSP)Trees



Fig.13. Computer Graphics Fractals

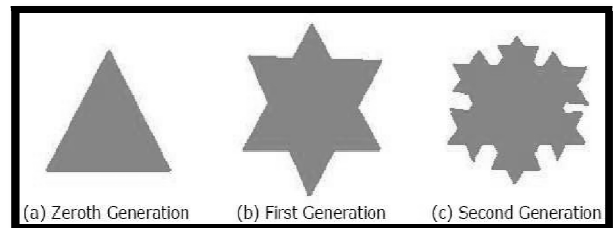


Fig.14. Generation of Fractals

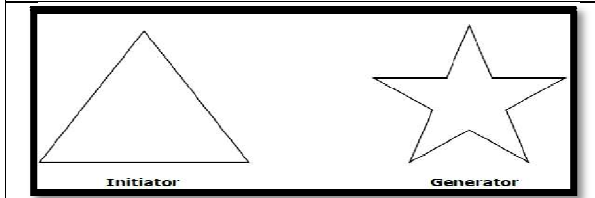


Fig.15. Geometric Fractals

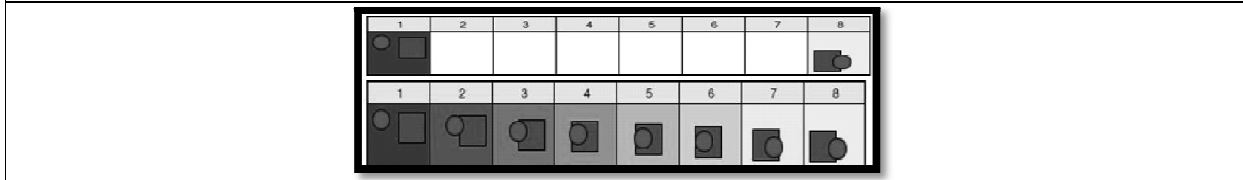
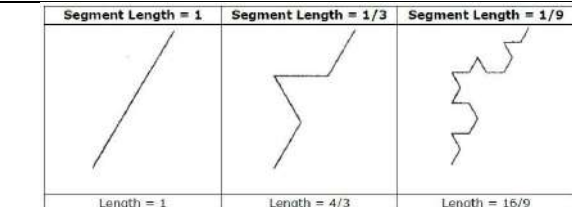


Fig.16. Key Framing





A Short Review of Path Planning Methods for Autonomous Surface Vehicle with Collision Free Movement

Keren Lois Daniel¹ and Ramesh Chandra Poonia²

¹Amity Institute of Information Technology, Amity University Rajasthan, Jaipur, India - 303002

²Department of Computer Science, CHRIST (Deemed to be University), Bangalore, Karnataka, India.

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*Address for Correspondence

Keren Lois Daniel

Amity Institute of Information Technology,

Amity University Rajasthan,

Jaipur, India - 303002

E. Mail: kerenldaniel@gmail.com



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ABSTRACT

The momentum of Autonomous surface vehicles is gaining more attention throughout the world, due to the necessity of safety and potential benefits for an efficient system of navigation. Many researchers have showed interest in seeking out new methods of path planning that can reduce the collision risks in ASVs, which in fact have caused many researchers to develop methods for path planning and collision avoidance, groundings, and abandoning accidents at sea, with costs and time. In this paper we present the theoretical review of methods used for path planning of autonomous surface vehicles moving along with marine area and the challenges of ASVs. The method of obtaining the path is with prediction knowledge along with the vehicle speed that minimises the motion time while considering vehicle dynamics, topography, obstacles, and path mobility. The area is represented by a span of grid in a matrix that are mapped to the area using various methods of path finding algorithm. The optimal path is computed by first obtaining the best obstacle free path from all paths represented by the selected algorithm of research. This path is further optimized with a local optimization, using the optimal path planning along the path taking the cost function. Artificial intelligence is an the upcoming technology for ASVs, with methods such as transforming algorithms, artificial potential fields, fast marching methods, and many more becoming popularly increasing to solve problems of path planning and collision avoidance. This paper presents the different techniques existing for path-planning of autonomous surface ships and offers a comparative study of present path planning and collision avoidance algorithms for autonomous surface vehicles.

Keywords: AI, ASVs, Path Planning, Collision Avoidance, global path, Local path

INTRODUCTION

Autonomous Surface Vehicles (ASVs) have the capability to reduce the contribution of human driver error and carelessness as the cause of vehicle collisions. These ASVs must be able to move from a point A (source) to point B (Destination) safely and efficiently with respect to time, distance, energy, and other factors. Path planning is ignition key in determining and evaluating plausible trajectories in support of these goals. Path planning is an

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important tool for smart cargo ships that move in coastal areas of waters, inland waters, or other crowded areas. Ships require expert and intelligent systems to plan safe paths to avoid collision with both static and dynamic obstacles. Path planning is one most foremost basic and significant contents of finding out the operation of autonomous navigation ships. When path planning is done the aim is to search out a path between the source and the destination and target the path in a step by step move with analysing the criteria (shortest path, shortest time or least energy consumption, etc.), and associating it with the degree of curvature for autonomous ship and safety measures to reach the destination purpose. Several researchers have done a great deal of analysis on autonomous ships. Designs for autonomous navigation system for unmanned boats, sail boats and other marine vehicles have used biological process of algorithms to understand path coming up with during dynamic and unpredictable surroundings have been created [1]. The problem lies in motion designing of autonomous vehicles consists of choosing the geometric path and vehicle speeds thus on avoid obstacles and to attenuate some value perform, like time or energy. in depth work has thought on computing the geometric path, whereas very little attention has been given to choosing the best vehicle speeds and therefore the size of the ship. In recent times, pilotless Ground Vehicles (UGVs), pilotless Aerial Vehicles (UAVs) and pilotless Surface Vessels (USVs) are developed and researched [2]. With the growing technologies, the quick development of UGVs, UAVs and USVs has awakened several researchers to explore automated ships. In addition, the reshaping of the shipping business additionally contributes to the event of good ships, particularly reaching safely with the aim of reducing crew and human errors. Such a drive will be additional unconcealed from recent maritime market desires. Some building blocks of path planning and collision avoidance are common across packed waters and open sea, thus concerned with shorter span in congested waters. While doing the movements of navigation, robotic systems like ASVs, use the capabilities that involve training the environment and relocating the system's position within the current environment, controlling the directions, detecting, and avoiding obstacles, and moving within dynamic scenario that are complex and simple. The major problems of navigation are perception, localization, motion control, and path planning [3][4][5]. Path planning has allured attention since the early 70s, and since then researchers are into the enigmatic solution to solve problems throughout the contiguous route plan to take an appropriate action that is required to reach a certain goal. Path planning can be used in fully known or partially known environments, as well as in entirely unknown environments where information is received from system-mounted sensors and update environmental maps to inform the desired motion of the robot/AV[6]. As ASVs have augmented and progressively need free path which has become the recent space of focus in the field of autonomous management. Researchers have effectively made applications for fitting the necessary challenges visage for implementing the autonomous navigation smoothly. Many algorithms exist with varied pertinence determined by the system's mechanics, the environment's dynamics, robotic and sensor computations, and other information convenient to perform quality trade-offs as the situation may be.

The below figure illustrates the chronology of algorithm generated and simulated for the fulfilment of path planning and collision avoidance. All of these algorithms have successfully been used earlier for path planning of autonomous underwater vehicles (AUVs), and other vehicles. As years pass by challenges have also increased along the way with more and more updates on the environments. It is seeming like a never-ending process. From the existing reviews of the past years, there is a slight inclination towards the research of path planning and collision avoidance problem for ASVs. Many authors who have investigated a review do refer to both ASV and USV vessels. The reviews paper for AUV talks about the review of path planning algorithm [15]. The Fig. 1 gives us the most popularly used algorithms for path planning over the years for Collision Avoidance in ASVs or USVs. It is very clear that these algorithms have been victorious and have been used at early days for manoeuvring the (AUVs), unmanned aerial vehicles (UAVs), or autonomous ground vehicles (AGVs). This analysis of the popular algorithms are never ending as still increasing research are done day by day researchers.

Overview of Path Planning

Path planning is a Phenomenon to solve difficult and unmanaged problems in the field of artificial intelligence and within the field of Automation. The inclination for the working of robots and automatic machines is to generate a high speed and come with the shorter optimal solution. Sometimes speed becomes and obstacle for accuracy and motion of automaton since the time take to define the path and the curvature does not match in extreme situation.



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Therefore, care must be taken while generating a mechanical phenomenon that would be dead at high speed, however at a similar situation it is harmless for the automaton. For such reasons, path planning is associated with algorithms assuming an increasing significance in artificial intelligence. These algorithms generate a geometrical path, from the initial to a final destination, passing through pre-defined or dynamic points of connectivity in the path, Path planning algorithms are usually divided according to the methodologies namely, Geometric path:

- Bug Algorithm
- Define road maps
- Cell decomposition algorithms
- Artificial potential methods.

Trajectory planning

It is solution to the problem that is navigation or motion planning. The typical planning is as follows:

- Task planning – Designing the goals or strategy of move.
- Path planning – feasible path from a source to destination by connection through the way points.
- Trajectory planning – Creating scheduled path in a given constraint.
- Trajectory Control – When the path is planned the method of movement must be accurate.

Properties of Path Planning

The literature analysis in in. [7] shows that there are several properties of path planning and collision avoidance algorithms such as: -

- Compliance with COLREGs: This needs to be considered for collision avoidance.
- Obstacles in Environment: All natural elements that happen in the ocean.
- Path planning type: It can global or local.
- Type of Obstacle: Static and Dynamic
- Environment type: discrete or continuous environment.
- Testing: It can be simulated or field test.
- Types of Traffic: congested with static or dynamic obstacles
- Environment: known or unknown environment.
- Planning time: real-time
- No of obstacles: single or multiple
- Ship dynamics and kinematics: Maximum level of curvature, speed, and other constraints.

Path Planning Environment

Path planning can be categorized into two major categories: global path planning and local path planning [8][9]. The method or the definition of global path planning is mainly targeted for autonomous ships like robots.

Local path planning

Unlike global path planning, where static obstacles or obstacles of the natural environment is considered. In comparison with global path planning, local path planning is used to navigate dynamic environments where there are dynamic obstacles moving and the required information is available only in the predefined area.[10]. Varied sensors or devices can be used to obtain the dynamic information [12] [13] e.g., ultrasonic sensors, image sensors and automatic identification systems (AIS). Researchers have different thoughts and motives when researching the local path planning for information obtained [14]. The research that focus on optimization algorithms can accomplish a relatively best optimal path, which can put up with energy conservation and emission reduction on area of simulation.



**Keren Lois Daniel and Ramesh Chandra Poonia****Global**

Global path planning is an important matter of research in the field of transportation in the ASVs. This could even affect the development of unmanned vehicles to a certain extent. This method of global path planning is suitable for situations where a predefined environment is available with only static obstacles, beforehand [10]. From the existing literature on the shipping, heuristic searching methods and optimization methods are popular [11]. Heuristic methods of search have become very important in recent research due to the study of collision statistics. The revelation of these heuristic searching methods came from the working mechanism of different algorithms at different situations. They are A* algorithm, the Dijkstra algorithm, the genetic algorithm, particle swarm optimization, etc. The basic principle is to search for a relatively optimal path within a range that is free of danger from obstacles and generate the optimal path with less path cost (path length, energy consumption). The benefit of heuristic searching methods is that it mixes the possibility of the path in an extraordinary speed when finding the shortest-distance path and it's capable of adjusting to the influence of various factors in the path.

Challenges of Automated Surface Vehicle

From the above study of algorithms the concept of ASV has been more promising when we have a local path planning. Use of ASV has a high prospective to outperform the conventional methodology for more safety in the marine zone. There has been an increased approval for the performance of ASV. The use of ASV has and will reduce the man-made accidents which will increase the global trade efficiency of larger vessels. Though there has been a varied research carried out yet mistakes happen today, and the rate of marine accidents has not much changed. However, the advantages of ASV do not merely talk about safety but also the potentiality of using ASV in the future.

Benefits ASV

Using ASV we can

- Can remove human interference which has demand for dynamic environments.
- Can increase the secured communication and human needs are reduced (Lodging, boarding etc)
- Increases reliability when compared with manned vehicles.
- Less use of labour force which raises the security system where collision avoidance can be achieved.
- The level of performance in dangerous environment when compared with manned system gives rise to the thought of reliable remote control.
- In a design of ASV when the crew labour is reduced -administration cost and hospitality can be avoided which can reduce the life support facility in the ship.
- A cargo ship that can follow the technique of ASV does not need traditional manoeuvring, the sensors can be an optimal option for better result.

With significant work undergone in the framework of ASV still there are many flaws in regulations that are not yet clear. [7]. Few main issues that need to be challenged in ASVs are as follows:

- Onus of accident: When the collision takes place who will be responsible for the cause of the action and who will be accountable for the accident.
- Cyber Attacks: These days with the facility of ARPANET the security plays a vital role in cyber scam which is of prime concern. Any small flaw can give room for hackers who can take the full control over the ship.
- Navigational Safety: When a cargo ship travels in a dynamic environment there may be those obstacles that are suspicious and not recognised by AIS. Thus an autonomous ship can be ready to handle such things.
- Ship Maintenance: In an unmanned ship a thorough planning of monitoring system that must work individually and all these efforts need to be done prior to the journey from the source. Special care needs to be given.
- Network Connectivity: As most of the satellites are geostationary, which are placed on the orbit there might be a varied frequency or bandwidth challenge at a particular point of the ship location. Due to natural calamities the connectivity might be lost which is yet another challenge.





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- Attacks by Water Pirates: in an unmanned ship is quiet expensive with its high robotic technological assistance that might be of high value to the pirates of the sea.

CONCLUSIONS

A path planning approach based on improved algorithms for autonomous ships can be the best suited for future research prospects. The existing algorithms if corrected of its shortcoming will fall into the local minimum and the turning point of the global path, which could be more in line with existing navigation strategy. In this paper, we have presented a overview on path planning functionalities. From the given above information it is seen that planning path in dynamic environment is quite confusing when compared to static as the obstacles is not known before. The related information given above conclude that still there are various methods available for planning path in different environment which could be used in an efficient path planning technique with no collision in a dynamic obstacle behaviour. Further research would be made on global path for an effective method in dynamic environment with effective use of graphical based representation using the optimal algorithms.

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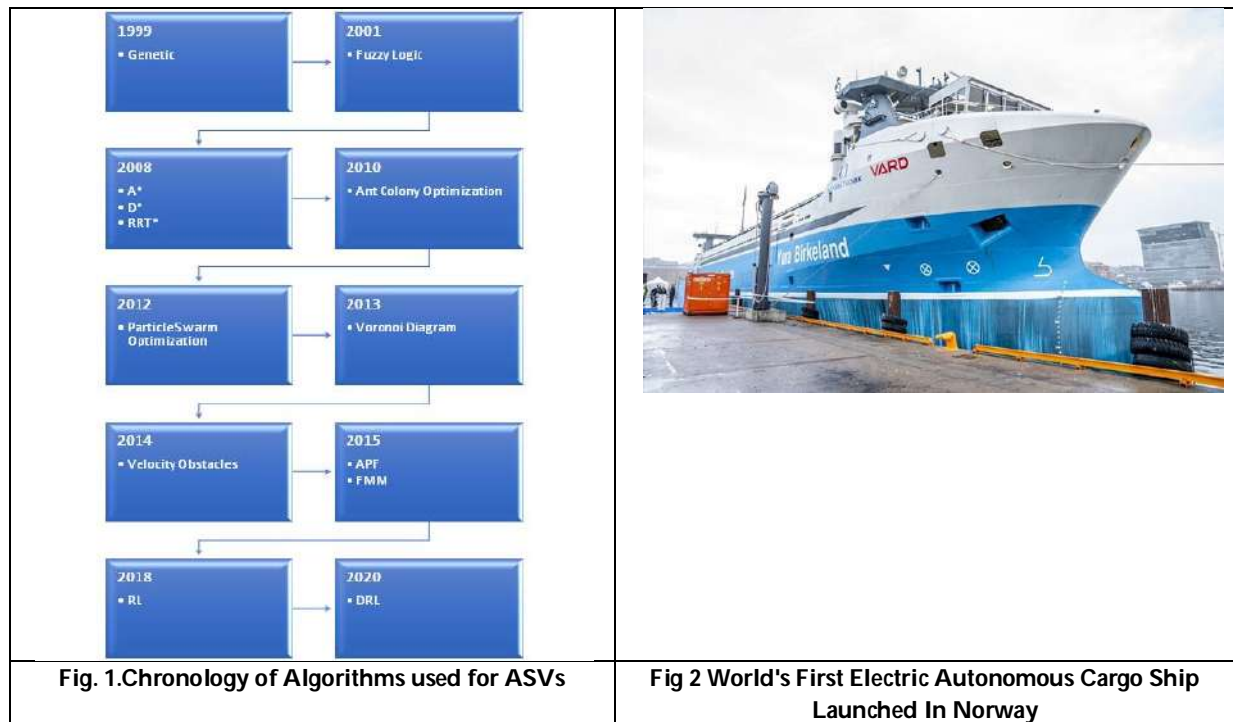
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Detection of Suicide Ideations in Social Media Posts: A Review using Deep Learning

Sailaja Mulakaluri^{1*} and Kalpana R²

¹Assistant professor, Research scholar, Department of Computer Applications St. Francis de sales college, Bengaluru, Karnataka, India.

²Assistant Professor, Department of Computer Applications St. Francis de sales college, Bengaluru, Karnataka, India.

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*Address for Correspondence

Sailaja Mulakaluri

¹Assistant professor, Research Scholar,
Department of Computer Applications,
St. Francis de Sales College,
Bengaluru, Karnataka, India.



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ABSTRACT

Suicide is one of the rising concerns in this techno savvy world. Around 8,00,000 people succumb to suicide every year according to the reports of the WHO (World Health Organization, 2018). In such a scenario, Machine learning and Artificial Intelligence has far-reaching effects. In this paper, we shall review the role of deep learning in detection of Suicide ideations. Deep learning has its own advantages over traditional statistical analysis methods which lack accuracy. The main objective is to review automatic recognition of suicidal posts as many at-risk individuals use social media forums to discuss their problems or get required information for their dilemmas from various sources. With early exposure of information received on Social media, the hidden symptoms of suicidal ideations can be found out to save lives. We will review the LSTM-CNN combination model of deep learning which is a tool for detecting suicide ideations. This is an emerging genre of research in recent times which is challenging as it is more subjective in nature. There are various risk factors involved and deep learning helps prevent these risk to some extent.

Keywords: Deep learning, LSTM, CNN, Suicide detection, social media.

INTRODUCTION

In recent times, mental illness has moved from being just a two-word phrase to a growing concern of today's society. With the younger generation getting more prone to depression, isolation, anxiety disorders and so on, it is indeed essential to address these issues with an undeviating urgency. Suicide, is the second leading cause of death among adults and adolescents like. Nearly 800,000 people die by suicide each year[1]. The death rate is anticipated to rise to



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one every 20 seconds by 2020. Nearly 79 percent of suicides take place in countries with low and intermediate incomes, where it is frequently difficult to find and manage resources insufficient and rare[1]. Suicide ideation is considered as a tendency to terminate ones' life spanning from depression, through a plan to commit suicide, to a strong obsession with self-destruction. People who are in risk can be distinguished from those who plan or attempt to commit suicide and those who succeed in doing so. Suicide ideators (or planners) and suicide attempters (or completers) can be identified as at-risk people.

Social media, which is primarily used by young people, has developed into a potent "window" into the mental health and wellbeing of its users in recent years. It provides anonymous participation in various online communities to create a forum for open discourse on socially taboo subjects. In general, more than 20% of people who attempt suicide and 50% of people who successfully commit suicide leave suicide notes[2]. Therefore, any written indication of suicidality is considered to be concerning, and the writer should be questioned about their own thoughts. Social media text, including blog posts, forum messages, tweets, and other online notes, is typically recorded. It can reduce any incorrect text interpretations created by a retrospective analysis when compared to an offline text. A new topic of study in computational linguistics is social media and its forums dedicated to mental health. It offers a useful research environment for the creation of cutting-edge technical innovations that could revolutionise suicide risk reduction and suicide detection. It can provide as a useful entry point for intervention. Reddit Suicide Watch users who follow news about celebrity suicides.

Deep learning techniques have already significantly advanced the fields of computer vision and pattern recognition in comparison to conventional text categorization techniques. On several Natural language processing (NLP) applications, neural networks based on dense vector representations can outperform classic machine learning algorithms, which rely largely on labour-intensive and frequently insufficient handcrafted features[3]. Word embedding's and [4]deep neural networks' rising popularity. The study's main goal is to use powerful deep learning architectures and data analysis to share knowledge about suicide thoughts in Reddit social media forums. The primary goal of our review is to examine the potential of Long Short-Term Memory (LSTM), Convolutional Neural Network (CNN), and their combined model when applied to various categorization tasks for those struggling with suicidal ideation. We attempt to determine whether combining CNN and LSTM classifiers into a single model may enhance the performance of language modelling and text categorization. We will attempt to show that, for themes connected to suicide, the LSTM-CNN model can surpass both the performance of its component CNN and LSTM classifiers as well as more conventional machine learning systems[5]. It might be possible to incorporate it in data from any online forums and blogs.

LITERATURE REVIEW

Numerous attempts have been made in recent years to draw attention to the influence that social media may have on suicidal ideation. Facebook Social Media for Depression Detection in the Thai Community is one such trial (Katchapakirin et al., 2018). In order to psychologically evaluate and develop a depression identification algorithm in Thai using Natural Language Processing Techniques, this article offers a tool to identify depression on Facebook. Using a user's Facebook activity, including their interactions with others, the number of posts they make, the day and time they publish, and their privacy settings, depressive symptoms were identified. Facebook users who were above 18 and willing to share their microblogs for depression were chosen for the study from the internet. The Thai Mental Health Questionnaire (TMHQ) separated 35 of the chosen users into two categories, with 22 being classed as depressive and 13 as not depressed. 1105 posts were gathered, and the properties were retrieved. Numerous Machine Learning (ML) methods were used, including Support Vector Machine (SVM) (Zhang, 2012), Deep Learning (DL) procedures, Random Forest (RF) (Donges, 2019), and Deep Learning (RF) algorithms. The dimension of the collected data was too tiny for the SVM algorithm, making it impossible to partition the training set and test set as in traditional validation without suffering a considerable modelling loss. Utilizing eight-cross validation, the model prediction performance was assessed. The SVM model's accuracy was marginally higher than that. Table 1. Comparison of related work





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METHODOLOGY

Researchers evaluated the data by using secondary data obtained by a database 'An ensemble deep learning technique for detecting suicidal ideation from posts in social media platforms' on mentioned topic to detect suicidal posts on various social media platforms like facebook, YouTube and so on. The collected data was analysed by using evaluating metrics(accuracy -percentage)

Models used

Proposed Design

In other studies Researchers used a mix of the LSTM and CNN (Saha, 2018) model, the attention model, and Reddit to find suicidal messages. The output vector from the LSTM is used as an input value for the Attention layer in the suggested model, while the output of the Attention layer is used as an input for the Convolutional layer. The proposed LSTM-Attention-CNN coupled model divides input posts into four groups that represent varying degrees of suicidal or non-suicidal tendencies, as shown in Figure given below.

The first layer of the model is a word embedding layer, as depicted in the picture, where each token or word in each sentence is mapped to a distinct index, generating a real-valued vector of a specific length. A dropout layer is used to avoid over-fitting. Convolutional layer aids in feature extraction while the LSTM layer helps identify long-distance dependencies over the textual input.[8] The attention model emphasises crucial information and gives each word a weight. The feature map is down sampled by the pooling layer, which lists all the features that are present in a certain area. The information gathered by the pooling layer will be transformed into a column vector by the flatten layer. In the output layer's final step, the input

Data: Using the Reddit dataset, where users submit their thoughts and opinions, we train our classification model. Through the comment threads that are linked to each user's submission or post, they communicate. For this research, we used the Philip Resnik-created University of Maryland Reddit Suicidality Dataset, which includes both non-suicidal and suicidal submissions (Zirikly et al., 2019).[9] By substituting a unique ID for the user's personal information, their privacy is maintained. The dataset was taken from the 2015 Full Reddit Submission Corpus and used postings from the SuicideWatch (SW) subreddit to identify (anonymous) people who may have suicidal tendencies. Four categories were used to classify these Reddit articles.[2]

No risk: No possibility that the user has suicidal tendency. Eg: ZOINKS! I just realized how much I'm starting to look like shaggy (scooby doo) help with a new haircut?[6]

Low risk: Some factors might be present here depicting that this user might have suicidal tendency, but chances are very low[3][4]: I have had a bad childhood. I wish no child to experience is this

Moderate Risk: There are chances that the user has a tendency to attempt suicide.[8]Eg: Im so sorry this is happening to you. Everytime i hear something like this i wish i could be of help. But im incapable. I don't want to help anyone. I just want to die peacefully...fast.[10]

Severe risk: There is high chance that the user will attempt to suicide.[7]Eg: Looks like.. even alcohol won't help my pain now.. that sucks... I will even worse when am drunk... and am afraid that i will say something bad to my friends about me... I guess its time to give up.

CONCLUSION

In this paper, three Deep Learning based models, particularly RNN, LSTM, and C-LSTM are employed for the task of





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suicidal ideation detection in tweets. For this purpose, a lexicon of terms was first generated by scraping and manually annotating anonymized data from known suicide Web forums[3]A dataset of tweets was collected using the Twitter REST API by using search queries corresponding to the generated lexicon[6]Human annotators labeled tweets with suicidal intent present or absent, which were then used to train both three machine learning-based baseline models as well as the three proposed deep learning models. A quantitative comparison between the various models revealed the effectiveness of a C-LSTM based model in suicidal ideation detection in tweets[9]This was attributed to the ability of CNNs [11]to spatially encode the tweets into a one dimensional structure to be fed into LSTMs along with the ability of LSTMs to capture long-term dependencies. In the future, this work can be extended by investigating other deep learning based architectures for the tasks of suicidal ideation detection on Twitter as well as other Web forums and Social media.[4] Also, nature-inspired heuristics can be explored for efficient feature selection as done by Sawhney *et al.* (2018b,c).

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Table 1. Comparison of related works.

Paper	Model	Evaluating Metrics
Facebook Social Media for Depression Detection in the Thai community (2018) (Katchapakirin <i>et al.</i> , 2018)[6]	RapidMiner with Deep Learning algorithm	Accuracy – 85%
Detecting Comments Showing Risk for Suicide in YouTube (2018) (Gao <i>et al.</i> , 2018)[2]	Cross Entropy Loss with SVM – no seed filter	Geometric Mean – 78.3%





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Paper	Model	Evaluating Metrics
	Cross Entropy Loss with LSTM-no seed filter	Geometric Mean – 84.3%
	Focal loss with LSTM-no seed filter	Geometric Mean – 81.8%
Detecting Suicidal Ideation on Forums and Blogs: Proof-of-Concept Study (2018) [7] <u>Aladağ et al., 2018</u>	RF	Accuracy – 89%
	ZeroR	Accuracy – 50%
	SVM	Accuracy – 92%
	Logistic Regression	Accuracy – 92%
Natural Language Processing of Social Media as Screening for Suicide Risk (2018)[3] <u>Coppersmith et al., 2018</u>	Bidirectional LSTM with Self Attention	AUC – 89%
Exploring and Learning Suicidal Ideation Connotations on Social Media with Deep Learning (2018)[4] <u>Sawhney et al., 2018</u>	RNN	Accuracy – 73.7%
	LSTM	Accuracy – 78.7%
	C-LSTM	Accuracy – 81.2%

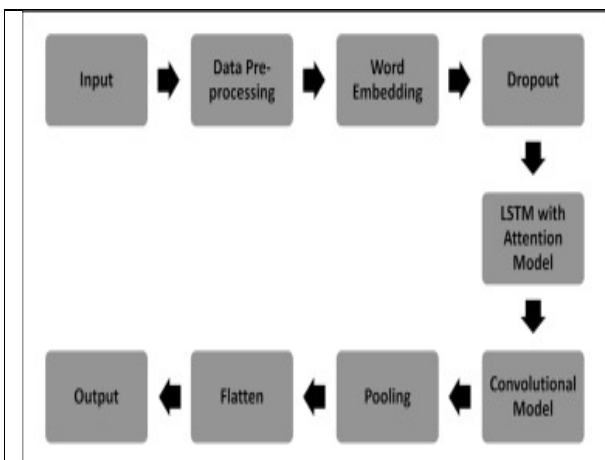


Fig. 1. Architecture for Suicidal Ideation Detection

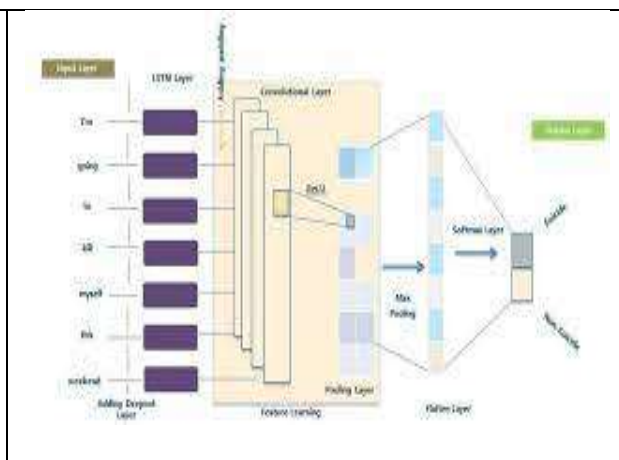


Fig. 2. LSTM-Attention - CNN Model for Suicidal Ideation Detection.





Land Use / Land Cover Changes in the Bhavani River Basin using Remote Sensing and GIS

A. Franchina Mary*

Assistant Professor, Department of Geography, Nirmala College for Women, Coimbatore-18, Tamil Nadu, India.

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*Address for Correspondence

A. Franchina Mary

Assistant Professor,
Department of Geography,
Nirmala College for Women,
Coimbatore-18, Tamil Nadu, India.
E. Mail : franchina.geo@gmail.com



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ABSTRACT

A study of the spatial and temporal changes in land use and land cover (LULC) was conducted using Remote Sensing and GIS. Analyzed the LULC of Bhavani River basin, Tamil nadu, south India using Toposheet and LANDSAT imageries of 1970-2018 time periods. 60% depletion in the natural vegetation cover and 10% depletion in wetland agriculture area were seen in the basin during the period. On the other hand the urban spread in the basin increased by 80%. The study highlights the need for a scientific management plan for the sustainability of the river basin, keeping in view the recent climatic anomalies and hydrological conditions of the basin.

Keywords: Land Use and Land Covers (LULC), Bhavani River Basin, RS, GIS

INTRODUCTION

Land is an important source of identity, a symbol of social status, the foundation of power and it often carries significant emotional attachment. Drastic changes in the earth's environment are being driven by the exponential growth in human population, the increasing levels of resource consumption and by changes in technology and socio-political organization. Economic growth due to increased agriculture and industrialization generally has a negative impact on the environmental issues of a region. In the last few decades, land use/ land cover changes have become a major issue at the global and regional level. It has caught international attention because of concerns over issues such as global warming and climate change. Many studies have been conducted over issues related to land use / land cover changes (Turner, 1991; Turner, 1994; Maycr *et al.*, 1994; Baulis, 1997; Thomas, 1997; Hellig, 1997; Ringfuss, 1998; Koning, 1999; Mc Connell, 2000; Solecki, 2001; Bicik, 2001). Some of these studies focus on understanding the process of land use / land cover change as well as developing predictive models of change at the global level (Turner, 1991; Turner, 1994; Mayer *et al.*, 1994; Baulis, 1997).



**Franchina Mary****Study area**

Bhavani river is one of the two perennial rivers of water deficient Tamil Nadu. It is the largest tributary of the river Cauvery in Tamil Nadu. The Bhavani River is one of the few perennial rivers of the river Cauvery. The Bhavani river basin is the fourth largest (about 6,500 km²) sub-basin in the Cauvery basin (81,000 km²). The Bhavani River is about 217 kms long and it meets the river Cauvery near the town of Bhavani. The river basin lies between 10° 56' 33" N and 11° 46' 14" N and 76 ° 24' 41" E and 77 ° 41' 11" E. The average length of the basin area is 217 kms and the average width is 57 kms. The basin elevation varies from 166 m amsl in the valleys to 2633 mts amsl in the hills. The Bhavani River basin is bounded on the north by the state of Karnataka and in the west by the state of Kerala.

Methods Used To Study Land Use / Land Cover

It is crucial to use each and every bit of available land in the most rational way in order to improve the economic conditions of an area without any damage to the environment. This requires detailed knowledge of land use practices and the changing patterns of land use.

The knowledge about land use can be gained by two different methods:

1. Conventional land survey methods
2. Geo-spatial techniques.

Data Processing and Analysis

Land use land cover map preparation for the study was done through the following steps:

- (i) The toposheet and satellite data was acquired. Then the satellite images were georeferenced and geocoded by extraction of the ground control points from SOI toposheets.
- (ii) The next step was the registration of satellite digital data and preparation of False colour composite. False colour composite of the study area was generated with the wavelength regions of Green, Red and infrared. Supervised classification was carried out for 2001, 2008 and 2018 data.
- (iii) Scanning and digitization of existing maps and editing data with the maps were done using GIS.
- (iv) Data manipulation and analysis and linking the spatial data with the attribute data for creation of topology was carried out by using GIS software. Then, the creation of GIS output in the form of land use land cover map showing various land use land cover pattern.

Pattern of Land Use Land Cover Pattern in Bhavani River Basin In 1970

Land use land cover of Bhavani river basin for the year 1970 was prepared by using Topographical sheets on a scale of 1:50000. Five broad categories of land use and land cover was identified from the toposheets (1970). It is seen from the table, that forests are the largest land cover followed by agriculture and then plantations. The built up areas of Bhavani river basin in 1970 was very little. From figure 1.1 it is seen that the forests dominate in the Bhavani River Basin occupying almost half of the basin area. There is considerable agriculture and built-up areas are negligible.

It is observed that in 1970, the Northern and western part of the sub- watersheds are largely covered by forest. The morphometric study of the Bhavani River Basin done in the earlier chapters shows that these are areas that have hilly terrain with a large number of streams. In the Western part of the basin, a few sub watersheds like Pykara, Nellitthurai Reserved Forest, Wellington, Pillur Reserved Forest, Kallur Reserved forest, Vagappanai Slopes Reserved Forest and Nilgiri Eastern Slope which are mainly covered by forest and also have plantations. This area also has a large number of hydroelectric power projects. Agricultural land and fallow land were found mainly in the eastern and southern part of the Bhavani River Basins. The morphometric study of the Bhavani River Basin shows that these are all areas which have a low elevation.

Pattern of land use land cover in Bhavani river basin in 2001

Land use land cover of Bhavani River Basin for the year 2001 was prepared by using LANDSAT 2001 image. It is seen from the above table, that forests together with scrub forest still forms the dominant land cover. This is followed by agriculture and agricultural fallow. Fig 1.2 shows the land use land cover pattern in the Bhavani River Basin in 2001. The land use land cover classification is classified according to the NRSA scheme.





Franchina Mary

It is seen that in 2001, forest area constituted the major type of land cover in the study area. It accounted for about (53 %) of the total area followed by agricultural fallow land (11 %), sand (7 %), Plantation (7 %), agriculture (6 %), Bare Soil (6 %), Scrub Forest (5 %), Wetlands (3%) and Water (0.9%). The built-up area in the Bhavani River Basin was still very small (0.8%). Map 1.3 shows the land use land cover of Bhavani River Basin in 2001. From the map, it is seen that the western part of the Bhavani River Basin is forested. Forests are found in the sub-watersheds of Pykara, Kalhatti Slope Reserved Forest, Kedar Halla, Kukkaltorai Hall, Denad Reserved Forest, Nilgiri Eastern Slope, Vagappanai Slopes Reserved Forest, Nambiyur, Wellington, Ittalar Reserved Forest, Nellitthurai Reserved Forest, Uliattu Coffee Estate and Attapadi Reserved Forests and they occupy 52.7% of the entire Bhavani River Basin (Table 4.3 and Fig 4.2). From the morphometric analysis of these basins in the earlier chapter, it is seen that these sub watersheds are hilly with complex terrain and compact bed rock lithology.

In the same sub-watersheds, there are plantations. In the eastern part of the Bhavani River Basin, sub-watersheds like Bhavani, Odatturai Eri, Kavundappadi, Periyapuliyur and Appanyakkanur with dominant of agriculture. There are swampy areas in small parts of the following sub watersheds in the Western part namely Kukkaltorai Hall Watershed, Denad Reserved Forest, Nilgri Eastern Slope Watershed, Vagappanai Slopes Reserved Forest, Kallur Reserved Forest, Pillur Reserved Forest, Anaikatti Reserved Forest, Gopannar Reserved Forest and in the northern part much as Andiyur, South Bargur Reserved Forest, Kallippatti, Satyamangalam, Kuttara Pallam, Kongarpalayam, Tayiru Pallam and Perum Pallam.

Pattern of Land use Land cover of the Bhavani river basin in 2008

Land use land cover of Bhavani River Basin for the year 2008 was prepared by using LANDSAT 2008 image. It is seen from the above table, that the forests together with scrub forests and degraded forests are the largest land cover. Agriculture together with agricultural fallow land and plantations together occupy the next largest area. Built-up areas are on the increasing stage (5.87%). The area covered by wetlands are the smallest land cover. It is seen from Fig 1.3 that in 2008, forest area under forest is still the largest land cover followed by scrub forests. Together with degraded forests, the land cover under the general category of forest, land cover is around 40%. The next largest area is under agriculture (14.9%), Bare soil (6.6%), built-up area (5.8%) and sand (5%) are the next largest land use land cover. Area under water is the smallest land cover (0.9%) in the Bhavani River Basin. It is seen from the Map 1.2 that 14 sub-watersheds in the south and south eastern part is covered by agricultural activity mainly in the sub-watersheds of Chinnatambipalayam, Jambai, Periyapuliyur, Bhavani, Gopichettipalayam, Odatturai Eri, Appanyakkanur, Varattukara Pallam, Kurumandur, Kavundappadi, Siruvalur, Varattukkara Pallam, Nambiyur and Vemandampalayam. These sub watersheds are areas with high and moderate drainage texture.

It is seen from Map 1.3 that 8 sub-watersheds namely Satyamangalam, Kuttara Pallam, Kongarpalayam, Tayiru Pallam, Perum Pallam, Andiyur, South Bargur Reserved Forest and Kallippatti shows two different types of land use pattern. The northern part of these watersheds are covered by forest and the southern parts have agricultural activities. Degraded forests are seen in the following sub-watersheds such as North Western part of Kupanara Betta Watershed, South eastern part of Talamalai Reserve Forest Watershed, western part Moyar River Watershed, southern part of Moyar Reserved Forest Watershed, northern part of Kedar Hall Watershed and central part of Attapadi Reserved Forest. Built-up areas are observed in the following sub-watersheds namely Karamadai, south west portion of Pillur Reserved Forest, North eastern part of Nellimalai Reserved Forest, Paniyampalli, Tenkai Malai, Nambiyur, Gopichettipalayam and small portions of Varattukkara Pallam, Bhavani, Chinnatambipalayam and also southern portion of Andiyur, Jambai and Tingalur.

Land use Land Cover Pattern of Bhavani River Basin in 2018

Land use land cover of Bhavani River Basin in the year 2018 was prepared by using LANDSAT 2018 image. It is seen from the above table, that forest cover is the largest land cover. This is followed by bare soil, agricultural fallow and agriculture. It is seen from Fig 1.4, that the forest cover still remains as the major part of the river basin (40.08 %). Bare soil cover a considerable portion (20.69 %). Agricultural fallow land and agricultural areas together cover almost 25% of the river basin. Built- up area is 5.5% and water covers 0.62%.



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It is seen from Map 1.4, that in 2018, several land use changes were identified in the Bhavani River Basin. Forest cover of the Western and Northern part of the Bhavani River Basin. It is clearly seen in the following sub-watersheds such as Pykara, Kalhatti Slope Reserved Forest, Bhandipur Reserve Forest, Kedar Hall Watershed, Kukkalatorai Hall Watershed, Denad Reserved Forest, Nilgri Eastern Slope Watershed, Vagappanai Slopes Reserved Forest, Wellington, Kallur Reserved Forest, Pillur Reserved Forest, Nellithurai Reserved Forest, Attapadi Reserved Forest, Nanjappa Malai, Siruvani and Anaikatti Reserved forest and extreme northern part like Andiyur, South Bargur Reserved Forest, Kallippatti, Kongarpalayam, Satyamangalam and Kuttara Pallam,

Agricultural fallow land is observed in the northern part of Chinnatambipalayam, Jambai and also in southern part of the Bhavani basin namely Kurumandur, Siruvalur, Tingalur, Nambiyur, Vemandampalayam, Punjai Puliyampatti, Varattukkara Pallam, Paniyampalli, Punjai Puliyampatti, Tenkai Malai, Sirumudaipudu, Salaiyur, Karamadai, Nellimalai Reserved Forest and Gopannar Reserved Forest. A few built-up areas can be seen in the following sub-watersheds of Ittalar Reserved Forest, Kedar Hall Watershed, Wellington, Kukkalatorai Hall Watershed Bhavani, Karamadai, Gopichettipalayam, south western part of Pillur Forest, Kurumandur, Andiyur and Kavundappadi sub-watersheds.

Change Detection Between 2001, 2008 and 2018

From 2001 to 2018 land use land cover has changed tremendously. Table 4.10 shows the land use land cover pattern of the different categories in 2001, 2008 and 2018. Since the categories of land use obtained from the topographic sheets of 1970, is not compatible, it is excluded in this table. The area under forest was majorly declined from 2001 to 2008 and in the next decade it increased marginally. Between 2001 to 2008, there is a large decrease in the forest area probably due to clearing of land for agriculture which made an increase during this period. Scrub forest saw a large increase from 2001 to 2008. Probably, there has been some intervention since the area under degraded forests decreased as the area under forests rose slightly in 2008 while the area under scrub forests declined. Between 2001 to 2008, the agricultural fallow land has decreased and there is an increase in agriculture. Agricultural fallow land may have been converted for agriculture. However, the area under agricultural fallow rose again between 2008 to 2018 and during the same period, the area under agriculture decreased slightly. The area under plantations has shown a steady decrease over the years. Bare soil which was negligible from 2001 to 2008 increased considerably by 2018. This may be due to more erosion, lesser rainfall and the slight decrease in agriculture. The area covered by sand has decreased considerably since 2001. The area covered by water and wetlands has decreased slightly. The area covered by plantations, sand and water has shown a steady decline. The area under built-up areas also shows a steady increase.

CONCLUSION

Drastic changes in the earth's environment are being driven by the exponential growth in human population, the increasing levels of resource consumption and by changes in technology and socio-political organization. A change in land use and land cover is part of this transformation. It is crucial to use each and every bit of available land in the most rational way in order to improve the economic conditions of an area without any damage to the environment. This requires detailed knowledge of land use practices and the changing patterns of land use. In view of the importance of properly managing river basins, a detailed understanding of the changes in the land use/land cover pattern has become necessary for the Bhavani river basin. Therefore, the present study was undertaken to analyze the extent of human-induced landscape transformation in the Bhavani river basin.

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Table No. 1.1 Land use Land cover of Bhavani River Basin 1970

S. No.	Class_Name 1970	Area in square in kilometer 1970	Area in Percentage 1970
1	Forest	3050.295	47.14
2	Agriculture	2542.768	39.25
3	Plantation	613.946	9.5
3	Water	144.552	2.23
4	Open scrub	101.66	1.57
5	Built up area	12.2	0.19
	Total	6465.421	100

Table No. 1.2 Land use Land cover pattern 2001

S.No.	Class_Name	Area in Square Km 2001	Area in percentage 2001
1	Forest	3410.1355	52.74
2	Agri Fallow Land	708.2334	10.96
3	Sand	468.3415	7.24





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4	Plantation	452.4705	6.99
5	Agriculture	400.4069	6.19
6	Bare Soil	384.6771	5.95
7	Scrub Forest	336.5874	5.2
8	Wetland	185.4837	2.86
9	Water	62.6436	0.96
10	Built Up	56.6262	0.87
11	Forest Degraded	0	0
	Total	6465.606	100

Table No. 1.3 Land Use Land Cover Pattern 2008

S. No.	Class Name	Area in Square km. 2008	Area in percentage 2008
1	Forest	2519.615	38.97
2	Scrub Forest	1151.571	17.81
3	Agriculture	964.441	14.91
4	Bare Soil	425.652	6.59
5	Built Up	379.266	5.87
6	Sand	326.349	5.04
7	Agri Fallow Land	247.523	3.8
8	Plantation	244.046	3.78
9	Wetlands	91.358	1.4
10	Forest Degraded	57.975	0.89
11	Water	57.810	0.89
	Total	6465.606	100

Table No. 1.4 Land use Land cover Pattern 2018

S. No.	Class_Name	Area in Square Kms 2018	Area in percentage 2018
1	Forest	2591.840	40.08
2	Bare Soil	1337.768	20.69
3	Agri Fallow Land	942.402	14.57
4	Agriculture	622.472	9.6
5	Built Up	356.818	5.51
6	Scrub Forest	234.334	3.62
7	Plantation	183.879	2.84
8	Wet lands	118.739	1.83
9	Water	40.545	0.62
10	Sand	36.809	0.56
11	Forest Degraded	0	0
	Total	6465.606	100

Table No. 1.5 Change Detection between 2001, 2008 and 2018

S. No	Class Name	2001 Area in %	2008Area in %	2018 Area in %	% of Change 2001 to 2008	% of Change 2008 to 2018
1	Agri Fallow Land	10.9	3.8	14.6	-7.126	10.747
2	Agriculture	6.2	14.9	9.6	8.724	-5.289
3	Bare Soil	5.92	6.6	20.7	0.634	14.107
4	Built Up	0.9	5.7	5.5	4.990	-0.347





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5	Forest	52.7	38.9	40.1	-13.773	1.117
6	Forest Degraded	0	0.9	0	0.897	-0.897
7	Sand	7.2	5.0	0.6	-2.196	4.478
8	Scrub Forest	5.2	17.8	3.6	12.605	-14.186
9	Water	0.9	0.9	0.7	-0.075	-0.267
10	Wet lands	2.8	1.4	1.8	-1.456	0.423
11	Plantation	6.9	3.8	2.8	-3.224	-0.931
	Total	100	100	100		

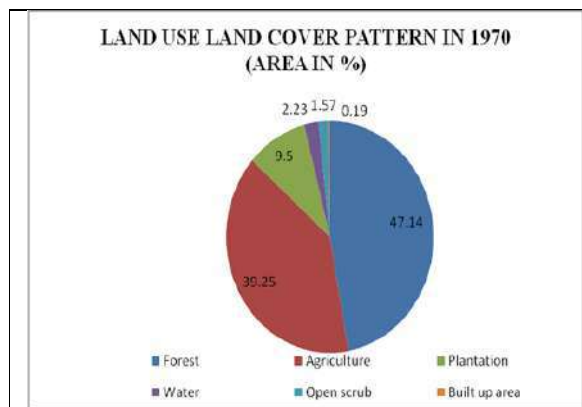


Fig No .1. Land use Land cover pattern in 1970

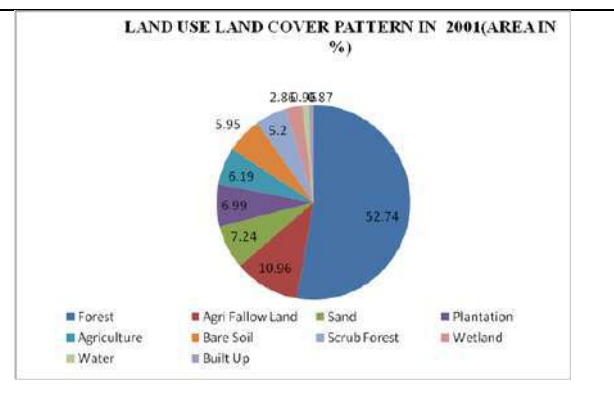


Fig No..2 Land use Land cover pattern in 2001

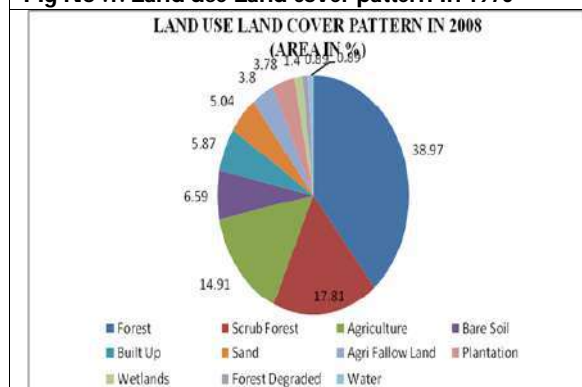


Fig No..3 Land use land cover Pattern of in 2008

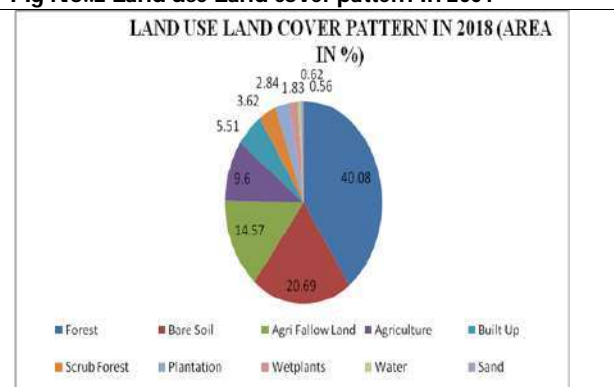


Fig No. .4 Land use Land cover Pattern in 2018

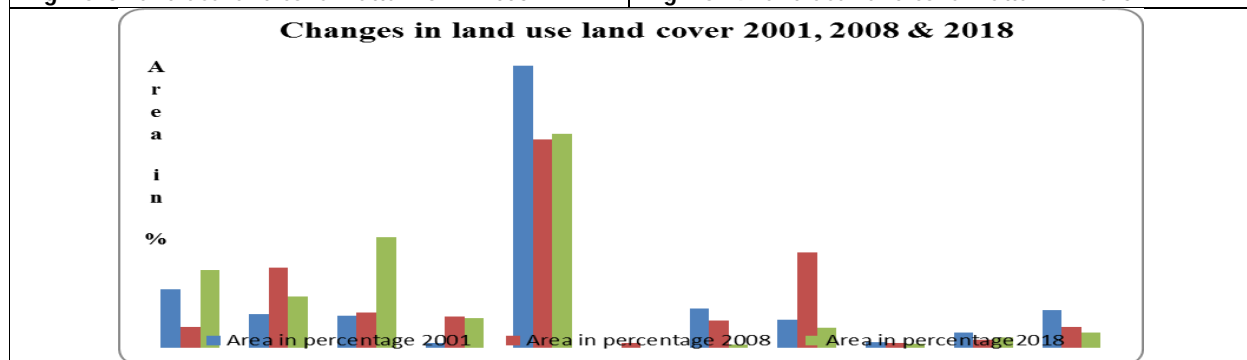
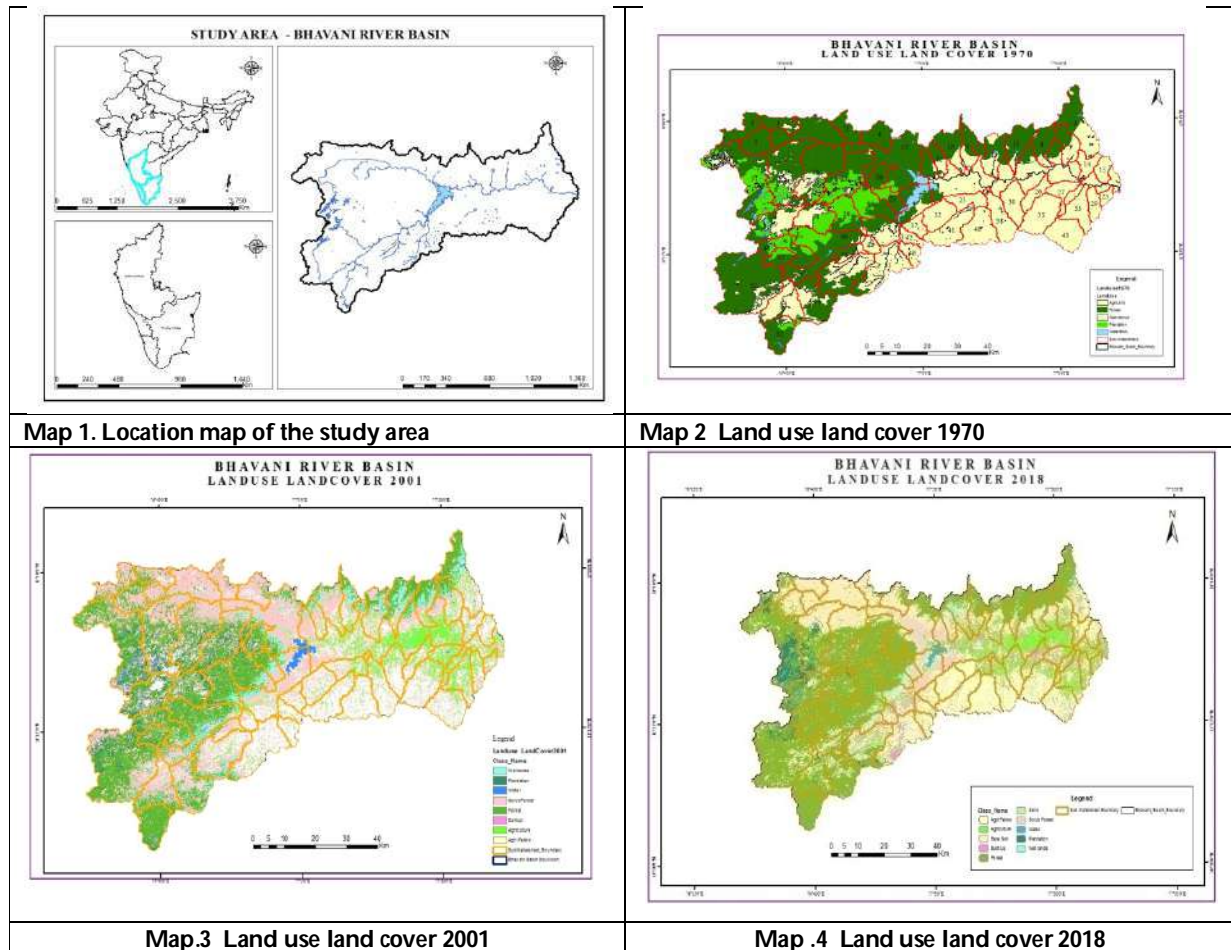


Fig No. 5 Changes in land use land cover 2001, 2008 & 2018.





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Quadripartitioned Neutrosophic Vague Topological Spaces

Mohana K¹ and HindujaV^{2*}

¹Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Department of Mathematics, St. Joseph's College for Women, Tirupur, Tamil Nadu, India

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*Address for Correspondence

HindujaV

Department of Mathematics,
St. Joseph's College for Women,
Tirupur, Tamil Nadu, India
E. Mail : ajudnih1023@gmail.com



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ABSTRACT

In this paper, we define the concept of a Quadripartitioned Neutrosophic vague set as a combination of Neutrosophic Vague set and Quadripartitioned Neutrosophic set. We also define and study the operations and properties of Quadripartitioned Neutrosophic vague set and give some examples. We use Quadripartitioned Neutrosophic vague sets and topological spaces and we construct and develop a new concept namely "Quadripartitioned Neutrosophic vague topological spaces" and have discussed some of its properties.

Keywords: Vague, Neutrosophy, Neutrosophic set, Neutrosophic vague set.

INTRODUCTION

In 1965 Lofti A. Zadeh [7] was first introduced the concept of Fuzzy Set. The main thing in this concept is that it defines the uncertainty of a set and is defined by membership function which assigns values to the universal set elements within the range $[0, 1]$. Those values are called membership degrees. To enhance the Fuzzy Set concept, in 1986 Atanassov [1] presented the Intuitionistic Fuzzy Set in which the non – membership degree is also considered. Here the number of occurrences of finite member is called its cardinality and is denoted by s . The theory of vague sets was first proposed by Gau and Buehrer [4] as an extension of fuzzy set theory and vague sets are regarded as a special case of context-dependent fuzzy sets. Smarandache extended the concept of intuitionistic fuzzy set by introducing the notion of Neutrosophic set (NS). In 1995, Smarandache talked for the first time about Neutrosophy, and in 2005 [3], he defined the Neutrosophic set theory, one of the most important new mathematical tools for handling problems involving imprecise, indeterminacy, and inconsistent data. Later on, many researchers use NS in their theoretical and practical research. Shawkat Alkhazaleh [6] in 2015 introduced the concept of Neutrosophic vague set as a combination of Neutrosophic set and vague set. Neutrosophic vague theory is an effective tool to process incomplete, indeterminate and inconsistent information.





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In the year 2016, Chatterjee [2] *et. al.* grounded the idea of Quadripartitioned Neutrosophic set and defined several similarity measures between two Quadripartitioned Neutrosophic sets. In this paper, we define the concept of a Quadripartitioned Neutrosophic vague set as a combination of Neutrosophic Vague set and Quadripartitioned Neutrosophic set. We also define and study the operations and properties of Quadripartitioned Neutrosophic vague set and give some examples. We use Quadripartitioned Neutrosophic vague sets and topological spaces and we construct and develop a new concept namely “Quadripartitioned Neutrosophic vague topological spaces” and have discussed some of its properties.

Preliminaries

In this section, we recall some basic notions.

In this section, we recall some basic notions.

Definition 2.1 Let X be a nonempty set. A **Fuzzy set** A in X is given by $A = \{(x, \mu_A(x)) / x \in X\}$

where $\mu_A(x) : X \rightarrow [0, 1]$ is the membership function of the Fuzzy Set A . (i.e.) $\mu_A(x) \in [0, 1]$ is the membership of $x \in X$ in A .

Definition 2.2: An **Intuitionistic Fuzzy Set (IFS)**, A in X is given by $A = \{(x, \mu_A(x), \nu_A(x)) / x \in X\}$ where $\mu_A : X \rightarrow [0, 1]$ and $\nu_A : X \rightarrow [0, 1]$ with the condition $0 \leq \mu_A(x) + \nu_A(x) \leq 1, \forall x \in X$. Here $\mu_A(x)$ and $\nu_A(x) \in [0, 1]$ denote the membership and non-membership functions of the Fuzzy set A .

Definition 2.3: A **vague set** is defined by a truth-membership function t_v and a false membership function f_v , 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 negation of x derived from the evidence against x . The values 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 $t_v(x) + f_v(x) \leq 1$.

Definition 2.4: Let U be a universe. A **Neutrosophic set** A on X can be defined as follows:

$A = \{(x, T_A(x), I_A(x), F_A(x)) : x \in X\}$ where $T, I, F : X \rightarrow [0, 1]$ and $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$. Here $T_A(x)$ is the degree of membership, $I_A(x)$ is the degree of indeterminacy and $F_A(x)$ is the degree of non-membership.

Definition 2.5: A **Neutrosophic vague set A_{NVS} (NVS in short)** on X written as

$A = \{(x; \hat{T}_A(x); \hat{I}_A(x); \hat{F}_A(x)) : x \in X\}$, whose truth membership, indeterminacy membership and false membership functions is defined as:

$$\hat{T}_A(x) = [T^-, T^+], \hat{I}_A(x) = [I^-, I^+], \hat{F}_A(x) = [F^-, F^+]$$

Where, (1) $T^+ = 1 - F^-$ (2) $F^+ = 1 - T^-$ and (3) $0 \leq T^- + I^- + F^- \leq 2^+$

when X is continuous, a NVS A can be written as

$$A = \int_X \langle x, \hat{T}_A(x), \hat{I}_A(x), \hat{F}_A(x) \rangle / x, x \in X.$$

When X is discrete, a NVS A can be written as

$$A = \sum_{i=1}^n \langle x_i, \hat{T}_A(x_i), \hat{I}_A(x_i), \hat{F}_A(x_i) \rangle / x_i, x_i \in X$$

Definition 2.6: Let X be a universe. A **Quadripartitioned Neutrosophic set** A on X is defined as

$$A = \{(x, T_A(x), C_A(x), U_A(x), F_A(x)) : x \in X\}$$

Where $T, C, U, F : X \rightarrow [0, 1]$ and $0 \leq T_A(x) + C_A(x) + U_A(x) + F_A(x) \leq 4$. Here $T_A(x)$ is the truth membership, $C_A(x)$ is contradiction membership, $U_A(x)$ is ignorance membership and $F_A(x)$ is the false membership.

Quadripartitioned Neutrosophic Vague Set

Definition 3.1 A **Quadripartitioned Neutrosophic Vague Set A_{QNVS} (QNVS in short)** on the universe of discourse written as $A_{QNVS} = \{(x; \hat{T}_{A_{QNVS}}(x); \hat{C}_{A_{QNVS}}(x); \hat{U}_{A_{QNVS}}(x); \hat{F}_{A_{QNVS}}(x)) : x \in X\}$, whose truth membership, contradiction membership, ignorance membership and false membership functions is defined as: $\hat{T}_{A_{QNVS}}(x) = [T^-, T^+], \hat{C}_{A_{QNVS}}(x) = [C^-, C^+], \hat{U}_{A_{QNVS}}(x) = [U^-, U^+], \hat{F}_{A_{QNVS}}(x) = [F^-, F^+]$

Where, (1) $T^+ = 1 - F^-$ (2) $F^+ = 1 - T^-$ (3) $C^+ = 1 - U^-$ (4) $U^+ = 1 - C^-$

(5) $0 \leq T^- + C^- + U^- + F^- \leq 3^+$





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Example 3.2 Let $U = \{x, y\}$ be a set of universe we define the QNVS A_{QNV} as follows:

$$A_{QNV} = \left\{ \frac{x}{\{[0.4,0.5], [0.3,0.6], [0.4,0.7], [0.5,0.6]\}}, \frac{y}{\{[0.3,0.7], [0.4,0.6], [0.4,0.6], [0.3,0.7]\}} \right\}$$

Definition 3.3 Let A_{QNV} and B_{QNV} be two QNVS of the universe U . If $\forall x \in U, \hat{T}_{A_{QNV}}(x) \leq \hat{T}_{B_{QNV}}(x); \hat{C}_{A_{QNV}}(x) \leq \hat{C}_{B_{QNV}}(x); \hat{U}_{A_{QNV}}(x) \geq \hat{U}_{B_{QNV}}(x); \hat{F}_{A_{QNV}}(x) \geq \hat{F}_{B_{QNV}}(x)$ then the QNVSA $_{QNV}$ is included by B_{QNV} , denoted by $A_{QNV} \subseteq B_{QNV}$.

Definition 3.4 The complement of QNVSA $_{QNV}$ is denoted by A_{QNV}^c and is defined by

$$\hat{T}_{A_{QNV}^c}(x) = [1 - T^+, 1 - T^-], \hat{C}_{A_{QNV}^c}(x) = [1 - C^+, 1 - C^-], \\ \hat{U}_{A_{QNV}^c}(x) = [1 - U^+, 1 - U^-], \hat{F}_{A_{QNV}^c}(x) = [1 - F^+, 1 - F^-]$$

Example 3.5 Let $U = \{x, y\}$ be a set of universe and let a QNVS A_{QNV} as

$$A_{QNV} = \left\{ \frac{x}{\{[0.4,0.5], [0.3,0.6], [0.4,0.7], [0.5,0.6]\}}, \frac{y}{\{[0.3,0.7], [0.4,0.6], [0.4,0.6], [0.3,0.7]\}} \right\}$$

Then the complement of A_{QNV} is

$$A_{QNV}^c = \left\{ \frac{x}{\{[0.5,0.6], [0.4,0.7], [0.3,0.6], [0.4,0.5]\}}, \frac{y}{\{[0.3,0.7], [0.4,0.6], [0.4,0.6], [0.3,0.7]\}} \right\}$$

Definition 3.6 Let A_{QNV} be a QNVS on the universe of discourse U where $\forall x \in U, \hat{T}_{A_{QNV}}(x) = [1, 1], \hat{C}_{A_{QNV}}(x) = [1, 1], \hat{U}_{A_{QNV}}(x) = [0, 0], \hat{F}_{A_{QNV}}(x) = [0, 0]$. Then A_{QNV} is called unit QNVS (1_{QNV} in short).

Definition 3.7: Let A_{QNV} be a QNVS on the universe of discourse U where $\forall x \in U,$

$$\hat{T}_{A_{QNV}}(x) = [0, 0], \hat{C}_{A_{QNV}}(x) = [0, 0], \hat{U}_{A_{QNV}}(x) = [1, 1], \hat{F}_{A_{QNV}}(x) = [1, 1]$$

Then A_{QNV} is called zero QNVS (0_{QNV} in short).

Definition 3.8 Let A_{QNV} and B_{QNV} be two QNVS of the universe U . If $\forall x \in U, \hat{T}_{A_{QNV}}(x) = \hat{T}_{B_{QNV}}(x); \hat{C}_{A_{QNV}}(x) = \hat{C}_{B_{QNV}}(x); \hat{U}_{A_{QNV}}(x) = \hat{U}_{B_{QNV}}(x); \hat{F}_{A_{QNV}}(x) = \hat{F}_{B_{QNV}}(x)$ then the QNVS A_{QNV} and B_{QNV} are equal.

Definition 3.9 The union of two QNVSs A_{QNV} and B_{QNV} is a QNVS K_{QNV} , written as $K_{QNV} = A_{QNV} \cup B_{QNV}$ whose truth-membership, contradiction-membership, ignorance membership and false-membership functions are related to those of A_{QNV} and B_{QNV} by

$$\hat{T}_{K_{QNV}}(x) = \left[\max(\hat{T}_{A_{QNV}}^-, \hat{T}_{B_{QNV}}^-), \max(\hat{T}_{A_{QNV}}^+, \hat{T}_{B_{QNV}}^+) \right] \\ \hat{C}_{K_{QNV}}(x) = \left[\max(\hat{C}_{A_{QNV}}^-, \hat{C}_{B_{QNV}}^-), \max(\hat{C}_{A_{QNV}}^+, \hat{C}_{B_{QNV}}^+) \right] \\ \hat{U}_{K_{QNV}}(x) = \left[\min(\hat{U}_{A_{QNV}}^-, \hat{U}_{B_{QNV}}^-), \min(\hat{U}_{A_{QNV}}^+, \hat{U}_{B_{QNV}}^+) \right] \\ \hat{F}_{K_{QNV}}(x) = \left[\min(\hat{F}_{A_{QNV}}^-, \hat{F}_{B_{QNV}}^-), \min(\hat{F}_{A_{QNV}}^+, \hat{F}_{B_{QNV}}^+) \right]$$

Example 3.10 Let $U = \{u_1, u_2\}$ be a set of universe and let A_{QNV} and B_{QNV} be QNVSs defined as follows: $A_{QNV} =$

$$\left\{ \frac{u_1}{\{[0.4,0.5], [0.3,0.6], [0.4,0.7], [0.5,0.6]\}}, \frac{u_2}{\{[0.3,0.7], [0.4,0.6], [0.4,0.6], [0.3,0.7]\}} \right\}, \\ B_{QNV} = \left\{ \frac{u_1}{\{[0.1,0.5], [0.3,0.4], [0.6,0.7], [0.5,0.9]\}}, \frac{u_2}{\{[0.25,0.6], [0.45,0.6], [0.4,0.55], [0.4,0.75]\}} \right\}$$

Then we have $K_{QNV} = A_{QNV} \cup B_{QNV}$

$$= \left\{ \frac{u_1}{\{(\max(0.4,0.1), \max(0.5,0.5)), (\max(0.3,0.3), \max(0.6,0.4)), (\min(0.4,0.6), \min(0.7,0.7)), (\min(0.5,0.5), \min(0.6,0.9))\}}, \frac{u_2}{\{(\max(0.3,0.25), \max(0.7,0.6)), (\max(0.4,0.45), \max(0.6,0.6)), (\min(0.4,0.4), \min(0.6,0.55)), (\min(0.3,0.4), \min(0.7,0.75))\}} \right\} \\ K_{QNV} = \left\{ \frac{u_1}{\{[0.4,0.5], [0.3,0.6], [0.4,0.7], [0.5,0.6]\}}, \frac{u_2}{\{[0.3,0.7], [0.45,0.6], [0.4,0.55], [0.3,0.7]\}} \right\}, \text{which is a QNVS.}$$

Definition 3.11 The intersection of two QNVSs A_{QNV} and B_{QNV} is a QNVS H_{QNV} , written as $H_{QNV} = A_{QNV} \cap B_{QNV}$ whose truth-membership, contradiction-membership, ignorance membership and false-membership functions are related to those of A_{QNV} and B_{QNV} by





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$$\begin{aligned} \hat{T}_{H_{QNV}}(x) &= [\min(\hat{T}_{A_{QNV}}^-, \hat{T}_{B_{QNV}}^-), \min(\hat{T}_{A_{QNV}}^+, \hat{T}_{B_{QNV}}^+)] \\ \hat{C}_{H_{QNV}}(x) &= [\min(\hat{C}_{A_{QNV}}^-, \hat{C}_{B_{QNV}}^-), \min(\hat{C}_{A_{QNV}}^+, \hat{C}_{B_{QNV}}^+)] \\ \hat{U}_{H_{QNV}}(x) &= [\max(\hat{U}_{A_{QNV}}^-, \hat{U}_{B_{QNV}}^-), \max(\hat{U}_{A_{QNV}}^+, \hat{U}_{B_{QNV}}^+)] \\ \hat{F}_{H_{QNV}}(x) &= [\max(\hat{F}_{A_{QNV}}^-, \hat{F}_{B_{QNV}}^-), \max(\hat{F}_{A_{QNV}}^+, \hat{F}_{B_{QNV}}^+)] \end{aligned}$$

Example 3.12 Let $U = \{u_1, u_2\}$ be a set of universe and let A_{QNV} and B_{QNV} be QNVSSs defined as follows: $A_{QNV} =$

$$\begin{aligned} & \left\{ \frac{u_1}{\{([0.4,0.5],[0.3,0.6],[0.4,0.7],[0.5,0.6])\}}, \frac{u_2}{\{([0.3,0.7],[0.4,0.6],[0.4,0.6],[0.3,0.7])\}} \right\}, \\ B_{QNV} &= \left\{ \frac{u_1}{\{([0.1,0.5],[0.3,0.4],[0.6,0.7],[0.5,0.9])\}}, \frac{u_2}{\{([0.25,0.6],[0.45,0.6],[0.4,0.55],[0.4,0.75])\}} \right\}. \\ \text{Then we have } H_{QNV} &= A_{QNV} \cup B_{QNV} \\ &= \left\{ \frac{u_1}{\{([\min(0.4,0.1), \min(0.5,0.5)], [\min(0.3,0.3), \min(0.6,0.4)], [\max(0.4,0.6), \max(0.7,0.7)], [\max(0.5,0.5), \max(0.6,0.9)])\}}, \right. \\ & \left. \frac{u_2}{\{([\min(0.3,0.25), \min(0.7,0.6)], [\min(0.4,0.45), \min(0.6,0.6)], [\max(0.4,0.4), \max(0.6,0.55)], [\max(0.3,0.4), \max(0.7,0.75)])\}} \right\} \\ H_{QNV} &= \left\{ \frac{u_1}{\{([0.1,0.5],[0.3,0.4],[0.6,0.7],[0.5,0.9])\}}, \frac{u_2}{\{([0.25,0.6],[0.4,0.6],[0.4,0.6],[0.4,0.75])\}} \right\} \text{ which is a QNVSS.} \end{aligned}$$

Definition 3.13 Let $\{A_{i_{QNV}} : i \in J\}$ be an arbitrary family of QNVSSs. Then

$$\begin{aligned} \bigcup A_{i_{QNV}} &= \left\langle \left(\begin{matrix} x; \left(\max_{i \in J}(\hat{T}_{A_{i_{QNV}}}^-), \max_{i \in J}(\hat{T}_{A_{i_{QNV}}}^+) \right), \left(\max_{i \in J}(\hat{C}_{A_{i_{QNV}}}^-), \max_{i \in J}(\hat{C}_{A_{i_{QNV}}}^+) \right), \right. \\ \left. \left(\min_{i \in J}(\hat{U}_{A_{i_{QNV}}}^-), \min_{i \in J}(\hat{U}_{A_{i_{QNV}}}^+) \right), \left(\min_{i \in J}(\hat{F}_{A_{i_{QNV}}}^-), \min_{i \in J}(\hat{F}_{A_{i_{QNV}}}^+) \right) \right) \right\rangle; x \in X \\ \bigcap A_{i_{QNV}} &= \left\langle \left(\begin{matrix} x; \left(\min_{i \in J}(\hat{T}_{A_{i_{QNV}}}^-), \min_{i \in J}(\hat{T}_{A_{i_{QNV}}}^+) \right), \left(\min_{i \in J}(\hat{C}_{A_{i_{QNV}}}^-), \min_{i \in J}(\hat{C}_{A_{i_{QNV}}}^+) \right), \right. \\ \left. \left(\max_{i \in J}(\hat{U}_{A_{i_{QNV}}}^-), \max_{i \in J}(\hat{U}_{A_{i_{QNV}}}^+) \right), \left(\max_{i \in J}(\hat{F}_{A_{i_{QNV}}}^-), \max_{i \in J}(\hat{F}_{A_{i_{QNV}}}^+) \right) \right) \right\rangle; x \in X \end{aligned}$$

Theorem 3.14 Let $A_{QNV}, B_{QNV}, C_{QNV}$ and D_{QNV} be QNVSSs. Then

- (i) $A_{QNV} \subseteq B_{QNV}$ and $D_{QNV} \subseteq E_{QNV} \Rightarrow A_{QNV} \cup D_{QNV} \subseteq B_{QNV} \cup E_{QNV}$ and $A_{QNV} \cap D_{QNV} \subseteq B_{QNV} \cap E_{QNV}$
- (ii) $A_{QNV} \subseteq B_{QNV}$ and $A_{QNV} \subseteq C_{QNV} \Rightarrow A_{QNV} \subseteq B_{QNV} \cap C_{QNV}$
- (iii) $A_{QNV} \subseteq C_{QNV}$ and $B_{QNV} \subseteq C_{QNV} \Rightarrow A_{QNV} \cup B_{QNV} \subseteq C_{QNV}$
- (iv) $A_{QNV} \subseteq B_{QNV}$ and $B_{QNV} \subseteq C_{QNV} \Rightarrow A_{QNV} \subseteq C_{QNV}$
- (v) $\overline{(A_{QNV} \cup B_{QNV})} = \overline{(A_{QNV})} \cap \overline{(B_{QNV})}$
- (vi) $\overline{(A_{QNV} \cap B_{QNV})} = \overline{(A_{QNV})} \cup \overline{(B_{QNV})}$
- (vii) $A_{QNV} \subseteq B_{QNV} \Rightarrow \overline{B_{QNV}} \subseteq \overline{A_{QNV}}$
- (viii) $\overline{\overline{(A_{QNV})}} = A_{QNV}$
- (ix) $\overline{1_{QNV}} = 0_{QNV}$
- (x) $\overline{0_{QNV}} = 1_{QNV}$

Corollary 3.15 Let $A_{QNV}, B_{QNV}, C_{QNV}$ and $\{A_{i_{QNV}} : i \in J\}$ be QNVSSs. Then

- (i) $A_{i_{QNV}} \subseteq B_{QNV} \forall i \in J \Rightarrow \bigcup A_{i_{QNV}} \subseteq B_{QNV}$
- (ii) $B_{QNV} \subseteq A_{i_{QNV}} \forall i \in J \Rightarrow B_{QNV} \subseteq \bigcap A_{i_{QNV}}$
- (iii) $\overline{\bigcup A_{i_{QNV}}} = \bigcap \overline{A_{i_{QNV}}}$
- (iv) $\overline{\bigcap A_{i_{QNV}}} = \bigcup \overline{A_{i_{QNV}}}$

Quadripartitioned Neutrosophic Vague Topological Space

Definition 4.1 A Quadripartitioned Neutrosophic vague topology (QNV T) on X_{QNV} is a family τ_{QNV} of Quadripartitioned Neutrosophic vague sets (QNV S) in X_{QNV} satisfying the following axioms:





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- (i) $0_{QNV}, 1_{QNV} \in \tau_{QNV}$
- (ii) $G_1 \cap G_2 \in \tau_{QNV}$, for any $G_1, G_2 \in \tau_{QNV}$
- (iii) $\cup G_i \in \tau_{QNV}, \forall \{G_i: i \in J\} \subseteq \tau_{QNV}$.

In this case the pair (X_{QNV}, τ_{QNV}) is called Quadripartitioned Neutrosophic vague topological space (QNVTS) and any QNVS in τ_{QNV} is known as Quadripartitioned Neutrosophic vague open set (QNVOS) in X_{QNV} . The complement A_{QNV}^c of QNVOS in QNVTS (X_{QNV}, τ_{QNV}) is called Quadripartitioned Neutrosophic vague closed set (QNVCS) in X_{QNV} .

Example 4.2: Let $X_{QNV} = \{e, f\}$ and

$$A_{QNV} = \left\{ \frac{e}{\{[0.25, 0.6], [0.35, 0.5], [0.5, 0.65], [0.4, 0.75]\}}, \frac{f}{\{[0.2, 0.55], [0.5, 0.6], [0.4, 0.5], [0.45, 0.8]\}} \right\},$$

$$B_{QNV} = \left\{ \frac{e}{\{[0.2, 0.6], [0.3, 0.5], [0.5, 0.7], [0.4, 0.8]\}}, \frac{f}{\{[0.2, 0.45], [0.4, 0.6], [0.4, 0.6], [0.55, 0.8]\}} \right\},$$

$$C_{QNV} = \left\{ \frac{e}{\{[0.4, 0.5], [0.3, 0.6], [0.4, 0.7], [0.5, 0.6]\}}, \frac{f}{\{[0.3, 0.7], [0.4, 0.6], [0.4, 0.6], [0.3, 0.7]\}} \right\}.$$

Then the family $\tau_{QNV} = \{0_{QNV}, A_{QNV}, B_{QNV}, C_{QNV}, 1_{QNV}\}$ of QNVSSs in X_{QNV} is QNVT on X_{QNV} .

Definition 4.3 Let (X_{QNV}, τ_{QNV}) be QNVTS and $A_{QNV} = \{(x, [\hat{T}_A(x); \hat{C}_A(x); \hat{U}_A(x); \hat{F}_A(x)])\}$ be QNVS in X_{QNV} . Then the Quadripartitioned Neutrosophic vague interior and Quadripartitioned Neutrosophic vague closure are defined by

- (i) $QNV \text{ int}(A_{QNV}) = \cup \{G_{QNV}/G_{QNV} \text{ is a QNVOS in } X_{QNV} \text{ and } G_{QNV} \subseteq A_{QNV}\}$
- (ii) $QNV \text{ cl}(A_{QNV}) = \cap \{K_{QNV}/K_{QNV} \text{ is a QNVCS in } X_{QNV} \text{ and } A_{QNV} \subseteq K_{QNV}\}$

Also for any QNVSA_{QNV} in (X_{QNV}, τ_{QNV}) , we have $QNV \text{ cl}(A_{QNV}^c) = (QNV \text{ int}(A_{QNV}))^c$ and $QNV \text{ int}(A_{QNV}^c) = (QNV \text{ cl}(A_{QNV}))^c$.

It can also be shown that $QNV \text{ cl}(A_{QNV})$ is QNVCS and $QNV \text{ int}(A_{QNV})$ is QNVOS in X_{QNV} .

- a) A_{QNV} is QNVCS in X_{QNV} if and only if $QNV \text{ cl}(A_{QNV}) = A_{QNV}$.
- b) A_{QNV} is QNVOS in X_{QNV} if and only if $QNV \text{ int}(A_{QNV}) = A_{QNV}$.

Example 4.4

Let $X_{QNV} = \{e, f\}$ and let $\tau_{QNV} = \{0_{QNV}, G_1, G_2, 1_{QNV}\}$ be NVT on X , where

$$G_1 = \left\{ \frac{e}{\{[0.2, 0.6], [0.3, 0.5], [0.5, 0.7], [0.4, 0.8]\}}, \frac{f}{\{[0.2, 0.45], [0.4, 0.6], [0.4, 0.6], [0.55, 0.8]\}} \right\} \text{ and}$$

$$G_2 = \left\{ \frac{e}{\{[0.4, 0.5], [0.3, 0.6], [0.4, 0.7], [0.5, 0.6]\}}, \frac{f}{\{[0.3, 0.7], [0.4, 0.6], [0.4, 0.6], [0.3, 0.7]\}} \right\}$$

If $A_{QNV} = \left\{ \frac{e}{\{[0.3, 0.8], [0.5, 0.6], [0.4, 0.5], [0.2, 0.7]\}}, \frac{f}{\{[0.4, 0.55], [0.7, 0.9], [0.1, 0.3], [0.45, 0.6]\}} \right\}$, then

$$QNV \text{ int}(A_{QNV}) = G_1 = \left\{ \frac{e}{\{[0.2, 0.6], [0.3, 0.5], [0.5, 0.7], [0.4, 0.8]\}}, \frac{f}{\{[0.2, 0.45], [0.4, 0.6], [0.4, 0.6], [0.55, 0.8]\}} \right\} \text{ and}$$

$$QNV \text{ cl}(A_{QNV}) = G_1^c = \left\{ \frac{e}{\{[0.4, 0.8], [0.5, 0.7], [0.3, 0.5], [0.2, 0.6]\}}, \frac{f}{\{[0.55, 0.8], [0.4, 0.6], [0.4, 0.6], [0.2, 0.45]\}} \right\}.$$

Proposition 4.5

Let A_{QNV} be any QNVS in X_{QNV} . then

- (i) $QNV \text{ int}(1_{QNV} - A_{QNV}) = 1_{QNV} - (QNV \text{ cl}(A_{QNV}))$ and
- (ii) $QNV \text{ cl}(1_{QNV} - A_{QNV}) = 1_{QNV} - (QNV \text{ int}(A_{QNV}))$

Proof (i) By Definition $QNV \text{ cl}(A_{QNV}) = \cap \{K_{QNV}/K_{QNV} \text{ is a QNVCS in } X_{QNV} \text{ and } A_{QNV} \subseteq K_{QNV}\}$.

$$\begin{aligned} \text{Then } 1_{QNV} - (QNV \text{ cl}(A_{QNV})) &= 1_{QNV} - \cap \{K_{QNV}/K_{QNV} \text{ is a QNVCS in } X_{QNV} \text{ and } A_{QNV} \subseteq K_{QNV}\} \\ &= \cup \{1_{QNV} - K_{QNV}/K_{QNV} \text{ is a QNVCS in } X_{QNV} \text{ and } A_{QNV} \subseteq K_{QNV}\} \\ &= \cup \{G_{QNV}/G_{QNV} \text{ is a QNVOS in } X_{QNV} \text{ and } G_{QNV} \subseteq 1_{QNV} - A_{QNV}\} \\ &= QNV \text{ int}(1_{QNV} - A_{QNV}) \end{aligned}$$

- (ii) The proof is similar to (i).





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Proposition 4.6

Let (X_{QNV}, τ_{QNV}) be a QNVTS and A_{QNV}, B_{QNV} be QNVs in X_{QNV} . Then the following properties hold:

- a) $QNV\ int(A_{QNV}) \subseteq A_{QNV}$
- a') $A_{QNV} \subseteq QNV\ cl(A_{QNV})$
- b) $A_{QNV} \subseteq B_{QNV} \Rightarrow QNV\ int(A_{QNV}) \subseteq QNV\ int(B_{QNV})$
- b') $A_{QNV} \subseteq B_{QNV} \Rightarrow QNV\ cl(A_{QNV}) \subseteq QNV\ cl(B_{QNV})$
- c) $QNV\ int(QNV\ int(A_{QNV})) = QNV\ int(A_{QNV})$
- c') $QNV\ cl(QNV\ cl(A_{QNV})) = QNV\ cl(A_{QNV})$
- d) $QNV\ int(A_{QNV} \cap B_{QNV}) = QNV\ int(A_{QNV}) \cap QNV\ int(B_{QNV})$
- d') $QNV\ cl(A_{QNV} \cup B_{QNV}) = QNV\ cl(A_{QNV}) \cup QNV\ cl(B_{QNV})$
- e) $QNV\ int(1_{QNV}) = 1_{QNV}$
- e') $QNV\ cl(0_{QNV}) = 0_{QNV}$

Proof (a), (b) and (e) are obvious and (c) follows from (a).

(d) From $QNV\ int(A_{QNV} \cap B_{QNV}) \subseteq QNV\ int(A_{QNV})$ and $QNV\ int(A_{QNV} \cap B_{QNV}) \subseteq QNV\ int(B_{QNV})$ we obtain $QNV\ int(A_{QNV} \cap B_{QNV}) \subseteq QNV\ int(A_{QNV}) \cap QNV\ int(B_{QNV}) \rightarrow (1)$

On the other hand, from the facts $QNV\ int(A_{QNV}) \subseteq A_{QNV}$ and $QNV\ int(B_{QNV}) \subseteq B_{QNV}$, we have

$QNV\ int(A_{QNV}) \cap QNV\ int(B_{QNV}) \subseteq A_{QNV} \cap B_{QNV}$ and $QNV\ int(A_{QNV}) \cap QNV\ int(B_{QNV}) \in \tau_{QNV}$, we see that $QNV\ int(A_{QNV}) \cap QNV\ int(B_{QNV}) \subseteq QNV\ int(A_{QNV} \cap B_{QNV}) \rightarrow (2)$.

From (1) and (2), we have $QNV\ int(A_{QNV} \cap B_{QNV}) = QNV\ int(A_{QNV}) \cap QNV\ int(B_{QNV})$

(a') – (e') can be easily deduced from (a) – (e).

CONCLUSION

We have defined Quadripartitioned Neutrosophic vague set and studied the operations and properties of Quadripartitioned Neutrosophic vague set and have given some examples. We used Quadripartitioned Neutrosophic vague sets and topological spaces and we have constructed and developed a new concept namely "Quadripartitioned Neutrosophic vague topological spaces" and have discussed some of its properties.

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AI-Driven Predictive Analytics in Marketing : Opportunities and Challenges

Anusha Nagesh*

¹Department of Computer Applications, Krupanidhi Group of Institutions, Bangalore, Karnataka, India.

²TKDM, GVHS, Kerala Vocational Higher Secondary Education, Kollam, Kerala, India.

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*Address for Correspondence

Anusha Nagesh

Department of Computer Applications,
Krupanidhi Group of Institutions,
Bangalore, Karnataka, India.

E.Mail: anusha.nagesh@ovgu.st.de



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ABSTRACT

AI and machine learning (ML) are reshaping the marketing environment, enabling wider adoption of AI-powered predictive analytics. The ability of AI systems to analyze large amounts of data and find patterns and trends has resulted in improved marketing methods, individualized consumer experiences, and increased revenue for businesses. Marketers can utilize predictive analytics tools to gain a better understanding of their customers' behaviours, forecast future behaviours, and optimize marketing strategies. Yet, there are several difficulties in implementing AI-driven predictive analytics in marketing. Data privacy is one of the most serious challenges, as AI algorithms rely on personal data to generate predictions. Furthermore, the possibility of biased or discriminating algorithms must be addressed in order to assure the ethical and fair use of AI-powered predictive analytics. The lack of openness and explainability in AI algorithms can lead to consumer distrust, which can harm brand reputation. To address these challenges, organizations must prioritize ethical considerations, transparency, and consumer trust when implementing AI-driven predictive analytics in marketing. Privacy policies and data governance frameworks should be put in place to protect consumer data, while ensuring that the algorithms are unbiased and transparent. Explainability and interpretability in AI algorithms can help build trust with consumers and prevent negative impacts on brand reputation. Despite these challenges, AI-driven predictive analytics presents significant opportunities for businesses to improve their marketing strategies and enhance customer experiences. By leveraging the insights and predictions generated by AI algorithms, businesses can tailor their marketing efforts to their target audience and boost their bottom line. Additionally, the use of AI-driven predictive analytics can help identify new revenue streams and improve the overall customer experience. In conclusion, AI-driven predictive analytics is transforming the marketing landscape, enabling businesses to gain a competitive edge through improved insights and predictions. However, to fully realize the benefits of this technology,

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organizations must address the challenges of data privacy, biased algorithms, and lack of transparency. By prioritizing ethical considerations, transparency, and consumer trust, organizations can leverage AI-driven predictive analytics in marketing to drive business growth and create positive impacts.

Keywords: transparent, behaviours, businesses, algorithms

INTRODUCTION

AI-driven predictive analytics in marketing has become a must-have tool for companies seeking to remain ahead of the competition. AI-driven predictive analytics, with its ability to analyze massive volumes of data fast and accurately, can provide significant insights into consumer behaviour that were previously difficult to gather via traditional approaches. Businesses can utilize this information to design customized marketing initiatives that are more likely to resonate with their target audience by identifying patterns and trends in customer data. AI-powered predictive analytics, for example, can assist firms in determining which products are likely to be most popular with specific groups of their client base based on their purchasing history and other data factors. This can assist firms in developing more targeted marketing campaigns that communicate directly to those customers' needs and interests, boosting the likelihood of a successful transaction. AI-powered predictive analytics may also assist organizations in optimizing their marketing budget by determining which channels are most efficient in reaching their target demographic. For example, artificial intelligence (AI) may evaluate data on customer involvement across numerous marketing channels, such as social media, email, and paid advertising, to decide which channels are most likely to drive conversions. This data can help organizations better allocate their marketing budgets, increasing their return on investment (ROI) and boosting revenue development.

In the digital world of today, businesses have access to massive amounts of data on their customers and the market. This data contains information about customer preferences, buying behaviour, demographics, social media participation, website traffic, and more. Yet, analysing and interpreting all of this data may be a challenging undertaking, and many firms struggle to derive insights that might inform their marketing plans. This is where AI-powered predictive analytics comes in.

Artificial intelligence and its role in marketing

Artificial Intelligence (AI) is an area of computer science that enables machines to perform tasks that normally require human intellect, such as reasoning, learning, and decision-making. Machine learning, natural language processing, computer vision, and robotics are all subfields of AI. AI plays a critical role in predictive analytics by automating the process of evaluating vast amounts of data and detecting patterns and linkages. Predictive analytics may learn from historical data and generate accurate forecasts about future outcomes by applying machine learning algorithms. Predictive analytics driven by AI develops models that can evaluate real-time data, discover correlations and patterns, and make suggestions or decisions based on those insights. To provide individualized predictions, these models can be trained on a variety of data types, including customer behaviour, demographics, purchase history, and social media activity. With more data available and advancements in AI technology, predictive analytics is becoming more powerful and complex, assisting marketers in making sensible decisions and improving marketing outcomes.

The paper aims to explore the opportunities and challenges of using AI-driven predictive analytics in marketing. The paper will address several research questions to provide a comprehensive understanding of the current state of AI-driven predictive analytics in marketing, the benefits of using predictive analytics in marketing, the challenges and limitations of using predictive analytics, the role of AI technology in enhancing the capabilities of predictive analytics, and the best practices for effectively integrating AI-driven predictive analytics into marketing strategies. The goal is to provide insights into how marketers can leverage this technology to achieve their marketing objectives.



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The seminar paper starts by providing an overview of predictive analytics and artificial intelligence in marketing and outlines the purpose of the paper. The body of the paper explores research questions related to the current state of AI-driven predictive analytics in marketing, the benefits and challenges associated with using predictive analytics, the role of AI technology in enhancing predictive analytics, and best practices for integrating AI-driven predictive analytics into marketing strategies along with examples to illustrate key concepts. The conclusion summarizes the key findings and emphasizes the importance of AI-driven predictive analytics in marketing, and encourages further research in this area.

AI in Predictive Analytics 2.1 Artificial intelligence and machine learning algorithms in predictive analytics

Predictive analytics is being transformed by artificial intelligence and machine learning (ML). AI is the use of computer systems to execute tasks that would ordinarily need human intellect, such as decision-making, visual perception, and natural language processing. Machine learning (ML), on the other hand, is a subset of AI that focuses on designing algorithms that can learn from data and make predictions or judgments based on it. Predictive analytics makes use of AI and machine learning algorithms to create prediction models that can analyze huge and complex datasets and provide credible forecasts. These algorithms can learn from previous data, recognize patterns, and predict based on those patterns. There are several types of ML algorithms that can be used in predictive analytics:

Supervised Learning: The most frequent sort of machine learning algorithm used in predictive analytics. It entails utilizing labelled data to train a model to predict the result of fresh, previously unknown data. Regression, classification, and decision trees are examples of supervised learning techniques.

• **Unsupervised Learning:** In this form of ML method, a model is trained on unlabelled data to detect patterns or relationships in the data. Unsupervised learning algorithms include clustering and association rule mining.

• **Reinforcement Learning:** In this sort of ML method, a model is trained to make decisions based on feedback from its surroundings. It's widely used in sectors like robotics and games.

Advantages of AI driven predictive analytics

AI and ML algorithms have several advantages over traditional predictive analytics techniques. They can analyze large and complex datasets, learn from the data, and provide more accurate and reliable predictions. They can also adapt to changes in the data and provide insights into the reasoning behind their predictions. However, they also require more data and computing power than traditional techniques, and their results can be harder to interpret and explain.

The technology has increased in popularity in recent years as firms attempt to exploit the power of big data to achieve a competitive advantage. AI-powered predictive analytics can be used in a range of fields, from banking and healthcare to marketing and logistics. By analysing large amounts of data and detecting patterns and trends, AI-driven predictive analytics may help businesses make more informed decisions, decrease costs, and improve customer experiences. In this section, we'll look at some of the most important advantages of AI-powered predictive analytics."

Increased accuracy: AI algorithms can learn from large and complex datasets and identify patterns and correlations that may not be apparent to humans. This leads to more accurate predictions and insights that can improve decision-making.

Scalability: AI algorithms can process and analyze vast amounts of data quickly, which means that they can handle large-scale datasets with ease. This makes them ideal for organizations that generate large amounts of data, and need to analyze it in real-time.



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Real-time decision-making: AI algorithms can process data in real-time, which means that they can provide insights and predictions in real-time as well. This enables organizations to make decisions quickly and respond to changes in the market or customer behavior in real-time.

Automation: AI algorithms can automate tasks such as data cleansing, preprocessing, and feature selection. This can save time and resources and reduce the risk of errors.

Adaptability: AI algorithms can adapt to changes in data and provide insights and predictions that are relevant to the current situation. This means that they can provide up-to-date insights that are relevant to current market conditions.

Improved Customer Experience: AI-driven predictive analytics can provide a more personalized and relevant customer experience. By analysing customer data and behaviours, AI algorithms can identify customer preferences and needs, and provide personalized recommendations and offers. 2.3 Real-world examples of AI driven predictive analytics in marketing

AI-driven predictive analytics can provide more accurate, scalable, and real-time insights and predictions that can improve decision-making and customer experience. However, they do require specialized skills and expertise to implement and can be more expensive than traditional predictive analytics techniques. AI-powered predictive analytics is transforming the marketing sector by enabling companies to acquire insights into client behaviour and preferences, improve campaigns, and drive revenue development. It delves into real-world examples of how organizations are leveraging this technology to remain ahead of the competition, such as personalized recommendations and customer attrition prediction. The study shows the benefits of AI-driven predictive analytics in assisting businesses in making better data-driven decisions for growth and success through these instances.

Customer Churn Prediction: To identify customers who are at danger of churning, a telecoms business can utilize AI algorithms to examine customer data such as call habits, billing history, and service consumption. To keep these clients, the organization might then provide tailored promotions or discounts.

Personalized Product Recommendations: AI algorithms are used by online retailers such as Amazon and Netflix to evaluate customer behaviours and create customised product recommendations. These companies can recommend products or services that the consumer is likely to be interested in by evaluating client data such as purchase history, browsing patterns, and search history.

Dynamic Pricing: To establish the ideal price to charge, AI algorithms may study market data, competitor pricing, and customer behaviours. Airlines, for example, use AI-powered predictive analytics to maximize revenue by altering ticket prices based on demand, availability, and other factors.

Lead Scoring: B2B companies can use AI-driven predictive analytics to score leads based on their likelihood to convert into a sale. By analysing data such as website activity, email engagement, and demographic information, the algorithm can assign scores to leads based on their level of interest and engagement. The sales team can then focus on the leads with the highest scores, increasing their chances of closing a sale.

Social Media Analytics: AI algorithms can analyze social media data to identify trends, sentiments, and influencers. Companies can use this data to develop targeted social media marketing campaigns and improve customer engagement



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The examples above are just a few of the numerous ways in which AI-driven predictive analytics can be used in the field of marketing. The possible applications are nearly unlimited, and the benefits might include increased client engagement, increased conversion rates, and increased revenue.

Opportunities of AI-Driven Predictive Analytics in Marketing

In marketing, digital predictive analytics has proven to be a game changer, offering up new channels for analysing consumer behaviour and preferences and making data-driven decisions. Predictive analytics is the process of analysing past data and making predictions about future outcomes using machine learning algorithms and statistical models. Marketers can utilize predictive analytics to get insights into customer behaviour and preferences, optimize advertising, and boost revenue growth.

Personalised marketing and customer engagement.

Personalized Recommendations: Artificial intelligence systems can analyze client data and behaviour to create personalized product recommendations and offers. This can enhance conversion rates and consumer loyalty.

Hyper-personalization: AI algorithms can evaluate client data at a granular level, such as browser history, search queries, and social media activity, to create hyper-personalized marketing messages and experiences.

Consumer Segmentation: AI algorithms can divide customers into groups depending on their behaviour, preferences, and needs. Marketers may now construct targeted and individualized marketing campaigns for specific customer groupings.

Predictive Lead Scoring: AI algorithms may rank leads based on their propensity to convert into sales. This allows marketers to focus their efforts on the most promising prospects, increasing their chances of closing a transaction.

Churn Prediction: AI algorithms can predict which customers are at risk of churning or leaving the company. This enables marketers to take proactive measures to retain these customers, such as offering special promotions or personalized communications.

Real-time Personalization: AI algorithms can analyze customer data in real-time and provide personalized experiences in real-time. This can improve customer engagement and loyalty by providing a relevant and timely experience.

Enhanced customer experience and loyalty

Personalization: Artificial intelligence systems can evaluate massive amounts of client data and create individualized recommendations, offers, and experiences. This can assist to provide a more personalized and relevant experience for each consumer, increasing satisfaction and loyalty.

Predicting client needs: AI systems can forecast what customers will need or want in the future by examining their behaviour and interactions with a business. This allows marketers to anticipate and address the demands of customers before they express them, which can improve client loyalty.

Better customer service: AI algorithms can aid in the automation of customer support duties such as answering frequently asked inquiries and addressing difficulties. This can result in a more efficient and speedier customer service experience, which can boost client satisfaction and loyalty.

Omnichannel marketing: AI algorithms may analyze client data from many channels, including social media, email, and website interactions, to create a more complete picture of the customer. This helps advertisers to provide a uniform and seamless experience across all platforms, thus increasing customer happiness and loyalty.



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Personalized loyalty programs: AI algorithms can analyze customer data to identify the most effective loyalty program incentives and rewards for each customer. This can help to create a more personalized and relevant loyalty program, which can increase customer engagement and loyalty.

Improved Marketing efficiency and effectiveness

AI-driven predictive analytics can also improve marketing efficiency and effectiveness by identifying the most effective marketing channels and tactics for specific customer segments. By analysing data on customer behaviour, preferences, and engagement, AI algorithms can identify which marketing channels and tactics are most likely to result in a conversion or sale. For example, an AI-driven predictive analytics platform can analyze data on customer behaviour and engagement with email marketing campaigns, and identify which types of emails are most likely to be opened and result in a purchase. This can help marketers optimize their email campaigns and allocate resources to the most effective tactics. In addition, AI algorithms can help automate repetitive and time-consuming tasks such as data cleansing and analysis, freeing up marketers to focus on more strategic tasks such as developing and implementing marketing strategies. This can result in improved efficiency and cost savings for organizations. Overall, AI-driven predictive analytics can help marketers make data-driven decisions that improve the efficiency and effectiveness of their marketing campaigns, resulting in increased revenue and ROI.

Challenges of AI Driven Predictive Analytics in Marketing

In recent years, the use of AI-driven predictive analytics in marketing has become increasingly popular due to its ability to provide valuable insights and improve marketing outcomes. However, there are also significant challenges associated with this technology that must be addressed. Three major challenges of AI-driven predictive analytics in marketing are data quality and privacy concerns, transparency and interpretability of AI models, and integration with existing marketing systems and processes.

Data quality and privacy concerns arise from the use of large volumes of data to train predictive models. Marketers must ensure that the data used is accurate, relevant, and unbiased, and that it is obtained and processed in compliance with privacy laws and regulations. Failure to do so can result in inaccurate predictions and legal consequences. Transparency and interpretability of AI models refer to the need for marketers to understand how predictive models make decisions and recommendations. This is important to ensure that the models are making ethical and fair decisions and that marketers can take appropriate actions based on the insights provided. Finally, integration with existing marketing systems and processes can be challenging due to the complexity of marketing ecosystems and the need to integrate AI-driven predictive analytics seamlessly. Marketers must ensure that predictive models are integrated into their existing workflows and technologies, and that they are able to derive maximum value from the insights generated by the models.

Addressing these challenges is crucial for marketers to leverage the full potential of AI-driven predictive analytics in marketing and achieve their marketing objectives effectively.

Future Directions of AI Driven Predictive Analytics in Marketing

As AI technology continues to evolve, there are many emerging trends in AI-driven predictive analytics that have the potential to revolutionize marketing practices. One of the emerging trends is natural language processing (NLP), which involves teaching machines to understand and analyze human language. NLP can help marketers gain insights from customer feedback, social media conversations, and online reviews. For instance, NLP can be used to extract customer sentiment from online reviews, which can help marketers understand how customers perceive their products or services.

Image recognition, which involves the use of computer vision techniques to analyze images and videos. This can help marketers gain insights into customer behaviour and preferences, as images and videos can provide rich contextual information about customers. For example, image recognition can be used to analyze the images shared by customers on social media to understand their interests, hobbies, and lifestyle.





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Predictive personalization is another trend in AI-driven predictive analytics that can be used to tailor marketing messages and experiences to individual customers based on their past behaviours and preferences. Predictive personalization can help marketers improve customer engagement and loyalty by providing personalized recommendations, offers, and experiences to customers.

The potential applications of AI-driven predictive analytics in marketing are vast and diverse, including personalized recommendations, dynamic pricing, customer segmentation, and predictive customer service. These applications can help marketers improve customer experience, increase efficiency, and generate more revenue. For instance, personalized recommendations can increase sales by suggesting products or services that customers are likely to be interested in, while dynamic pricing can help marketers optimize prices based on demand and supply. To fully realize the potential of AI-driven predictive analytics in marketing, future research and development are necessary. This includes developing more advanced algorithms, improving data quality and governance, and addressing ethical concerns such as bias and privacy. Further research is also needed to explore new applications of AI-driven predictive analytics and to evaluate the impact of these technologies on marketing outcomes. In conclusion, the use of AI-driven predictive analytics in marketing has great potential, and ongoing research and development will continue to drive innovation in this field.

CONCLUSION

AI-driven predictive analytics is a powerful tool for organizations to boost customer engagement and drive revenue growth by analysing enormous volumes of consumer data to acquire useful insights into their behaviours and preferences. Yet, because AI algorithms learn from skewed or inadequate historical data, biased findings are a possible challenge. Human oversight is required to ensure accurate and ethical findings, and organizations must balance the benefits of AI with ethical considerations, assuring openness, fairness, and respect for customer privacy while accepting responsibility for any bad effects. Besides these obstacles, the potential benefits of AI-powered predictive analytics in marketing are substantial. Businesses may design focused and successful marketing campaigns, find new customer segments, predict sales trends, optimize pricing strategies, and improve customer service by studying customer data. The ongoing progress of technology has the potential to automate many portions of the marketing process, allowing marketers to focus on strategy and creative development. Businesses must comply with relevant regulations, ensure transparency, and incorporate human oversight and interpretation into their processes to ensure accurate and ethical results in order to maximize the benefits of AI-driven predictive analytics while minimizing its potential negative consequences. While the potential benefits of AI-driven predictive analytics in marketing are substantial, these gains must be balanced with ethical issues and human control. AI models have the potential to introduce prejudice and perpetuate existing imbalances, as well as to have unforeseen effects for user privacy and trust. As a result, it is critical to guarantee that AI models are built and deployed in an ethical and responsible manner, with sufficient human oversight and decision-making transparency.

Future Implications of Predictive analytics in marketing

Looking to the future, there is significant potential for AI-driven predictive analytics to continue to revolutionize marketing practices. Emerging trends in AI and predictive analytics, such as natural language processing, image recognition, and predictive personalization, offer exciting possibilities for gaining insights into customer behaviours and preferences. The potential applications of AI-driven predictive analytics in marketing are vast, including personalized recommendations, dynamic pricing, customer segmentation, and predictive customer service. However, to fully realize the potential of AI in marketing, future research and development is needed to address challenges related to algorithm development, data quality and governance, and ethical considerations. In conclusion, AI-driven predictive analytics presents both opportunities and challenges for marketers. To achieve the benefits of AI in marketing, businesses must prioritize ethical considerations and human oversight, and continue to invest in research and development to improve AI models and address challenges. With the right approach, AI-





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driven predictive analytics has the potential to revolutionize marketing practices and drive business growth in the years to come.

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A Study of Urbanization in Coimbatore City Corporation, Coimbatore using Geographic Information System

Helan Jenifer S^{1*} and Jyothirmayi P²

¹Research Scholar, Department of Geography, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Assistant Professor, Department of Geography, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

Helan Jenifer S

Research Scholar,

Department of Geography,

Nirmala College for Women,

Coimbatore, Tamil Nadu, India.

E. Mail : helanrai1229@gmail.com



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ABSTRACT

The process of expanding a city's area and population is known as urbanization. It is because of the people moving from rural to urban areas. The current study focuses on analyzing the population growth in Coimbatore City Corporation (CCC). According to the census of India, 2011, Coimbatore City Corporation is one of the metropolitan cities in Tamil Nadu, next to Chennai City. The drastic rate of increase of population began from 1981 onwards when the city was uplifted to the position of the Corporation. The population of Coimbatore city is growing constantly every decade. Population growth leads to lot of problems, including traffic congestions, accidents, water shortage, rising land values, rising costs of living, garbage disposal issues, crowding in commercial and market areas, pollution of the air, water, noise, and land. Analyzing population growth and its trend is urgently needed to resolve these problems. Spatial technological approaches were used to analyze the data gathered from the census portal, numerous government records, Coimbatore City Corporation, and other reliable sources. This paper is a humble approach to clarify, how the population increased between 1961 to 2021. To create a sustainable city with all the necessities, this article may be useful to urban planners and developers, public and private enterprises, NGOs, and certain social well-wishers.

Keywords: Urbanization, Metropolitan, Urban Planners, and Sustainable.



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INTRODUCTION

Urbanization is defined as a rise in the proportion of the total population living in urban areas (Pacione, 2009). However, the term 'urbanization' is also often used in a broader sense, referring to the physical expansion of urban areas from rural regions as a result of population movement to an existing urban region. Changes in urban density and administrative services are two effects of urbanization. Rapid urbanization is to blame for several other environmental and social changes in the city, and its consequences are closely linked to concerns about global change. Rapid urbanization is putting pressure on cities ability to supply services including energy, education, health care, transportation, sanitation, and physical security (Bhatta, 2010). The process of urbanization frequently results in an unplanned expansion in metropolitan cities, deterioration in living circumstances, and worsening of the environmental situation (Pathan *et al.*, 1991). Based on this concern, this paper aims to analyze the population growth trends for Coimbatore City Corporation, a fast-growing city in Tamil Nadu next to Chennai.

Study Area

The Coimbatore Metropolitan Region, also known as the 16th Urban Agglomeration in India and the second most populous city in the Tamil Nadu state after Chennai, is situated on the banks of the Noyyal River. It serves as the Coimbatore District's administrative hub. It is one of the most industrialized cities in Tamil Nadu and is referred to as the Manchester of the South or the textile center of South India. Engineering companies, the textile industry, educational institutions, and producers of car components are all well-known in Coimbatore. One of the fastest-growing metropolitan areas in India, the city is well renowned for its entrepreneurial spirit (City-wide Concept Plan for Coimbatore, 2015 & Anuradha Yagya, 2017). Coimbatore City is situated between 10°54'36" and 11°06'17" N latitude and 76°52'13" and 77°97'25" E longitude in the extreme west of Tamil Nadu, close to Kerala State with an area of 257 sq. km. On average, the city is 432 meters above sea level. The Vellingiri hills in the west are the source of the river Noyyal, which runs through the heart of the city. The metropolitan area of Coimbatore has 10 lakh residents, according to the 2011 census. Major Indian cities are easily accessible by road and train from the city. At Peelamedu, 11 km outside the city, Coimbatore's international airport offers air service to all significant Indian cities as well as to overseas locations. (District Energy in Cities Initiative in India, 2017).

Objectives

- The current study examines the level and trends of urban population growth in Coimbatore City Corporation.
- To investigate the population and density distribution zone wise from 2001 to 2021.

DATABASE AND METHODOLOGY

The present study relies on secondary data sources, like census data, Coimbatore City Municipal Corporation data, Master Plan for Coimbatore City, and other government reports. Using these data, the maps and charts were generated using a software ArcMap 10.5 and excel.

RESULTS AND DISCUSSION

Coimbatore City experienced a significant population increase of 7 lakhs and recorded the highest decadal growth rate of 49.20% when Coimbatore was raised to a Municipal Corporation in 1981. The population increased from 2 lakhs in 1961 to 18.59 lakhs in 2021. The highest decadal growth rate of 76.98% was seen in 2021. When the city was elevated as a corporation in 1981, the area first remained static (105.66sq.km) and increased significantly (257.04) from 2011 onwards. The trends in the city's urban population and area growth since 1961 are shown in Table: 1 and figure: 1. The city's boundaries were increased to become a municipal corporation in 1981, and a few more villages were added, including Villankurichi (Partial), Telugupalayam, Kumarapalayam, Sanganoor, Ganapathy Krishnarayapalayam, Sowripalayam, Singanallur, Upplipalayam, Ramanathapuram, Puliakulam, and

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Anuparpalayam, increasing the size of the city to 105.66 sq. km. In 2011, the city was once more expanded to incorporate surrounding areas, increasing its size to 257.04 sq km and its population increased to 16.17 lakhs. The Coimbatore city had a population density of 10000 people per/sq.km in 2011. The population density has grown since 1981, although the city's boundaries have stayed constant. When Coimbatore Corporation's boundaries merged with a few additional areas in 2011, which included three municipalities, seven town panchayats, and one village panchayat, the city's size also increased significantly to 257.04 sq. km. In 2021 the population density is 7235 people per/sq.km (Table:2).

Zone-Wise Distribution of Population in Coimbatore city 2001, 2011 & 2021

According to Figures. 3 and 4, the east zone had the highest population in 2001& 2011 and the lowest density overall. The South zone had the lowest population, but it also has the highest density. The East zone has the largest population and population density in 2021, followed by the Central and West zones. The South zone showed the lowest population density. The East zone had the highest population, while the South zone had the lowest population, according to a comparison of the years 2001, 2011 and 2021 (Table: 3). The lowest population density (<10000) was found in 21 wards (West Zone: 48,49,50,51,53,63,64; North Zone: 29,30,32,35,68; and South Zone: 25,27,31,36,38,39,40,41,43,45,46,47,48,49,50,51) in 2011 and 5 wards in 2021 respectively (West Zone: 23; South Zone: 78; East Zone: 69; & North Zone: 1,31). From 2011 to 2021, the medium density pattern (10000 – 20000) increased in 37 (West Zone: 52,56,57,58,59,60,6,62; North Zone: 1,2,3,33,65,67; (East Zone: 5,7,11,14,15,21,22,23,24,26; South Zone: 44) to 58 wards (West Zone: 5,9,10,11,12,13,14,20,21; South Zone: 77,79,85,86,87,88,89,90,91,93,94,96; East Zone: 33,34,37,38,39,60,62,64,65,66,67,68,75; Central Zone: 50,51,52,53,54,70,71,72,73,82,83,8); & North Zone: 2,3,4,5,9,26,27,30,38,39,42,43,46). In 2011, 11 wards (West Zone: 55; North Zone: 66,68,69,70; South Zone: 12,13; & East Zone: 4,6,8,9,10,16) had a high population density (20000 – 30000), which has now been increased to 31 wards by 2021 (West Zone: 7,8,15,18,22; South Zone: 74,76,92,95,97,98,100; East Zone: 32,35,47,55,56,57,58,59,61,63; Central Zone: 24,25,48,49,74,80,81; & North Zone: 28,40,44,47). In 2011, 2 wards (North Zone: 72; South Zone: 54) had a very high population density (>30000); by 2021, this had increased to six wards (North Zone: 41; East Zone: 36; West Zone: 6,16,17; Central Zone: 45) (Table:4 & Fig:5& 6). According to the Coimbatore City Municipal Corporation and City Development Plan, the population of the city is projected to increase from 20.24 lakhs to 27.87 lakhs between 2025 to 2045.

CONCLUSION

According to the current study, the population of Coimbatore increased by 7 lakhs in 1981 to 18.59 lakhs in 2021. When the city was upgraded as a corporation in 1981, the area of the city initially remained the same and later increased significantly around 257.04 sq.km. A comparison of the city's population in 2001 and 2021 reveals that the East zone had the highest population and the South zone had the lowest population in both periods. Between 2025 and 2045, the population of Coimbatore is expected to grow by 20.24 lakhs to 27.87 lakhs. Considering this expected increase proper urban planning needs to be done to address the issues of traffic congestions, accidents, rising land values, rising costs of living, garbage disposal and water shortage.

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Table:1 Trends of Urban Population growth in Coimbatore City

Year	Population (Lakhs)	Decadal Growth %	Area Sq.km
1961	286305	-	4.26
1971	356368	19.71	5.64
1981	700923	49.20	105.66
1991	806321	15.04	105.66
2001	930882	15.45	105.66
2011	1050721 (After expanding 1617711)	18.56 (73.78)	105.66(257.04)
2021	1859632	76.98	257.04

Source: Census of India 2001, 2011 & Coimbatore City Municipal Corporation, 2021

Table:2 Density of Coimbatore City Population

S.No	Year	Population Density (per/sq.km)
1	1981	6667
2	1991	7727
3	2001	8815
4	2011	10000
6	2021	7235

Source: Census of India 2001, 2011 & Coimbatore City Municipal Corporation

Table:3 Zone-wise details of Coimbatore Corporation 2001,2011 and 2021

Zone	2001			2011			2021		
	Area	Population in Lakhs	Density (Per/ sq.km)	Area	Population in Lakhs	Density (Per/ sq.km)	Area	Population in Lakhs	Density (Per/ sq.km)
North Zone	28.1	256,434	9115	28.1	302021	10748	53.96	373156	6915
East Zone	33.0	261,889	7945	33.0	292314	8858	42.34	386464	9128
South Zone	21.5	202,021	9383	21.5	217532	10117	69.0	351116	5089
West Zone	22.8	210,538	9235	22.8	238854	10476	49.24	383324	7785
Central Zone	-	-	-	-	-	-	42.5	365572	8602

Source: Statistical Handbook, 2001 & 2011 and Coimbatore City Municipal Corporation, 2021





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Table 4: Number of wards with different population density patterns in Coimbatore Corporation 2001

Density Pattern	Range	Number of wards in 2001	Number of wards in 2011	Number of wards in 2021
Low	<10000	18	21	5
Medium	10000 – 20000	48	37	58
High	20000 – 30000	4	11	31
Very High	>30000	2	3	6

Source: Coimbatore City Corporation, 2021

Table5: Population Projection for Coimbatore City Municipal Corporation

Year	Projected Population
2025	2,024,055
2030	2,192,704
2035	2,375,405
2040	2,573,329
2045	2,787,745

Source: Coimbatore City Municipal Corporation, 2021

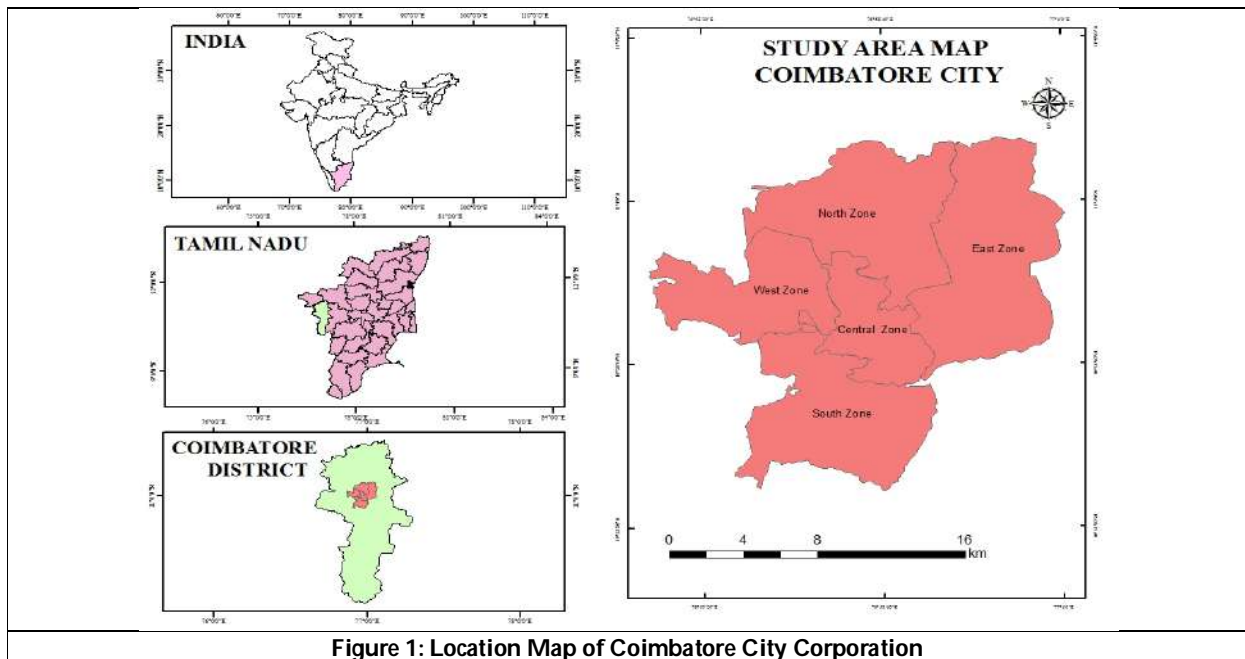


Figure 1: Location Map of Coimbatore City Corporation





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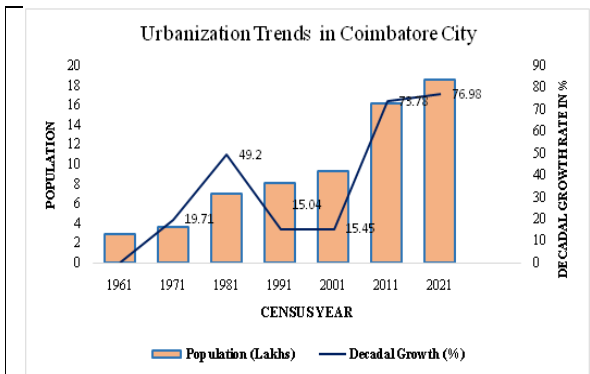


Figure 2: Trends of Urbanization in Coimbatore City

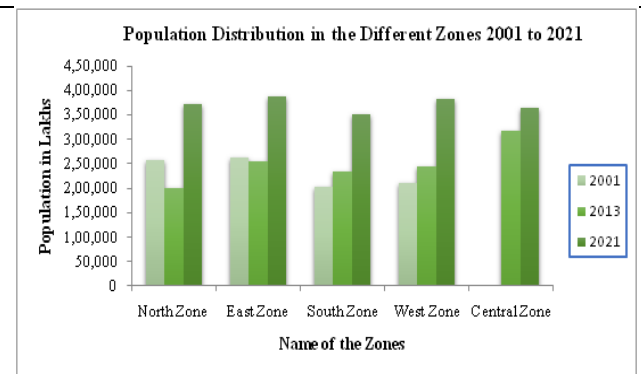


Figure 3: Distribution of Population in the Different Zones

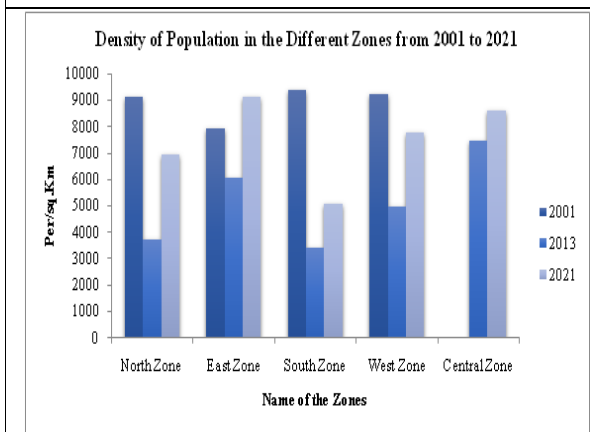


Figure 4: Density of Population in the Different Zones

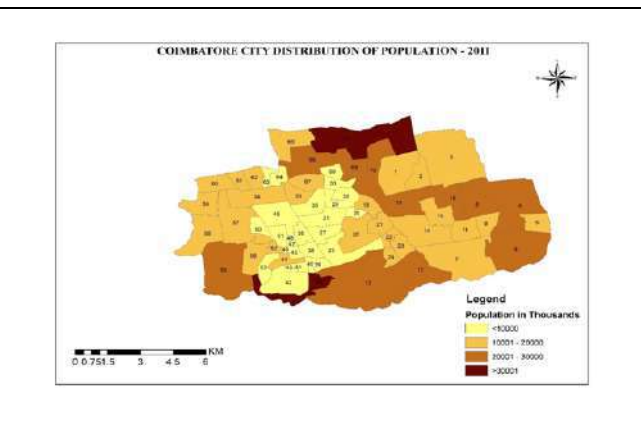


Figure 5: Population Distribution Ward wise - 2011

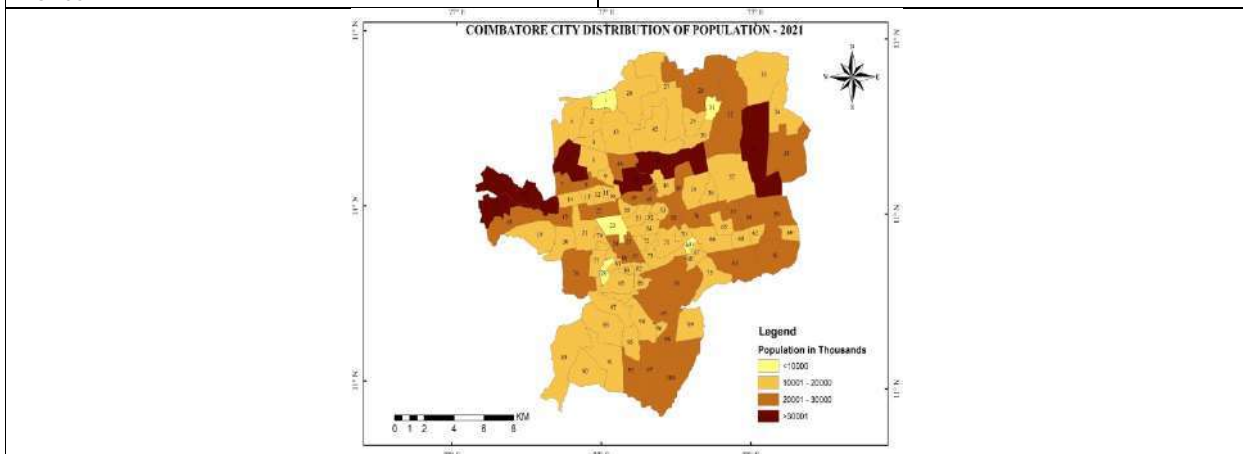


Figure 6: Population Distribution in Ward wise - 2021





Geodetic, Edge Geodetic and Geo Chromatic Number of Bull Graphs for Some Related Graphs

Mary. U¹ and Joseph Paul. R^{2*}

¹Department of Mathematics, Department of Mathematics, Nirmala College for Women (Autonomous), Coimbatore–641018, India.

²Research Scholar, Nirmala College for Women (Autonomous), Coimbatore – 641018, India.

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Accepted: 29 Mar 2023

*Address for Correspondence

Joseph Paul. R

Research Scholar,

Nirmala College for Women (Autonomous),

Coimbatore – 641018, India.

E. Mail: jprmat2020@gmail.com



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ABSTRACT

In this paper, a graph G is connected graph $G = (V, E)$ as follows. We have investigated the geodetic number $g(G)$, edge geodetic number $g_1(G)$ and Geo Chromatic number $\chi_{gc}(G)$ of bull graph G and their related graph, it is shown that $g(G) \leq g_1(G) \leq \chi_{gc}(G)$.

Keywords: Geodetic number, edge geodetic number, geo chromatic number, Bull graph.

INTRODUCTION

The distance $d(u, v)$ between two vertices u and v in a connected graph G is the length of a shortest $u - v$ path in G . An $u - v$ path of length $d(u, v)$ is called a $u - v$ geodesic [1]. The geodetic closure of a set $S \subseteq V(G)$ is the set of all vertices $u \in v$ which lies in some geodesic in G joining two vertices x and y of S . The minimum geodetic number of a connected graph G , denoted by $g(G)$. We define the geodetic number of a graph G as $g(G) = \min \{|S| : S \subseteq V \wedge S^c = V\}$. A geodetic cover of G is a set $S \subseteq V(G)$ such that every vertex of G is contained in a geodesic joining some pair of vertices in S . The geodetic number $g(G)$ of G is the minimum order of its geodetic covers and any covers of order $g(G)$ is a geodetic basis and any edge geodetic cover of order $g_1(G)$ is an edge geodetic basis of G [4]. In [3] proposed the notion of Geo Chromatic Number. A set $S_c \subseteq V(G)$, If S_c is both geodetic set and chromatic set, it is said to be a Geo chromatic set of G . The Geo chromatic number $\chi_{gc}(G)$ of a graph G [2] is its minimal cardinality among all Geo chromatic set. A planar undirected graph with five vertices and five edges in the shape of a triangle with two disjointed pendant edges is known as the Bull graph. Weisstein [5] introduced the Bull graph. Throughout the





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following G denotes a connected graph G as Bull graph and discussing about the comparison of geodetic number and edge geodetic number of Bull graph and some related graph.

Geodetic Number of Bull Graph

Theorem 2.1. For a graph G then the $g(G) = 3$.

Proof: Consider G be the bull graph, where G is a planar undirected graph with the vertex set $V(G) = \{v_1, v_2, v_3, v_4, v_5\}$ and the edge set as $E(G) = \{e_1, e_2, e_3, e_4, e_5\}$. Thus, it is in the form of triangle with two disjoint pendant edges. It has radius 2 and diameter 3. For the graph G , $S = \{v_1, v_3, v_5\}$ is a minimum geodetic set of G . Hence, $g(G) = 3$.

Theorem 2.2. For a graph G then $g(\overline{G}) = 3$.

Proof: Consider G be the bull graph, where $V(G) = \{v_1, v_2, v_3, v_4, v_5\}$ and $E(G) = \{e_1, e_2, e_3, e_4, e_5\}$. $S = \{v_2, v_3, v_4\}$ is a minimum geodetic set of G . Hence, $g(\overline{G}) = 3$.

Remark: The geodetic number of Bull graph G and \overline{G} is $g(G) = g(\overline{G})$.

Theorem 2.3. For a graph G then the Line graph of geodetic number of G is 3.

Proof: Consider the graph G be the bull graph with the vertices $v_i: 1 \leq i \leq 5$ and $e_i \in v_i v_{i+1}$ for $1 \leq i \leq 4$, $e_5 \in v_2 v_4$ respectively. Thus, the set $S = \{e_1, e_3, e_4\}$ be the minimum geodetic set of G . Hence, the line graph of geodetic number of G is 3.

Theorem 2.4. For a graph G then the Middle graph of geodetic number of G is $V(G)$.

Proof: Consider the graph G be the bull graph, where as middle graph $M(G)$ of a graph G is the graph, Let the vertices of $M(G)$ be $v_i: 1 \leq i \leq 5$ and $e_i: 1 \leq i \leq 5$. Hence, the geodetic number of the graph $M(g(G))$, the set of the vertex set $V(G)$. Therefore, the Middle graph of geodetic number of G is $V(G)$.

Theorem 2.5. For a graph G then the Central graph of geodetic number of G is 4.

Proof: Consider the vertex set of the central graph $C(G)$ be $v_i: 1 \leq i \leq 5$ and $v'_j: 1 \leq j \leq 5$ of G which is subdivided each edge exactly once and joining all the non – adjacent vertices of G . Thus, $V(C(G)) = \{v_i\} \cup \{v'_j\}, 1 \leq i, j \leq 5$. For the graph $C(G)$, $S = \{v'_1, v'_4, v'_5, v_3\}$ be the minimum geodetic number of $C(g(G))$. So that $C(g(G)) = 4$.

Theorem 2.6. For a graph G then the Total graph of geodetic number of G is 3.

Proof: Let G be the bull graph, where $v_i: 1 \leq i \leq 5$ and $e_j: 1 \leq j \leq 5$ be the vertex set and edge set of total graph $T(G)$, $S = \{v_1, v_5, e_3\}$ be the minimum geodetic number of $T(g(G))$. Thus, $T(g(G)) = 3$.

Theorem 2.7. For a graph G then the Splitting graph $S(G)$ of geodetic number of the graph G is $v'_i: 1 \leq i \leq 5$.

Proof: The graph $S(G)$ of a graph G is obtained by adding a new vertex v' corresponding to each vertex $V(G)$ such that $N(v) = N(v')$ where $N(v)$ and $N(v')$ are the neighborhood set of v and v' respectively. For the graph $S(G)$, $S = v'_i: 1 \leq i \leq 5$ be the minimum geodetic number of $S(g(G))$. Therefore, $S(g(G)) = v'_i: 1 \leq i \leq 5$.

Theorem 2.8. For a graph G then the degree Splitting graph $DS(G)$ of geodetic number of the graph G is 3.

Proof: Consider the vertices of the $DS(G)$ be $v_i: 1 \leq i \leq 5$ and w_j for $j = 1, 2$. For the graph $DS(G)$ is figure, $S = \{w_1, w_2, v_3\}$ be the minimum geodetic set. Hence, $DS(g(G)) = 3$.

Theorem 2.9. For a graph G , then the shadow graph $D_2(g(G)) = 4$.

Proof: The graph $D_2(g(G))$ is constructed by taking two copies of G , say G' and G'' and joining each vertex v' in G' to all the adjacent vertices of the corresponding vertex v'' in G'' . Let v'_i and $v''_i, 1 \leq i \leq 5$ be the vertex set of $D_2(g(G))$. Therefore, $S = \{v'_1, v''_1, v'_4, v''_4\}$ be the minimum geodetic set. Hence, $D_2(g(G)) = 4$.

Edge Geodetic Number of Bull Graph

Proposition 3.1. For a graph G then the edge geodetic number of G is 3.

Proof: Follows from theorem 2.1. Thus, S be the vertex that has the minimum edge geodetic number in G . So that $g_1(G) = 3$

Proposition 3.2. For a graph G then the edge geodetic number of \overline{G} is 3.





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Proof: Let G be the bull graph and the complement of G be \overline{G} , where as $g(G) = g(\overline{G})$. Thus, from the theorem 3.2. Hence, S is an edge geodetic basis for G . So that $g_1(\overline{G}) = 3$.

Remark: The edge geodetic number of Bull graph G and \overline{G} is $g(G) = g_1(\overline{G}) = V(G)$.

Theorem 3.3. For a graph G then the Line graph of edge geodetic number of G is 5.

Proof: Consider the vertices $v_i: 1 \leq i \leq 5$ and $e_i \in v_i v_{i+1}$ for $1 \leq i \leq 4$, $e_5 \in v_2 v_4$ respectively. Edges are considered as a vertex set $V(L(G)) = \{e_1, e_2, e_3, e_4, e_5\}$. For the graph $L(G)$, $S = V(L(G))$ be the minimum edge geodetic set of G . therefore, the line graph of edge geodetic number of G is 5.

Theorem 3.4. For a graph G then the Middle graph of edge geodetic number of G is $V(G)+2$.

Proof: Consider the graph G be the bull graph, follows from the theorem 2.4, thus the edge geodetic number of the graph $M(g_1(G))$ is $S = V(G) \cup \{e_2, e_5\}$ be the minimum edge geodetic number. Hence, $M(g_1(G)) = V(G)+2$.

Theorem 3.5. For a graph G then the Central graph of edge geodetic number of G is equal to central graph of geodetic number of G .

Proof: Follows from theorem 2.5, that S be the minimum geodetic and edge geodetic number of $C(G)$. Thus, its results $C(g_1(G)) = C(g(G))$.

Theorem 3.6. For a graph G then the Total graph of edge geodetic number of G is 7.

Proof: Let G be the bull graph, for the graph $T(G)$, then the edge geodetic number of the graph $T(g_1(G))$ is $S = \{v_1, v_4, v_5, e_1, e_2, e_3, e_4\}$ be the minimum edge geodetic number. Hence, $T(g_1(G)) = 7$.

Theorem 3.7. For a graph G then the $S(g_1(G)) = S(g(G))$.

Proof: Follows from theorem 2.7, that S be the minimum edge geodetic number of $S(G)$. Hence, its results that $S(g_1(G)) = S(g(G))$.

Theorem 3.8. For a graph G then the degree Splitting graph $S(G)$ of edge geodetic number of the graph G is 5.

Proof: Follow from the theorem 2.8., that $S = \{w_1, w_2, v_2, v_3, v_5\}$ be the minimum edge geodetic number of $DS(G)$. Hence, its result that degree Splitting graph $S(G)$ of edge geodetic number of the graph G is 5.

Theorem 3.9. For a graph G , then the shadow graph $D_2(g_1(G)) = 6$.

Proof: Follows from the theorem 2.9., that the set $S = \{v'_1, v''_1, v'_3, v''_3, v'_4, v''_4\}$ be the minimum edge geodetic number of $D_2(g(G))$. Hence, its result that $D_2(g(G)) = 6$.

Geo Chromatic Number of Bull Graph

Theorem 4.1. For a Bull graph G , $\chi_{gc}(G) = 3$.

Proof: Consider a graph G , where $V(G) = \{v_1, v_2, v_3, v_4, v_5\}$ and $E(G) = \{e_1, e_2, e_3, e_4, e_5\}$ in the forms of triangular with e_1, e_5 as disjoint pendant edges. By proper coloring, assign color C_1 to v_1, v_4 , assign color C_2 to v_2, v_5 and assign color C_3 to v_3 . Thus, $\chi(G) = 3$. Therefore, set $S = \{v_1, v_3, v_5\}$ is the minimum geodetic set and also chromatic set of G , that is $g(G) = |S|$ and $\chi(G) = |C| = |S|$. Thereby, $S_c = |S|$ is the minimum geo chromatic set of G . thus, $|S| = |S_c|$. Hence, $\chi_{gc}(G) = 3$.

Theorem 4.2. For a graph G then $\chi_{gc}(\overline{G}) = 3$.

Proof: Follows from the theorem 1.1, that $G \cong \overline{G}$. Therefore, $\chi_{gc}(\overline{G}) = 3$.

Theorem 4.3. For a Line graph of Bull graph G , $\chi_{gc}[L(G)] = 4$.

Proof: Consider G be a Bull graph with the vertex set $V(G) = \{v_1, v_2, v_3, v_4, v_5\}$ and $e_i \in v_i v_{i+1}$ for $1 \leq i \leq 4$, $e_5 \in v_2 v_4$ respectively. Edges are consider a vertex set $V(L(G)) = e_i, 1 \leq i \leq 5$. By proper coloring, e_1, e_5 are assigned with color C_1 , e_3, e_4 are assigned with color C_3 and e_2 is assigned with color C_2 . Thus, $S = \{e_1, e_3, e_4\}$ is a minimum geodetic set but not a chromatic set. Since, S belongs to the similar color class. Therefore, by taking another vertex from $L(G)$ which belongs to the various color classes. Let $e_i \in C_j, j \neq 1, 2$. If $e_i \in S$, thus the set becomes $S_c = \{S\} \cup \{e_i\}$ is a geodetic set





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as well as chromatic set of $L(G)$. Thus, $\chi_{gc}[L(G)] \leq 4$, whereas $\chi_{gc}[L(G)] < 4$ is not possible. Hence, $\chi_{gc}[L(G)] = 4$.

Theorem 4.4. For a Middle graph of Bull graph G , $\chi_{gc}[M(G)] = 5$.

Proof: Consider $M(G)$ of a graph G , whose vertex set $V(G) \cup E(G)$ and in which two vertices of $M(G)$ are adjacent if only if either they are adjacent edges of G or one is a vertex of G and the other is an edge of G incident to and it. Therefore, the number of vertices of G be $v_i, 1 \leq i \leq 5$ and $e_j, 1 \leq j \leq 5$ whereas $|V(M(G))| = 2n$ and $|E(M(G))| = 3n + 2$. By proper coloring, the vertices v_1, e_5 and v_5 are assigned by color C_1 , e_1, e_4, v_3 are assigned by color C_2 , v_4, e_2 are assigned as color C_3 and v_4, e_3 are assigned as color C_4 . Since, it has an induced subgraph, K_4 at least need 4 colors for its coloring which is 4 – colorable. Thereby, the set $S = V(G)$ be the minimum geodetic set and chromatic set. Hence, $\chi_{gc}[M(G)] = 5$.

Theorem 4.5. For a Central graph of Bull graph G , $\chi_{gc}[C(G)] = 4$.

Proof: Let the vertices of the Central graph $C(G)$ be $v_i, 1 \leq i \leq 5$ and $v'_j, 1 \leq j \leq 5$ of G which subdividing each edge exactly once and joining all the non – adjacent vertices of G . Thus, $V(C(G)) = \{v_1, v_2, v_3, v_4, v_5\} \cup \{v'_1, v'_2, v'_3, v'_4, v'_5\}$. By proper coloring, $\chi(C(G)) = 4$, Hence, v_1, v'_4 assign color C_1 , v'_1, v_4, v_3 assigns color C_2 , v'_2, v'_3, v_5 are assign color C_3 and v_2, v'_4 are assign color C_4 . Thus, the set $S = \{v'_1, v'_3, v'_4, v'_5\}$ be the minimum geodetic set and also chromatic set of $C(G)$. Therefore $S_c = |S|$ is the minimum geo chromatic set of $C(G)$. Hence, $\chi_{gc}[C(G)] = 4$.

Theorem 4.6. For a Total graph of Bull graph G , $\chi_{gc}[T(G)] = 7$.

Proof: Let the vertices of the Total graph $T(G)$ be $v_i, 1 \leq i \leq 5$ and $e_j, 1 \leq j \leq 5$. By proper coloring, $\chi(C(G)) = 3$, Hence, v_1, v_3, v_5, e_5 are assigned as color C_1 , e_2, e_4 assigns color C_2 , v_2, e_3 are assigned as color C_3 and v_4, e_1 are assigned as color C_4 which is 4 – colorable. Thus, the set $S = \{v_1, v_4, v_5, e_1, e_2, e_3, e_4\}$ be the minimum geodetic set and also chromatic set of $T(G)$. Therefore $S_c = |S|$ is the minimum geo chromatic set of $T(G)$. Hence, $\chi_{gc}[T(G)] = 7$.

Theorem 4.7. For a Splitting graph of Bull graph G , $\chi_{gc}[S(G)] = 5$.

Proof: Consider the Splitting graph of Bull graph with the vertex set $V(G) = \{v_1, v_2, v_3, v_4, v_5\}$ and $v'_j, j = 1, 2, 3, 4, 5$. By proper coloring, v_2, v_5, v'_2 are assigned as color C_1 , $v_1, v_3, v'_1, v'_3, v'_5$ are assigned as color C_2 and v_4, v'_4 are assigned as color C_3 which is 3 – colorable. Thus, the set $S = \{v'_j\}, 1 \leq j \leq 5$ be the minimum geo chromatic set. Hence, $\chi_{gc}[S(G)] = 5$.

Theorem 4.8. For the degree Splitting graph of Bull graph G , $\chi_{gc}[DS(G)] = 4$.

Proof: Consider the degree Splitting graph of Bull graph with the vertex set $V(DS(G)) = \{v_1, v_2, v_3, v_4, v_5\} \cup \{w_1, w_2\}$. By proper coloring, v_3, v_5, w_2 are assigned as color C_1 , v_2, w_1 are assigned as color C_2 and v_1, v_4 are assigned as color C_3 , therefore $\chi(DS(G)) = 3$ which is 3 – colorable. Thus, $S = \{w_1, w_2, v_3\}$ be the minimum geodetic set but which is not a chromatic set of $DS(G)$, where as S belongs to similar color classes in $DS(G)$ since $\chi(DS(G)) = 3$. Choose another vertex from $DS(G)$ which belong to different color class. Let $v_i \in C_j, j \neq 1, 2$. Thereby, the set becomes $S_c = \{S\} \cup \{v_i\}$ is a geodetic set as well as chromatic set of $DS(G)$. Hence, $\chi_{gc}[DS(G)] = 4$.





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Theorem 4.9. For the Shadow graph of Bull graph G , $\chi_{gc}[D_2(G)] = 5$.

Proof: Consider the Shadow graph of Bull graph, let the vertices be $v'_i, 1 \leq i \leq 5$ and $v''_j, 1 \leq j \leq 5$. That is $V(D_2(G)) = \{v'_i\} \cup \{v''_j\}$. By proper coloring, v'_4, v''_1, v''_4 are assigned as color C1, v'_1, v'_3, v''_3 are assigned as color C2 and v'_2, v'_5, v''_2, v''_5 are assigned as color C3. Thus $\chi(D_2(G)) = 3$, which is 3 – colorable. Thereby, the set $S = \{v'_1, v''_1, v'_4, v''_4\}$ be the minimum geodetic but not a chromatic set, where as S received same color class. Let us add the different color to the set S . Hence, $\chi_{gc}[D_2(G)] = 5$.

CONCLUSION

In this paper, we obtain the geodetic number, edge geodetic number and geo chromatic number of a Bull graph and related graphs and its comparison between geodetic number, edge geodetic number and geo chromatic number also we have contributed some new results and its bounds. This concept can be applied to a variety of another graph.

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Assessing the Intrinsic Vulnerability of Groundwater Resources to Contamination using SINTACS Method in Coimbatore District, Tamil Nadu, India

P. Meenakshi*

Assistant Professor, Department of Geography, Nirmala College for Women, Coimbatore-18, Tamil Nadu, India.

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*Address for Correspondence

P. Meenakshi

Assistant Professor,

Department of Geography,

Nirmala College for Women,

Coimbatore-18, Tamil Nadu, India.

E. Mail : Meenakshi.p.2010@gmail.com



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ABSTRACT

The usage of groundwater is increasing geometrically everyday globally. Groundwater is one of the most reliable resources available around the world. The leaning on the groundwater is more as result of degradation of the quality and quantity of the freshwater because of anthropogenic activities. Therefore the proper assessment and evaluation of the groundwater resources becomes crucial for the sustainable. The objective of the study is to assess the aquifer vulnerability using the hydro geologic parameters in the Coimbatore district using SINTACS Method. This method uses the hydro geological properties of the aquifer system The assessment of the vulnerability of groundwater to contamination becomes necessary since the study area has to depend on the groundwater resources for domestic, industrial and agricultural purposes. The high vulnerability areas are characterized by flat topography, shallow water table, thinner vadose zone, intensively cultivated areas, dense settlements and geologic formation with more fissures and fractures.

Keywords: Vulnerability, GIS, SINTACS, Hydrogeology

INTRODUCTION

Water is essential for the socio-economic development of society. The geometric growth of the population results in urbanization, food insecurity, poverty, water scarcity, migration etc. It creates stress on natural resources around the world. The stress on natural resources is particularly evident in water resources. i.e., deterioration in the quality as



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well as the quantity. The groundwater has been preferred to surface water on account of its widespread and continuous availability in proximity to the point of use or living place, less vulnerability to contamination and low cost development in both urban and rural area of developed and developing countries of the world. The contribution from groundwater is vital. Groundwater is one of the precious resources that function as part of the hydrological cycle, for human existence and economic development on earth. In many nations, it is found to be a significant source of water for agricultural, industrial, and domestic purposes (Ramesh & Elango, 2011)

Almost all the countries in the world depend on groundwater resources for the increasing water demand. It is easily accessible and contamination is less when compared with freshwater resources. Its importance stems from its ability to act as an extensive reservoir of water that provides “buffer storage” during periods of drought (Kaur & Rosin, undated, p.1). As water availability per capita declines, the threat to groundwater quality, the largest freshwater resource, stands out as one of the major contemporary environmental challenges facing humanity (Masocha et al. 2020). Despite the fact that groundwater remains contamination free because of the natural system of attenuating the pollutants, but once the aquifer gets contaminated, it becomes more difficult to remediate. The entire aquifers may be rendered unfit for the use for generations once contaminated (Masocha et al. 2020). The vulnerability of groundwater measures how easy or difficult it is to reach contamination or pollution from the soil surface to the production aquifer [Alsharifa 2017]. Therefore, the prevention of aquifers from contamination is much more crucial than the reclamation process, which might require many more years. Increasing groundwater contamination across the globe triggered the concept of “aquifer vulnerability”, which has been extensively used worldwide during the past three to four decades by researchers and policymakers to protect groundwater from pollution. (Machiwal et al. 2018). It plays a pivotal role in the rational management of groundwater resources and subsequent land use planning.

The term “vulnerability of groundwater to contamination” was introduced by French hydro geologist J. Margat in 1968 (Margat 1968). Groundwater vulnerability is the tendency of, or probability for, contaminants to reach a given position in the system of ground water after introduction at some place above the upper most aquifer (Vrba & Zoporozec, 1994). It is determined based on the assumption that the attenuation capacity of hydro geological factors may prevent the pollutants generated by the natural and anthropogenic activities from entering the sub-surface medium, thus reducing the pollutant load of the groundwater. Numerous approaches and methods have been developed to assess the vulnerability of the aquifer, such as process-based, statistical and overlay-index methods. The most commonly used method of assessing vulnerability is index and overlay method. It considers different physical and hydro geological parameters that control the movement of pollutants through the unsaturated zone till they reach the water table and their further spread (Aller et al. 1987). In this method, hydro geological parameters are rated on a scale from 1 to 10 according to the contamination potential and relative weights are assigned for each parameter which influences the probability of pollution in the aquifer. The overlay and index method is the most preferred method due to the ease of the availability of data and because it attempts to describe fully the processes that lead to contamination (NRC 1993).

Several methods such as DRASTIC (Aller et al. 1987), GOD (Foster 1987), AVI (Stempvort et al. 1993), DRARCH (Guo et al. 2006), Susceptibility Index (SI), (Stigter et al. 2006) etc. have been developed over the years which assess vulnerability using various hydro geological and anthropogenic components such as land use/land cover etc. The present study assesses the groundwater vulnerability to contamination of the Coimbatore district region in Tamil Nadu state, India using the SINTACS method. Coimbatore District has an extensive system of tanks fed by the rivers and rainwater, which is the major source of groundwater recharge for hundreds of years. However the effluents of the District are released into these resulting in the eutrophication of water bodies which is an indicator of severe contamination of the water resources. The quality and as well as quantity of groundwater are showing a declining trend as a result of an increase in the point and non-point source of pollution sources. It becomes necessary to assess the vulnerability to contamination in the study area, which helps in better and more effective management of the resources in the study area. The purpose of the groundwater vulnerability map integrating SINTACS model into GIS and to delineate the areas in the Coimbatore district which are more susceptible to high degree of contamination.





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Study Area

The study area, Coimbatore, is the second largest district and is located in the western part of Tamil Nadu, India. It spreads over an area of 4714.22 km² (Fig.1). The study area enjoys a sub-tropical climate and the weather is pleasant during the period from November to January. It receives rainfall under the influence of both the southwest and northeast monsoon. The study area Coimbatore district does not have any major perennial source of surface water supply. The region has to depend upon the groundwater resources largely for its growing domestic, industrial and agricultural requirements. It has an extensive system of tanks fed by the rivers and rainwater, which is the major source of groundwater recharge for hundreds of years. The study area is dominated by hard rock formations with stretches of fluvial formations occurring in the western part of the study area adjacent to the river courses. The river alluvium occurs along the major stream courses. The hard consolidated crystalline rocks which occupy more than 50 percent are represented by weathered and fractured Granites, gneiss, charnockites, khondalites and intrusive rocks. The study area being a hard rock region, the groundwater occurs in joints, fractures and weathered zones. The biotite gneissic rocks form better potential zones than the charnockite and granitic aquifers. The average depth of the ground water level is 12.43 m and the level fluctuates up to 5 m between the post monsoon and pre monsoon seasons. The shallow water table noted during the rainy season declines afterwards in February which indicates the influence of rainfall intensity and abstraction on the depth of the groundwater level. The higher yielding capacities of wells in the study area show a greater fluctuation in the groundwater level.

MATERIALS AND METHODS

The present study applied SINTACS model, for assessing the aquifer vulnerability in GIS environment. It was first put forth by Civita and De Maio in 1997. This model is a development of DRASTIC model. In SINTACS method same parameters are used but the weighting factors vary according to the situations (Table 2.). This method uses seven physical and hydrogeological factors such as Depth to water table (S), net recharge (I), vadose zone (N), soil media (T), aquifer media (A), hydraulic conductivity (C) and Topography (S).

The SINTACS Method is calculated using the following equation.

$$SINTACS = SrSw + Irlr + NrNw + TrTw + ArAw + CrCw + SrSw$$

Where S, I, N, T, A, C, S are the seven parameters and the subscripts "r" and "w" refers to Scores and Weightages respectively. In this method, parameters are rated on a scale according to the contamination potential and relative weightages are assigned for each parameter which influences the probability of the pollution in the aquifer. It is based on the assumption that contaminants on the ground surface are flushed into the groundwater by precipitation and the mobility of water.

The intrinsic vulnerability index (In) can be calculated by adding up the products of ratings and the respective weights of the different parameters

$$\sum_{i=1}^7 Si . Wi$$

Where Si = rating of parameters, and Wi = weights of parameters

Since the study area is the district with rapidly expanding population and higher stress on the groundwater resources, which is evident lowering of quality and quantity the Relevant Impact Scenario weightage (Table 1.) was selected for the assessment purpose.

Description of the Parameters

The abovementioned hydrogeological and the man-made parameters in Table 1 were used for the assessment purpose. Each of the parameters is classified into ranges or into significant media types and assigned with ranks ranging from 1 (least contamination potential) to 10 (highest contamination potential). The parameters are then given weights from 1 (least significant) and 5 (greater significance).





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Depth to Water Level (S)

The depth to water level is important because it determines the length of the path which a contaminant has to travel before reaching the water table. The deeper the groundwater level, the more the chances of contamination and vice versa (Table 2). The average depth to water level in the study area varies from 2.62 m to 40.22 m below groundwater level. (Fig.2) The highest score of 10 is assigned to 0-4 m bgl and the lowest score is assigned to the places with more than 12 m bgl. The shallow water level of < 4m bgl is noted in the gneissic rocks region whereas the deeper water table is noted in unconsolidated rock formation predominantly found in the western and central part of the study area.

Net Recharge (I)

Net recharge (R) is the total quantity of water that infiltrates from the ground surface to the water table on an annual basis. The recharge water transports contaminant vertically to the water table and horizontally within the aquifer(Aller *et.al.*1987). The higher the recharge, the greater the chance of contamination. The higher recharge potential is given with higher scores(Table 2). The recharge is found to be high in the region such as southern part of the study area and score of 4 is assigned. And higher recharge potential is found in the region which is underlain by limestone formation which has high permeability. (Table 2) (Fig. 3).

Impact of Vadose Zone (N)

It refers to the unsaturated zone lying below the ground surface and water level. The impact of vadose zone is the ability to control water movement and attenuation capacity. It has high impact on water movement if it is composed of permeable materials. This zone protects the aquifer from pollutants for an extent. The contaminants are diluted by process of physical and chemical operations within this zone(Colins *et al.*, 2016) The contamination potential is also high in highly weathered gneissic rocks which possess well developed fractures and joint systems which in turn favours the percolation of more water into the subsurface with less time to attenuate the contaminant plume. They are assigned with scores ranging from 8 to 10 (Table 2) The central and western part of the study area has lower impact due to the texture of the soil which is composed of higher clay content and less development of fractures and fissures in the rocks (Fig.4)

Soil Texture (T)

Soil texture has a significant impact on the amount of recharge which can infiltrate into the ground. Presence of fine textured materials in soil like clay, silt and organic matter decreases the permeability and restricts the contamination loading. The soil media of the study area is classified based on texture into clay loam, loamy sand, sand, sandy clay loam and sandy loam (Fig.5). The sandy soil is assigned with the high score of 10 because of the high infiltration which may transport large amount of contaminants. The soil with high clay content is given lesser score because of shrink and swell potential which delays the entry of contaminants into the subsurface and hence reduce the level of contamination to some extent(Table 2). The attenuation process that takes place inside an aquifer system (i.e. soil + vadose zone + saturated zone) as it receives a contaminant (fluid and/or water vectored) depends on the properties and primary concentration of each contaminant but also on the reactivity of the system, which can be reduced or, in the long term, completely depleted in time. (M. Civita and M. De Maio,2004)

Aquifer Media (A)

It refers to the nature of geologic formation(consolidated / unconsolidated) which yield sufficient water for use. It controls the route and path length of a contaminant which in turn determines the attenuation or purification capacity. The aquifer media in the study area is composed of hard rock formation like gneiss occupying 77% of the study area followed by charnockite, fluvial and granites (Fig.6). The unconsolidated formations are found in the western part along the river course and granitic rocks are found spread over the study area. The deeply weathered and fractured rocks are assigned with higher score of 7-9 indicating its higher contamination potential (Table 2).



**Meenakshi****Hydraulic Conductivity (C)**

It refers to the ability of an aquifer to transmit water. It plays a significant role in controlling the migration and dispersion of contaminants from the source point within the saturated zone and consequently plume concentration in aquifer. The study area, which is underlain by hard rock formations with deep weathering, has higher ability to transmit water along with the presence of loamy textured soil (Fig.7). The area with more than 40 m /day is assigned with maximum score of 7-9 because of its potential to transmit more contaminant into the aquifer (Table 2).

Topography (S)

The slope variability of the land surface is a significant factor in controlling the travel time of the contaminant. The slope of the study area has been reclassified and assigned scores and weightages (Table 1). The gentle topography would result in the contaminant remaining on the surface for a long time whereas in the steep slopes, the contaminant materials will flow as run off reducing the rate of infiltration. The study area is an undulating plain region with slope gradually decreasing from west to east (Fig.8). The higher rank is assigned to gentle slope ($< 2^\circ$) which facilitates low run off having greater contamination potential. It refers to the ability of an aquifer to transmit water. It plays a significant role in controlling the migration and dispersion of contaminants from the source point within the saturated zone and consequently plume concentration in aquifer. The study area, which is underlain by hard rock formations with deep weathering, has higher ability to transmit water along with the presence of loamy textured soil (Fig. 8). The area with more than 40 m /day is assigned with maximum score of 7-9 because of its potential to transmit more contaminant into the aquifer (Table 2).

RESULT AND DISCUSSION

The vulnerability maps are prepared by overlaying all the thematic layers in the GIS environment. The vulnerability map obtained shows the different levels of vulnerability of the aquifers towards contamination the maps are the combination of selected physical and geologic factors which delineates the zones vulnerable to contamination as a result of natural and human activities. These maps are very useful in planning in a region as it attempts to identify more sensitive areas and resulting in better framework for protection of groundwater resources. The assessment of vulnerability to contamination using SINTACS method shows that about 75 per cent of the study area has high to very high vulnerability (Fig 9.). The higher vulnerability is observed mainly in the north western and southern part of the study area. The higher vulnerability may be attributed to its hydrogeological parameters such as sand textured soil, low to moderate slope, intensive cultivation and dense settlements. The lower degree of vulnerability is found in the central part of the study area (Table 3). These areas are characterized with sand textured soil, low to moderate slope, intensive cultivation and dense settlements. The river courses record low vulnerability because of the high dilution capacity of the water despite the presence of the sand textured soil with high rate of infiltration. The high degree of vulnerability of the central part of the study area is because of the increased level of human activity by discharging more untreated effluents in to the nearby tanks which is the main source of water storage in the region. In this model more weightage is given to the water table, recharge capacity and soil media whereas role of unsaturated zone and topography is given less significance. The attenuation capacity of the soil is taken into account instead of the dilution capacity for assessment purpose. On the other hand impact of dilution process in reducing the contamination potential is recognized worldwide. Hence, the dilution process influenced by the purification capacity of the soil and the restoration capability of the aquifer has to be given its due consideration while assessing vulnerability. The results generated from the model could be used for the monitoring of the high risk area and in the prevention, protection and restoration of the groundwater system in the study area

CONCLUSION

The present study assesses the groundwater vulnerability to contamination in Coimbatore district using SINTACS model in GIS environment. The vulnerability map obtained identifies areas which must have high priority in terms of protection and pollution prevention. In the SINTACS Method of assessing vulnerability, 75 % of the total study





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area is found to be with moderate to high vulnerability (High - 49% and Very High 26 %) and only 6 per cent of the total area is identified as low vulnerable areas. In this method higher weightage is assigned to the parameters such as Depth to water level, Net Recharge and Soil media according to their potential in increasing or decreasing the contamination probability of the aquifer. Such modification in the weightages assigned to the parameters has resulted in the subsequent increase of the area represented under high – extremely high category. The zones with higher vulnerability are found in the south central and northwestern part of the study area. It is observed that vulnerability is high in the areas adjacent to the water bodies and in the intensively cultivated areas. The areas adjacent to the elevated region characterized by thicker vadose zone, sandy texture, gentle slope and lower hydraulic conductivity in the central part are identified as areas with higher vulnerability to contamination in SINTACS model. It indicates the significant role played by the human activities in transforming the groundwater characteristics resulting in groundwater contamination. The results generated from the model could be used for the monitoring of the high risk area and in the prevention, protection and restoration of the groundwater system in the study area.

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Table 1. Weighting scenarios in SINTACS Method(Based on Civita)

Weighting Scenarios	S	I	N	T	A	C	S
Normal Impact	5	4	5	3	3	3	3
Relevant impact	5	5	4	5	3	2	2
Drainage from surficial network	4	4	4	2	5	5	2
Karstic impact	2	5	1	3	5	5	5
Fissuring impact	3	3	3	4	4	5	4

Table 2. Assigned Weightage and Scores for the parameters used in SINTACS Method

Parameters	Weightage	Range	Score
Depth to water level (in metres) (S)	5	0-4	10
		4-12	9
		12-20	7
		>20	3
Net Recharge (I)	5	Poor	1
		Moderate	2
		Good	3
		Excellent	4





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Impact of Vadose Zone (N)	4	Very High	10
		High	7
		Moderate	5
		Low	3
Soil Media (T) (Based on Texture)	5	Clay loam	5
		Loamy sand	8
		Sand	10
		Sand Clay loam	6
		Sandy loam	7
Aquifer Media (A)	3	Charnockite	7
		Fluvial	9
		Gneiss	8
		Granite	7
		Intrusives	6
		Khondalite	5
Hydraulic Conductivity (C)	2	0-20	3
		20-40	5
		60-80	7
		>80	9
Topography (S) (in Percentage)	2	0-2	10
		2-6	9
		6-12	7
		12-18	5
		>18	2

Table 3. Areal Extent of Vulnerability Zones – Coimbatore District

Vulnerability Zones	Area* (in km ²)	Area in Percentage
Low	189.12	6%
Moderate	655.20	19 %
High	1649.20	49%
Very High	898.56	26%
	3392.08	100

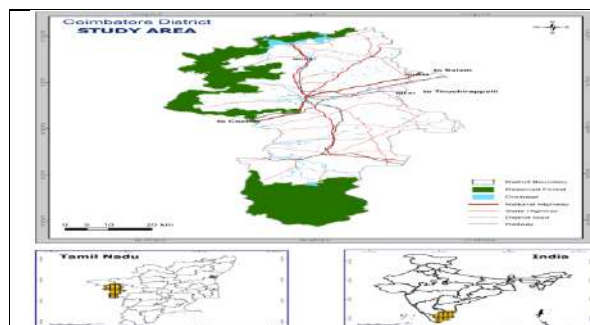


Fig.1 Location of the Study Area.

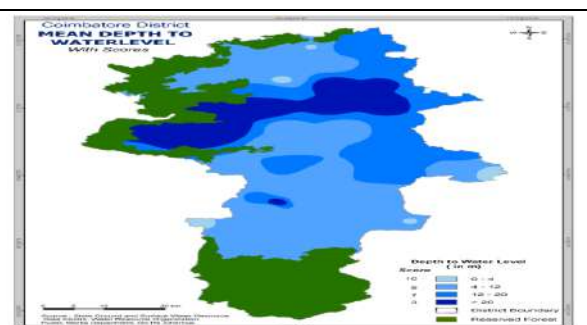


Fig.2 Depth to Water Level





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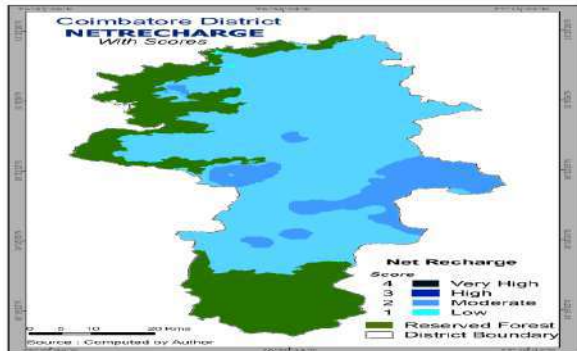


Fig.3 Net Recharge

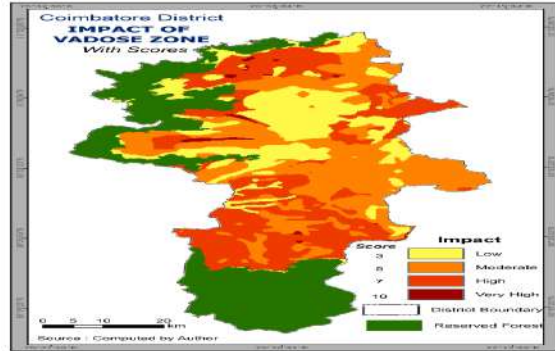


Fig. 4 Impact of Vadose Zone

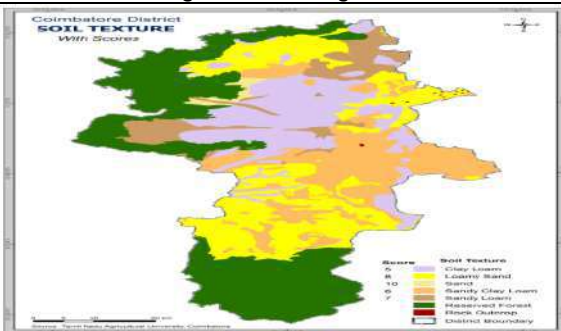


Fig.5 Soil Texture

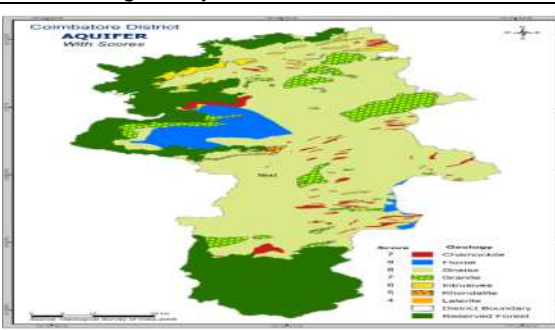


Fig.6 Aquifer Media

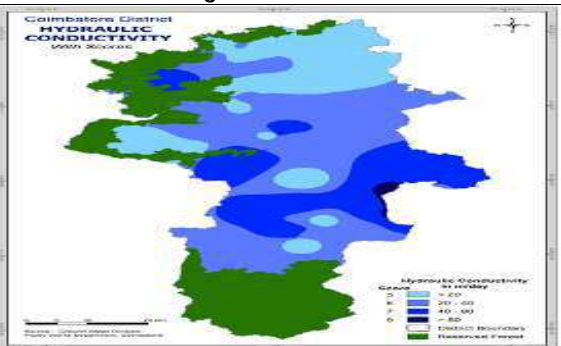


Fig.7 Hydraulic Conductivity

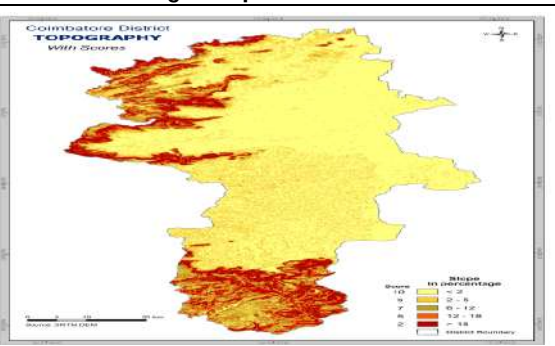


Fig. 8 Topography

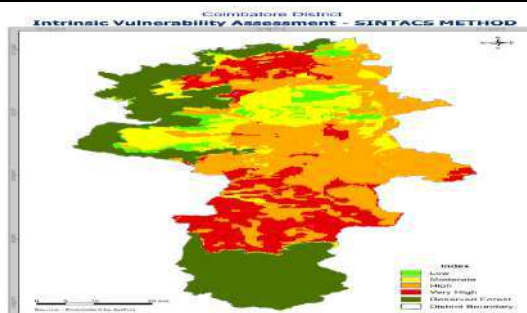


Fig.9 Vulnerability Index map





Pythagorean Neutrosophic Refined Semi- Connected Spaces

M.Emimanimcy^{1*} and Francina Shalini.A²

¹Research Scholar, Nirmala College For Women, Coimbatore, Tamil Nadu, India

²Assistant Professor, Nirmala College For Women, Coimbatore, Tamil Nadu, India

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*Address for Correspondence

M.Emimanimcy

Research Scholar,

Nirmala College For Women,

Coimbatore, Tamil Nadu, India

E. Mail : emimanimcy@gmail.com



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ABSTRACT

The main objective of this paper is to define the Semi - connectedness of the Pythagorean Neutrosophic Refined Set which clarifies the inter relationship between the Separable space and the connected space. The Pythagorean Neutrosophic Refined Semi- Connected space and Pythagorean Neutrosophic Refined Semi – separable space are defined and examined with suitable examples which satisfies the required properties. The Semi connectedness and Separable space of the Pythagorean Neutrosophic Refined Sets are clearly explained with possible examples.

Keywords: Pythagorean Neutrosophic Refined set, Connectedness, separable space, PNR semi-Connected, PNR semi- Separable.

INTRODUCTION

The history of Neutrosophic set was travelled in the path of fuzzy set[1],fuzzy topology[2], intuitionistic fuzzy set[3], intuitionistic fuzzy topological space[4] which was firstly introduced and developed by Zadeh(1965) , Chang(1968), Atanassov(1983), Coker (1997)respectively. The Concept of Neutrosophic Set which possess degree of membership , degree of non – membership and degree of indeterminacy was introduced by Smarandache [5] in 1999. After the arrival of Neutrosophic set in the topological field , it gets vibrantly moduled in various manner as Neutrosophic Topological space, Pythagorean Neutrosophic Set, Neutrosophic bipolar set and so on. In 2022, Emimanimcy deliberated the notation of Pythagorean Neutrosophic Refined Set , Pythagorean Neutrosophic Refined Semi - Open ,Pythagorean Neutrosophic Refined Semi – Closed set, Pythagorean Neutrosophic Refined continuous function [6,7] . On further continuation Pythagorean Neutrosophic Refined Semi – Connected Space was introduced and explained with the reference of Ahu Acikgoz et al's [8] 'A Study on connectedness in neutrosophic topological spaces'(2021). In this paper firstly the basic definitions that are used in subsequent sections are given. The Pythagorean Neutrosophic





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Refined Semi - connectedness and Pythagorean Neutrosophic Refined Semi -Separable spaces are explained as further sections.

Preliminaries

Definition: 2.1[5]

Let U be a universe. A Neutrosophic set A on U can be defined as follows:

$$A = \{ \langle x, T_A(x), I_A(x), F_A(x) \rangle : x \in U \}$$

Where $T_A, I_A, F_A : U \rightarrow [0,1]$ and $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$

Here, $T_A(x)$ is the degree of membership, $I_A(x)$ is the degree of indeterminacy and $F_A(x)$ is the degree of non-membership.

Definition:2.2[5]

Let U be a Universe, a Neutrosophic refined set on can be defined as follows:

$$A = \{ \langle x, (T_A^1(X), T_A^2(X), T_A^3(X), \dots, T_A^p(X)), (I_A^1(X), I_A^2(X), I_A^3(X), \dots, I_A^p(X)), (F_A^1(X), F_A^2(X), F_A^3(X), \dots, F_A^p(X)) \rangle : x \in U \}$$

Where $T_A^j(X), I_A^j(X), F_A^j(X) : U \rightarrow [0,1]$ and $0 \leq T_A^j(X) + I_A^j(X) + F_A^j(X) \leq 3$ for

$j = 1, 2, 3, \dots, p$ and for any $x \in U$. $(T_A^1(X), T_A^2(X), T_A^3(X), \dots, T_A^p(X)), (I_A^1(X), I_A^2(X), I_A^3(X), \dots, I_A^p(X)), (F_A^1(X), F_A^2(X), F_A^3(X), \dots, F_A^p(X))$ is the Truth-membership sequence, Indeterminate membership

sequence & Falsity-membership sequence of the element x, respectively. Also, p is called the dimension of Neutrosophic refined set (NRS) A.

Definition:2.3[9]

Let U be a universe. A Pythagorean Neutrosophic set with T and F are dependent Neutrosophic components A on U is an object of the form

$$A = \{ \langle x, T_A(x), I_A(x), F_A(x) \rangle : x \in U \}$$

Where $T_A, I_A, F_A : U \rightarrow [0,1]$ and $0 \leq (T_A(X))^2 + (I_A(X))^2 + (F_A(X))^2 \leq 2$

$T_A(x)$ is the degree of membership, $I_A(x)$ is the degree of indeterminacy and $F_A(x)$ is the degree of non-membership.

Definition: 2.4[7]

Let U be a Universe. A Pythagorean Neutrosophic Refined Set can be defined as follows:

$$P_{PNR} = \{ \langle x, (T_p^1(X), T_p^2(X), T_p^3(X), \dots, T_p^k(X)), ((I_p^1(X), I_p^2(X), I_p^3(X), \dots, I_p^k(X)), (F_p^1(X), F_p^2(X), F_p^3(X), \dots, F_p^k(X)) \rangle : x \in U \}$$

Where $T_p^j(X), I_p^j(X), F_p^j(X) : U \rightarrow [0,1]$,

$0 \leq (T_p^j(X))^2 + (I_p^j(X))^2 + (F_p^j(X))^2 \leq 2$ and

for $j = 1, 2, 3, \dots, k$ and for any $x \in U$. $T_p^k(X)$ is the degree of membership sequence, $I_p^k(X)$ is the degree of indeterminacy

membership sequence and $F_p^k(X)$ is the degree of non-membership sequence.

And $0 \leq (T_p^k(X))^2 + (I_p^k(X))^2 + (F_p^k(X))^2 \leq 2$

Definition:2.5[7]

Let P_{PNR} and Q_{PNR} be Pythagorean Neutrosophic Refined sets (PNRS) in U. P_{PNR} is said to be Pythagorean Neutrosophic Refined Subset of Q_{PNR} ,

If $T_p^k(X) \leq T_q^k(X), I_p^k(X) \geq I_q^k(X), F_p^k(X) \geq F_q^k(X)$ for every $x \in U$.

It is denoted by $P_{PNR} \subseteq Q_{PNR}$

Definition:2.6[7]

Let P_{PNR} and Q_{PNR} be Pythagorean Neutrosophic Refined sets (PNRS) in U. P_{PNR} is said to be Pythagorean Neutrosophic Refined equal set of Q_{PNR} ,





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If $T_P^k(X) = T_Q^k(X), I_P^k(X) = I_Q^k(X), F_P^k(X) = F_Q^k(X)$ for every $x \in U$.

It is denoted by $P_{PNR} = Q_{PNR}$.

Definition:2.7[7]

Let P_{PNR} be Pythagorean Neutrosophic Refined sets (PNRS) in U . It's compliment is defined as follows:

$$P_{PNR}^c = \{ \langle x, (F_P^1(X), F_P^2(X), F_P^3(X), \dots, F_P^k(X)), (1 - I_P^1(X), 1 - I_P^2(X), 1 - I_P^3(X), \dots, 1 - I_P^k(X)), T_P^1(X), T_P^2(X), T_P^3(X), \dots, T_P^k(X) \rangle : x \in U \}$$

It is denoted as P_{PNR}^c

Definition : 2.8[7]

1. If $T_P^k(X) = 0$ and $I_P^k(X) = F_P^k(X) = 1$ for all $j = 1, 2, 3, \dots, p$, then the set P_{PNR} is called null – Pythagorean Neutrosophic Refined Set . It is denoted as \emptyset_{PNR}
2. If $T_P^k(X) = 1$ and $I_P^k(X) = F_P^k(X) = 0$ for all $j = 1, 2, 3, \dots, p$, then the set P_{PNR} is called Universal – Pythagorean Neutrosophic Refined Set . It is denoted as U_{PNR}

Definition: 2.9[7]

Let X be a non empty set in U ,

$$P_{PNR} = \{ \langle x, (T_P^1(X), T_P^2(X), T_P^3(X), \dots, T_P^k(X)), (I_P^1(X), I_P^2(X), I_P^3(X), \dots, I_P^k(X)), (F_P^1(X), F_P^2(X), F_P^3(X), \dots, F_P^k(X)) \rangle : x \in U \}$$

$$Q_{PNR} = \{ \langle x, (T_Q^1(X), T_Q^2(X), T_Q^3(X), \dots, T_Q^k(X)), (I_Q^1(X), I_Q^2(X), I_Q^3(X), \dots, I_Q^k(X)), (F_Q^1(X), F_Q^2(X), F_Q^3(X), \dots, F_Q^k(X)) \rangle : x \in U \}$$

are Pythagorean Neutrosophic Refined sets (PNRS) in U .
The union of P_{PNR} and Q_{PNR} is defined as Follows :

$$P_{PNR} \cup Q_{PNR} = \{ \langle x, s((T_P^1(X), T_Q^1(X)), (T_P^2(X), T_Q^2(X)), \dots, (T_P^k(X), T_Q^k(X))), t((I_P^1(X), I_Q^2(X)), (I_P^2(X), I_Q^2(X)), \dots, (I_P^k(X), I_Q^k(X))), t((F_P^1(X), F_Q^1(X)), (F_P^2(X), F_Q^2(X)), \dots, (F_P^k(X), F_Q^k(X))) \rangle : x \in U \}$$

Definition: 2.10[7]

Let X be a non empty set in U ,

$$P_{PNR} = \{ \langle x, (T_P^1(X), T_P^2(X), T_P^3(X), \dots, T_P^k(X)), (I_P^1(X), I_P^2(X), I_P^3(X), \dots, I_P^k(X)), (F_P^1(X), F_P^2(X), F_P^3(X), \dots, F_P^k(X)) \rangle : x \in U \}$$

$$Q_{PNR} = \{ \langle x, (T_Q^1(X), T_Q^2(X), T_Q^3(X), \dots, T_Q^k(X)), (I_Q^1(X), I_Q^2(X), I_Q^3(X), \dots, I_Q^k(X)), (F_Q^1(X), F_Q^2(X), F_Q^3(X), \dots, F_Q^k(X)) \rangle : x \in U \}$$

are Pythagorean Neutrosophic Refined sets (PNRS) in U .

The intersection of P_{PNR} and Q_{PNR} is defined as Follows:

$$P_{PNR} \cap Q_{PNR} = \{ \langle x, t((T_P^1(X), T_Q^1(X)), (T_P^2(X), T_Q^2(X)), \dots, (T_P^k(X), T_Q^k(X))), s((I_P^1(X), I_Q^2(X)), (I_P^2(X), I_Q^2(X)), \dots, (I_P^k(X), I_Q^k(X))), s((F_P^1(X), F_Q^1(X)), (F_P^2(X), F_Q^2(X)), \dots, (F_P^k(X), F_Q^k(X))) \rangle : x \in U \}$$

Definition: 2.11[6]

A Pythagorean Neutrosophic Refined topology (PNRT) is a non-empty set X is a family τ of a Pythagorean Neutrosophic Refined sets in X satisfying the following conditions

- a. (PNRT 1) $\emptyset_{PNRS}, I_{PNRS} \in \tau$
- b. (PNRT 2) $\cup G_{PNRS_i} \in \tau$ for every $\{G_{PNRS_i}; i \in j\} \subseteq \tau$
- c. (PNRT 3) $P_{PNRS_1} \cap P_{PNRS_2} \in \tau$ for any $P_{PNRS_1}, P_{PNRS_2} \in \tau$

In this case (X, τ) is called a Pythagorean Neutrosophic Refined topological space.

Definition:2.12[6]

If (X, τ) is called Pythagorean Neutrosophic Refined topological space and





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$$A_{PNR} = \{ \langle x, (T_P^1(X), T_P^2(X), T_P^3(X), \dots, T_P^K(X)), ((I_P^1(X), I_P^2(X), I_P^3(X), \dots, I_P^K(X)), (F_P^1(X), F_P^2(X), F_P^3(X), \dots, F_P^K(X)) \rangle : x \in X \}$$

is a Pythagorean Neutrosophic Refined Set in X then Pythagorean Neutrosophic Refined Closure and Pythagorean Neutrosophic Refined Interior are defined by

- 1) $PNRcl(A_{PNR}) = \cap \{ A_{PNR} \subseteq P_{PNRS}, \text{ where } P_{PNRS} \text{ is a collection of Pythagorean Neutrosophic Refined closed sets in } X(PNRCs) \}$
- 2) $PNRint(A_{PNR}) = \cup \{ Q_{PNRS} \subseteq A_{PNR}, \text{ where } Q_{PNRS} \text{ is a collection of Pythagorean Neutrosophic Refined open sets in } X(PNROS) \}$

We can also show that $PNRcl(A)$ is Pythagorean Neutrosophic Refined closed set and $PNRint(A_{PNR})$ is Pythagorean Neutrosophic Refined open set in X .

Pythagorean Neutrosophic Refined Semi – Connected Space

Definition:3.1

Let X_{PNR} be a Pythagorean Neutrosophic Refined topological space and P_{PNR} be the Pythagorean Neutrosophic Refined set in X_{PNR} . If there exist two pythagorean neutrosophic refined semi-open sets Q_{PNR} and R_{PNR} such that $P_{PNR} = Q_{PNR} \cup R_{PNR}$ and $Q_{PNR} \cap R_{PNR} = 0_{PNR}$, Then the pythagorean neutrosophic refined set P_{PNR} is called as pythagorean neutrosophic refined semi- disconnected set in X_{PNR} .

Example: 3.2

Let $X_{PNR} = \{ a,b,c \}$ with $\tau_{PNR} = \{ 0_{PNR}, P_{PNR}, Q_{PNR}, R_{PNR}, 1_{PNR} \}$, where $P_{PNR} = \{ \langle 0.1,0.1,0.1 \rangle, \langle 0.1,0.1,0.1 \rangle, \langle 0.9,0.9,0.9 \rangle \}$, $Q_{PNR} = \{ \langle 0.1,0.1,0.1 \rangle, \langle 1,1,1 \rangle, \langle 0.9,0.9,0.9 \rangle \}$ $R_{PNR} = \{ \langle 0,0,0 \rangle, \langle 0.1,0.1,0.1 \rangle, \langle 1,1,1 \rangle \}$. Then $P_{PNR}, Q_{PNR}, R_{PNR}$ are pythagorean neutrosophic refined semi-open sets in X_{PNR} . $Q_{PNR} \cup R_{PNR} = \{ \langle 0.1,0.1,0.1 \rangle, \langle 0.1,0.1,0.1 \rangle, \langle 0.9,0.9,0.9 \rangle \} = P_{PNR}$ and $Q_{PNR} \cap R_{PNR} = \{ \langle 0,0,0 \rangle, \langle 1,1,1 \rangle, \langle 1,1,1 \rangle \} = 0_{PNR}$. Hence by definition 3.1 P_{PNR} is a pythagorean neutrosophic refined semi- disconnected set in X_{PNR} .

Example : 3.3

Let $X_{PNR} = \{ a,b,c \}$ with $\tau_{PNR} = \{ 0_{PNR}, P_{PNR}, Q_{PNR}, R_{PNR}, 1_{PNR} \}$, where $P_{PNR} = \{ \langle 0.2,0.3,0.4 \rangle, \langle 0.1,0.1,0.1 \rangle, \langle 0.8,0.7,0.6 \rangle \}$, $Q_{PNR} = \{ \langle 0.1,0.1,0.1 \rangle, \langle 1,1,1 \rangle, \langle 0.9,0.9,0.9 \rangle \}$ $R_{PNR} = \{ \langle 0.1,0.1,0.1 \rangle, \langle 0.1,0.1,0.1 \rangle, \langle 1,1,1 \rangle \}$. Then $P_{PNR}, Q_{PNR}, R_{PNR}$ are pythagorean neutrosophic refined semi-open sets in X_{PNR} . $Q_{PNR} \cup R_{PNR} = \{ \langle 0.1,0.1,0.1 \rangle, \langle 0.1,0.1,0.1 \rangle, \langle 0.9,0.9,0.9 \rangle \} \neq P_{PNR}$ and $Q_{PNR} \cap R_{PNR} = \{ \langle 0.1,0.1,0.1 \rangle, \langle 1,1,1 \rangle, \langle 1,1,1 \rangle \} \neq 0_{PNR}$. Hence by definition 3.1 P_{PNR} is a pythagorean neutrosophic refined semi - connected set in X_{PNR} .

Definition:3.4

If $f : (P_{PNR}, \tau_{PNR1}) \rightarrow (Q_{PNR}, \tau_{PNR2})$ is Pythagorean Neutrosophic Refined irresolute, if for every inverse image of closed sets in Q_{PNR} is closed in P_{PNR} .

Definition:3.5

If $f : (P_{PNR}, \tau_{PNR1}) \rightarrow (Q_{PNR}, \tau_{PNR2})$ is Pythagorean Neutrosophic Refined semi-irresolute, if for every inverse image of semi - closed sets in Q_{PNR} is semi- closed in P_{PNR} .

Theorem:3.6

Let P_{PNR} and Q_{PNR} be two Pythagorean Neutrosophic Refined Topological spaces , A_{PNR} be the Pythagorean Neutrosophic Set in P_{PNR} and $f : P_{PNR} \rightarrow Q_{PNR}$ be a Pythagorean Neutrosophic Refined semi-irresolute. If A_{PNR} is Pythagorean Neutrosophic Refined semi – connected , then $f(A_{PNR})$ is Pythagorean Neutrosophic Refined semi – connected.

Proof:

Suppose $f(A_{PNR})$ is a Pythagorean Neutrosophic Refined semi – disconnected set. Then there exist two Pythagorean Neutrosophic Semi- Open sets B_{PNR} and C_{PNR} such that $f(A_{PNR}) = B_{PNR} \cup C_{PNR}$ and $B_{PNR} \cap C_{PNR} = 0_{PNR}$. Thus $A_{PNR} \subseteq (f^{-1}(A_{PNR})) = f^{-1}(B_{PNR} \cup C_{PNR}) = f^{-1}(B_{PNR}) \cup f^{-1}(C_{PNR})$ and $f^{-1}(B_{PNR}) \cap f^{-1}(C_{PNR}) = f^{-1}(B_{PNR} \cap C_{PNR}) =$





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$f^{-1}(0_{PNR}) = 0_{PNR}$. That is $A_{PNR} = f^{-1}(B_{PNR}) \cup f^{-1}(C_{PNR})$ and $f^{-1}(B_{PNR}) \cap f^{-1}(C_{PNR}) = 0_{PNR}$. This is a contradiction to the assumption. Hence $f(A_{PNR})$ is a Pythagorean Neutrosophic Refined semi – connected set.

Definition: 3.7

A Pythagorean Neutrosophic Refined Topological Space P_{PNR} is Pythagorean Neutrosophic Refined semi – disconnected space if there exist Pythagorean Neutrosophic Refined open sets, A_{PNR}, B_{PNR} in P_{PNR} , $A_{PNR} \neq 0_{PNR}$, $B_{PNR} \neq 0_{PNR}$ such that $A_{PNR} \cup B_{PNR} = 1_{PNR}$ and $A_{PNR} \cap B_{PNR} = 0_{PNR}$. If P_{PNR} is not a Pythagorean Neutrosophic Refined semi – disconnected space, then it is said to be a Neutrosophic semi-connected space.

Example: 3.8

Let $X = \{p,q,r\}$ with $\tau_{PNR} = \{ 0_{PNR}, A_{PNR}, B_{PNR}, 1_{PNR} \}$ Where $A_{PNR} = \{ \langle \bar{x}, [0,0,0], [1,1,1], [0,0,0] \rangle \}$, $B_{PNR} = \{ \langle \bar{x}, [1,1,1], [0,0,0], [1,1,1] \rangle \}$ and also $A_{PNR} \neq 0_{PNR}$, $B_{PNR} \neq 0_{PNR}$, $A_{PNR} \cup B_{PNR} = \{ \langle \bar{x}, [1,1,1], [0,0,0], [0,0,0] \rangle \} = 1_{PNR}$, $A_{PNR} \cap B_{PNR} = \{ \langle \bar{x}, [0,0,0], [1,1,1], [1,1,1] \rangle \} = 0_{PNR}$ Where A_{PNR}, B_{PNR} is Pythagorean Neutrosophic Refined Open Set in X . Since every Pythagorean Neutrosophic Refined Open Set is Pythagorean Neutrosophic Refined Semi- Open Set which implies A_{PNR}, B_{PNR} is Pythagorean Neutrosophic Refined Semi- Open Set. Therefore X is Pythagorean Neutrosophic Refined Semi- Disconnected .

Example : 3.9

Let $X = \{p,q,r\}$ with $\tau_{PNR} = \{ 0_{PNR}, A_{PNR}, B_{PNR}, 1_{PNR} \}$ Where $A_{PNR} = \{ \langle \bar{x}, [0,0,0], [0.2,0.1,0.8], [0.7,0.8,0.3] \rangle \}$, $B_{PNR} = \{ \langle \bar{x}, [1,1,1], [0.2,0.5,0.8], [0.4,0.1,0.6] \rangle \}$ and also $A_{PNR} \neq 0_{PNR}$, $B_{PNR} \neq 0_{PNR}$, $A_{PNR} \cup B_{PNR} = \{ \langle \bar{x}, [1,1,1], [0.2,0.1,0.8], [0.4,0.1,0.6] \rangle \} \neq 1_{PNR}$, $A_{PNR} \cap B_{PNR} = \{ \langle \bar{x}, [0,0,0], [0.2,0.1,0.8], [0.7,0.8,0.3] \rangle \} = A_{PNR} \neq 0_{PNR}$ Where A_{PNR}, B_{PNR} is Pythagorean Neutrosophic Refined Open Set in X . Since every Pythagorean Neutrosophic Refined Open Set is Pythagorean Neutrosophic Refined Semi - Open Set which implies A_{PNR}, B_{PNR} is Pythagorean Neutrosophic Refined Semi- Open Set. Therefore X is Pythagorean Neutrosophic Refined Semi -Connected .

Theorem:3.10

Let (P_{PNR}, τ_{PNR}) be a Pythagorean Neutrosophic Refined Semi –Connected Space and $\varphi_{PNR} \subseteq \tau_{PNR}$. Then (P_{PNR}, φ_{PNR}) is a Pythagorean Neutrosophic Refined Semi –Connected Space.

Proof:

Consider (P_{PNR}, φ_{PNR}) be a Pythagorean Neutrosophic Refined Semi – Disconnected Space. Then by the definition 3.7, there exist two distinct Pythagorean Neutrosophic Refined Semi – Open Sets M_{PNR}, N_{PNR} in φ_{PNR} , where $M_{PNR}, N_{PNR} \neq 0_{PNR}$ such that $M_{PNR} \cup N_{PNR} = 1_{PNR}$ and $M_{PNR} \cap N_{PNR} = 0_{PNR}$. It is Given that $\varphi_{PNR} \subseteq \tau_{PNR}$, then M_{PNR}, N_{PNR} in τ_{PNR} , where $M_{PNR}, N_{PNR} \neq 0_{PNR}$ such that $M_{PNR} \cup N_{PNR} = 1_{PNR}$ and $M_{PNR} \cap N_{PNR} = 0_{PNR}$ which implies (P_{PNR}, τ_{PNR}) is a Pythagorean Neutrosophic Refined Semi – Disconnected Space, which is a contradiction. Thus (P_{PNR}, φ_{PNR}) be a Pythagorean Neutrosophic Refined Semi –Connected Space .

Theorem:3.11

Let P_{PNR} and Q_{PNR} be Pythagorean Neutrosophic Refined Topological Spaces and $h: P_{PNR} \rightarrow Q_{PNR}$ be a Pythagorean Neutrosophic Refined Semi-irresolute and surjective. If P_{PNR} is Pythagorean Neutrosophic Refined Semi- Connected , then Q_{PNR} is Pythagorean Neutrosophic Refined Semi- Connected.

Proof:

Consider Q_{PNR} is Pythagorean Neutrosophic Refined Semi- Disconnected Space. Then by definition there exists two distinct Pythagorean Neutrosophic Refined Semi – Open Sets M_{PNR}, N_{PNR} in τ_{PNR} , where $M_{PNR}, N_{PNR} \neq 0_{PNR}$ such that $M_{PNR} \cup N_{PNR} = 1_{PNR}$ and $M_{PNR} \cap N_{PNR} = 0_{PNR}$. Thus $h^{-1}(M_{PNR}) \cup h^{-1}(N_{PNR}) = h^{-1}(M_{PNR} \cup N_{PNR}) = h^{-1}(1_{PNR}) = 1_{PNR}$ and also $h^{-1}(M_{PNR}) \cap h^{-1}(N_{PNR}) = h^{-1}(M_{PNR} \cap N_{PNR}) = h^{-1}(0_{PNR}) = 0_{PNR}$ which is a contradiction. Thus Q_{PNR} is Pythagorean Neutrosophic Refined Semi- Connected.





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Theorem:3.12

In a Pythagorean Neutrosophic Refined Topological Space P_{PNR} the conditions given below are equivalent:

- (i) P_{PNR} is a Pythagorean Neutrosophic Refined Semi-Connected Space
- (ii) 1_{PNR} is the only Pythagorean Neutrosophic Refined Set which is both Pythagorean Neutrosophic Refined Semi- Open and Pythagorean Neutrosophic Refined Semi- Closed set.

Proof:

(i)→(ii) Assume that P_{PNR} is a Pythagorean Neutrosophic Refined Semi-Connected Space. Let M_{PNR} is a Pythagorean Neutrosophic Refined set of P_{PNR} which is both Pythagorean Neutrosophic Refined Semi- Open and Pythagorean Neutrosophic Refined Semi- Closed. Then M_{PNR} and M_{PNR}^c are disjoint Pythagorean Neutrosophic Refined Semi- Open sets and $M_{PNR} \cup M_{PNR}^c = 1_{PNR}$. Since P_{PNR} is a Pythagorean Neutrosophic Refined Semi-Connected, either $M_{PNR} = 0_{PNR}$ or $M_{PNR}^c = 0_{PNR}$. Thus either $M_{PNR} = 0_{PNR}$ or $M_{PNR} = 1_{PNR}$

(ii)→(i) Suppose P_{PNR} is a Pythagorean Neutrosophic Refined Semi-disconnected Space. Then there exist two disjoint non – empty Pythagorean Neutrosophic Refined Semi open sets A_{PNR} and B_{PNR} such that $A_{PNR} \cup B_{PNR} = 1_{PNR}$. $A_{PNR} = B_{PNR}^c$, A_{PNR} is Pythagorean Neutrosophic Refined Semi closed. Assume that $A_{PNR} = 1_{PNR}$ or $A_{PNR} = 0_{PNR}$ which is a contradiction that A_{PNR} is Pythagorean Neutrosophic Refined Semi open set. Thus P_{PNR} is a Pythagorean Neutrosophic Refined Semi - Connected.

Pythagorean Neutrosophic Refined Semi – Separated Spaces

In this section, we discuss some basic properties and theorems related with Pythagorean Neutrosophic Refined Semi - Connected and Pythagorean Neutrosophic Refined Semi – Separated Sets.

Definition:4.1

A_{PNR} and B_{PNR} be Pythagorean Neutrosophic Refined Sets in X_{PNR} are Pythagorean Neutrosophic Refined Semi – Separated Sets if $PNRCI(A_{PNR}) \cap B_{PNR} = A_{PNR} \cap PNRCI(B_{PNR}) = 0_{PNR}$.

Theorem:4.2

If A_{PNR} and B_{PNR} are Pythagorean Neutrosophic Refined Semi – Closed disjoint Sets then A_{PNR} and B_{PNR} are Pythagorean Neutrosophic Refined Semi – Separated Sets.

Proof:

If A_{PNR} and B_{PNR} are Pythagorean Neutrosophic Refined Semi – Closed disjoint Sets. $PNRCI(A_{PNR}) \cap B_{PNR} = A_{PNR} \cap PNRCI(B_{PNR}) = A_{PNR} \cap B_{PNR} = 0_{PNR}$. Then A_{PNR} and B_{PNR} are Pythagorean Neutrosophic Refined Semi – Separated Sets. The converse of the theorem does not hold. It is explained in the following example.

Example:4.3

Let $X = \{a,b,c\}$ with $\tau_{PNR} = \{0_{PNR}, A_{PNR}, B_{PNR}, C_{PNR}, 1_{PNR}\}$ and $\tau_{PNR}^c = \{1_{PNR}, A_{PNR}^c, B_{PNR}^c, C_{PNR}^c, 0_{PNR}\}$ where $A_{PNR} = \{(a,0,0,0),(b,0,2,0,2),(c,1,1,1)\}$, $B_{PNR} = \{(a,0,0,0),(b,1,1,1),(c,1,1,1)\}$, $C_{PNR} = \{(a,1,1,1),(b,0,0,0),(c,0,0,0)\}$, $A_{PNR}^c = \{(c,1,1,1),(b,0,8,0,8),(a,0,0,0)\}$, $B_{PNR}^c = \{(c,1,1,1),(b,0,0,0),(c,0,0,0)\}$, $C_{PNR}^c = \{(c,0,0,0),(b,1,1,1),(a,1,1,1)\}$. Then $PNRCI(A_{PNR}^c) = A_{PNR}^c$ and $PNRCI(B_{PNR}) = C_{PNR}^c$. Thus $PNRCI(A_{PNR}^c) \cap B_{PNR} = A_{PNR}^c \cap B_{PNR} = 0_{PNR}$ and $A_{PNR}^c \cap PNRCI(B_{PNR}) = A_{PNR}^c \cap C_{PNR}^c = 0_{PNR}$ which implies A_{PNR}^c and B_{PNR} are PNR semi-separated sets. But B_{PNR} is not a PNR semi-closed set.

Theorem:4.4

If A_{PNR} and B_{PNR} be Pythagorean Neutrosophic Refined Semi- Separated Sets and $C_{PNR} \subseteq A_{PNR}$, $D_{PNR} \subseteq B_{PNR}$ then C_{PNR} and D_{PNR} are also Pythagorean Neutrosophic Refined Semi- Separated Sets.

Proof:

If A_{PNR} and B_{PNR} be Pythagorean Neutrosophic Refined Semi- Separated Sets, $PNRCI(A_{PNR}) \cap B_{PNR} = A_{PNR} \cap PNRCI(B_{PNR}) = 0_{PNR}$. $PNRCI(C_{PNR}) \subseteq PNRCI(A_{PNR})$ and $PNRCI(D_{PNR}) \subseteq PNRCI(B_{PNR})$. Then $PNRCI(C_{PNR}) \cap D_{PNR} \subseteq$





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$PNRCI(A_{PNR}) \cap B_{PNR} = 0_{PNR}$, similarly $C_{PNR} \cap PNRCI(D_{PNR}) \subseteq A_{PNR} \cap PNRCI(B_{PNR}) = 0_{PNR}$. Thus C_{PNR} and D_{PNR} are also Pythagorean Neutrosophic Refined Semi- Separated Sets.

Theorem:4.5

If A_{PNR} and B_{PNR} be Pythagorean Neutrosophic Refined Semi- Open Sets and $P_{PNR} = A_{PNR} \cap B_{PNR}^c$ and $Q_{PNR} = B_{PNR} \cap A_{PNR}^c$ then P_{PNR} and Q_{PNR} Pythagorean Neutrosophic Refined Semi- Separated Sets.

Proof:

If A_{PNR} and B_{PNR} be Pythagorean Neutrosophic Refined Semi- Open Sets, A_{PNR}^c and B_{PNR}^c are Pythagorean Neutrosophic Refined Closed Sets . It is given that $P_{PNR} \subseteq B_{PNR}^c$, $PNRCI(P_{PNR}) \subseteq PNRCI(B_{PNR}^c) = B_{PNR}^c$ which implies $PNRCI(P_{PNR}) \cap B_{PNR} = 0_{PNR}$. $Q_{PNR} \subseteq A_{PNR}^c$, $PNRCI(Q_{PNR}) \subseteq PNRCI(A_{PNR}^c) = A_{PNR}^c$ which implies $PNRCI(Q_{PNR}) \cap A_{PNR} = 0_{PNR}$. Thus P_{PNR} and Q_{PNR} are Pythagorean Neutrosophic Refined Semi- Separated Sets.

Theorem:4.6

The Pythagorean Neutrosophic Refined Sets A_{PNR} and B_{PNR} are PNR Semi- Separated in P_{PNR} if and only if there exist PNR semi open sets X_{PNR} and Y_{PNR} in P_{PNR} such that $A_{PNR} \subseteq X_{PNR}$, $B_{PNR} \subseteq Y_{PNR}$ and $A_{PNR} \cap Y_{PNR} = 0_{PNR}$ and $B_{PNR} \cap X_{PNR} = 0_{PNR}$.

Proof:

If Pythagorean Neutrosophic Refined Sets A_{PNR} and B_{PNR} are PNR Semi- Separated in P_{PNR} , then $A_{PNR} \cap PNRCI(B_{PNR}) = 0_{PNR}$ and $B_{PNR} \cap PNRCI(A_{PNR}) = 0_{PNR}$. Let us consider $X_{PNR} = PNRCI(A_{PNR})$ and $Y_{PNR} = PNRCI(B_{PNR})$. Then X_{PNR} and Y_{PNR} are PNR semi- open sets in P_{PNR} such that $A_{PNR} \subseteq X_{PNR}$, $B_{PNR} \subseteq Y_{PNR}$ and $A_{PNR} \cap Y_{PNR} = 0_{PNR}$ and $B_{PNR} \cap X_{PNR} = 0_{PNR}$.

Conversely, let X_{PNR} and Y_{PNR} are PNR semi- open sets in P_{PNR} such that $A_{PNR} \subseteq X_{PNR}$, $B_{PNR} \subseteq Y_{PNR}$ and $A_{PNR} \cap Y_{PNR} = 0_{PNR}$ and $B_{PNR} \cap X_{PNR} = 0_{PNR}$. $A_{PNR} \subseteq Y_{PNR}^c$ and $B_{PNR} \subseteq X_{PNR}^c$ where X_{PNR}^c and Y_{PNR}^c are PNR semi-closed sets. $PNRCI(A_{PNR}) \subseteq PNRCI(Y_{PNR}^c) = Y_{PNR}^c \subseteq B_{PNR}^c$, $PNRCI(B_{PNR}) \subseteq PNRCI(X_{PNR}^c) = X_{PNR}^c \subseteq A_{PNR}^c$. Thus $A_{PNR} \cap PNRCI(B_{PNR}) = 0_{PNR}$ and $B_{PNR} \cap PNRCI(A_{PNR}) = 0_{PNR}$. Therefore A_{PNR} and B_{PNR} are PNR Semi- Separated sets.

Theorem:4.7

Any two PNR semi – separated sets are always disjoint

Proof

Let A_{PNR} and B_{PNR} are PNR Semi- Separated Sets, then $A_{PNR} \cap PNRCI(B_{PNR}) = 0_{PNR} = B_{PNR} \cap PNRCI(A_{PNR})$. $A_{PNR} \cap B_{PNR} \subseteq A_{PNR} \cap PNRCI(B_{PNR}) = 0_{PNR}$. $A_{PNR} \cap B_{PNR} = 0_{PNR}$. Thus A_{PNR} and B_{PNR} are PNR Semi- Separated Sets.

The converse part is not true.

Example:4.8

Let $X = \{a,b,c\}$ with $\tau_{PNR} = \{0_{PNR}, A_{PNR}, B_{PNR}, C_{PNR}, 1_{PNR}\}$ and $\tau_{PNR}^c = \{1_{PNR}, A_{PNR}^c, B_{PNR}^c, C_{PNR}^c, 0_{PNR}\}$ where $A_{PNR} = \{ (a,0,0,0), (b,0.2,0.2,0.2), (c,1,1,1) \}$, $B_{PNR} = \{ (a,0.3,0.4,0.5), (b,1,1,1), (c,0.7,0.6,0.5) \}$, $C_{PNR} = \{ (a,0.5,0.5,0.5), (b,1,1,1), (c,0.5,0.5,0.5) \}$, $A_{PNR}^c = \{ (c,1,1,1), (b,0.8,0.8,0.8), (a,0,0,0) \}$, $B_{PNR}^c = \{ (c,0.7,0.6,0.5), (b,0,0,0), (c,0.3,0.4,0.5) \}$, $C_{PNR}^c = \{ (c,0.5,0.5,0.5), (b,0,0,0), (a,0.5,0.5,0.5) \}$. Then $A_{PNR} \cap B_{PNR} = 0_{PNR}$ and $PNRCI(A_{PNR}) = C_{PNR}^c$, $PNRCI(B_{PNR}) = C_{PNR}^c$. Thus $PNRCI(A_{PNR}) \cap B_{PNR} = C_{PNR}^c \cap B_{PNR} = B_{PNR} \neq 0_{PNR}$ and $A_{PNR} \cap PNRCI(B_{PNR}) = A_{PNR} \cap C_{PNR}^c = A_{PNR} \neq 0_{PNR}$ which implies A_{PNR} and B_{PNR} are not PNR semi-separated sets.

Theorem:4.9

A PNR subset B_{PNR} of PNR topological space A_{PNR} is PNR semi – Connected if and only if B_{PNR} is not a union of any two PNR semi – separated sets.





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Proof

Let A_{PNR} be PNR semi – connected space and $B_{PNR} = P_{PNR} \cup Q_{PNR}$ where P_{PNR}, Q_{PNR} are PNR semi – separated sets. Then $PNRCI(P_{PNR}) \cap Q_{PNR} = PNRCI(Q_{PNR}) \cap P_{PNR} = 0_{PNR}$. We know that $P_{PNR} \subseteq PNRCI(P_{PNR}), P_{PNR} \cap Q_{PNR} \subseteq PNRCI(P_{PNR}) \cap Q_{PNR} = 0_{PNR}$. Also $PNRCI(P_{PNR}) \subseteq Q_{PNR}^c = P_{PNR}$ and $PNRCI(Q_{PNR}) \subseteq P_{PNR}^c = Q_{PNR}$. Hence $PNRCI(P_{PNR}) = P_{PNR}, PNRCI(Q_{PNR}) = Q_{PNR}$. P_{PNR} and Q_{PNR} are semi closed sets which is a contradiction that B_{PNR} be PNR semi – connected space. Thus B_{PNR} is not a union of any two PNR semi – separated sets. Conversely, Let B_{PNR} is not a union of any two PNR semi – separated sets and A_{PNR} is PNR disconnected space. $B_{PNR} = P_{PNR} \cup Q_{PNR}$ where P_{PNR} and Q_{PNR} are non empty disjoint PNR semi – separated sets in A_{PNR} . $P_{PNR} \subseteq Q_{PNR}^c$ and $Q_{PNR} \subseteq P_{PNR}^c$. $PNRCI(P_{PNR}) \cap Q_{PNR} \subseteq Q_{PNR}^c \cap Q_{PNR} = 0_{PNR}$ and $PNRCI(Q_{PNR}) \cap P_{PNR} \subseteq P_{PNR}^c \cap P_{PNR} = 0_{PNR}$. Thus P_{PNR} and Q_{PNR} are PNR semi – separated sets. This is contradiction to our assumption. Therefore B_{PNR} is PNR semi – Connected.

Theorem:4.10

A PNR topological space X_{PNR} is PNR semi-connected if and only if 1_{PNR} is not the union of any two PNR semi-separated spaces.

Proof

Let X_{PNR} be PNR semi-connected space. $1_{PNR} = P_{PNR} \cup Q_{PNR}$ where P_{PNR}, Q_{PNR} are PNR semi-separated spaces. By the definition 4.1, $PNRCI(P_{PNR}) \cap Q_{PNR} = P_{PNR} \cap PNRCI(Q_{PNR}) = 0_{PNR}$. Since $P_{PNR} \subseteq PNRCI(P_{PNR}), P_{PNR} \cap Q_{PNR} \subseteq PNRCI(P_{PNR}) \cap Q_{PNR} = 0_{PNR}$. Also $PNRCI(P_{PNR}) \subseteq Q_{PNR}^c = P_{PNR}$ and $PNRCI(Q_{PNR}) \subseteq P_{PNR}^c = Q_{PNR}$. Thus $P_{PNR} = PNRCI(P_{PNR})$ and $Q_{PNR} = PNRCI(Q_{PNR})$, which implies P_{PNR}, Q_{PNR} are semi- closed sets. Hence $P_{PNR} = Q_{PNR}^c$ and $Q_{PNR} = P_{PNR}^c$ are disjoint PNR semi-open sets. That is 1_{PNR} is not a PNR semi-connected set which is a contradiction. Thus 1_{PNR} is not the union of any two PNR semi-separated spaces. Conversely, Let us assume that 1_{PNR} is not the union of any two PNR semi-separated spaces and X_{PNR} be PNR semi-connected space. Then $1_{PNR} = P_{PNR} \cup Q_{PNR}$ where P_{PNR}, Q_{PNR} are non empty disjoint PNR semi-open sets in X_{PNR} . Since $P_{PNR} \subseteq Q_{PNR}^c$ and $Q_{PNR} \subseteq P_{PNR}^c$, $PNRCI(P_{PNR}) \cap Q_{PNR} \subseteq Q_{PNR}^c \cap Q_{PNR} = 0_{PNR}$ and $P_{PNR} \cap PNRCI(Q_{PNR}) \subseteq P_{PNR} \cap P_{PNR}^c = 0_{PNR}$. Thus P_{PNR}, Q_{PNR} are PNR semi-separated spaces which is a contradiction to our assumption, then X_{PNR} be PNR semi-connected space.

Theorem:4.11

If $A_{PNR} \subseteq P_{PNR} \cup Q_{PNR}$ where A_{PNR} is PNR semi-connected set and P_{PNR}, Q_{PNR} are PNR semi- separated sets, then either $A_{PNR} \subseteq P_{PNR}$ or $A_{PNR} \subseteq Q_{PNR}$.

Proof

Let us assume that A_{PNR} is not a PNR subset of P_{PNR} and also not a PNR subset of Q_{PNR} . Then $A_{PNR_1} = P_{PNR} \cap A_{PNR}$ and $A_{PNR_2} = Q_{PNR} \cap A_{PNR}$ where A_{PNR_1}, A_{PNR_2} are non-empty PNR sets. $A_{PNR_1} \cup A_{PNR_2} = (P_{PNR} \cap A_{PNR}) \cup (Q_{PNR} \cap A_{PNR}) = (P_{PNR} \cup Q_{PNR}) \cap A_{PNR} = A_{PNR}$, because $A_{PNR} \subseteq P_{PNR} \cup Q_{PNR}$. Since $A_{PNR_1} \subseteq P_{PNR}$ and $A_{PNR_2} \subseteq Q_{PNR}$, where P_{PNR}, Q_{PNR} are PNR semi- separated sets, $PNRCI(A_{PNR_1}) \cap A_{PNR_2} \subseteq PNRCI(P_{PNR}) \cap Q_{PNR} = 0_{PNR}$ and also $A_{PNR_1} \cap PNRCI(A_{PNR_2}) \subseteq P_{PNR} \cap PNRCI(Q_{PNR}) = 0_{PNR}$. Which implies A_{PNR_1}, A_{PNR_2} are PNR semi-separated sets such that $A_{PNR} = A_{PNR_1} \cup A_{PNR_2}$. By theorem 4.9, A_{PNR} is PNR semi-disconnected which is a contradiction to A_{PNR} is PNR semi-connected. Thus either $A_{PNR} \subseteq P_{PNR}$ or $A_{PNR} \subseteq Q_{PNR}$.

Theorem: 4.12

If P_{PNR} be PNR semi-connected set, then $PNRCI(P_{PNR})$ is also a PNR semi-connected set.

Proof

Let P_{PNR} be PNR semi-connected set, and $PNRCI(P_{PNR})$ is a PNR semi-disconnected. By the theorem 3.9, there exists PNR semi- separated sets A_{PNR} and B_{PNR} such that $P_{PNR} = A_{PNR} \cup B_{PNR}$. Since P_{PNR} is PNR semi-connected and $P_{PNR} \subseteq PNRCI(P_{PNR}) = A_{PNR} \cup B_{PNR}$. By the theorem 4.11, either $P_{PNR} \subseteq A_{PNR}$ or $P_{PNR} \subseteq B_{PNR}$. Since $P_{PNR} \subseteq A_{PNR}$, then $PNRCI(P_{PNR}) \subseteq PNRCI(A_{PNR})$. A_{PNR} and B_{PNR} are PNR semi-separated sets, $A_{PNR} \neq 0_{PNR}$ and $B_{PNR} \neq 0_{PNR}$ and $PNRCI(P_{PNR}) \cap B_{PNR} \subseteq PNRCI(A_{PNR}) \cap B_{PNR} = 0_{PNR}$. Thus $B_{PNR} \subseteq PNRCI(A_{PNR})^c$. Also $B_{PNR} \subseteq A_{PNR} \cup B_{PNR} = PNRCI(A_{PNR})$. Thus $B_{PNR} \subseteq PNRCI(A_{PNR})^c \cap PNRCI(A_{PNR}) = 0_{PNR}$ which is a contradiction to $B_{PNR} \neq 0_{PNR}$. Similarly if $P_{PNR} \subseteq B_{PNR}$, we get a contradiction to $A_{PNR} \neq 0_{PNR}$. Thus $PNRCI(P_{PNR})$ is also a PNR semi-connected set.





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Theorem:4.13

Let M_{PNR} be a PNR semi-connected in X_{PNR} . If $M_{PNR} \subseteq N_{PNR} \subseteq \text{PNRCI}(M_{PNR})$, then N_{PNR} is also a PNR semi-connected set.

Proof:

Suppose N_{PNR} be a PNR semi-disconnected set. Then there exists non-empty PNR semi-separated sets A_{PNR} and B_{PNR} such that $M_{PNR} = A_{PNR} \cup B_{PNR}$. Since $M_{PNR} \subseteq N_{PNR} = A_{PNR} \cup B_{PNR}$ and by the theorem 4.11, either $M_{PNR} \subseteq A_{PNR}$ or $M_{PNR} \subseteq B_{PNR}$. Let $M_{PNR} \subseteq A_{PNR}$ then $\text{PNRCI}(M_{PNR}) \subseteq \text{PNRCI}(A_{PNR})$. $\text{PNRCI}(M_{PNR}) \cap B_{PNR} \subseteq \text{PNRCI}(A_{PNR}) \cap B_{PNR} = 0_{PNR}$. Also $A_{PNR} \cup B_{PNR} = N_{PNR} \subseteq \text{PNRCI}(M_{PNR})$, $B_{PNR} \subseteq N_{PNR} \subseteq \text{PNRCI}(M_{PNR})$. Therefore $\text{PNRCI}(M_{PNR}) \cap B_{PNR} = B_{PNR} = 0_{PNR}$ which is contradiction to $B_{PNR} \neq 0_{PNR}$. Thus N_{PNR} is also a PNR semi-connected set.

Theorem: 4.14

If A_{PNR} and B_{PNR} are the PNR semi-connected space in X_{PNR} such that $A_{PNR} \cap B_{PNR} \neq 0_{PNR}$, $A_{PNR} \cup B_{PNR}$ is a PNR semi-connected space in X_{PNR} .

Proof

Let $A_{PNR} \cup B_{PNR}$ is a PNR semi-disconnected. By the theorem 4.8, there exists two non-empty PNR semi-separated sets C_{PNR} , D_{PNR} such that $A_{PNR} \cup B_{PNR} = C_{PNR} \cup D_{PNR}$, since C_{PNR} and D_{PNR} are PNR semi-separated, C_{PNR} and D_{PNR} are non-empty PNR sets and $C_{PNR} \cap D_{PNR} \subseteq \text{PNRCI}(C_{PNR}) \cap D_{PNR} = 0_{PNR}$. Since $A_{PNR} \subseteq A_{PNR} \cup B_{PNR} = C_{PNR} \cup D_{PNR}$, $B_{PNR} \subseteq A_{PNR} \cup B_{PNR} = C_{PNR} \cup D_{PNR}$ and A_{PNR} and B_{PNR} are the PNR semi-connected, By the theorem 4.11, either $A_{PNR} \subseteq C_{PNR}$ or $A_{PNR} \subseteq D_{PNR}$ and $B_{PNR} \subseteq C_{PNR}$ or $B_{PNR} \subseteq D_{PNR}$

Case (i)

If $A_{PNR} \subseteq C_{PNR}$ and $B_{PNR} \subseteq C_{PNR}$, then $A_{PNR} \cup B_{PNR} \subseteq C_{PNR}$. Thus $A_{PNR} \cup B_{PNR} = C_{PNR}$. Since C_{PNR} and D_{PNR} are disjoint and $D_{PNR} = 0_{PNR}$ which is a contradiction to $D_{PNR} \neq 0_{PNR}$. Similarly, if $A_{PNR} \subseteq D_{PNR}$ and $B_{PNR} \subseteq D_{PNR}$, we get a contradiction.

Case(ii)

If $A_{PNR} \subseteq C_{PNR}$ and $B_{PNR} \subseteq D_{PNR}$, then $A_{PNR} \cap B_{PNR} \subseteq C_{PNR} \cap D_{PNR} = 0_{PNR}$. $A_{PNR} \cap B_{PNR} = 0_{PNR}$ which is a contradiction to $A_{PNR} \cap B_{PNR} \neq 0_{PNR}$. Similarly if $A_{PNR} \subseteq D_{PNR}$ and $B_{PNR} \subseteq C_{PNR}$, we get a contradiction. Therefore $A_{PNR} \cup B_{PNR}$ is a PNR semi-connected space in X_{PNR} .

Theorem:4.15

Let $f: A_{PNR} \rightarrow B_{PNR}$ be PNR semi-open, PNR semi-closed and injection and B_{PNR} be PNR semi-connected. Then A_{PNR} is PNR semi-connected.

Proof

Let f be PNR semi-open, PNR semi-closed. Then $f(A_{PNR})$ is both PNR semi-open and PNR semi-closed. Since B_{PNR} is PNR semi-connected then by definition, $f(A_{PNR}) = 0_{PNR}$ or $f(A_{PNR}) = 1_{PNR}$. Since f is injection $A_{PNR} = 0_{PNR}$ or $A_{PNR} = 1_{PNR}$. Hence by definition, A_{PNR} is PNR semi-connected.

CONCLUSION

In this paper we introduced and evaluated PNR semi-connected and PNR semi-separated spaces. Some of their basic properties, theorems and inter-relationships were examined and solved with suitable examples.





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Analysis of Road Transportation System with Special Reference to Vehicle Flow and Accidents in Kozhikode Corporation, Kerala

P. Jyothirmayi^{1*} and Akisha²

¹Head and Assistant Professor, Department of Geography, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Research Scholar, Department of Geography, Nirmala College for Women. Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

P. Jyothirmayi

Head and Assistant Professor,
Department of Geography,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.



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ABSTRACT

Transport creates time and space utility and contributes to the overall development of urban or any rural area also. Contemporary issues of transportation have become a matter of concern recently. Traffic problems have increased significantly over the last 50 years, despite a great deal of urban transport planning. It is now accepted that what is required is better management of the transport system through new approaches to planning. Transport network analysis using Geographical information system and the Remote sensing techniques have opened up new avenues for better solutions and monitoring the transport system as a whole. This paper is an attempt in understanding the relationship between vehicle flow and the number and type of accidents in Kozhikode Corporation in Kerala. The analysis highlights eleven major junctions where traffic flow was scrutinized and the results were represented by statistical techniques and tools. The study explicitly shows that there is inevitable relationship between the traffic flow, the type of vehicle and the accidents caused by them. Critical areas were identified and recommendations were suggested.

Keywords: Traffic flow, Accidents, GIS & Remote sensing, Urban transport, over crowding

INTRODUCTION

Transport has throughout history been a spur to expansion; better transport allows more trade and a greater spread of people. Economic growth has always been dependent on increasing the capacity and rationality of transport. As the infrastructure and operation of transport has a great impact on the land and is the largest drainer of energy,

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making transport sustainability is a major concern in today's world. Transport burns most of the world's petroleum. This creates air pollution, including nitrous oxides and particulates, and is a significant contributor to global warming through emission of carbon dioxide for which transport is the fastest-growing emission sector. By subsector, road transport is the largest contributor to global warming. In purview of this an investigation on the road transportation is being carried forward with reference to vehicle flow and the accidents in Kozhikode Corporation in Kerala. Transport planning allows for high utilization and less impact regarding new infrastructure. Using models of transport forecasting, planners are able to predict future transport patterns.

The selected region for the present study is Kozhikode Corporation, which is located in Kozhikode District. It extends from 11° 12' 00" and 11° 19' 00" North latitudes and between 75° 44' 30" and 75° 52' 30" East longitudes, covering 118.56 sq.km area(fig:1). Kozhikode Corporation is divided in to 14 villages and 75 blocks. As per the 2011 Census, the total population of Kozhikode Corporation is 432,097 out of that 2, 63,232 are staying in rural and 2, 87,689 in urban area. The climate of this region is wet. The average annual rainfall in the region is 789.5 mm. The mean daily maximum temperature is 34.5°C and the mean daily minimum 21.51°C. The study area has an undulating topography characterized by plains, valleys and hills which is shown by figure 2 and geomorphologic features shown in figure 3. Generally, the ground elevations show a rising trend towards the east. The two physiographic zones are low land (or coastal plain) and midland. Topographically the corporation has three regions, the sandy coastal zone low land, the rocky high land covering the hilly portions of Western Ghats and the lateritic mid land. The headquarters of the district, viz. Kozhikode city is the one among the three city corporations in the state. The study aims to bring out the relationship between traffic flow and the types of vehicles involved in road accidents in Kozhikode Corporation.

MATERIALS AND METHODS

The study is conducted to scrutinize the traffic flow and the accidents that take place in Kozhikode Corporation from 2009 to 2014. The accident data were collected from the traffic police and traffic flow data is collected from the NATPAC (National Transportation Planning and Research Centre). The traffic flow and accidents of Kozhikode was mapped using ArcGIS 10.2. The accident data is calculated for six years. Major part of the study is based on secondary data taken from published and unpublished sources and websites. All the data was statistically analyzed and the results were cartographically portrayed. 11 major junctions are identified and the accidents were identified six time periods were taken viz. 2009, 2010, 2011, 2012, 2013 and 2014.

RESULTS AND DISCUSSION

The traffic flow data were collected from 11 junctions across the Corporation. Based on the collected data, all junctions are mapped. Among 11 junctions the maximum traffic flow is at the Mavoor Road Junction which is 201 and second is at Eranjipalam Junction which is 199.95 and that the lowest is Meenchantha Junction which is 191.61. Autos and Two wheelers are the motor vehicles which are widely used and increasing the traffic flow. Compared to bus transportation the car and autos are widely used. The vehicles like cycle, tempo van, containers, LPG tanker, etc. are very less in number. In Urban Centers of Kozhikode, both Pedestrians and Vehicles use the road, which results in overcrowding on roads, steep curves and gradients. The transport network and the types of roads have been delineated and mapped (Figure 6)

The study reveals that the traffic flow is highest in Mavoor Road Junction, because the availability of various medical facilities, lot of schools, colleges, entertainment centers etc. The traffic flow is lowest in PWD Junction. Compared to other vehicles, two wheeler traffic flow has recorded highest from these junctions. The accident data for the years from 2009 to 2014 was analyzed and graphically charted (Graph 1 to 6). Road traffic accidents increased in the year 2009(Table 1 & graph 1) to 2010 (Table 3 & graph 2), causing the loss of valuable work force and resources. But the



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rate is decreasing in the year 2011 (Table 5 & graph 3); however, again increase can be witnessed in the year 2012 (Table 7 & graph 4) which reached the level of the years 2009 and 2010. The year 2013 (Table 9 & graph 5) again shows a decreased rate of accident death. The rate of accidents became very low in 2014 (Table 11 & graph 6). In the year 2009 and 2014, 193 fatalities occurred per day on an average in the Calicut Corporation. At certain times of the year, such as summer holidays, death toll rose dramatically. During the Festival period, on an average, 45 fatalities involving alcoholic-driver occurred each day, and soared to 54 per day over the New Year's holiday. Sudden increase in the number of motor vehicles with the same infrastructure of roads especially during the last two decades has been the major reason for the increasing number of road accidents. Increasing number of New generation vehicles especially Two wheelers, Aggressive driving behavior of Heavy vehicle drivers especially Private Buses & Tipper Lorries, drivers sleeping while driving especially of Heavy vehicles & light motor vehicles after midnight due to fatigue and other reasons, over speeding, bad condition of Roads and absence of different lanes, driver /Rider's ignorance of Road conditions, Road signs and the Environmental factors, driver /Rider's ignorance or violation of Traffic Rules are identified as the major cause of these accidents and traffic congestions.

CONCLUSION

Road accidents and Traffic flow is interrelated. When traffic flow is increasing then road accidents are increasing. Among 11 junctions the maximum traffic flow is at the Mavoor Road Junction which is 201 and second is at Eranjipalam Junction which is 199.95 and that the lowest is Meenchantha Junction which is 191.61. The reason for the highest traffic flow at Mavoor Road Junction is the availability of various medical facilities like hospitals, clinics, schools, colleges and other entertainment places like theaters, shopping complex, park, beach, planetarium, etc. The study reveals that the number of accidents was highest in the year 2009 and the accident rates deteriorated to a greater extent in the year 2014. The accident cases were very high in the month of June and came down in the month of November. This shows that in the months from January to June the accident cases were showing an increasing trend whereas after June the accidents show a decreasing trend in the month of February. When we see the type of vehicles which are causing highest number of accidents two wheelers are on the higher side followed by car and bus. This is because the safety involved in two wheelers is lesser when compared to other vehicles. Road Traffic Accident is due to the tremendous increase in the number of vehicles, high-speed technology along with other contributing factors like, poor roads, intoxicating influence of alcohol or drugs, inexperienced drivers without having proper driving license, ignorance or intentional violation of traffic rules etc. Victims in RTAs sustain varieties of injuries; external as well as internal injuries, may be abrasions, lacerations, contusions etc. Proper education and awareness regarding the traffic rules, dividing traffic into homogenous groups for plying, reallocation of bus stops to avoid overcrowding in junctions and proper maintenance of roads are some of the possible solutions to avoid accidents.

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Table 1: Total Road Accident Case -2009

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day	90	80	84	79	77	86	76	66	85	81	80	92
Night	36	32	32	25	39	38	24	30	32	34	35	45
Total	126	112	116	104	116	124	100	96	117	115	115	137

Source: Traffic Police Station Kozhikode City

Table 2: Type of Vehicle involved in Accident -2009

Vehicle	KSRTC	Pvt. Bus	G. vehicle	Car	Jeep	A/R	T/W	Others	Not Known
Accident	1.66	17.61	8.16	20.7	2.89	9.49	36.46	2.51	0.47

Source: Traffic Police Station Kozhikode City

Table 3: Total Road Accident Case - 2010

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day	89	101	102	90	102	91	106	80	57	72	68	79
Night	46	33	50	52	42	35	28	34	36	28	42	34
Total	135	134	152	142	144	126	134	114	93	100	110	113

Source: Traffic Police Station Kozhikode City

Table 4: Type of Vehicle involved in Accident -2010

Vehicle	KSRTC	Pvt. Bus	G. vehicle	Car	Jeep	A/R	T/W	Others	Not Known
Accident	1.08	16.06	7.51	21.13	2.66	9.66	37.84	2.57	0.73

Source: Traffic Police Station Kozhikode City

Table 5: Total Road Accident Case -2011

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day	89	85	81	74	86	78	82	64	59	59	65	74
Night	46	21	21	29	42	32	33	35	32	32	30	24
Total	135	106	102	103	128	110	115	99	91	91	95	98

Source: Traffic Police Station Kozhikode City

Table 4: Type of Vehicle involved in Accident -2010

Vehicle	KSRTC	Pvt. Bus	G. vehicle	Car	Jeep	A/R	T/W	Others	Not Known
Accident	1.08	16.06	7.51	21.13	2.66	9.66	37.84	2.57	0.73

Source: Traffic Police Station Kozhikode City





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Table 5: Total Road Accident Case -2011

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day	89	85	81	74	86	78	82	64	59	59	65	74
Night	46	21	21	29	42	32	33	35	32	32	30	24
Total	135	106	102	103	128	110	115	99	91	91	95	98

Source: Traffic Police Station Kozhikode City

Table 6: Type of Vehicle involved in Accident -2011

Vehicle	KSRTC	Pvt. Bus	G. vehicle	Car	Jeep	A/R	T/W	Others	Not Known
Accident	2	16.4	6.6	19.3	2.3	8.95	40.3	3.5	0.65

Source: Traffic Police Station Kozhikode City

Table 7: Total Road Accident Case - 2012

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day	82	81	80	72	85	77	81	63	57	58	64	72
Night	45	20	20	28	41	31	32	34	31	31	29	23
Total	127	101	100	100	126	108	113	87	88	89	93	95

Source: Traffic Police Station Kozhikode City

Table 8: Type of Vehicle involved in Accident -2012

Vehicle	KSRTC	Pvt. Bus	G. vehicle	Car	Jeep	A/R	T/W	Others	Not Known
Accident	2.48	15.24	5.06	18.29	1.49	8.57	46.2	2.53	0.2

Source: Traffic Police Station Kozhikode City

Table 9 : Total Road Accident Case - 2013

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day	80	80	79	71	84	76	80	62	56	57	63	71
Night	44	19	19	27	40	31	30	33	30	29	27	22
Total	124	99	98	98	124	107	110	95	86	86	90	93

Source: Traffic Police Station Kozhikode City

Table 11: Type of Vehicle involved in Accident -2013

Vehicle	KSRTC	Pvt. Bus	G. vehicle	Car	Jeep	A/R	T/W	Others	Not Known
Accident	2.09	14.88	4.52	19.68	1.65	8.82	44.87	2.86	0.6

Source: Traffic Police Station Kozhikode City

Table12: Total Road Accident Case - 2014

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day	70	72	69	64	82	74	76	60	55	56	62	69
Night	34	18	17	25	31	30	29	31	28	27	26	21
Total	104	90	86	89	113	104	105	91	83	83	88	90

Source: Traffic Police Station Kozhikode City



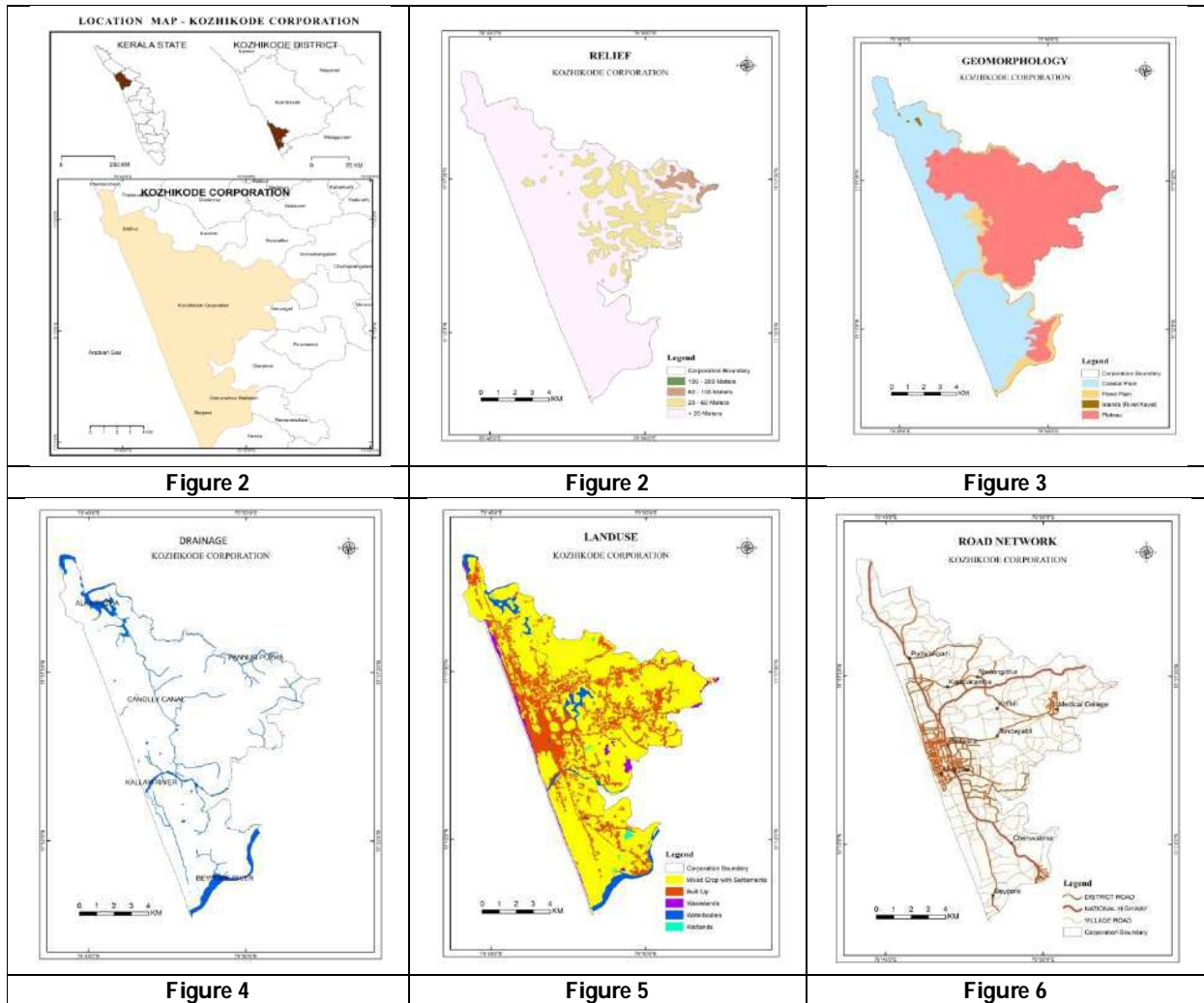


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Table No: 4.42 Type of Vehicle involved in Accident in the Year 2014

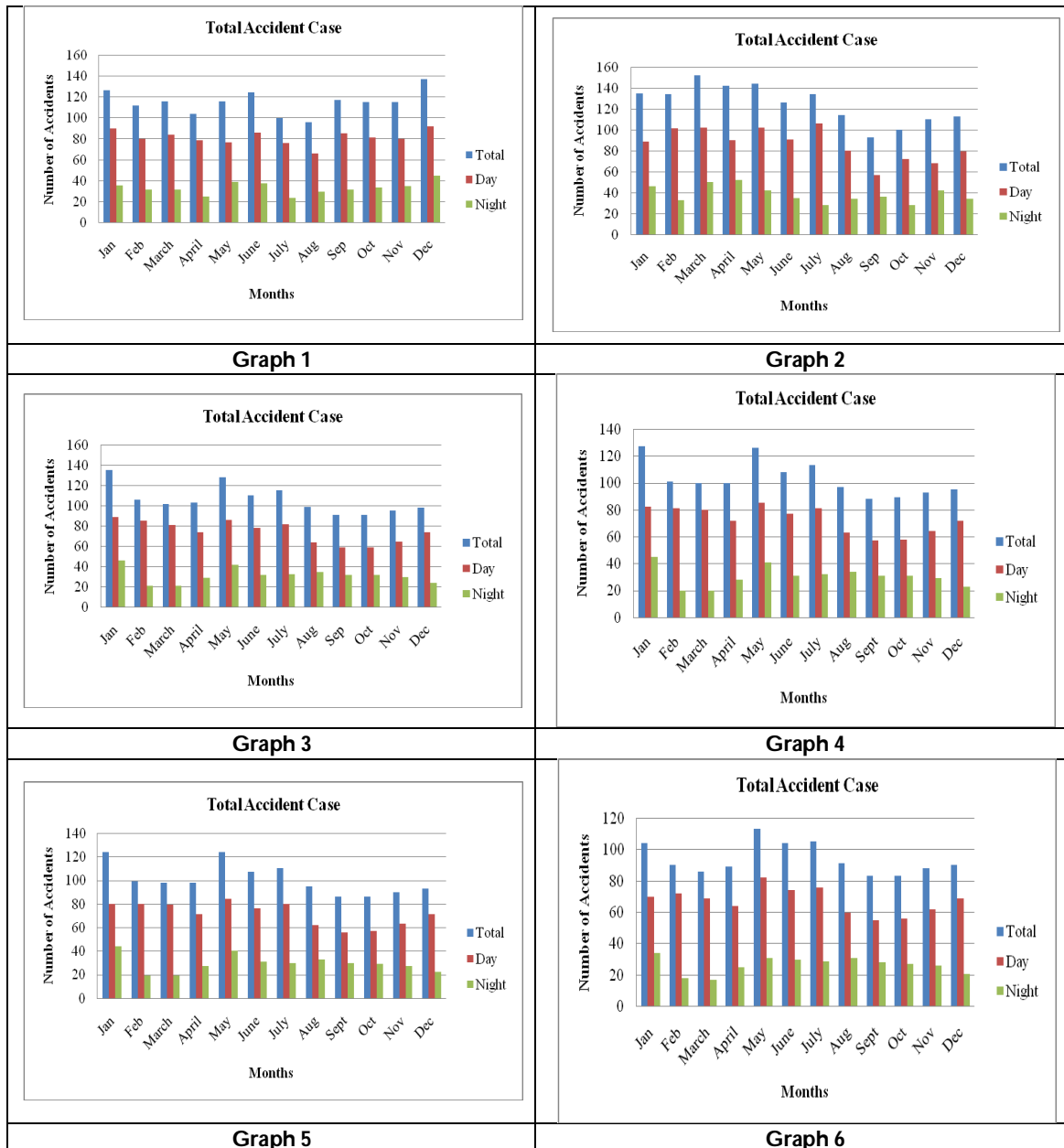
Vehicle	KSRTC	Pvt. Bus	G. vehicle	Car	Jeep	A/R	T/W	Others	Not Known
Accident	1.41	11.43	5.75	16.64	1.34	7.49	52.05	3.07	0.78

Source: Traffic Police Station Kozhikode City





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Generalized β Closed Set Sinpytha Gorean Neutrosophic Vague Topological Spaces

Vargees Vahini.T^{1*} and Trinita Pricilla.M²

¹Research Scholar, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Assistant Professor, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

Vargees Vahini. T

Research Scholar,

Department of Mathematics,

Nirmala College for Women,

Coimbatore, Tamil Nadu, India.

E. Mail : vargeesvahini3@gmail.com



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ABSTRACT

The purpose of this paper is to introduce and develop a generalized β closed sets in Pythagorean Neutrosophic Vague Topological Space. Some of basic definitions and properties of generalized β open set in Pythagorean Neutrosophic Vague Topological Space are also introduced and analyzed.

Keywords: Pythagorean Neutrosophic Vague set, Pythagorean Neutrosophic Vague Topology, Pythagorean Neutrosophic Vague Generalized β closed Set, Pythagorean Neutrosophic Vague Generalized β Open Set, Pythagorean Neutrosophic Vague $T_{1/2}$ space.

INTRODUCTION

Fuzzy was first introduced by L.A.Zadeh [11] in 1965 and is the most influential concepts in mathematics today. C.L.Chang[2] introduced the concept of Fuzzy Topology in 1967 and Levine[4] initiated the study of generalized closed sets in 1970. Atanassov[1] in 1986 introduced the Intuitionistic Fuzzy Set which is widely used in various branches of mathematics. Yager[7] introduced the new concept Pythagorean fuzzy set with the limitation that sum of their square is less than or equal to 1. Gau and Buehrer [9] in 1993 defined the Vague sets, an extension of Fuzzy sets. The IFS was failed to deal with indeterminant and inconsistent information. So Smarandache[3] in 1995 introduced the Neutrosophic Sets. Each element of a Neutrosophic Set has a truth membership degree, a Indeterminacy membership degree and a falsity membership degree where these membership degree are within the real standard or non standard unit interval $]0, 1+[$. As a combination of Neutrosophic set and Vague set Shawkat





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Alkhazaleh[8] in 2015 initiated the concept of Neutrosophic Vague set. As a combination of Pythagorean fuzzy set and Neutrosophic Vague set, in this paper we introduced the Pythagorean Neutrosophic Vague Set and Pythagorean Neutrosophic Vague Topological Space and also have introduced the generalized β closed sets in Pythagorean Neutrosophic Vague Topological Spaces, generalized β open sets in Pythagorean Neutrosophic Vague Topological Space and their characterizations are analyzed.

Preliminaries

Definition 2.1 Let X be a non-empty set, and I be the unit interval $[0,1]$. A Neutrosophic Set is an object of the form $A = \{(x, T_A(x), I_A(x), F_A(x)); x \in X\}$ where $T_A(x), I_A(x), F_A(x) \in [0,1]$ with $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3 \forall x \in X$. Where $T_A(x), I_A(x)$ and $F_A(x)$ are Degree of truth membership, Degree of indeterminacy membership and Degree of falsity membership respectively.

Definition 2.2 A Vague set V in the universe of discourse X is characterized by a truth membership function t_v , and a falsity 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 2.3 Let X be a universe of discourse. A Pythagorean Fuzzy Set P in X is given by $P = \{(x, T_P(x), F_P(x)); x \in X\}$, where $T_P: X \rightarrow [0,1]$ denotes the degree of truth membership and $F_P: X \rightarrow [0,1]$ denotes the degree of non-membership of the element $x \in X$ to the set P respectively, with the condition that $0 \leq (T_P(x))^2 + (F_P(x))^2 \leq 1$.

Definition 2.4 A Neutrosophic Vague set A_{NV} on the universe of discourse X written as $A_{NV} = \{(x; \hat{T}_{A_{NV}}(x); \hat{I}_{A_{NV}}(x); \hat{F}_{A_{NV}}(x)); x \in X\}$, whose truth membership, indeterminacy membership and false membership function are defined as follows:

$$\hat{T}_{A_{NV}}(x) = [T^-, T^+], \hat{I}_{A_{NV}}(x) = [I^-, I^+], \hat{F}_{A_{NV}}(x) = [F^-, F^+]$$

Where,

$$T^+ = 1 - F^-$$

$$F^+ = 1 - T^- \text{ and}$$

$$0 \leq T^- + I^- + F^- \leq 2^+.$$

Pythagorean Neutrosophic Vague Topological Space

Definition 3.1 A Pythagorean Neutrosophic Vague Set A_{PNV} (PNVS in short) on the universe of discourse X is written as

$$A_{PNV} = \{(x; \hat{T}_{A_{PNV}}(x); \hat{I}_{A_{PNV}}(x); \hat{F}_{A_{PNV}}(x)); x \in X\},$$

Whose truth membership, indeterminacy membership and false membership functions are defined as

$$\hat{T}_{A_{PNV}}(x) = [T^-, T^+], \hat{I}_{A_{PNV}}(x) = [I^-, I^+], \hat{F}_{A_{PNV}}(x) = [F^-, F^+]$$

Where,

$$T^+ = 1 - F^-$$

$$F^+ = 1 - T^- \text{ and}$$

$$0 \leq (T^-)^2 + (I^-)^2 + (F^-)^2 \leq 2^+.$$

Definition 3.2 Let A_{PNV} and B_{PNV} be two PNVSs of the universe U . If $\forall u_i \in U, \hat{T}_{A_{PNV}}(u_i) \leq \hat{T}_{B_{PNV}}(u_i); \hat{I}_{A_{PNV}}(u_i) \geq \hat{I}_{B_{PNV}}(u_i); \hat{F}_{A_{PNV}}(u_i) \geq \hat{F}_{B_{PNV}}(u_i)$; then the PNVS A_{PNV} is included in B_{PNV} , denoted by $A_{PNV} \subseteq B_{PNV}$, where $1 \leq i \leq n$.

Definition 3.3 The complement of a PNVS A_{PNV} is denoted by A_{PNV}^c and is defined by $\hat{T}_{A_{PNV}^c}(x) = [1 - T^+, 1 - T^-], \hat{I}_{A_{PNV}^c}(x) = [1 - I^+, 1 - I^-], \hat{F}_{A_{PNV}^c}(x) = [1 - F^+, 1 - F^-]$.





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Definition 3.4 Let A_{PNV} be PNVS of the universe U where $\forall u_i \in U, \hat{T}_{A_{PNV}}^2(x) = [1,1]; \hat{I}_{A_{PNV}}^2(x) = [0,0]; \hat{F}_{A_{PNV}}^2(x) = [0,0]$. Then A_{PNV} is called unit PNVS (1_{PNV} in short), where $1 \leq i \leq n$.

Definition 3.5 Let A_{PNV} be PNVS of the universe U where $\forall u_i \in U, \hat{T}_{A_{PNV}}^2(x) = [0,0]; \hat{I}_{A_{PNV}}^2(x) = [1,1]; \hat{F}_{A_{PNV}}^2(x) = [1,1]$. Then A_{PNV} is called zero PNVS (0_{PNV} in short), where $1 \leq i \leq n$.

Definition 3.6 The union of two PNVSs A_{PNV} and B_{PNV} is a PNVS C_{PNV} , written as $C_{PNV} = A_{PNV} \cup B_{PNV}$, whose truth membership, indeterminacy membership and false membership functions are related to those of A_{PNV} and B_{PNV} given by,

$$\begin{aligned} \hat{T}_{C_{PNV}}(x) &= [\max(T_{A_{PNV,x}}^-, T_{B_{PNV,x}}^-), \max(T_{A_{PNV,x}}^+, T_{B_{PNV,x}}^+)] \\ \hat{I}_{C_{PNV}}(x) &= [\min(I_{A_{PNV,x}}^-, I_{B_{PNV,x}}^-), \min(I_{A_{PNV,x}}^+, I_{B_{PNV,x}}^+)] \\ \hat{F}_{C_{PNV}}(x) &= [\min(F_{A_{PNV,x}}^-, F_{B_{PNV,x}}^-), \min(F_{A_{PNV,x}}^+, F_{B_{PNV,x}}^+)] \end{aligned}$$

Definition 3.7 The intersection of two PNVSs A_{PNV} and B_{PNV} is a PNVS C_{PNV} , written as $C_{PNV} = A_{PNV} \cap B_{PNV}$, whose truth membership, indeterminacy membership and false membership functions are related to those of A_{PNV} and B_{PNV} given by,

$$\begin{aligned} \hat{T}_{C_{PNV}}(x) &= [\min(T_{A_{PNV,x}}^-, T_{B_{PNV,x}}^-), \min(T_{A_{PNV,x}}^+, T_{B_{PNV,x}}^+)] \\ \hat{I}_{C_{PNV}}(x) &= [\max(I_{A_{PNV,x}}^-, I_{B_{PNV,x}}^-), \max(I_{A_{PNV,x}}^+, I_{B_{PNV,x}}^+)] \\ \hat{F}_{C_{PNV}}(x) &= [\max(F_{A_{PNV,x}}^-, F_{B_{PNV,x}}^-), \max(F_{A_{PNV,x}}^+, F_{B_{PNV,x}}^+)] \end{aligned}$$

Definition 3.8 Let A_{PNV} and B_{PNV} be two PNVSs of the universe U . If $\forall u_i \in U, \hat{T}_{A_{PNV}}(u_i) = \hat{T}_{B_{PNV}}(u_i); \hat{I}_{A_{PNV}}(u_i) = \hat{I}_{B_{PNV}}(u_i); \hat{F}_{A_{PNV}}(u_i) = \hat{F}_{B_{PNV}}(u_i)$; then the PNVS A_{PNV} and B_{PNV} are called equal and denoted by $A_{PNV} = B_{PNV}$, where $1 \leq i \leq n$.

Definition 3.9 A Pythagorean Neutrosophic Vague Topology (PNVT) on X is a family τ of Pythagorean Neutrosophic Vague sets (PNVS) in X satisfying the following axioms:

$$\begin{aligned} 0_{PNV}, 1_{PNV} &\in \tau \\ G_1 \cap G_2 &\in \tau \text{ for any } G_1, G_2 \in \tau \\ \cup G_i &\in \tau, \forall \{G_i; i \in J\} \subseteq \tau \end{aligned}$$

In this case the pair (X, τ) is called a Pythagorean Neutrosophic Vague Topological Space (PNVTS) and any NVS in τ is known as a Pythagorean Neutrosophic vague Open Set (PNVOS) in X . The complement A^c of PNVOS in a PNVTS (X, τ) is called Pythagorean Neutrosophic Vague Closed Set (PNVCS) in X .

Definition 3.10 A PNVS $A = \{x, [\hat{T}_A, \hat{I}_A, \hat{F}_A]\}$ in PNVTS (X, τ) is said to be Pythagorean Neutrosophic Vague β closed set (PNV β CS) if $PNVint(PNVcl(PNVint(A))) \subseteq A$
Pythagorean Neutrosophic Vague β Open set (PNV β OS) if $A \subseteq PNVcl(PNVint(PNVcl(A)))$

Definition 3.11: Let A be a PNVS of a PNVTS (X, τ) . Then the Pythagorean Neutrosophic Vague β interior of A (PNV β int(A)) and Pythagorean Neutrosophic Vague β closure of A (PNV β cl(A)) are defined as
PNV β int(A) = $\cup \{G / G \text{ is a PNV}\beta\text{OS in } X \text{ and } G \subseteq A\}$
PNV β cl(A) = $\cap \{K / K \text{ is a PNV}\beta\text{CS in } X \text{ and } A \subseteq K\}$

Definition 3.12: A PNVS A of a PNVTS (X, τ) is said to be Pythagorean Neutrosophic Vague Generalized Closed set (PNVGCS) if $PNVcl(A) \subseteq U$ whenever $A \subseteq U$ and U is a PNVOS in X .

Definition 3.13: A PNVS A is said to be Pythagorean Neutrosophic Vague Generalized β closed set (PNVG β CS) in (X, τ) if $PNV\beta cl(A) \subseteq U$ whenever $A \subseteq U$ and U is a PNVOS in X .





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Definition 3.14: Let (X, τ) be a PNVTS. The Pythagorean Neutrosophic Vague Generalized β Closure $(PNV\beta cl(A))$ and Pythagorean Neutrosophic Vague Generalized β interior $(PNV\beta int(A))$ for any PNVS A is defined as follows:

$$PNV\beta cl(A) = \cap \{K / K \text{ IS A PNV}\beta CS \text{ IN } X \text{ AND } A \subseteq K\}$$

$$PNV\beta int(A) = \cup \{G / G \text{ IS A PNV}\beta OS \text{ IN } X \text{ AND } G \subseteq A\}$$

Theorems On Pythagorean Neutrosophic Vague Generalized Bopenset

In this section we provide some theorems on Pythagorean Neutrosophic Vague Generalized β closed sets

Definition 4.1: A PNVS A is said to be Pythagorean Neutrosophic Vague Generalized β Open Set $(PNV\beta OS)$ in (X, τ) if the complement A^c is $PNV\beta CS$ in (X, τ) . The family of all $PNV\beta OS$ of PNVTS (X, τ) is denoted by $PNV\beta O(X)$.

Theorem 4.1: Let (X, τ) be a PNVTS. If $A \in PNV\beta O(X)$, then $V \subseteq PNVint(PNVcl(A))$ whenever $V \subseteq A$ and V is PNVCS in X .

Proof: Let $A \in PNV\beta O(X)$. Then A^c is $PNV\beta CS$ in X . Therefore $PNV\beta cl(A^c) \subseteq U$ and U is PNVOS in X . That is $PNVcl(PNVint(A^c)) \subseteq U$. This implies $U^c \subseteq PNVint(PNVcl(A))$ whenever $U^c \subseteq A$ and U^c is PNVCS in X . Replacing U^c by V , we get $V \subseteq PNVint(PNVcl(A))$ whenever $V \subseteq A$ and V is PNVCS in X .

Theorem 4.2: Let (X, τ) be a PNVTS. Then for every $A \in PNV\beta O(X)$ and for every $B \in PNVS(X)$, $PNV\beta int(A) \subseteq B \subseteq A$ implies that $B \in PNV\beta O(X)$.

Proof: By hypothesis $A^c \subseteq B^c \subseteq (PNV\beta int(A))^c$. Let $B^c \subseteq U$ and U be PNVOS. Since $A^c \subseteq B^c$, $A^c \subseteq U$. But A^c is $PNV\beta CS$, $PNV\beta cl(A^c) \subseteq U$. Also $B^c \subseteq (PNV\beta int(A))^c = PNV\beta cl(A^c)$. Therefore $PNV\beta cl(B^c) \subseteq PNV\beta cl(A^c) \subseteq U$. Hence B^c is $PNV\beta CS$. Which implies B is $PNV\beta OS$ of X .

Theorem 4.3: A PNVS 'A' of PNVTS (X, τ) is $PNV\beta OS$ if and only if $F \subseteq PNV\beta int(A)$ whenever F is PNVCS and $F \subseteq A$

Proof: Necessity: Suppose A is $PNV\beta OS$ in X . Let F be PNVCS and $F \subseteq A$. Then F^c is PNVOS in X such that $A^c \subseteq F^c$. Since A^c is $PNV\beta CS$, we have $PNV\beta cl(A^c) \subseteq F^c$. Hence $(PNV\beta int(A))^c \subseteq F^c$. Therefore $F \subseteq PNV\beta int(A)$.

Sufficiency: Let A be PNVOS of X and let $F \subseteq PNV\beta int(A)$ whenever F is PNVCS and $F \subseteq A$. Then $A^c \subseteq F^c$ and is PNVOS. By hypothesis $(PNV\beta int(A))^c \subseteq F^c$. which implies $PNV\beta cl(A^c) \subseteq F^c$. Therefore A^c is $PNV\beta CS$ in X . Hence A is $PNV\beta OS$ of X .

Corollary 4.4: A PNVS A of a PNVTS (X, τ) is $PNV\beta OS$ if and only if $F \subseteq PNVint(PNVcl(A))$ whenever F is PNVCS and $F \subseteq A$.

Proof: Necessity: Suppose A is $PNV\beta OS$ in X . Let F be PNVCS and $F \subseteq A$. Then F^c is PNVOS in X such that $A^c \subseteq F^c$. Since A^c is $PNV\beta CS$, we have $PNV\beta cl(A^c) \subseteq F^c$. Therefore $PNVcl(PNVint(A^c)) \subseteq F^c$. Hence $(PNVint(PNVcl(A)))^c \subseteq F^c$. This implies $F \subseteq PNVint(PNVcl(A))$.

Sufficiency: Let A be PNVOS of X and let $F \subseteq PNVint(PNVcl(A))$ whenever F is PNVCS and $F \subseteq A$. Then $A^c \subseteq F^c$ and F^c is PNVOS. By hypothesis, $(PNVint(PNVcl(A)))^c \subseteq F^c$. Hence, $PNVcl(PNVint(A^c)) \subseteq F^c$, which implies $PNV\beta cl(A^c) \subseteq F^c$. Hence A is a $PNV\beta OS$ of X .

Theorem 4.5: For a PNVS A , A is PNVOS and $PNV\beta CS$ in X if and only if A is a PNVROS in X .

Proof: Necessity: Let A be a PNVOS and $PNV\beta CS$ in X . Then $PNV\beta cl(A) \subseteq A$. This implies that $PNVcl(PNVint(A)) \subseteq A$. Since A is PNVOS, it is $PNV\beta OS$. Hence $A \subseteq PNVint(PNVcl(A))$. Therefore $A = PNVint(PNVcl(A))$ hence A is a PNVROS in X . Sufficiency: Let A be a PNVROS in X . Therefore $A = PNVint(PNVcl(A))$. Let $A \subseteq U$ and U is PNVOS in X . This implies $PNV\beta cl(A) \subseteq A$. Hence A is a $PNV\beta CS$ in X .

Pythagorean Neutrosophic Vague $T_{1/2}$ Space

Definition 5.1: A PNVTS (X, τ) is said to be Pythagorean Neutrosophic Vague $T_{1/2}$ space $(PNVT_{1/2})$ if every $PNV\beta CS$ in X is PNVCS in X .

Definition 5.2: A PNVTS (X, τ) is said to be Pythagorean Neutrosophic Vague $\beta T_{1/2}$ space $(PNV_{\beta T_{1/2}}S)$ if every $PNV\beta CS$ in X is PNVCS in X .

Definition 5.3: A PNVTS (X, τ) is said to be Pythagorean Neutrosophic Vague $g\beta T_{1/2}$ space $(PNV_{g\beta T_{1/2}})$ if every $PNV\beta CS$ in X is PNVCS in X .





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Definition 5.4: A PNVTS (X, τ) is said to be Pythagorean Neutrosophic Vague $_{g\beta}T_{\beta}$ Space $(PNV_{g\beta}T_{\beta})$ if every $PNVG\beta CS$ in X is $PNV\beta CS$ in X .

Theorem 5.1: Let (X, τ) be PNVTS and X is $PNV_{g\beta}T_{1/2}$ space, then

Any union of $PNVG\beta CS$ s is $PNVG\beta CS$.

Any intersection of $PNVG\beta OS$ s is $PNVG\beta OS$.

Proof: Let $\{A_i\}_{i \in J}$ is a collection of $PNVG\beta CS$ s in $PNV_{g\beta}T_{1/2}$ space (X, τ) . Therefore every $PNVG\beta CS$ is $PNVCS$; the union of $PNVCS$ is $PNVCS$. Hence the union of $PNVG\beta CS$ s is $PNVG\beta CS$ in X .

It can be proved by taking compliment of (1).

Theorem 5.2: Let PNVTS X is $PNV_{g\beta}T_{1/2}$ space if and only if $PNVG\beta O(X) = PNV\beta O(X)$.

Proof: Necessity: Let A be a $PNVG\beta OS$ in X , then A^c is $PNVG\beta CS$ in X . By hypothesis A^c is $PNV\beta CS$ in X . Therefore A is $PNV\beta OS$ in X . Hence $PNVG\beta O(X) = PNV\beta O(X)$.

Sufficiency: Let A be a $PNV\beta CS$ in X , then A^c is $PNVG\beta OS$ in X . By hypothesis A^c is $PNVG\beta OS$ in X . Therefore A is $PNV\beta CS$ in X . Hence X is $PNV_{g\beta}T_{1/2}$ space.

CONCLUSION

Thus in this paper we have given the Pythagorean Neutrosophic Vaguet and Pythagorean Neutrosophic Vague Topological Space. Along with those definitions, we have defined the generalized β closed sets in Pythagorean Neutrosophic Vague Topological Space and generalized β open sets in Pythagorean Neutrosophic Vague Topological Space.

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A Study of the Math Skills of VIII Std School Children in the Adopted Schools and their Progress in Resolving Math Problems

A. Francina Shalini^{1*} and M. Trinita Pricilla²

¹Assistant Professors, Department of Mathematics, Nirmala College for Women (Autonomous), Red Fields, Coimbatore-18, Tamil Nadu, India.

²PG and Research Department of Mathematics, Nirmala College for Women (Autonomous), Red Fields, Coimbatore-18, Tamil Nadu, India.

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*Address for Correspondence

A. Francina Shalini

Assistant Professor,

Department of Mathematics,

Nirmala College for Women (Autonomous),

Red Fields, Coimbatore-18, Tamil Nadu, India

E. Mail : francshalu@gmail.com



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ABSTRACT

Mathematics is the queen of science. It is used by everyone in their day today life. To foster the school children to score high marks in Mathematics focusing on VIII standard children in three adopted schools. All these reasons made mathematics education as an inevitable part from primary level itself. But because of critical thinking this subject seems to be a row subject to majority of students. Students with financially strong background will seek help from outside to complete their doubts. But students with lower financial backgrounds kept aside from the main streams of any other additional supports with these reasons. This project concentrated towards this marginalized students and put forward a plan to make them also come forward to the main stream.

Keywords: Questionnaire, Work Book, Model Making, Problem Solving, Exit Test

INTRODUCTION

The world we live today is coming back to its normal position after the pandemic and people in all walks of life and in every field have started to resume their work. So, we are back to square one but the situation is different in education field. In today's scenario after the pandemic all school children as well College students lag in studies. When students hear the word Mathematics, it scares most of them and after the lockdown students have lost the interest in the subject since classes were online and mostly many of our children didn't make the proper use of online

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classes during the Pandemic for two solid years. But it is now our prime duty to change this attitude among children. In 2014, Mehraj Ahmad Bhat [5] gave the Effect of Problem Solving Ability on the Achievement in Mathematics of High School Students. In 2019, Monica Ontaneda [7], introduced a design to Implement Backward students to improve Academic Performance in EFL Classes. In 2019, Charles Y. C. Yeh, Hercy. N. H. Cheng, Zhi-Hong Chen, Calvin C. Y. Liao and Tak-Wai Chan [2] published a paper on Enhancing achievement and interest in mathematics learning through Math-Island, Yeh et al. Research and Practice in Technology Enhanced Learning. In 2019, Yeh, Charles Y. C., Cheng, Hercy N. H., Chen, Zhi-Hong; Liao, Calvin C. Y., Chan, Tak-Wai [12] introduced a game based learning technique called Math- Island and after its implement results were fabulous and fantastic! In 2021, Gwo-Jen Hwang and Yun-Fang Tu [3] gave conduct a bibliometric mapping analysis and systematic review to explore the role and research trends of Artificial Intelligence in mathematics education. For this they searched for the relevant articles published in the quality journals indexed by the Social Sciences Citation Index (SSCI) from the Web of Science (WOS) database. In 2019, Wolfgang Leister, Ingvar Tjøstheim, Göran Joryd, Jan Alfred Andersson and Håvard Heggelund [11] discussed the concept off Strengthening Engagement in Science Understanding with Learning Trails. In 2022, Neelam Kumari [8] discussed self-esteem, academic achievement and vocational aspirations as a predictor of problem-solving competence among senior secondary school's students. In 2019, Annisa Sulistyarningsih, Suparman, Elyya Rakhmawati [1] mentioned Mathematics Module Development Design Based On PBL To Improve Mathematics Problem-Solving Ability. In 2022, Ishfaq Ahmad Bhat, Anisa Akhter, Sameer Babu. M, Rukhsana Kousar [4] discussed the construction and validation of Problem-Solving Ability Test. In 2022, Puvanah Ganesen, Sharifah Osman, Mohd Salleh Abu, Jeya Amantha Kumar [9] gave The Relationship Between Learning Styles and Achievement of Solving Algebraic Problems Among Lower Secondary School Students. In 2022, Mohamad Ariffin Abu Bakar, Norulhuda Ismail [6] analyzed the express student's problem solving skills from metacognitive skills perspective on effective mathematics learning. Educated parents knew the importance of understanding the concept of doing Mathematics and thus help their wards in developing the math skill. We need now to concentrate on children studying in Government schools were most of their parents don't know about the importance of education. So in this project we have proposed to concentrate on the school children doing VIII Std in the adopted Schools of our college by helping them to master the Math skills.

Objectives

In this paper, 4 main objectives are framed.

- (1) First to instill the school children a liking for Mathematics.
- (2) Second to eradicate the fear of the subject.
- (3) Third is to teach the students the techniques to solve the problems.
- (4) Fourth is to motivate the students to acquire mathematical skills.
- (5) Fifth and final is to promote in creating short cuts to work out problems

In first step a filtration has done to sort out the students for the project. In each stage their improvement and results are monitored closely and it is recorded accurately. In the final stage a comparison has done with the main stream students. Also this selected students initial and final results are scrutinized closely. This will enable to analyze the existing problems in a clear cut manner.

METHODOLOGY

The methodology used is given as follows: This newly formed criteria is focusing towards to 8th standard children. First have to conduct an entry level test to sort out the low caliber students. In next level have to concentrate on these children. For that, in next stage 5 PG Students and 2 Staff will go to the school on Friday afternoon for 6 months consecutively. After finishing second stage, in third stage a work book will be provided to the students for working out problems. Also, Formula Book will be issued. Two weeks once students will be given tests and their improvement will be analyzed closely. At the end of 6 months students will be given questionnaire and their skill in





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solving Mathematics will be tested. Separate notebooks will be issued for the students selected for this project will be maintained regularly. Then Students will be trained to solve the problems.

Work Plan and Approximate Budget are given as a table below:

Work Plan

WORK	MONTHS					
	I	II	III	IV	V	VI
Composing a Questionnaire for Entry Level Test	■					
Problem Solving		■				
Model Making			■			
Problem Solving & Distributing Formulae Book				■		
Maths Workbook					■	
Exit Test and Summary of the Project						■

Budget

Particulars	Amount (Rs)
5 PG students – TA	10000
Model- Making Charges	5000
Stationery	2000
Technical Support	1000
Questionnaires	1000
Printing Charges (Formulae Book)	1000
Total	20,000

ANALYZATION AND RESULTS

We have selected 50 students after a tight filtration. Their marks level is as shown below:

Student Number	Weekend 1 Test Result	Weekend 2 Test Result	Weekend 3 Test Result	Weekend 4 Test Result	Weekend 5 Test Result	Weekend 6 Test Result
1	0.10	0.3	0.45	0.56	0.78	0.83
2	0.05	0.2	0.3	0.42	0.62	0.7
3	0.05	0.34	0.47	0.32	0.22	0.53
4	0.00	0.4	0.5	0.67	0.82	0.9
5	0.25	0.24	0.34	0.36	0.47	0.75
6	0.50	0.35	0.67	0.71	0.79	0.81
7	0.25	0.31	0.36	0.42	0.52	0.67
8	0.15	0.4	0.5	0.6	0.7	0.78
9	0.20	0.25	0.35	0.49	0.54	0.69
10	0.10	0.67	0.73	0.78	0.8	0.92
11	0.05	0.32	0.54	0.56	0.61	0.79
12	0.5	0.62	0.73	0.75	0.45	0.8




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13	0.25	0.32	0.46	0.52	0.59	0.65
14	0.37	0.38	0.42	0.46	0.59	0.67
15	0.25	0.35	0.38	0.45	0.56	0.69
16	0.4	0.45	0.52	0.64	0.75	0.94
17	0.1	0.32	0.31	0.36	0.47	0.83
18	0.23	0.22	0.21	0.35	0.50	0.84
19	0.15	0.13	0.24	0.37	0.64	0.92
20	0.24	0.14	0.35	0.39	0.69	0.96
21	0.115	0.16	0.37	0.4	0.7	0.78
22	0.13	0.17	0.27	0.49	0.5	0.89
23	0.16	0.18	0.34	0.39	0.6	0.92
24	0.18	0.19	0.38	0.6	0.71	0.82
25	0.19	0.20	0.42	0.7	0.8	0.9
26	0.20	0.21	0.32	0.8	0.9	0.92
27	0.21	0.30	0.33	0.7	0.89	0.98
28	0.2	0.3	0.45	0.55	0.65	0.78
29	0.3	0.25	0.35	0.47	0.78	0.79
30	0.04	0.35	0.37	0.54	0.79	0.8
31	0.23	0.25	0.34	0.023	0.23	0.34
32	0.21	0.24	0.37	0.045	0.23	0.32
33	0.12	0.23	0.38	0.3	0.32	0.34
34	0.05	0.22	0.39	0.5	0.52	0.67
35	0.07	0.125	0.41	0.6	0.59	0.75
36	0.3	0.12	0.23	0.4	0.72	0.824
37	0.09	0.04	0.26	0.5	0.8	0.93
38	0.12	0.03	0.25	0.8	0.82	0.9
39	0.13	0.04	0.123	0.5	0.6	0.789
40	0.14	0.05	0.023	0.567	0.75	0.74
41	0.15	0.06	0.045	0.687	0.81	0.812
42	0.124	0.23	0.3	0.47	0.26	0.74
43	0.12	0.3	0.35	0.53	0.45	0.65
44	0.09	0.5	0.52	0.64	0.73	0.64
45	0.05	0.4	0.52	0.71	0.7	0.79
46	0.02	0.6	0.62	0.79	0.8	0.85
47	0.01	0.3	0.45	0.65	0.85	0.87
48	0.34	0.4	0.5	0.68	0.75	0.89
49	0.5	0.3	0.54	0.69	0.76	0.92
50	0.45	0.4	0.6	0.70	0.79	0.82





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Every weekend we have conducted a test and continuous 6 weeks systematical observations are recorded in the above table. By a vigilant observation it is clear that majority of students got improved after each session. Only a few of students showed an irregular pattern of outputs. For that other reasons like family atmosphere, IQ level etc should be analysed again and have to take a proper other remedial measure.

Improvement Percentage

SL No (Students)	Depending on Weekend 1	Depending on Weekend 2	Depending on Weekend 3	Average Improvement Percentage
1	73	18	84	58
2	13	25	13	17
3	96	56	13	55
4	90	22	80	64
5	20	21	12	18
6	62	13	21	32
7	17	12	86	38
8	42	95	56	64
9	42	18	14	25
10	82	37	26	48
11	15	15	46	25
12	60	29	9	33
13	16	10	41	22
14	81	76	60	72
15	18	97	82	66
16	14	11	81	35
17	73	16	17	35
18	27	28	30	28
19	51	61	28	47
20	30	59	17	35
21	58	39	11	36
22	59	42	23	41
23	48	41	17	35
24	36	33	12	27
25	37	35	11	28
26	36	34	19	30
27	37	23	20	27
28	29	16	73	39
29	16	22	13	17
30	19	13	12	15
31	48	36	0	28
32	52	33	-13.5	24
33	18	48	-10.5	18.5
34	12	21	72	35
35	97	50	83	77
36	18	59	26	34
37	93	22	26	47
38	65	29	13	36
39	51	19	54	41





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40	43	14	32	30
41	44	13	17	25
42	50	22	15	29
43	44	12	86	47
44	61	28	23	37
45	15	98	52	55
46	42	42	37	40
47	86	19	93	66
48	16	12	78	35
49	84	21	70	58
50	82	11	37	43

Improvement percentage level of the 50 students are calculated above. Most of the students showed improvement rate above 40. It is satisfactory, since a tight filtration has done in the starting stage itself and tried to improve marginalized children.

CONCLUSION

The methodology used to teach will definitely enable the students to eradicate the fear and arouse interest to study maths. Continuous practice with workbook and formulae book will instil in them the curiosity to work hard. Understanding of concepts at lower level classes will ensure students to score high in higher secondary classes. Problem solving and model making exercises will be a tool to progress a liking towards maths subject. This project proposal for VIII standard children of the adopted schools will serve as the best for improvisation of the primary level to higher level of education.

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Big Data: Privacy and Security

Trishala.M^{1*} and Janani Nethra.R²

¹Assistant Professor, Department of Psychology (PG), St. Francis De Sales College, Electronics City, Bangalore-100,Karnataka,India.

²Krupanidhi Degree College of Commerce and Management, Bangalore, Karnataka, India.

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*Address for Correspondence

Trishala. M

Assistant Professor,
Department of Psychology (PG),
St. Francis De Sales College, Electronics City,
Bangalore-100,Karnataka,India.
E. Mail : trishalam@sfscollge.in



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ABSTRACT

The pattern of unstructured, semi structured and structured data which is collected by organizations for the purpose of machine learning and analytical purposes is termed as Big data. These collected data is utilised to enhance the operations, make the customer service effective, to personalize the marketing tactics and lastly to improve revenue and make profits. There are many utilities of big data for the organizations and the people as such. But it is also accompanied with certain risks. The main purpose of this paper is to understand the awareness people have for big data. Along with it, an effort is made to grasp the accompanying privacy and security aspects associated with big data. It also attempts to shed light on the change big data has brought in the society.

Keywords: Awareness, Big Data, Privacy, Security, Risks

INTRODUCTION

Big data is an emerging concept that found is spotlight in recent decade as the use of smart phone, computer, desktops has increased data are being accumulated to an extent where is difficult to store and manage without professional. Big Data comprises of structured and unstructured data which is in greater in size and then through certain organizations it is flooded to data servers on a day-to-day basis in terms of billions of bytes [13, 14]. The term big data [15, 16] is defined as *“a new generation of technologies and architectures, designed to economically separate value from very large volumes of a wide variety of data, by enabling high-velocity capture, discovery and analysis”*

Big data is used as tool to collect large or complex data (information)store and access to make business decisions. Although data collection, accessing data has been around many years they were small data which were easy to store and analyse. Big data was introduced in around 1990's and 2000's but gained its popularity during 2005 when the



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source for information got wider through smart phones computer. Never seen before raw unstructured data that discovered changing trends, business operation, consumers behaviour, social media, and so on. The purpose for collection of large data is to give enough data for the organisation to make effective and efficient business decisions. The flaws or negations of big data is predominantly about the identity, power, and transparency [11].

The V's in big data

The major properties of big data can be clearly understood by the following V's. these V's provide a complete explanation of big data [18]:

1. Volume: Amount of information that is available.
2. Variability: Data has to change from time to time which give vibration from available data which company can depend upon to take decision.
3. Velocity: At what speed company obtain this data, store, manage it according to their need.
4. Value: outcome generated from analysis of data represent the value of the data. Since there is verity of data available it is important to use the necessary information to create value.
5. Variety: Data are generated from various sources they can be unstructured, structured or semi structured
6. Veracity: Since gathered information large accuracy of the data plays important role for analysing the data. Insignificant or misleading information can the outcome of the analysis.

Privacy and Security

Privacy is the border line drawn where the data should not be used without users' permission. User can decide what information can be shared and what not by setting changes in privacy policy. But one of the major or a serious privacy issue in big data is the problem in identification of personal information while transmitting the data of internet [17]. Whereas security technical tool that set up to protect information from falling into wrong hands, getting hacked, stolen data misuse for profit [12]. Big data is storage of enamours data where data are unstructured and undefined data protecting users' information is an issue in the recent days. There should be regulation for usage of data which can restrict from using personal, sensitive information. This paper focuses on people's opinion how they feel about sharing their information. There are certain protection techniques suggested for protecting the data of people like file encryption, key management, data logging, double masking, access control and others [9] [10].

REVIEW OF LITERATURE

CSA (Cloud Security Alliance) [19] mentioned that various tools and technologies are being developed for handling the big volumes of data, but yet they are not sufficient for protecting the privacy and security of these data. They also mentioned that there is a constant breach of these security accidentally as well as intentionally. The CSA released a list of top 10 privacy and security challenges of big data. Porambage *et al.* , 2016 [17] in their study mentioned that privacy refers to the privilege of a person to have control on the manner in which their personal information can be collected and utilized. They also mentioned that information privacy is the ability a person or a group has in controlling and stopping the information spread of theirs which they don't want to. But a major privacy challenge faced is the identification and segregation of personal information while transmission of information in internet.

METHODOLOGY

The research paper was analysed by using a quantitative method. Survey method is used for data collection. Google forms were created and were sent to adults in the age group of 18 to 24years. A total of 50 responses were collected online. In 50, a total of 24 were male and 26 were female. The sample included adults with a minimum education of degree.



**Trishala and Janani Nethra****Objectives**

1. To gauge the awareness level of big data among adults.
2. To understand effect of big data's interference in individual's life
3. To recognize the privacy concerns due to big data, perceived by adults.

Data Analysis

A questionnaire was formed which consisted of various statements regarding the knowledge adults have about big data. Questions included the purpose of big data, monitoring body for big data, the privacy concerns, utility value and the developments big data is bringing to the society. Based on the objectives of this study questions were formed. Every question was made mandatory to be answered. Each question is analyzed individually to understand the awareness level and privacy-security concerns associated with the advent of big data in society. Also, an overall analysis is done to know about the privacy and security concerns of big data, as perceived by adults.

The Table no 1 represents how much of the population is aware of the concept big data. Maximum (36) of the population is aware of the concepts, where as rest of the population chose different option, which means that majority are aware of what big data means. Few people have less knowledge on what is big data and some are even unaware of fact that data is being collected [1]. Concept was later explained for those who were not aware of big data. The Table no 9 shows what is the purpose of big data and why it is used. Majority (41) of the sample has selected "all the above" option. Where as nine sample chose different option. According to these results, it is understood that majority of the sample understands the purpose of big data[3].

In table no 3 when population was asked if big data can bring development in technical field, a maximum of population (35) strongly agreed to the statement. This indicates that sample believed that big data is extremely needed and how it can contribute in developing and building the technical field. Whereas 05 of the population were neutral and 10 respondents of the sample disagreed with the statement. The Table no 2 is about the samples opinion on getting customised information. In here around 30 respondents from the sample agreed and strongly agreed with the statement and 11 respondents of the population disagreed with the statement. Based on this answer, it can be interpreted that majority of the sample believed that getting customized information according to their needs is in a way matter of privacy concern. But it should not be neglected that this customized preference is also making life easier. For other half of the population, getting customised preference is not making much of a difference.

The Table no 4 shows the population's opinion for site or link asking for privacy policy while accessing the link. 26 respondents believed that those links collect data from searches done through the device and give similar suggestion for future. While 24 respondents opined that information is collected things that they collect information for multipurpose. It can be interpreted that some believe the information collected can be used for good or for bad (4).

The Table no 5 is about big data bringing better development for the world by being a technical tool. In this question around 23 respondents felt neutral about the statement. They opined that it can bring in a good development or may not as well. Whereas 14 respondents strongly agreed to the statement that big data is a competent tool to bring in immense development for the world. While 13 respondents did not agree to the statement. Social networking sites usually give feeds based on likes and dislikes updated by a person. The Table no 7 is about how a normal online text conversation between two people is also collected by big data and based on that feeds are given in various networking sites. For this statement 38 of the respondents feel that they are being spied and their personal conversation is also tracked. They were of the opinion that their conversation is being used by third party, unaware of for what is it being used. While 6 respondents feel that this feature should not be developed and other 6 opined that this is making convenient and will also help in online search.

The Table no 6 shows the samples opinion on giving complete access to Google. A majority of the respondents agree to the statement that, it is useful if a complete access is given to Google as they help in backing up all data. This makes a person less susceptible towards losing data in the form of photos, documents, information, messages,



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contacts, and others. Whereas the other 16 respondents are neutral regarding this statement. It seems they are unable to decide if a complete access should be given or not, and if given will it be dangerous or no. So, a few were undecided. There is no standardized state or federal any international law which is governing the big data. The Table no 8 is about to opinion of people whether they prefer for the big data to be governed by certain rules and law for big data as it stores and uses certain personal, sensitive, private, and crucial information of a person which can be violating their personal space. For this, 33 respondents strongly agreed responded that a governing body is of utmost necessity for big data. While 11 respondents were neutral regarding this statement.

CONCLUSION

The above survey was conducted to know the opinion of people regarding the privacy and security issues of big data. It was understood that most of the people knew about the concept of big data, indicating technical awareness among people is present. Coming to the privacy and security issues, it should be noted that not having a governing body for big usage and manage of information is a disadvantage. As only a few governing or regulatory authorities are being made to protect the rights of people's privacy(5). There exists certain important security and privacy concerns associated with big data (6) (7). But the advantages of big data are numerous. This paper tried to focus on how much general public are aware of this big data function and on the extent to which people have knowledge regarding the privacy and security concerns (8). Through this survey it is understood that people are informed about the concept of big data and on how customized information is being sent to individuals, the extent of access, tracking being done is known by general public. Though some have raised queries while some respondents seemed to be okay with providing persona information too. As this will make their search easier. Hence, big data is a huge amount of data which will enrich and develop the technical field with a certain amount of disadvantages and advantages. Through this paper it can understood that few people are hesitant in sharing the personal information or getting personalized updates, while others are easy going with this sharing.

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Table 1: Question on what is Big Data?

Options	Response
Big data focuses only on collection data in particular field. (Medical field, management, etc.)	04
Big data is used to develop machine learning and artificial intelligence.	10
Big data is collection data for managing an effectively organization	05
Big data means collection of data from every available source that surface around internet.	36
Total	50

Table 2: Question on purpose of Big Data?

Options	Response
To gather all the information to a common centre.	01
To utilise the data to give customized preference for consumers.	08
Through big data many fields (Medical, banking, technical companies) use to grow and develop.	0
All the above.	41
Total	50

Table 3: Question on, with the help of big data there is huge development in technical field.

Options	Response
Strongly agree	35
Agree	
Neutral	05
Disagree	10
Strongly Disagree	
Total	50

Table 4: Question on, Online information is getting way more customized, do you think it is invading your privacy?

Options	Response
Strongly agree	18
Agree	14
Neutral	02
Disagree	7
Strongly Disagree	9
Total	50





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Table 5: Question on, Every site or link you access ask for privacy policy. Why would that be?

Options	Response
To protect their site from our device.	
To get access to information on your device and use it.	24
To collect data from your device to give you information that matches your preference.	26
It's just a privacy policy doesn't have any meaning to it.	
Total	50

Table 6: Question on, In time, with proper development and usage of data, big data can bring huge development for the world.

Options	Response
Strongly agree	14
Agree	
Neutral	23
Disagree	13
Strongly Disagree	
Total	50

Table 7: Question on, You have an online conversation with your friend about going on a trip or watching a movie this weekend, after a while Instagram or Facebook gives you similar suggestion feeds in your account. How do you feel about this?

Options	Response
It is convenient. We don't have to search online.	6
Feels like someone is spying on you.	38
This kind of features should not be developed.	6
Total	50

Table 8: Question on, Is it useful giving google complete access to your device and information.

Options	Response
Strongly agree	
Agree	34
Neutral	16
Disagree	
Strongly Disagree	
Total	50

Table 9: Question on, Do you think there should be certain rules and regulation to control and monitor big data from using information.

Options	Response
Strongly agree	33
Agree	06
Neutral	11
Disagree	
Strongly Disagree	
Total	50





Traffic Network and Accident Analysis in Coimbatore Corporation, Tamil Nadu

Vanangamudi.K^{1*} and Jyothirmayi.P²

¹Research Scholar, Department of Geography, Nirmala College for Women, Coimbatore, Tamil Nadu, India

² Head and Assistant Professor, Department of Geography, Nirmala College for Women, Coimbatore, Tamil Nadu, India

Received: 15 Jan 2023

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*Address for Correspondence

K.Vanangamudi

Research Scholar,

Department of Geography,

Nirmala College for Women,

Coimbatore, Tamil Nadu, India

E. Mail: vanangamudigeo2020@gmail.com



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ABSTRACT

The emergence of traffic and subsequently traffic congestion in urban road networks are increasing worldwide with the growing number of vehicles, which results in excess delays, and reduced safety. The aim of this paper is to use many (network analyst, Overlay Analysis) to evaluate the spots of traffic congestions during working hours and day. The study area selected is Coimbatore in the state of Tamil Nadu. The results are utilized in evaluating congestion spots and diverting the traffic to newly suggested roads to reduce the congestion.

Keywords: Traffic, accidents, congestion, transport network

INTRODUCTION

In today's world, the number of vehicles in the road is increasing day by day. While this shows a good scale of development, it also means that there are higher chances of road accidents. The critical problem that an urban area faces is the traffic congestion which occurs when the demand exceeds the capacity. The main cause of congestion is oversaturation and the situation worsens if an incident occurs. Most of the road users are quite well aware of the general rules and safety measures while using roads but it is only the laxity on part of road users, which cause accidents and crashes. Main cause of accidents and crashes are due to human errors. General congestion management measures include a wide range of data collection, system monitoring, identifying and evaluating transportation control measures. One must always wear seat belts, stick to the speed limit, wear helmets while riding





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bikes etc., which will reduce the road accidents. The accident data for the year 2015 to 2020 is analyzed by the current study. The objectives of this study are to determine the zones prone to traffic congestion, factors that influences traffic congestion and to identify the accident prone zones.

Study Area

The study area geographically extends from 10° 55'04"N to 11° 05'11"N latitude and between 76° 49'16"E to 77° 06'46"E longitude. For administrative purposes, the city is divided into five zones, namely north zone, east zone, west zone, south zone and central zone. The five zones are classified into 100 wards, each zone comprising 20 wards of Coimbatore Corporation (Figure1). The Corporation has its headquarters in Coimbatore. Coimbatore Corporation has a gradual slope from West to East. The slope level varies generally from 390 to 440m above mean sea level. It is surrounded by the Western Ghats mountain range on the west and north, with reserve forests and the Nilgiri Biosphere reserve on the northern side. The city is traversed in the middle by the river Noyyal rising from the Vellingiri hills on the West. The city has a tropical wet and dry climate with the wet season from October to December due to the north-east monsoon. Coimbatore has vast deposition of Black cotton soil. But the black cotton soil extends only to shallow depths and it is followed by good stratum of soils. Urbanization and industrialization have brought up a rise in population.

MATERIALS AND METHODS

The accident data for the years 2015-2020 for Coimbatore city were collected from the police department. The accidents were classified into three types namely (i) accidents without injury (safe), (ii) accidents that caused injury and (iii) accidents that resulted in death. The details of the accidents are given in. From the Table, it can be seen that 90% of the accidents are caused by motor cycle, 60% of accidents are caused by motor car, 45% of accidents are caused by moped and 30% of accidents are caused by scooter. By limiting the speed of moped and scooter, most of the accidents are happened motor cycle and motor car by through ring roads, the number of accidents can be reduced.

Roads and Signals of Coimbatore Corporation

As Coimbatore City is a Metropolitan City it is widely connected with road networks. Roads such as National Highways, State Highways and local roads, metalled and unmetalled roads and mud roads are also present in the study area. The Coimbatore city has fairly better transport infrastructure, though road infrastructures are not well maintained and developed according to the growing needs of transport. Traffic congestion is a major problem in the city. A comprehensive transport development plan is made part of Coimbatore Master Plan as part to ease many of the traffic problems. The city and metropolitan area are served by major arterial roads that run either in an east-west or north-south direction. Avinashi road is one of the city's most important arterial roads. It traverses most of central and east Coimbatore, the road runs in a west to east direction. Other arterials roads include Trichy Road (Central to Southeast), Mettupalayam Road (North to South), Sathy Road (South to North East), Palakkad Road (East to West), Pollachi Road (North to South) and Thadagam Road (east to west). Maruthamalai Road starts at the intersection of Lawley Road Junction and connects Vadavalli and extends up to Maruthamalai foothills. Other roads include 100 feet road, Bharatiyar Road, Dr.Nanjappa Road, Balasundarum Road, Cross-cut Road in Gandhipuram Area, Diwhan Bahadur Road (DB Road), TV Swamy Road, Brooke Bond Road in RS Puram Areas, Race Course Road etc. Six major National Highways radiating outward from Coimbatore, NH47 (Avinashi Road) towards Salem leading to Bangalore and Chennai, NH47 (Pallakad Road) towards Trichur, Kochi and Trivandram, NH67 (Trichy Road) towards Karur, Trichy, Thanjavur and Nagapattinam, NH67 (Mettupalayam Road) towards Ooty and Gudalur leading to Karnataka and Kerala, NH209 (Sathy Road) towards Sathyamangalam, Chamrajnagar and Bangalore and NH209 (Pollachi Road) towards Palani and Dindigul. In Coimbatore Corporation signals are analyzed for the present study. The study area has a total number of 56 signals of which only 3 main signals have been taken for the present study. That is Women's Polytechnique College Signal, Anna Statue Signal and Sungam Signal.





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CONCLUSION AND SUGGESTIONS

Effective management of traffic flow will ensure safe and secured the traffic movement. The population of Coimbatore is increasing due to the presence of major educational and industrial institutions. As a result recently the population in the city rose. Existing city road network is not adequate to the needs of the increasing traffic volume. There are so many road intersections in Coimbatore city road network. There are no separate lanes for slow moving vehicles as due to which the problems like traffic congestion delay and road accidents occur at the major road intersection in Coimbatore city. The accident locations and suggested some possible alternative or corrective measures were given to improve the transportation system in these locations, from which the decision maker can select suitable measure for the location.

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Table-1 Details of vehicles involved in accidents

Year	Motor cycle	Motor car	Jeep	scooter	Moped
2015-2016	9,05,038	1,59,940	429	3,08,178	1,95,892
2016-2017	10,74,046	1,83,475	197	3,75,415	13,706
2017-2018	10,35,625	1,99,065	182	4,51,530	1,11,753
2018-2019	13,92,290	1,96,501	67	2,52,880	1,14,845
2019-2020	13,93,041	1,81,401	0	82,937	96,190





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Table 2: Number of Vehicles crossed and the vehicle violating the traffic rules

S.No	Vehicles	No. of vehicles following traffic rules signals	No. of vehicles violating the traffic rules	Percentage
1.	Car	593933	20800	3.50
2.	Two-wheeler	685408	175981	25.67
3.	lorry	14162	1334	9.41
4.	Auto	126754	12981	10.24
5.	Bus	40735	5050	12.39

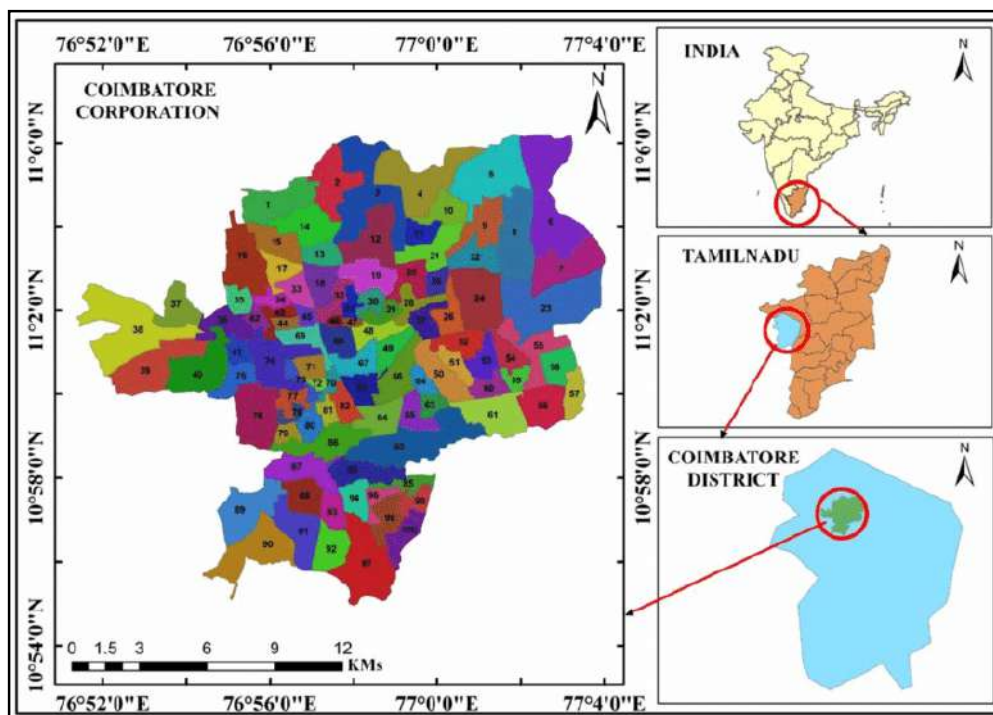


Figure 1: Study Area





On Generalized Pre Connectedness in Fermatean Neutrosophic Hypersoft Topological Space

P. Reena Joice^{1*} and M. Trinita Pricilla²

¹Research Scholar, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Assistant Professor, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

P. Reena Joice

Research Scholar,
Department of Mathematics,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.
E. Mail : reenajoice98@gmail.com



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ABSTRACT

Intent of this paper is to introduce and investigate some of the several connected spaces in FNH topological space including FNH C_5 -connected space, FNH generalized connected space and FNH generalized pre connected space. Spaces such as FNH generalized pre- super connected space, FNH generalized pre- extremely disconnected space are also introduced. Additionally we discover a number of properties and characterizations regarding connectedness in these areas.

Keywords: FNH C_5 -connected space, FNHG-connected space and FNHG- C_5 -connected space and FNHG- C_5 super connected space.

INTRODUCTION

Smarandache[10] in 1995 initiated the concept of neutrosophic sets. Each element of a neutrosophic set has three membership degrees including a truth membership degree, an indeterminacy membership degree, and a falsity membership degree which are within the real standard or non standard unit interval $]-0, 1+[$. Undergoing this neutrosophic conditions, numerous researchers have performed on their extension and proposed many results and application. Molodtsov[4] introduced the concept of soft theory as a new outlook dealt with uncertainty and recently there is an ascent rise of soft theory beside application in different fields. Smarandache[9] initiated generalized hypersoft set from soft set by transmuting into multiargument function from argument function. He also gave many outcome results from hypersoft sets. Salami and Alblowi[7] proposed neutrosophic topological spaces





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and further notions such as semiclosed sets, connectedness and generalized closed sets[3] were also advanced . Fuzzy hypersoft set idea was put into fuzzy topological spaces and Ajay and Charisma[1] exposed fuzzy hypersoft topological spaces. Then the concept of neutrosophic hypersoft topological spaces was presented by Ajay and Charisma[1]. Fermatean fuzzy set was proposed by Tapan Senapati and Ronald R. Yager[8] in 2020 by comapring with pythagorean fuzzy sets and intuitionistic fuzzy sets. By the elongation of Pythagorean neutrosophic set C.A.C sweety and R. Jansi[2] defined Fermatean neutrosophic set. In recent times P.Reena Joice and M. Trinita Pricilla [6] has evolved an advanced outcome of Fermatean neutrosophic hypersoft topological spaces.

Preliminaries

Definition 2.1[6]

Let \mathbb{U} be the universal set and $P(\mathbb{U})$ be the power set of \mathbb{U} . Consider s^1, s^2, \dots, s^n for $n \geq 1$ be n well defined attributes, whose corresponding attribute values are respectively the set S^1, S^2, \dots, S^n with $S^i \cap S^j = \emptyset$, for $i \neq j$ and $i, j \in \{1, 2, \dots, n\}$ and their relation $S^1 \times S^2 \times \dots \times S^n = \omega$, then the pair (R, ω) is said to be Fermatean Neutrosophic Hypersoft (FNH in short) set over \mathbb{U} where, $R: S^1 \times S^2 \times \dots \times S^n \rightarrow P(\mathbb{U})$ and

$$R(S^1 \times S^2 \times \dots \times S^n) = \{(x, \mu_A(R(\omega)), \nu_A(R(\omega)), \delta_A(R(\omega))), x \in \mathbb{U}\}$$

where μ is the membership value, ν is the indeterminate value and δ is the non-membership value such that $\mu, \nu, \delta: \mathbb{U} \rightarrow [0, 1]$,

$$0 \leq (\mu_A(R(\omega)))^3 + (\delta_A(R(\omega)))^3 \leq 1 \text{ and } 0 \leq (\nu_A(R(\omega)))^3 \leq 1. \text{ Then } 0 \leq (\mu_A(R(\omega)))^3 + (\nu_A(R(\omega)))^3 + (\delta_A(R(\omega)))^3 \leq 2$$

Definition 2.2[6]

Let (\mathcal{M}, \aleph) and $(\mathcal{R}, \mathcal{S})$ be two Fermatean neutrosophic hypersoft set of the form $(\mathcal{M}, \aleph) = \{(x, \mu_A(R(\omega)), \nu_A(R(\omega)), \delta_A(R(\omega))), x \in \mathbb{U}\}$ and $(\mathcal{R}, \mathcal{S}) = \{(x, \mu_B(R(\omega)), \nu_B(R(\omega)), \delta_B(R(\omega))), x \in \mathbb{U}\}$. Then

- $(\mathcal{M}, \aleph) \subseteq (\mathcal{R}, \mathcal{S})$ if and only if $\mu_A(R(\omega)) \leq \mu_B(R(\omega)), \nu_A(R(\omega)) \geq \nu_B(R(\omega)), \delta_A(R(\omega)) \geq \delta_B(R(\omega))$.
- $(\mathcal{M}, \aleph) = (\mathcal{R}, \mathcal{S})$ if and only if $(\mathcal{M}, \aleph) \subseteq (\mathcal{R}, \mathcal{S})$ and $(\mathcal{R}, \mathcal{S}) \subseteq (\mathcal{M}, \aleph)$
- $(\mathcal{M}, \aleph) \setminus (\mathcal{R}, \mathcal{S}) = \{(x, \delta_A(R(\omega)), 1 - \nu_A(R(\omega)), \mu_A(R(\omega))), x \in \mathbb{U}\}$
- $(\mathcal{M}, \aleph) \cup (\mathcal{R}, \mathcal{S})$ is defined as

$$\mu_A((\mathcal{M}, \aleph) \cup (\mathcal{R}, \mathcal{S})) = \begin{cases} \mu_{A\mathcal{M}(R(\omega))}(x), & \text{if } R(\omega) \in \aleph - \mathcal{S} \\ \mu_{A\mathcal{R}(R(\omega))}(x), & \text{if } R(\omega) \in \mathcal{S} - \aleph \\ \max\{\mu_{A\mathcal{M}(R(\omega))}(x), \mu_{A\mathcal{R}(R(\omega))}(x)\}, & \text{if } R(\omega) \in \aleph \cap \mathcal{S} \end{cases}$$

$$\nu_A((\mathcal{M}, \aleph) \cup (\mathcal{R}, \mathcal{S})) = \begin{cases} \nu_{A\mathcal{M}(R(\omega))}(x), & \text{if } R(\omega) \in \aleph - \mathcal{S} \\ \nu_{A\mathcal{R}(R(\omega))}(x), & \text{if } R(\omega) \in \mathcal{S} - \aleph \\ \min\{\nu_{A\mathcal{M}(R(\omega))}(x), \nu_{A\mathcal{R}(R(\omega))}(x)\}, & \text{if } R(\omega) \in \aleph \cap \mathcal{S} \end{cases}$$

$$\delta_A((\mathcal{M}, \aleph) \cup (\mathcal{R}, \mathcal{S})) = \begin{cases} \delta_{A\mathcal{M}(R(\omega))}(x), & \text{if } R(\omega) \in \aleph - \mathcal{S} \\ \delta_{A\mathcal{R}(R(\omega))}(x), & \text{if } R(\omega) \in \mathcal{S} - \aleph \\ \min\{\delta_{A\mathcal{M}(R(\omega))}(x), \delta_{A\mathcal{R}(R(\omega))}(x)\}, & \text{if } R(\omega) \in \aleph \cap \mathcal{S} \end{cases}$$

- $(\mathcal{M}, \aleph) \cap (\mathcal{R}, \mathcal{S})$ is defined as

$$\mu_A(\mathcal{M}, \aleph) \cap (\mathcal{R}, \mathcal{S}) = \begin{cases} \mu_{A\mathcal{M}(R(\omega))}(x), & \text{if } R(\omega) \in \aleph - \mathcal{S} \\ \mu_{A\mathcal{R}(R(\omega))}(x), & \text{if } R(\omega) \in \mathcal{S} - \aleph \\ \min\{\mu_{A\mathcal{M}(R(\omega))}(x), \mu_{A\mathcal{R}(R(\omega))}(x)\}, & \text{if } R(\omega) \in \aleph \cap \mathcal{S} \end{cases}$$





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$$v_A((\mathcal{M}, \mathfrak{K}) \cap (\mathcal{R}, \mathcal{S})) = \begin{cases} v_{A\mathcal{M}(R(\omega))}(x), & \text{if } R(\omega) \in \mathfrak{K} - \mathcal{S} \\ v_{A\mathcal{R}(R(\omega))}(x), & \text{if } R(\omega) \in \mathcal{S} - \mathfrak{K} \\ \max\{v_{A\mathcal{M}(R(\omega))}(x), v_{A\mathcal{R}(R(\omega))}(x)\}, & \text{if } R(\omega) \in \mathfrak{K} \cap \mathcal{S} \end{cases} \delta_A((\mathcal{M}, \mathfrak{K}) \cap (\mathcal{R}, \mathcal{S})) = \begin{cases} \delta_{A\mathcal{M}(R(\omega))}(x), & \text{if } R(\omega) \in \mathfrak{K} - \mathcal{S} \\ \delta_{A\mathcal{R}(R(\omega))}(x), & \text{if } R(\omega) \in \mathcal{S} - \mathfrak{K} \\ \max\{\delta_{A\mathcal{M}(R(\omega))}(x), \delta_{A\mathcal{R}(R(\omega))}(x)\}, & \text{if } R(\omega) \in \mathfrak{K} \cap \mathcal{S} \end{cases}$$

Definition 2.3[6]

Let FNHS (\mathbb{U}, \mathbb{G}) be the family of all fermatean neutrosophic hypersoft sets over the universe set \mathbb{U} and $\sigma \subseteq$ FNHS (\mathbb{U}, \mathbb{G}) . Then σ is said to be a fermatean neutrosophic hypersoft topology on \mathbb{U} if

1. $0_{(\mathbb{U}, \mathbb{G})}, 1_{(\mathbb{U}, \mathbb{G})}$ belongs to σ
2. the union of any number of fermatean neutrosophic hypersoft sets in σ belongs to σ
3. the intersection of finite number of fermatean neutrosophic hypersoft sets in σ belongs to σ .

Then $(\mathbb{U}, \mathbb{G}, \sigma)$ is said to be a fermatean neutrosophic hypersoft topological space over \mathbb{U} . Each members of σ is said to be fermatean neutrosophic hypersoft open set.

Definition 2.4[6]

Let $(\mathbb{U}, \mathbb{G}, \sigma)$ be a fermatean neutrosophic hypersoft topological space over \mathbb{U} and $(\mathcal{M}, \mathfrak{K}) \in$ FNHS (\mathbb{U}, \mathbb{G}) be a fermatean neutrosophic hypersoft set. Then, the fermatean neutrosophic hypersoft interior of $(\mathcal{M}, \mathfrak{K})$, denoted FNHint $(\mathcal{M}, \mathfrak{K})$ is defined as the fermatean neutrosophic hypersoft union of all fermatean neutrosophic hypersoft open subsets of $(\mathcal{M}, \mathfrak{K})$. Clearly, FNHint $(\mathcal{M}, \mathfrak{K})$ is the biggest fermatean neutrosophic hypersoft open set that is contained by $(\mathcal{M}, \mathfrak{K})$. Let $(\mathbb{U}, \mathbb{G}, \sigma)$ be a fermatean neutrosophic hypersoft topological space over \mathbb{U} and $(\mathcal{M}, \mathfrak{K}) \in$ FNHS (\mathbb{U}, \mathbb{G}) be a fermatean neutrosophic hypersoft set. Then, the fermatean neutrosophic hypersoft closure of $(\mathcal{M}, \mathfrak{K})$, denoted FNHScI $(\mathcal{M}, \mathfrak{K})$, is defined as the fermatean neutrosophic hypersoft intersection of all fermatean neutrosophic hypersoft closed super sets of $(\mathcal{M}, \mathfrak{K})$. Clearly, FNHScI $(\mathcal{M}, \mathfrak{K})$ is the smallest fermatean neutrosophic hypersoft closed set that containing $(\mathcal{M}, \mathfrak{K})$.

Fermatean Neutrosophic Hypersoft Generalized Pre-Connected Spaces

Definition 3.1

A FNHTS (\mathbb{U}, σ) is said to be fermatean neutrosophic hypersoft C_5 -connected (FNH C_5 -connected for short) space if the only FNHSs which are both fermatean neutrosophic hypersoft open and fermatean neutrosophic hypersoft closed are 0 and 1 .

Definition 3.2

A FNHTS (\mathbb{U}, σ) is said to be fermatean neutrosophic hypersoft generalized connected (FNHG-connected for short) space if the only FNHSs which are both fermatean neutrosophic hypersoft generalized open and fermatean neutrosophic hypersoft generalized closed are 0 and 1 .

Definition 3.3

A FNHTS (\mathbb{U}, σ) is said to be fermatean neutrosophic hypersoft generalized pre-connected (FNHGP-connected for short) space if the only FNHSs which are both fermatean neutrosophic hypersoft generalized pre-open and fermatean neutrosophic hypersoft generalized pre-closed are 0 and 1 .

Theorem 3.4

Every FNHGP-connected space is FNH C_5 -connected.

Proof: Let (\mathbb{U}, σ) be FNHGP-connected space. Suppose (\mathbb{U}, σ) is not FNH C_5 -connected space, then there exists a proper FNHS $(\mathcal{M}, \mathfrak{K})$ which is both fermatean neutrosophic hypersoft open and fermatean neutrosophic hypersoft closed in (\mathbb{U}, σ) . That is $(\mathcal{M}, \mathfrak{K})$ is both fermatean neutrosophic hypersoft generalized pre-open and fermatean neutrosophic hypersoft generalized pre closed in (\mathbb{U}, σ) . This implies that (\mathbb{U}, σ) is not FNHGP-connected space





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which is a contradiction to the fact that (\mathbb{U}, σ) is FNHG \mathcal{P} connected space. Therefore (\mathbb{U}, σ) is FNH C_5 -connected space.

Theorem 3.5

Every FNHG \mathcal{P} - connected space is FNHG- connected.

Proof: Let (\mathbb{U}, σ) be FNHG \mathcal{P} - connected space. Suppose (\mathbb{U}, σ) is not FNHG- connected space, then there exists a proper FNHS $(\mathcal{M}, \mathfrak{N})$ which is both fermatean neutrosophic hypersoft generalized open and fermatean neutrosophic hypersoft generalized closed in (\mathbb{U}, σ) . This implies that $(\mathcal{M}, \mathfrak{N})$ is both fermatean neutrosophic hypersoft generalized pre open and fermatean neutrosophic hypersoft generalized pre closed in (\mathbb{U}, σ) . This implies that (\mathbb{U}, σ) is not FNHG \mathcal{P} -connected space which is a contradiction to the fact that (\mathbb{U}, σ) is FNHG \mathcal{P} -connected space. Therefore (\mathbb{U}, σ) is FNH C_5 -connected space.

Theorem 3.6

A FNHTS (\mathbb{U}, σ) is FNHG \mathcal{P} -connected space if and only if there exists no non-zero FNHGPOs $(\mathcal{M}, \mathfrak{N})$ and $(\mathcal{R}, \mathcal{S})$ in (\mathbb{U}, σ) such that $(\mathcal{M}, \mathfrak{N}) = (\mathcal{R}, \mathcal{S})^c$.

Proof: Necessity: Let $(\mathcal{M}, \mathfrak{N})$ and $(\mathcal{R}, \mathcal{S})$ be two FNHGPOs in (\mathbb{U}, σ) such that $(\mathcal{M}, \mathfrak{N}) \neq 0 \neq (\mathcal{R}, \mathcal{S})$ and $(\mathcal{M}, \mathfrak{N}) = (\mathcal{R}, \mathcal{S})^c$. Since $(\mathcal{M}, \mathfrak{N}) = (\mathcal{R}, \mathcal{S})^c$, $(\mathcal{R}, \mathcal{S})$ is FNHGPO which implies that $(\mathcal{R}, \mathcal{S})^c = (\mathcal{M}, \mathfrak{N})$ is FNHGPCS. Since $(\mathcal{R}, \mathcal{S}) \neq 0$ this implies that $(\mathcal{R}, \mathcal{S})^c \neq 1$ (i.e) $(\mathcal{M}, \mathfrak{N}) \neq 1$. Hence there exists a proper FNHS $(\mathcal{M}, \mathfrak{N})$ ($(\mathcal{M}, \mathfrak{N}) \neq 0, (\mathcal{M}, \mathfrak{N}) \neq 1$) which is both FNHGPO and FNHGPCS in (\mathbb{U}, σ) . Hence (\mathbb{U}, σ) is not FNHG \mathcal{P} -connected space. But it is contradiction to our hypothesis. Thus there exists no non-zero FNHGPOs $(\mathcal{M}, \mathfrak{N})$ and $(\mathcal{R}, \mathcal{S})$ in (\mathbb{U}, σ) such that $(\mathcal{M}, \mathfrak{N}) = (\mathcal{R}, \mathcal{S})^c$. Sufficiency: Let (\mathbb{U}, σ) be FNHTS and $(\mathcal{M}, \mathfrak{N})$ is both FNHGPO and FNHGPC in (\mathbb{U}, σ) such that $0 \neq (\mathcal{M}, \mathfrak{N}) \neq 1$. Now let $(\mathcal{R}, \mathcal{S}) = (\mathcal{M}, \mathfrak{N})^c$. In this case, $(\mathcal{R}, \mathcal{S})$ is FNHGPO and $(\mathcal{M}, \mathfrak{N}) \neq 1$ this implies that $(\mathcal{R}, \mathcal{S}) = (\mathcal{M}, \mathfrak{N})^c \neq 0$. Hence $(\mathcal{R}, \mathcal{S}) \neq 0$ which is a contradiction to our hypothesis. Therefore there is a proper FNHS of (\mathbb{U}, σ) which is both FNHGPO and FNHGPC in (\mathbb{U}, σ) . Hence (\mathbb{U}, σ) is FNHG \mathcal{P} -connected space.

Theorem 3.7

A FNHTS (\mathbb{U}, σ) is FNHG \mathcal{P} -connected space if and only if there exists no non-zero FNHGPOs $(\mathcal{M}, \mathfrak{N})$ and $(\mathcal{R}, \mathcal{S})$ in (\mathbb{U}, σ) such that $(\mathcal{M}, \mathfrak{N}) = (\mathcal{R}, \mathcal{S})^c$, $B = (FNHgpcl(\mathcal{M}, \mathfrak{N}))^c$ and $(\mathcal{M}, \mathfrak{N}) = (FNHgpcl(\mathcal{R}, \mathcal{S}))^c$.

Proof: Necessity: Assume that there exists FNHSs $(\mathcal{M}, \mathfrak{N})$ and $(\mathcal{R}, \mathcal{S})$ in (\mathbb{U}, σ) such that $(\mathcal{M}, \mathfrak{N}) \neq 0 \neq (\mathcal{R}, \mathcal{S})$, $(\mathcal{R}, \mathcal{S}) = (\mathcal{M}, \mathfrak{N})^c$, $(\mathcal{R}, \mathcal{S}) = (FNHgpcl(\mathcal{M}, \mathfrak{N}))^c$ and $(\mathcal{M}, \mathfrak{N}) = (FNHgpcl(\mathcal{R}, \mathcal{S}))^c$. Since $(FNHgpcl(\mathcal{M}, \mathfrak{N}))^c$ and $(FNHgpcl(\mathcal{R}, \mathcal{S}))^c$ are FNHGPOs in (\mathbb{U}, σ) , $(\mathcal{M}, \mathfrak{N})$ and $(\mathcal{R}, \mathcal{S})$ are FNHGPOs in (\mathbb{U}, σ) . This implies (\mathbb{U}, σ) is not FNHG \mathcal{P} -connected space, which is a contradiction to the statement that (\mathbb{U}, σ) is FNHG \mathcal{P} -connected space. Therefore there exists no non-zero FNHGPOs $(\mathcal{M}, \mathfrak{N})$ and $(\mathcal{R}, \mathcal{S})$ in (\mathbb{U}, σ) such that $(\mathcal{M}, \mathfrak{N}) = (\mathcal{R}, \mathcal{S})^c$, $(\mathcal{R}, \mathcal{S}) = (FNHgpcl(\mathcal{M}, \mathfrak{N}))^c$ and $(\mathcal{M}, \mathfrak{N}) = (FNHgpcl(\mathcal{R}, \mathcal{S}))^c$.

Sufficiency: Let $(\mathcal{M}, \mathfrak{N})$ be both FNHGPO and FNHGPC in (\mathbb{U}, σ) such that $1 \neq (\mathcal{M}, \mathfrak{N}) \neq 0$. Now by taking $(\mathcal{R}, \mathcal{S}) = (\mathcal{M}, \mathfrak{N})^c$ we obtain a contradictory to our hypothesis. Hence (\mathbb{U}, σ) is FNHG \mathcal{P} -connected space.

Definition 3.8

Two FNHSs $(\mathcal{M}, \mathfrak{N})$ and $(\mathcal{R}, \mathcal{S})$ are said to be q-coincident $((\mathcal{M}, \mathfrak{N})q(\mathcal{R}, \mathcal{S})$ in short) if and only if there exists an element $x \in \mathbb{U}$ such that $\mu_{A(\mathcal{M}, \mathfrak{N})}(x) > \mu_{A(\mathcal{R}, \mathcal{S})}^C(x)$, $\nu_{A(\mathcal{M}, \mathfrak{N})}(x) < \nu_{A(\mathcal{R}, \mathcal{S})}^C(x)$, $\delta_{A(\mathcal{M}, \mathfrak{N})}(x) < \delta_{A(\mathcal{R}, \mathcal{S})}^C(x)$.

Definition 3.9

Two FNHSs $(\mathcal{M}, \mathfrak{N})$ and $(\mathcal{R}, \mathcal{S})$ in (\mathbb{U}, σ) are said to be not q-coincident $((\mathcal{M}, \mathfrak{N})q^c(\mathcal{R}, \mathcal{S})$ for short) if and only if $(\mathcal{M}, \mathfrak{N})$ contained in $(\mathcal{R}, \mathcal{S})^c$.

Definition 3.10

A FNHTS (\mathbb{U}, σ) is called FNH C_5 - connected between two FNHSs $(\mathcal{M}, \mathfrak{N})$ and $(\mathcal{R}, \mathcal{S})$ if there is no fermatean neutrosophic hypersoft open set $(\mathcal{P}, \mathcal{Q})$ in (\mathbb{U}, σ) such that $(\mathcal{M}, \mathfrak{N}) \subseteq (\mathcal{P}, \mathcal{Q})$ and $(\mathcal{P}, \mathcal{Q})q^c(\mathcal{R}, \mathcal{S})$.





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Definition 3.11

A FNHTS (U, σ) is called FNHGP-connected between two FNHSs (M, κ) and (R, S) if there is no fermatean neutrosophic hypersoft generalized pre-open set (P, Q) in (U, σ) such that $(M, \kappa) \subseteq (P, Q)$ and $(P, Q) q^c (R, S)$.

Theorem 3.12

If a FNHTS (U, σ) is FNHGP connected between two FNHSs (M, κ) and (R, S) , then it is FNH C_5 -connected between two FNHSs (M, κ) and (R, S) .

Proof: Suppose (U, σ) is not FNH C_5 - connected between two FNHSs (M, κ) and (R, S) , then there exists a FNHOS (P, Q) in (U, σ) such that $(M, \kappa) \subseteq (P, Q)$ and $(P, Q) q^c (R, S)$. Since every FNHOS is FNHGPOS, there exists a FNHGPOS (P, Q) in (U, σ) such that $(M, \kappa) \subseteq (P, Q)$ and $(P, Q) q^c (R, S)$. This implies (U, σ) is not FNHGP connected between (M, κ) and (R, S) , which is a contradiction to our hypothesis. Therefore (U, σ) is FNH C_5 -connected between two FNHSs (M, κ) and (R, S) .

Theorem 3.13

A FNHTS (U, σ) is FNHGP connected between two FNHSs (M, κ) and (R, S) if and only if there is no FNHGP open and FNHGP closed set (P, Q) in (U, σ) such that $(M, \kappa) \subseteq (P, Q) \subseteq B^c$.

Proof: Necessity: Let (U, σ) be FNHGP connected between two FNHSs (M, κ) and (R, S) . Suppose that there exists FNHGP open and FNHGP closed set (P, Q) in (U, σ) such that $(M, \kappa) \subseteq (P, Q) \subseteq (R, S)^c$, then $(P, Q) q^c (R, S)$ and $(M, \kappa) \subseteq (P, Q)$. This implies (U, σ) is not FNHGP connected between two FNHSs (M, κ) and (R, S) , by Definition 3.11. It is a contradiction to our hypothesis. Therefore there is no FNHGPO and FNHGPC set (P, Q) in (U, σ) such that $(M, \kappa) \subseteq (P, Q) \subseteq (R, S)^c$.

Sufficiency: Suppose that (U, σ) is not FNHGP connected between two FNHSs (M, κ) and (R, S) . Then there exists a FNHGPOS (P, Q) in (U, σ) such that $(M, \kappa) \subseteq (P, Q)$ and $(P, Q) q^c (R, S)$. This implies that there is FNHGPOS (P, Q) in (U, σ) such that $(M, \kappa) \subseteq (P, Q) \subseteq (R, S)^c$. But this is a contradiction to our hypothesis. Hence (U, σ) is FNHGP connected between two FNHSs (M, κ) and (R, S) .

Theorem 3.14

If a FNHTS (U, σ) is FNHGP connected between two FNHSs (M, κ) and (R, S) , $(M, \kappa) \subseteq (M, \kappa)_1$ and $(R, S) \subseteq (R, S)_1$, then (U, σ) is FNHGP connected between $(M, \kappa)_1$ and $(R, S)_1$.

Proof: Suppose that (U, σ) is not FNHGP connected between $(M, \kappa)_1$ and $(R, S)_1$, then by Definition 3.11, there exists a FNHGPOS D in (U, σ) such that $(M, \kappa)_1 \subseteq (P, Q)$ and $(P, Q) q^c (R, S)_1$. This implies $(P, Q) \subseteq (R, S)_1^c$ and $(M, \kappa)_1 \subseteq (P, Q)$ implies $(M, \kappa) \subseteq (M, \kappa)_1 \subseteq (P, Q)$. That is $(M, \kappa) \subseteq (P, Q)$. Now let us prove that $(P, Q) \subseteq (R, S)^c$, that is, to prove that $(P, Q) q^c (R, S)$. Suppose that $(P, Q) q (R, S)$, then by Definition 3.8, there exists an element $x \in U$ such that $\mu_{A(P,Q)}(x) > \mu_{A(R,S)}^c(x)$, $\nu_{A(P,Q)}(x) < \nu_{A(R,S)}^c(x)$ and $\delta_{A(P,Q)}(x) < \delta_{A(R,S)}^c(x)$.

Therefore $\mu_{A(P,Q)}(x) > \mu_{A(R,S)}^c(x) > \mu_{A(R,S)_1}^c(x)$, $\nu_{A(P,Q)}(x) < \nu_{A(R,S)}^c(x) < \nu_{A(R,S)_1}^c(x)$ and $\delta_{A(P,Q)}(x) < \delta_{A(R,S)}^c(x) < \delta_{A(R,S)_1}^c(x)$. since $(R, S) \subseteq (R, S)_1$. Thus $(P, Q) q (R, S)_1$. But $(P, Q) \subseteq (R, S)_1$. That is $(P, Q) q^c (R, S)_1$, which is a contradiction. Therefore $(P, Q) q^c (R, S)$. That is $(P, Q) \subseteq (R, S)^c$. Hence (U, σ) is not FNHGP connected between (M, κ) and (R, S) , which is a contradiction to our hypothesis. Thus (U, σ) is FNHGP connected between $(M, \kappa)_1$ and $(R, S)_1$.

Definition 3.15

A FNHGP open set (M, κ) is called fermatean neutrosophic hypersoft regular generalized pre open set (FNHRGPOS in short) if $(M, \kappa) = \text{FNHgpint}(\text{FNHgpcl}(M, \kappa))$. The complement of a FNHRGPOS is called FNHRGPCS.

Definition 3.16

A FNHTS (U, σ) is called fermatean neutrosophic hypersoft generalized pre super connected space (FNHGP super connected space) if there exists no FNHRGPOS in (U, σ) .

Theorem 3.17

Let (U, σ) be FNHTS, then the following are equivalent.





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- i) (U, σ) is FNHGPs super connected space.
- ii) For every non-zero FNHRGPOS (M, \aleph) , $\text{FNHgpcl}(M, \aleph) = 1$.
- iii) For every FNHRGPCS (M, \aleph) with $(M, \aleph) \neq 1$, $\text{FNHgpint}(M, \aleph) = 0$.
- iv) There exists no FNHRGPOSs (M, \aleph) and (R, S) in (U, σ) such that $(M, \aleph) \neq 1 \neq (R, S)$, $(M, \aleph) \subseteq (R, S)^c$.
- v) There exists no NVRGPOSs (M, \aleph) and (R, S) in (U, σ) such that $(M, \aleph) \neq 0 \neq (R, S)$, $(R, S) = (\text{FNHgpint}(M, \aleph))^c$, $(M, \aleph) = (\text{FNHgpint}(R, S))^c$.
- vi) There exists no FNHRGPCSs (M, \aleph) and (R, S) in (U, σ) such that $(M, \aleph) \neq 1 \neq (R, S)$, $(R, S) = (\text{FNHgpint}(M, \aleph))^c$, $A = (\text{FNHgpint}(R, S))^c$.

Proof: (i) \Rightarrow (ii) Assume that there exists a FNHRGPOS (M, \aleph) in (U, σ) such that $(M, \aleph) \neq 0$ and $\text{FNHgpcl}(M, \aleph) \neq 1$. Now let $(R, S) = \text{FNHgpint}(\text{FNHgpcl}(R, S))$, then (R, S) is a proper FNHRGPOS in (U, σ) . But this is a contradiction to the fact that (U, σ) is FNHGPs super connected space. Therefore $\text{FNHgpcl}(M, \aleph) = 1$.
 (ii) \Rightarrow (iii) Let $(M, \aleph) \neq 1$ be FNHRGPCS in (U, σ) . If $(R, S) = (M, \aleph)^c$ then (R, S) is a FNHRGPOS in (U, σ) with $(R, S) \neq 0$. Hence $\text{FNHgpcl}(R, S) = 1$. This implies $(\text{FNHgpcl}(R, S))^c = 0$. That is $\text{FNHgpint}((R, S)^c) = 0$. Hence $\text{FNHgpint}(M, \aleph) = 0$.
 (iii) \Rightarrow (iv) Let (M, \aleph) and (R, S) be two FNHRGPOSs in (U, σ) such that $(M, \aleph) \neq 0 \neq (R, S)$, $(M, \aleph) \subseteq (R, S)^c$. Since $(R, S)^c$ is FNHRGPCS in (U, σ) and $(R, S) \neq 0$ implies $(R, S)^c \neq 1$, $(R, S)^c = \text{FNHgpcl}(\text{FNHgpint}((R, S)^c))$ and we have $\text{FNHgpint}((R, S)^c) = 0$. But $(M, \aleph) \subseteq (R, S)^c$. Therefore $0 \neq (M, \aleph) = \text{FNHgpint}(\text{FNHgpcl}(M, \aleph)) \Rightarrow \text{FNHgpint}(\text{FNHgpcl}((R, S)^c)) = \text{FNHgpint}(\text{FNHgpcl}(\text{FNHgpcl}(\text{FNHgpint}((R, S)^c)))) = \text{FNHgpint}((\text{FNHgpcl}(\text{FNHgpint}((R, S)^c)))) = 0$ which is a contradiction. Therefore (iv) is true.
 (iv) \Rightarrow (i) Let $0 \neq (M, \aleph) \neq 1$ be a FNHRGPOS in (U, σ) . If we take $(R, S) = (\text{FNHgpcl}(M, \aleph))^c$, since $\text{FNHgpint}(\text{FNHgpcl}(R, S)) = \text{FNHgpint}(\text{FNHgpcl}(\text{FNHgpcl}(M, \aleph))^c) = \text{FNHgpint}(\text{FNHgpint}(\text{FNHgpcl}(M, \aleph)))^c = \text{FNHgpint}((M, \aleph)^c) = (\text{FNHgpcl}(M, \aleph))^c = (R, S)$. Also we get $(R, S) \neq 0$, since otherwise, we have $(R, S) = 0$ and this implies $(\text{FNHgpcl}(M, \aleph))^c = 0$. That is $\text{FNHgpcl}(M, \aleph) = 1$. Hence $\text{FNHgpint}(\text{FNHgpcl}(M, \aleph)) = \text{FNHgpint}(1) = 1$. That is $(M, \aleph) = 1$, which is a contradiction. Therefore $(R, S) \neq 0$ and $(M, \aleph) \subseteq (R, S)^c$. But this is a contradiction to (iv). Therefore (U, σ) is FNHGPs super connected space. (i) \Rightarrow (v) Let (M, \aleph) and (R, S) be two FNHRGPOSs in (U, σ) such that $(M, \aleph) \neq 0 \neq (R, S)$, $(R, S) = (\text{FNHgpcl}(M, \aleph))^c$, $(M, \aleph) = (\text{FNHgpcl}(R, S))^c$. Now we have $\text{FNHgpint}(\text{FNHgpcl}(M, \aleph)) = \text{FNHgpint}((R, S)^c) = (\text{FNHgpcl}(R, S))^c = (M, \aleph)$, $(M, \aleph) \neq 0$ and $(M, \aleph) \neq 1$, since if $(M, \aleph) = 1$, then $1 = (\text{FNHgpcl}(R, S))^c \Rightarrow \text{FNHgpcl}(R, S) = 0 \Rightarrow (R, S) = 0$. But $(R, S) \neq 0$. Therefore $(M, \aleph) \neq 1$ implies that (M, \aleph) is proper FNHRGPOS in (U, σ) , which is a contradiction to (i). Hence (v) is true.
 (v) \Rightarrow (i) Let (M, \aleph) be FNHRGPOS in (U, σ) such that $(M, \aleph) = \text{FNHgpint}(\text{FNHgpcl}(M, \aleph))$ and $0 \neq (M, \aleph) \neq 1$. Now take $(R, S) = (\text{FNHgpcl}(M, \aleph))^c$. In this case we get $(R, S) \neq 0$ and (R, S) is a FNHRGPOS in (U, σ) , $(R, S) = (\text{FNHgpcl}(M, \aleph))^c$ and $(\text{FNHgpcl}(R, S))^c = (\text{FNHgpcl}(\text{FNHgpcl}(M, \aleph)))^c = \text{FNHgpint}(\text{FNHgpcl}(M, \aleph))^c = \text{FNHgpint}(\text{FNHgpcl}(M, \aleph)) = (M, \aleph)$. But this is a contradiction to (v). Therefore (U, σ) is FNHGPs super connected space. (v) \Rightarrow (vi) Let (M, \aleph) and (R, S) be two FNHRGPCSs in (U, σ) such that $(M, \aleph) \neq 1 \neq (R, S)$, $(R, S) = (\text{FNHgpint}(M, \aleph))^c$, $(M, \aleph) = (\text{FNHgpint}(R, S))^c$. Taking $(G, A) = (M, \aleph)^c$ and $(P, Q) = (R, S)^c$, (G, A) and (P, Q) becomes FNHRGPOSs in (U, σ) with $(G, A) \neq 0 \neq (P, Q)$, $(P, Q) = (\text{FNHgpint}(G, A))^c$, $(G, A) = (\text{FNHgpint}(P, Q))^c$ which is a contradiction to (v). Hence (vi) is true. (vi) \Rightarrow (v) Can be easily proved by the similar way as in (v) \Rightarrow (vi).

CONCLUSION

In this paper we have discussed about the concept of FNHC₅- Connected space, FNHG- Connected Space and FNHGPs- Connected Space and FNHGPs Super Connected Space and their characterizations are analyzed in these areas.

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Fermatean Pentapartitioned Neutrosophic Set

R. Subha^{1*} and K.Mohana²

¹Research Scholar, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Assistant Professor, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

R. Subha

Research scholar,
Department of Mathematics,
Nirmala College for women,
Coimbatore, Tamil Nadu, India
E. Mail : subhamurali6@gmail.com



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ABSTRACT

The Fermatean pentapartitioned neutrosophic set (FPN) concept and its properties are discussed in this paper. The topological space's interior and closure are also examined.

Keywords: Neutrosophic set, Neutrosophic Pythagorean set, Fermatean quadripartitioned set

INTRODUCTION

Zadeh introduced the fuzzy set in 1965, which allows members to perform work valued between 0 and 1, and set theory is an extension of classical pure mathematics. The fuzzy set helps to deal with the idea of uncertainty, ambiguity, and impreciseness in a way that the cantor set cannot. Atanassov introduced the intuitionistic fuzzy set (IFS) in 1986 as an extension of Zadeh's fuzzy set theory. This fuzzy set has degrees of membership and non-membership within a range of 0.1. The IFS theory is widely used in logic programming, medical diagnosis, clustering analysis, and other related fields. In 1995, Florentine Smarandache proposed the concept of neutrosophic set, which incorporates the parts of truth membership function (T), indeterminacy membership function (I), and falsity membership function (F) in multiple ways and provides the information of neutral thought by introducing the new issue referred to as uncertainty within the set. The non-normal interval of $[0, 1]$ is the subject of neutrosophic sets. Neutrosophic set plays a crucial role in a number of applications, including diagnosis, multicriteria higher cognitive process issues, the internet of decisions, electronic database systems, and information technology.

Preliminaries

Definition [17]





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Consider X to be a universe. The following is how a neutrosophic set A on X is defined $A = \{ \langle x, T_A(x), I_A(x), F_A(x) \rangle : x \in X \}$

Where $T_A, I_A, F_A: U \rightarrow [0,1]$ and $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$

The degree of membership is represented by $T_A(x)$. The degree of non-membership and indeterminacy are represented by $I_A(x)$ and $F_A(x)$.

$I_A(x)$ is an independent neutrosophic component, whereas $T_A(x)$ and $F_A(x)$ are dependent neutrosophic components.

Definition [10]

Consider R to be a universe. An object of the form $A = \langle x, T_A, U_A, F_A \rangle$ is a Neutrosophic Pythagorean set A with U as an independent component for A on R and T and F as dependent Neutrosophic Pythagorean components. $r \in R$, where $(T_A)^2 + (F_A)^2 \leq 1$ and $(T_A)^2 + (U_A)^2 + (F_A)^2 \leq 2$, with $T_A(x)$ representing the truth membership, $U_A(x)$ representing the indeterminacy membership, and $F_A(x)$ representing the false membership.

A note:

$T + F \leq 1$ when T and F are dependent Neutrosophic components.

Definition [10]

The complement of a Neutrosophic Pythagorean set

$A = \{ \langle x, T_A, U_A, F_A \rangle : r \in R \}$ and dependent Neutrosophic Pythagorean components is $A^c = \{ \langle x, F_A, 1 - U_A, T_A \rangle : r \in R \}$.

Definition [10]

Let $A = \{ \langle x, T_A, U_A, F_A \rangle : r \in R \}$ and $B = \{ \langle x, T_B, U_B, F_B \rangle : r \in R \}$ are two Neutrosophic Pythagorean set with dependent Neutrosophic Pythagorean components on the universe R. Then the union and intersection of two sets can be defined by

$$A \cup B = \{ \max(T_A, T_B), \min(U_A, U_B), \min(F_A, F_B) \}$$

$$A \cap B = \{ \min(T_A, T_B), \max(U_A, U_B), \max(F_A, F_B) \}.$$

Definition [1]

Let X be a universe. A Fermatean Neutrosophic set (FN) A on X is an object of the form $A = \{ \langle x, T_A, C_A, U_A, F_A \rangle : x \in X \}$ $(T_A)^3 + (C_A)^3 + (F_A)^3 \leq 2$

Here, $T_A(x)$ is the truth membership. $I_A(x)$ is indeterminacy membership, $F_A(x)$ is the false membership.

Fermatean Pentapartitioned Neutrosophic Set

Definition

Let X be a universe. A Fermatean pentapartitioned neutrosophic set (FPN) A on X is an object of the form

$$A = \{ \langle x, T_A, C_A, K_A, U_A, F_A \rangle : x \in X \}$$

$$(T_A)^3 + (C_A)^3 + (K_A)^3 + (U_A)^3 + (F_A)^3 \leq 3$$

Here, $T_A(x)$ is the truth membership.

$C_A(x)$ is contradiction membership,

$U_A(x)$ is ignorance membership,

$F_A(x)$ is the false membership,

$K_A(x)$ is unknown membership.

Example

Let $R = \{a,b,c\}$ and $A = \{(a,0.3,0.5,0.4,0.5,0.7), (b,0.3,0.8,0.5,0.3,0.7), (c,0.4,0.6,0.8,0.4,0.6)\}$. Then A is a Fermatean pentapartitioned neutrosophic set on R.





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Definition

A Fermatean pentapartitioned neutrosophic set A is contained in another A is a Fermatean pentapartitioned neutrosophic set B. (i.e) $A \subseteq B$ if $T_A \leq T_B, C_A \leq C_B, K_A \geq K_B, U_A \geq U_B$ and $F_A \geq F_B$.

Example

Let $R = \{a,b,c\}$ and $A = \{(a,0.3,0.6,0.8,0.4,0.7),(b,0.5,0.8,0.5,0.2,0.5), (c,0.4,0.8,0.5,0.2,0.6)\}$ and $B = \{(a,0.6,0.3,0.2,0.7,0.4), (b,0.4,0.2,,0.3,0.8,0.5),(c,0.5,0.6,0.3,0.4,0.5)\}$ are Fermatean pentapartitioned neutrosophic sets on R.

Definition

A Fermatean pentapartitioned neutrosophic A's complement on X is denoted by $(A)^c$ and is calculated as $A^c(x) = \{<x, K_A, F_A, U_A, C_A, T_A > : x \in X\}$.

Example

Let $R = \{a,b,c\}$ and $A = \{(a,0.3,0.6,0.5,0.4,0.7),(b,0.5,0.2, 0.7,0.5,0.3),(c,0.2,0.4,0.5,0.4,0.6)\}$ is a Fermatean pentapartitioned neutrosophic sets on R.
Then $A^c = \{(a,0.7,0.4,0.5,0.6,0.3),(b,0.3,0.5,0.7,0.2,0.5),(c,0.6,0.4,0.5,0.4,0.2)\}$

Definition

Let X be a non – empty set, $A = < x, T_A, C_A, K_A, U_A, F_A >$ and $B = < x, T_B, C_B, K_B, U_B, F_B >$ are two Fermatean pentapartitioned neutrosophic sets. Then

$$A \cup B = <x, \max(T_A, T_B), \max(C_A, C_B), \min(K_A, K_B), \min(U_A, U_B), \min(F_A, F_B)>$$

$$A \cap B = <x, \min(T_A, T_B), \min(C_A, C_B), \max(K_A, K_B), \max(U_A, U_B), \max(F_A, F_B)>$$

Example

Let $R = \{a,b,c\}$ and $A = \{(a,0.3,0.6,0.4,0.5,0.7),(b,0.5,0.2,0.5,0.3,0.7),(c,0.2,0.4,0.5,0.4,0.6)\}$ and $B = \{(a,0.4,0.5,0.1,0.5,0.6),(b,0.5,0.3,0.2,0.7,0.5),(c,0.3,0.5,0.2,0.5,0.7)\}$ are Fermatean pentapartitioned neutrosophic sets on R.
Then $A \cup B = \{(a,0.4,0.6,0.1,0.5,0.6)(b,0.5,0.3,0.2,0.3,0.5),(c,0.3,0.5,0.2,0.4,0.6)\}$
 $A \cap B = \{(a,0.3,0.5,0.4,0.5,0.7)(b,0.5,0.2,0.5,0.7,0.7)(c,0.2,0.4,0.5,0.5,0.7)\}$

Definition

An empty Fermatean pentapartitioned neutrosophic set A over the universe X is referred to as an empty Fermatean pentapartitioned neutrosophic set If $T_A = 0, C_A = 0, K_A = 1, U_A = 1$ and $F_A = 1$,

Definition

If $T_A = 1, C_A = 1, K_A = 0, U_A = 0$, and $F_A = 0$, a Fermatean pentapartitioned neutrosophic set A over the universe X is referred to as a "universe Fermatean pentapartitioned neutrosophic set" in relation to the parameter A and is denoted by "or 1."

Definition

Let A and B be two Fermatean pentapartitioned neutrosophic set on X then $A \setminus B$ may be defined as $A \setminus B = <x, \min(T_A, F_B), \min(C_A, U_B), \max(K_A, K_B), \max(U_A, C_B), \max(F_A, T_B)>$

Example

Let $R = \{a,b,c\}$ and $A = \{(a,0.3,0.6,0.4,0.5,0.7),(b,0.5,0.2,0.5,0.3,0.7), (c,0.2,0.4,0.5,0.4,0.6)\}$ and $B = \{(a,0.4,0.5,0.1,0.5,0.6),(b,0.5,0.3,0.2,0.7,0.5), (c,0.3,0.5,0.2,0.5,0.7)\}$ are Fermatean pentapartitioned neutrosophic sets on R. Then $A \setminus B = \{<x,(0.3,0.5,0.2)(0.5,0.5,0.5)(0.4,0.5,0.5)(0.5,0.3,0.5)(0.7,0.7,0.6)\}$

Theorem

Let K (A), L (B) and M(C) are three Fermatean pentapartitioned neutrosophic sets over the universe X. Then the following properties holds true.





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Commutative Law

$$A \cup B = B \cup A \quad A \cap B = B \cap A$$

Associative law

$$(A \cup B) \cup C = A \cup (B \cup C) \quad (A \cap B) \cap C = A \cap (B \cap C)$$

Absorption law

$$A \cup (A \cap C) = A$$

$$A \cap (A \cup C) = A$$

Involution law

$$(A^c)^c = A$$

Law of contradiction

$$A \cap A^c = \phi$$

Morgan’s law

$$(A \cup B)^c = A^c \cap B^c$$

$$(A \cap B)^c = A^c \cup B^c$$

Theorem

Let K be Fermatean pentapartitioned neutrosophic set over the universe X. Then the following are true.

$$K \cap L \text{ iff } K \cap L = K$$

$$K \cap L \text{ iff } K \cap L = L$$

Theorem

Let K be Fermatean pentapartitioned neutrosophic set over the universe X. Then the following are true.

$$(\phi)^c = X$$

$$(X)^c = \phi$$

$$K \cup \phi = K$$

$$K \cup X = X$$

$$K \cap \phi = \phi$$

$$K \cap X = K$$

proof: It is obvious

Definition

A Fermatean pentapartitioned neutrosophic topology on a non-empty set X is a τ of Fermatean pentapartitioned neutrosophic sets satisfying the following axioms.

i) $0_M, 1_M \in \tau$

ii) The union of the elements of any sub collection of τ is in τ

The intersection of the elements of any finite sub collection of τ is in τ

The pair (X, τ) is called a Fermatean pentapartitioned neutrosophic topological space over X.

Note

Every member of τ is called a FPN open set in X

The set A_M is called a FPN closed set in X if $A_M \in \tau^c$, where $\tau^c = \{A_M^c : A_M \in \tau\}$.

Example

Let $M = \{b_1, b_2\}$ and Let A_M, B_M, C_M be Fermatean pentapartitioned neutrosophic sets where $A_M = \langle 0.5, 0.1, 0.7, 0.2, 0.4 \rangle$ $B_M = \langle 0.7, 0.5, 0.2, 0.1, 0.6 \rangle$ $C_M = \langle 0.6, 0.5, 0.4, 0.3, 0.2 \rangle$





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$B_M = \{ \langle b_1, 0.6, 0.7, 0.1, 0.2, 0.4 \rangle < b_2, 0.2, 0.3, 0.4, 0.7, 0.6 \rangle < b_3, 0.5, 0.6, 0.1, 0.3, 0.2 \rangle \}$
 $C_M = \{ \langle b_1, 0.6, 0.7, 0.1, 0.2, 0.4 \rangle < b_2, 0.7, 0.5, 0.2, 0.1, 0.6 \rangle < b_3, 0.6, 0.6, 0.1, 0.3, 0.2 \rangle \}$
 $\tau = \{A_M, B_M, C_M, 0_M, 1_M\}$ is an Fermatean pentapartitioned neutrosophic topology on M.

Preposition

Let (M, τ_1) and (M, τ_2) be two Fermatean pentapartitioned neutrosophic topological space on M. Then $\tau_1 \cap \tau_2$ is an Fermatean pentapartitioned neutrosophic topology on M where $\tau_1 \cap \tau_2 = \{A_M : A_M \in \tau_1 \text{ and } A_M \in \tau_2\}$
 proof:

Obviously $0_M, 1_M \in \tau$.

Let $A_M, B_M \in \tau_1 \cap \tau_2$

Then $A_M, B_M \in \tau_1$ and $A_M, B_M \in \tau_2$

We know that τ_1 and τ_2 are two Fermatean pentapartitioned neutrosophic topological space on M.

Then $A_M \cap B_M \in \tau_1$ and $A_M \cap B_M \in \tau_2$ Hence $A_M \cap B_M \in \tau_1 \cap \tau_2$.

$B_M \in \tau_1 \cap \tau_2$.

Let τ_1 and τ_2 are two Fermatean pentapartitioned neutrosophic topological space on X.

Denote $\tau_1 \vee \tau_2 = \{A_M \cup B_M : A_M \in \tau_1 \text{ and } A_M \in \tau_2\}$

$\tau_1 \wedge \tau_2 = \{A_M \cap B_M : A_M \in \tau_1 \text{ and } A_M \in \tau_2\}$

Example

Let A_M and B_M be two Fermatean pentapartitioned neutrosophic topological space on X.

Define $\tau_1 = \{0_M, 1_M, A_M\}$

$\tau_2 = \{0_M, 1_M, B_M\}$

Then $\tau_1 \cap \tau_2 = \{0_M, 1_M\}$ is a Fermatean pentapartitioned neutrosophic topological space on M.

But $\tau_1 \cup \tau_2 = \{0_M, A_M, B_M, 1_M\}$.

$\tau_1 \vee \tau_2 = \{0_M, A_M, B_M, 1_M, A_M \cup B_M\}$

$\tau_1 \wedge \tau_2 = \{0_M, A_M, B_M, 1_M, A_M \cap B_M\}$ are not Fermatean pentapartitioned neutrosophic topological space on X.

Definition

Let (M, τ) be a Fermatean pentapartitioned neutrosophic topological space on M and let A_M belongs to A Fermatean pentapartitioned neutrosophic topological space on M. Then the interior of A_M is denoted as FPN Int (A_M) . It is defined by $FPN \text{ Int } (A_M) = \cup \{B_M \in \tau : B_M \subseteq A_M\}$

Definition

Let (M, τ) be a Fermatean pentapartitioned neutrosophic topological space on M and let A_M belongs to fermatean pentapartitioned neutrosophic topological space on M. Then the closure of A_M is denoted as FPN CI (A_M) . It is defined by

$FPN \text{ CI } (A_M) = \cap \{B_M \in \tau^c : A_M \subseteq B_M\}$

Theorem

Let (M, τ) be a Fermatean pentapartitioned neutrosophic topological space on M. Then the following properties are hold.

0_M and 1_M are Fermatean pentapartitioned neutrosophic closed sets over M

The intersection of any number of Fermatean pentapartitioned neutrosophic closed set is a Fermatean pentapartitioned neutrosophic closed set over M.

The union of any two Fermatean pentapartitioned neutrosophic closed set is a Fermatean pentapartitioned neutrosophic set over M.

Proof

It is obviously true.





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Theorem

Let (M, τ) be a fermatean pentapartitioned neutrosophic topological space on M and let A_M belongs to fermatean pentapartitioned neutrosophic topological space. Then the following properties hold.

- i) $\text{FPN Int} (A_M) \subseteq A_M$
- ii) $A_M \subseteq B_M$ implies $\text{FPN Int} (A_M) \subseteq \text{FPN Int} (B_M)$
- iii) $\text{FPN Int} (A_M) \in \tau$
- iv) A_M is a FPN open set implies $\text{FPN Int} (A_M) = A_M$.
- v) $\text{FPN Int} (\text{FPN Int} (A_M)) = \text{FPN Int} (A_M)$
- vi) $\text{FPN Int} (0_M) = 0_M, \text{FPN Int} (1_M) = 1_M$.

Theorem

Let (M, τ) be a fermatean pentapartitioned neutrosophic topological space on M and let A_M belongs to fermatean pentapartitioned neutrosophic topological space. Then the following properties hold.

- i) $A_M \subseteq \text{FPN Cl} (A_M)$
- ii) $A_M \subseteq B_M$ implies $\text{FPN Cl} (A_M) \subseteq \text{FPN Cl} (B_M)$
- iii) $\text{FPN Cl} (A_M)^c \in \tau$.
- iv) A_M is a FPN closed set implies $\text{FPN Cl} (A_M) = A_M$.
- v) $\text{FPN Cl} (\text{FPN Cl} (A_M)) = \text{FPN Cl} (A_M)$
- vi) $\text{FPN Cl} (0_M) = 0_M, \text{FPN Cl} (1_M) = 1_M$.

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A Mathematical Model for Estimating Intelligence Quotient of Mathematics Students Post COVID Scenario

F.Nirmala Irudayam*, K. Mohana and A. ArokiaLancy

Assistant Professor, PG and Research Department of Mathematics, Nirmala College for Women, Coimbatore-641018, Tamil Nadu, India.

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*Address for Correspondence

F.Nirmala Irudayam

Assistant Professor,
PG and Research Department of Mathematics,
Nirmala College for Women,
Coimbatore-641018, Tamil Nadu, India.
E. Mail : riyaraju1116@gmail.com



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ABSTRACT

After the COVID lockdown, the development of a mathematical model for estimating the Intelligent Quotient of mathematics students is the subject of this article. Its goals are to gather a small sample of data, determine the mental age, and create a modeling equation.

Keywords: Intelligence Quotient, Mathematical Model, post covid students IQ.

INTRODUCTION

The capacity to acquire knowledge and comprehension that can be applied in a variety of novel contexts is one narrow definition of intelligence. The individual is able to deal with real-world situations and benefit intellectually from sensory experience thanks to this ability or capacity [1, 2]. The purpose of a test of intelligence is to investigate human performance in detail. The degree to which an individual is successful at adapting to a particular circumstance is recorded under test conditions.

Criticism has been leveled at both the definition of intelligence and the validity and dependability of IQ tests. Emotional intelligence, for instance, is one type of intelligence that the researcher [2] has proposed exists. However, these may also be regarded as personality traits rather than intelligence-related traits. IQ tests have also been the subject of criticism [3]. However, it has been demonstrated that IQ tests have a high level of predictive validity for academic success [4,] and that their results are positively correlated with objective measures like simple reaction times [4,]. According to the findings, individuals who perform well on spatial and mathematical tasks also perform well on linguistic tasks [5,6]. In a similar vein, researcher [7] utilized data from a variety of sources to estimate the IQ of nations. The forecasting of a nation's wealth has been made possible by these IQ estimates. The purpose of this

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paper is to provide an estimate of state IQ and to discuss the estimate's strengths and weaknesses. The paper also aims to assess the degree to which estimated state IQ is linked to other state variables from the fields of political science, economics, public health, and criminal justice. We use IQ data to examine the mathematical concept of intelligence in this study.

Children's scores are currently higher because their brains are more developed rather than because their actual intelligence has increased. A 10-year-old's brain today is more developed and has more neural connections than a 10-year-old's brain from decades ago. Cognitive deduction demonstrates that these children's real intelligence has not increased but rather been acquired, and that adults today may actually be less intelligent than they were decades ago [9]. The evaluation of the contribution that education and ongoing learning make to the growth of an individual's IQ results in a more powerful mind and an increased level of competence in all aspects of life. Covid has a significant impact on education, particularly in math. The development of a mathematical model for estimating the Intelligent Quotient of post-covid Mathematics students is the focus of this study.

METHODOLOGY

This section of the research work is subdivided into two aspects which are model formulation and data description for proper elaboration.

Formulation of the Model Equations

To create the research model equation, we considered some measurable parameters that strongly influence intelligence quotient and the mathematical relationship between model and the parameters. Thus major parameters are;

Chronological Age (CA): Chronological age refers to the actual amount of time a person has been alive.

Mental Age (MA): it is the level of native mental ability or capacity of an individual, usually as determined by an intelligence test, in relation to the chronological age of the average individual at that level.

However, under this section, we employ the basic assumptions needed to give us a model that conforms to reality, which lead to the model formulation.

Model Assumptions

Intelligent Quotient (IQ) Versus Chronological Age (CA) of the Post Covid Mathematics Students

It is then observed that as after covid students IQ tends to drop. Hence, IQ is inversely proportional to CA. Thus mathematically,

$$IQ \propto 1 / CA \text{-----(1)}$$

$$\therefore IQ = K_1 / CA \text{-----(2)}$$

Intelligent Quotient (IQ) Versus Chronological Age (CA) and Mental Age (MA) of the Post Covid Students

Similarly, human IQ is directly proportional to his mental Age (MA) and inversely proportional to his Chronological Age (CA).

Thus mathematically,

$$IQ \propto MA / CA \text{-----(3)}$$

$$IQ = K_2 MA / CA \text{-----(4)}$$

Establishment of Model Parameter Relationship

Combining equations (2) and (4) gives,

$$IQ = K_1 / CA + K_2 MA / CA \text{-----(5)}$$

Data Description

This section of the research work entails source of data, choice of dataset, data analysis tool.





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Source of Data

Data are sought from post covid students using simple sampling techniques and well-structured questionnaire for accessing student respondent. This is a situation whereby a certain sample of the Nirmala college students was randomly made to represent the entire population of the post covid students in the research. Also, the data collected were appropriate as they were directly from the research field within the Nirmala College for women, after all possible and positive screening, 25 data were finally considered for the research.

Choice of Dataset

The dataset is highly affected by major factors which support their numbers for the analysis of the research work.. However, after evaluation of the dataset prior to the total number of students per season in every other institutions to be minimal (mostly 30%), and mental age prompt the choice of dataset to meet the best line of fit as it conform to reality.

Data Analysis Tool

The cumbersomeness of data and accuracy of model can't be handled numerically or other means, we adopt the least square method in evaluating the set of data as the analysing tool the model. The least square is a modeling tool aimed at producing result for unknown constants along with the highest value of model equations.

Analysing and Modelling

To evaluate the constants in the model equation above, our equation (5) is going to be differentiated partially with respect to the constants.

Hence, minimize the model using least squares method as follows:

$$y_{min} = \min \sum (I_Q - K_1^*/C_A - K_2^*M_A/C_A)^2 \text{ ----- (6)}$$

Differentiating with respect to the constants (K_1^*, K_2^*) yields the following

$$\frac{\partial y}{\partial K_1^*} = -2 \sum_{i=1}^{25} (I_Q - \frac{K_1}{C_A} - \frac{K_2 M_A}{C_A}) * \frac{1}{C_A} = 0 \text{ ----- (7)}$$

$$\frac{\partial y}{\partial K_2^*} = -2 \sum_{i=1}^{25} (I_Q - \frac{K_1}{C_A} - \frac{K_2 M_A}{C_A}) * \frac{M_A}{C_A} = 0 \text{ ----- (8)}$$

From equation (7) we have

$$\sum_{i=1}^{25} (I_Q)_i - (\frac{1}{C_A})_i = K_1^* \sum_{i=1}^{25} (\frac{1}{C_A})_i^2 + K_2^* \sum_{i=1}^{25} \frac{(M_A)_i}{(C_A)_i^2} \text{ ----- (9)}$$

Similarly from equation (8), we have

$$\sum_{i=1}^{25} (I_Q)_i - (\frac{M_A}{C_A})_i = K_1^* \sum_{i=1}^{25} \frac{(M_A)_i^2}{(C_A)_i^2} + K_2^* \sum_{i=1}^{25} (\frac{M_A}{C_A})_i^2 \text{ ----- (10)}$$

Research Instrument used

The research instrument used is known as random sampling technique. This is a situation where a certain sample of the post covid students was randomly made to represent the entire studentspopulation of the post covid in the research. After all possible and positive screening of the data, 25 data were finally considered for the research as shown below:

Using the data collected form equations as evaluated in table1, we have

$$\sum_{i=1}^{25} I_Q/C_A = 38, \sum_{i=1}^{25} 1/(C_A)^2 = 0.06, \sum_{i=1}^{25} (M_A/C_A)^2 = 4.54, \sum_{i=1}^{25} M_A/(C_A)^2 = 0.50, \sum_{i=1}^{25} I_Q(M_A/C_A) = 343.45$$

By substituting our values above into equation (9) and (10) gives,

$$38=0.06K_1^*+0.50K_2^* \text{ ----- (11)}$$

$$343.45=0.50K_1^*+4.54K_2^* \text{ ----- (12)}$$

Solving the system simultaneously by computational method in order to obtain (K_1^* and K_2^*)

$$K_1^* = 35.8, K_2^* = 71.7$$

Substituting the values of K_1^* and K_2^* into equation (5)

$$\therefore I_Q = (35.8)/C_A + (71.7) * (M_A/C_A) \text{ ----- (13)}$$

Hence the model's result.





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CONCLUSION

A mathematical model is developed to estimate the Intelligent Quotient of mathematics course students following the COVID lockdown.

ACKNOWLEDGEMENTS

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Table1: Analysis of the random sample of 25

S. No.	C_A	IQ	M_A	IQ/C_A	$1/(C_A)^2$	M_A/C_A	$(M_A/C_A)^2$	$M_A/(C_A)^2$	$IQ(M_A/C_A)$	$1/C_A$
1	22	21.05	6	0.96	0.00	0.27	0.07	0.01	5.74	0.05
2	20	52.63	14	2.63	0.00	0.70	0.49	0.04	36.84	0.05
3	19	26.32	7	1.39	0.00	0.37	0.14	0.02	9.70	0.05
4	21	31.58	8	1.50	0.00	0.38	0.15	0.02	12.03	0.05
5	22	31.58	8	1.44	0.00	0.36	0.13	0.02	11.48	0.05
6	20	52.63	14	2.63	0.00	0.70	0.49	0.04	36.84	0.05
7	20	26.32	7	1.32	0.00	0.35	0.12	0.02	9.21	0.05
8	19	21.05	6	1.11	0.00	0.32	0.10	0.02	6.65	0.05
9	22	31.58	8	1.44	0.00	0.36	0.13	0.02	11.48	0.05





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10	20	31.58	8	1.58	0.00	0.40	0.16	0.02	12.63	0.05
11	22	31.58	8	1.44	0.00	0.36	0.13	0.02	11.48	0.05
12	20	52.63	14	2.63	0.00	0.70	0.49	0.04	36.84	0.05
13	22	21.05	6	0.96	0.00	0.27	0.07	0.01	5.74	0.05
14	23	21.05	6	0.92	0.00	0.26	0.07	0.01	5.49	0.04
15	19	21.05	6	1.11	0.00	0.32	0.10	0.02	6.65	0.05
16	19	42.11	11	2.22	0.00	0.58	0.34	0.03	24.38	0.05
17	17	21.05	6	1.24	0.00	0.35	0.12	0.02	7.43	0.06
18	18	26.32	7	1.46	0.00	0.39	0.15	0.02	10.23	0.06
19	22	26.32	7	1.20	0.00	0.32	0.10	0.01	8.37	0.05
20	22	26.32	7	1.20	0.00	0.32	0.10	0.01	8.37	0.05
21	19	26.32	7	1.39	0.00	0.37	0.14	0.02	9.70	0.05
22	21	42.11	11	2.01	0.00	0.52	0.27	0.02	22.06	0.05
23	21	36.84	10	1.75	0.00	0.48	0.23	0.02	17.54	0.05
24	20	21.05	6	1.05	0.00	0.30	0.09	0.02	6.32	0.05
25	18	26.32	7	1.46	0.00	0.39	0.15	0.02	10.24	0.06
Tot	508	768.43	205	38.00	0.06	10.14	4.54	0.50	343.45	1.24





5G - Enhancing the Performance Efficiency using Software Defined Radio

Padmageetha.B.G^{1*}, Pramod Kumar Naik² and Mallanagouda Patil³

¹Associate Professor, Department of Computer Applications, Dayananda Sagar University, Bengaluru, Karnataka, India.

²Associate Professor, Department of CSE, Dayananda Sagar University, Bengaluru, Karnataka, India.

³Department of CSE, RVITM, Bengaluru, Karnataka, India.

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*Address for Correspondence

Padmageetha.B.G

Associate Professor,
Department of Computer Applications,
Dayananda Sagar University,
Bengaluru, Karnataka, India.
E.Mail: padmageethabg@gmail.com



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ABSTRACT

5G providing wireless connectivity for applications is extending faster with the advancement in network architecture and due to the increasing demand on utilization of frequency spectrum and bandwidth. 5G immensely provides an interconnection among heterogeneous devices and instigated to move from rigid networks to adaptable network through radio access network (RAN). So in this paper survey has been made on the 5G architecture and emerging technologies such as Software Defined Radio(SDR) that enable to manage effectively 5G networks to enhance the performance of network.

Keywords: 5G, SDR, RAN, WSN, SDN

INTRODUCTION

5G fits into 5th generation of global wireless standard under integrated air interface mobile technology standard. 5G uses high data speeds of 3GHz to 300 GHz frequency, low latency and connects globally with devices to fulfill the demand rising with the development of user peripherals or devices such as automobiles. By the invention of Qualcomm, the technologies has played a major role to drive the industry forward and make up 5G [2]. In the application such as mobile technology, 5G communicate with radio waves that have wide range of frequencies. 5G uses low, mid and high radio frequency range. High frequencies are used with sensors for communicating with vehicles or satellites. Many Services are in use that is with higher data rates, carrier frequencies and broad bandwidth





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to meet the demand of user. Much user equipment has been developed having lower bandwidth and delay [4]. It has increased the data traffic to 74% with gaming applications, multimedia applications [1]. This has led to the introduction of fifth generation-5G as it supports higher upward mobility user equipment. Nowadays in the industry spectrum accessing becomes the key role for the faster access of data. As wireless sensor network (WSN) can be integrated to the fields of IoT, agriculture, manufacturers, automation, emergency care centers, the concept of software defined radio (SDR) has been useful to implementing dynamic functionalities to the spectrum. SDR implements hardware features as software to achieve signals. So digitization is done instead of analogue using SDR. This SDR as cognitive radio gives various ways to improve the performance of WSN in terms of modulation, coding, topology, frequency band through the metrics Packet Error Rate, Link Quality Indicator [19].

APPLICATION OF SDR IN 5G

System to Track

SDR technology provides ad-hoc services in point-to-point or multipoint networks, and various network topologies such as tracking traffic using traffic signals.

System to Monitor

The tools provided by SDR technology allow for assured communication in the communication system.

System to Automate

SDR provide tools to provide high level QoS and security without fault tolerance.

System to routing

SDR acts as the central device of the network implementing software defined network (SDN) by reducing energy consumption among nodes

Applications of 5G

- Voice applications
- Healthcare—consulting/diagnosing/surgery patients remotely
- Virtual Reality, Augmented Reality with lighter devices - laptops
- Web applications
- Virtual conferencing with high quality
- Online gaming and video streaming
- Tracking Connected vehicles or traffic,
- Use of drones to supply resources
- Use in society
- Device to device (D2D) communications

CHARACTERISTICS OF 5G

- Data rates are faster to directly connect to devices.
- Latency Time for data to move from one point to another is lowered
- Delay in downloading is reduced
- Bandwidth is expanded to a large extent.

EVOLUTION OF 5G TECHNOLOGIES

In the year 1980, 1G apps with analog voice call was invented . At the same time the internet was introduced in 1990's with 2G technology. GSM and CDMA with digital voice services and with 34 to 171kbps digital services were introduced. with data rates were available at 2.75Gbps service with the data rates of 128Kbps to 348kbps. Then 3G





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wireless communication with technologies WCDMA, HSPA, EVDO which are capable of providing both voice service and data service at 10Mbps. Next was 4G technology like LTE, WiMAX which can provide data of 100Mbps, LAN cable connection. Also the concept of orthogonal frequency division multiple access was introduced to handle high data rates. Now an application to handle high data rates, low latency, massive number of connected devices such as Enhanced Mobile Broadband (eMBB), machine critical services(MCS), massive internet of things(IOT) are handled by 4G and moving to the new technology named 5G or fifth generation of wireless communication. Its main aim is to make wireless network same as wired fiber like performance at low cost per bit. In the application such as mobile technology, 5G communicate with radio waves that have wide range of frequencies. 5G uses low, mid and high radio frequency range.

- Low-band spectrum : 600 MHz - 1 GHz
- mid-band spectrum :1GHz - 6 GHz
- High-band spectrum : 24 GHz band and higher(mm wave)

5G NR is the new wireless standard and foundation of 5th generation wireless communication, is then given the name as 5G New Radio or NR. It was developed by the broadband communication and to meet the requirements of 5G outlined by International Mobile telecommunication (IMT)-2020. As the lower bands below 5GHz are completely occupied , we need to move towards the higher frequencies in millimeter wave band so current technology like LTE, are not designed to work at higher frequency band that can support high data rates in Gbps. As we need larger bandwidths of 1 GHz , 5G NR was developed.

5G ARCHITECTURE

5G can connect to any cluster of devices including cellular phone. With the conventional setup of physical network for communication, exchange of information can be optimized by 5G protocol. It will have same number of base stations like 4G but can support the increase of number of devices or user's connection thereby base station needs protocol with some modifications. 5G Parameters used in air media [18] is shown below in Table 1. As 5G supports new requirements, the entire architecture as shown figure 2, is with radio waves. So, it engages a new radio technology- a cloud based center supporting network slicing. 5G Network Architecture uses physical layer algorithms and radio access technology. It consists of huge base stations. Technologies such as Millimeter wave and MIMO antenna array hybrid beam forming wireless technologies are used. The cloud will be connected with billions of devices to access and share data by improving energy efficiency.

All the radio access networks use the same interface. The aggregator is situated at the controller (Base station and Radio network), aggregates all its traffics and routes to gateway. Each terminal has its own interface to access its spectrum. Global provider uses cloud and remote servers to maintain data.

CLUSTERING IN 5G

Clustering scheme scan use multiple clustering metrics, such as weighted clustering that uses four kinds of clustering metrics, namely the node degree, transmission power, mobility, and residual energy of a node While existing clustering schemes have shown network performance enhancement in various contexts, they are insufficient to cater to the needs of next generation wireless mobile networks. The network performance is measured from throughput, fairness, load balancing, lifetime is considered for cluster formation. Traditionally, clustering has been proposed to achieve network stability and scalability in order to improve network performance, such as throughput, the fairness of resource distribution and load balancing, as well as the lifetime of a CH, a cluster, or a network, while providing support for routing





SOFTWARE DEFINED RADIO

- A wireless transceiver should be equipped with a Radio Frequency (RF) transceiver to support a wireless standard
- Traditional RF transceivers are designed and implemented on a radio chip or an embedded module in a chip ensuring small size, high performance, low power consumption, and cost.
- It limits the programmability of the RF transceivers.
- An alternative solution to implement RF transceivers is using Software Defined Radio (SDR) platforms.
- SDR platform hardware exists with different configurations
- SDR platform satisfies the wireless standard requirements. An SDR device is a small handheld type of device which is capable of transmitting and receiving signals at different frequencies.
- Software-defined radio (SDR) is a radio communication system where components that have been traditionally implemented in analog hardware (mixers, filters, amplifiers, modulators/demodulators)
- Implemented by means of software on a personal computer or embedded system.
- Uses software for the modulation and demodulation of radio signals

GENERAL SDR BLOCK DIAGRAM

- Upgrading the software, changing the logic of the dedicated hardware or reusing the transceiver to implement a wireless standard other than the one the other transceiver SDR also allows to reuse software across multiple radio devices and download software over-the-air to implement new standards.
- Tracking systems: in this field, SDR technology is capable of providing ad-hoc services in point-to-point or multipoint networks.
- while providing different services in very different network topologies, for example, for buildings or traffic signals.
- Monitoring system: SDR technology provides tools that allow the communication system to be adapted in the most efficient way to guarantee communication in each particular environment.
- The SDR technology opens the possibility of adding new interfaces to the SDR devices by providing them adaptability in the electromagnetic domain
- Industrial automation: aspects of quality of service and information security are of vital importance without fault tolerance, and in this sense SDR provides the tools to provide a high level of QoS.
- Antennas radiate energy. They are used at high frequencies to transmit and receive electromagnetic waves. It has a reasonable size mechanical device.
- They are designed by the specialized tool as it works on high frequency.

While designing an antenna many different aspects are to be noted. They are efficiency, frequency, directivity, electrical properties such as impedance, current, leakage, pattern, charge distribution and so on. Antenna design should meet some specifications that meet the geometrical properties such as boundary conditions are critical to get correct results. To achieve antenna should be integrated into the system. Set up the communication system using hardware supporting packages in matlab and simulink . voice or video signals are sent for source coding . By using LTE system toolbox , generate LTE waveform and transmit and receive at the other end. Process and analyse the received signal. The Supported SDR instruments as transmitter are: RF Signal generator, Zynq Radio SDR, USRP SDR. Receivers are : RF Spectrum Analyser, Zynq Radio SDR, USRP SDR, RTL SDR. Signal generation is required to test the design for end to end communication for channel modelling and measure bit error rates, baud error rates, EVM, spectromax and finally test everything live with hardware.

LITERATURE REVIEW (Table 2)





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PERFORMANCE ANALYSIS [19]

To implement a wireless technology on SDR platforms or use existing implementations, it is necessary that the selected SDR platform performance should meet at least the requirements of the target wireless technology. These requirements are operating frequency band, bandwidth, bitrate, latency

FREQUENCY BAND

The frequency band of SDR platforms is the operating frequency range covered by the SDR device is the local oscillator (LO) signals generated by the frequency synthesizer.

BANDWIDTH

Any analog or digital signal has a bandwidth defined as the occupied range of frequencies carrying most of its energy. It is expressed at the ADC/DAC stage.

LATENCY

Refers to the time delay spent in the transceiver chain between host and the antenna connected to the SDR device.

ADC/DAC SAMPLE RATE

- The DAC sample rate, given on Samples per Second allows to determine the time interval between two samples applied to the input of a DAC.
- The ADC sample rate determines the time interval between two samples at the output of an ADC.
- Both sample rates are related to the input signal spectrum by the Nyquist-Shannon sampling theorem

SYMBOL RATE

- This rate, given in Symbol per second (Sym/s), refers to the constant rate at which symbols occur.
- One symbol can carry one or more bits according to the digital modulation format.
- For example, in a BPSK system, each symbol represents one bit; in a 64-QAM system, each symbol represents 6 bits.

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Table 1

Parameter	Data
Latency in air media	<1 ms and <10ms
Area capacity density	1 (Tbit/s)/km ²
Peak throughput (downlink) per connection	10 Gbit/s
Energy efficiency	> 90% over LTE

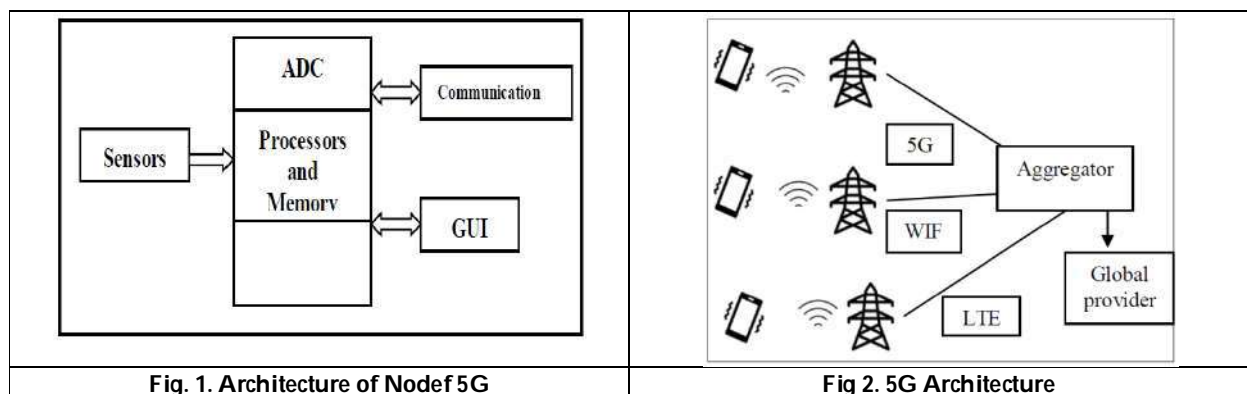




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Table 2 Literature Review

Title of the paper	Authors	Contribution of author
Software Defined Radio Platforms for Wireless Technologies[19]	Dereje M. Molla, Hakim Badis	An application, run within GNU Radio, is presented, deployed to overcome the hardware analog-to-digital converter limitation to monitor wide bandwidths
SDR Solution for Enhanced Quality Wider Bandwidth Communication[21]	Girish Chandra Tripathi; Meenakshi Rawat	Digital intermediate-frequency-based method to expand the band width of the multichannel SDR transmitter using a single LO configuration while avoiding RF imperfections
Design and implementation of DA-RFIR filter for effective removal of noise from audio signal for SDR applications [22]	G. Srikanth, Bhanu Murthy Bhaskara	Designed an efficient reconfigurable finite impulse response (RFIR) filter for the software defined radio applications.
Strong Noise Rejection in VLC Links under Realistic Condition through a Real-Time SDR Front-End [23]	Muhammad Ali Umair, Marco Meucci	Presents an extensive experimental evaluation of a complete VLC system, embedding a software-defined-radio (SDR)-based digital signal processing (DSP) filter stage, which is tested either indoors, in the presence of strong artificial 100-Hz stray illumination, and outdoors, under direct sunlight
Extreme Learning Machine based Spectrum Sensing in Coloured Noise with RTL-SDR [24]	Saikat Majumder; Manish Kumar Giri	Mitigating the detrimental effects of coloured noise on detection using an RTL-SDR device and propose an ELM based spectrum sensing algorithm.
Complete Stream Fusion for Software-Defined Radio [25]	Tomoaki Kobayashi, Oleg Kiselyov	High-performance signal processing will be reported using the SDR benchmark and FM Radio reception --to evaluate the recently developed single-thread stream processing library streamon, contrasting it with the synchronous dataflow system Stream.





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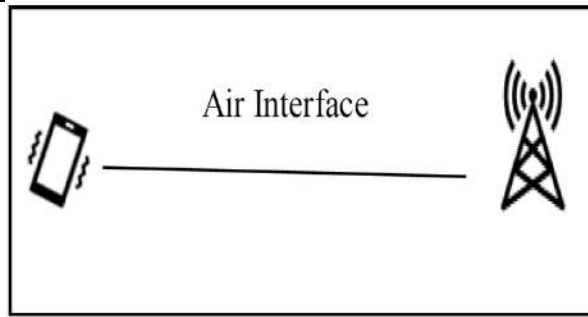


Fig. 3. 5G Air Interface

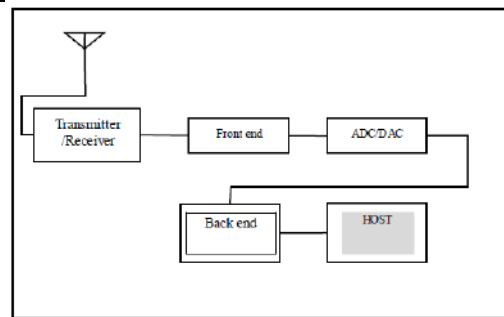


Fig. 4. Simplified Block Diagram of SDR

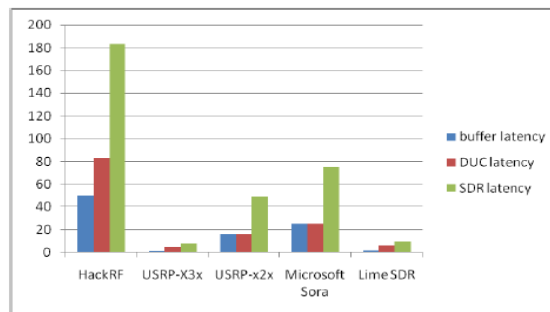


Fig. 5. SDR Comparitive Graph with Latency [19]





Geospatial Analysis of Land use Land Cover Change in Coimbatore City

S. Nagarathinam^{1*} and Jyothirmayi P²

¹Research Scholar and Department of Geography, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Head and Assistant Professor, Department of Geography, Nirmala College for Women, Tamil Nadu, Coimbatore, India.

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*Address for Correspondence

S. Nagarathinam

Research Scholar and Department of Geography,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.

E. Mail : nagarathinamgeo2020@gmail.com



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ABSTRACT

The natural landscape has been substantially changed by anthropogenic activity. Overpopulation has resulted in an increase in settlement area and a decrease in agricultural land. Using image classification methods, in Remote sensing and GIS technology provides precise information regarding LULC classification. Pixel spectral reflection, programme simulates the widely used pixel-based picture classification technique. The primary goal of the current study is to identify changes in land use and land cover in Coimbatore City Corporation. The USGS provided satellite images (Landsat 7) with a 30 m spatial resolution for the three separate time periods of 2013, 2017, and 2021 were used for the analysis. LULC categories were classified using supervised classification techniques on pixels using maximum likelihood classifiers. The current analysis shows that the urban built-up area is rising by 12.78% over the study period. The area under barren land has reduced to large extend which reveals the fast pace of urbanization.

Keywords: GIS, Land use and land cover, Image Classification, Maximum Likelihood, Change Detection

INTRODUCTION

Knowledge of changes in land use and land cover is necessary to comprehend how people interact with the environment on various levels. Land use, to put it simply, is the use of land resources for various purposes. As the urban population grows, so does the demand for land for diverse urban activities. Coimbatore is the second-largest city in the Tamil Nadu state after Chennai and the sixteenth-largest urban agglomeration in India, situated on the banks of the Noyyal River and surrounded by the Western Ghats. It is one of the fastest-growing three tier cities in





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India and a significant centre for manufacturing, education, information technology, healthcare, and the textile and industrial sectors in Tamil Nadu. The LULC study confirms how much and why certain single or multiple components are changing in a specific time phase, which is relatively beneficial for local to national level planning to the planners. Remote sensing & GIS techniques aid the feasible studies for the change detection. To accomplish the urban planning, the temporal and spatial aspects of town growth and changes in land use, and land cover in Coimbatore City Corporation were investigated in this study, from 2013 to 2021. The main objectives of this study are to identify and quantify the land use/cover categorization map for the Coimbatore city corporation in the Coimbatore district from 2013 to 2021 using satellite data and topographic maps.

The Study Area

Coimbatore city is located between latitudes 10°52'0" and 11°09'0"N and longitudes 76°51'30" and 77°4'30"E. Known also as Kovai, Coimbatore is a significant city in the Tamil Nadu state of India. Coimbatore is known as the "Manchester of South India" because of the presence of Cotton and Textile Industry. Nearly half of India's needs for motors and pumps are met by Coimbatore, commonly known as the "Pump City." Municipality of Coimbatore City, includes five administrative zones with 100 wards each, namely North, South, Central, East, and West.(Figure 1: Location of the study area, Coimbatore)

MATERIALS AND METHODS

✓ Satellite data has been collected from the USGS website and Survey of India topographical sheets used for the study period.

✓ Arc map10.5, ERDAS IMAGINE - 9.2, Google Earth Pro, Microsoft office 2007 – Excel & Word were the software used for the analysis.

The satellite images for the period of 2013, 2017, and 2021 obtained from Landsat 7 data downloaded from the USGS website and were geo referenced using Arcmap. Landsat 7's Enhance Thematic Mapper has a 30 metres spatial resolution. The Survey of India topographic sheets 58A/16, 58B/13, 58E/4, and 58F/1, were used for preparing base maps.

The digital data from Lands at 7 geo referenced for LULC mapping for the year 2013 was being classified using a supervised signature extraction with the maximum likelihood technique. In order to obtain precise locational point data for each class of land use and land cover included in the categorization system, build training sites, and generate signatures, ground cross-verification with Google Earth was carried out. Histogram equalisation in ERDAS Imagine 8.7 was used to enhance the remote sensing satellite data prior to classification in order to provide better images and increase classification accuracy. The post classification study utilized the land use maps from three distinct time periods, allowing for the evaluation of changes to the land use classifications.

RESULTS AND DISCUSSION

Land Use and Land Cover Status over various timeframes: Using Landsat pictures, an assessment of land use and land cover is made for the years 2013, 2017, and 2021. The image pixels were correctly categorised into several land use and land cover categories using the supervised classification technique with a Maximum Likelihood Classifier. Following the classification of the images the areas covered by various land use and land cover classes were identified using a conservative change detection technique. The total number of pixels recognized in each class is magnified at a 30m × 30m pixel resolution (for Landsat-7).

Land Use and Land Cover in 2013

The study region is divided into five LULC categories: settlements, vegetation, water bodies, agricultural land, and barren terrain. According to the results of pixel-based supervised classification in 2013, 42.05 percent of the entire geographical region was covered by barren land (Table No. 2). The barren lands in Coimbatore city is scattered





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throughout in the northern eastern ,western and southern parts (Figure No 4). The second most common use of land is for settlements, which makes up around 26.88 percent of the total geographical area and are primarily concentrated in the central part of Coimbatore city. Agriculture occupies roughly 20.26 percent of the land. VVegetation covers about 9.55 percent of the land. About 1.24 percent of the study area consists of water bodies, namely the river Noyyal, its tributaries, and numerous lakes in the south west and south east.

Land Use and Land Cover in 2017

According to the classification method, barren land made up around 47.26 percent of the total area (Fig. No. 4). Settlements extend over 30.65 percent of the total area. According to calculations, vegetation cover approximately 11.01 percent of the entire area, while agriculture took up roughly 6.64 percent. There is little change in the area under water bodies. It just covers about 4.43 percent (Table No. 2).

Land Use and Land Cover in 2021

In comparison to the overall geographic area, the proportion of agricultural land has increased to 32.59 percent, while the proportion of barren land has decreased to 24.11 percent (Fig. No 4). 39.66% of the area consists of settlement (Table No. 2). Vegetation only makes about 1.68 percent of the total land. 1.93 percent of the entire geographical region is covered by water bodies in 2021.

CONCLUSION

Coimbatore city corporation limits have changed drastically over last few decades in terms of land use, land cover, and even the climate. This research study is demonstrating that major LULC alterations occurred between 2013 and 2021. The built-up area has increased significantly by 12.78% as a result of the tremendous growth of the industrial sectors like cars and Information technology, which has prompted migration from various districts to Coimbatore. However, the area of barren land has decreased by 15.95%, which is the proof for the fast pace of urbanization. This study adequately indicates how crucial it is to consider the people as well as the activities that support, when managing and planning an urban area development. The change detection and identification of the vulnerable zones which needs immediate attention in the Coimbatore Municipal Corporation area is particularly beneficial for environmental management organizations, policymakers, and the general public to think about a sustainable development for their city.

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Table 1 : Area Under different Land Use and Land Cover in 2013-2021 (Area in Sq.km)

S.No	Class Name	2013 Area in Sq km	2017 Area in Sq km	2021 Area in Sq km
1	Agriculture	52.72	17.27	84.78
2	Barren Land	109.41	122.94	62.73
3	Settlements	69.92	79.74	103.18
4	Vegetation	24.84	28.64	4.3
5	Water bodies	3.22	11.52	5.04

Table 2 : Area Under different Land Use and Land Cover in 2013-2021 (Area in Sq.km)

S.No	Class Name	2013 Area in %	2017 Area in %	2021 Area in %	Changes (2013-2021) %
1	Agriculture	20.26	6.64	32.59	12.33
2	Barren Land	42.05	47.26	24.11	-15.94
3	Settlements	26.88	30.65	39.66	12.78
4	Vegetation	9.55	11.01	1.68	- 7.87
5	Water bodies	1.24	4.43	1.93	0.69

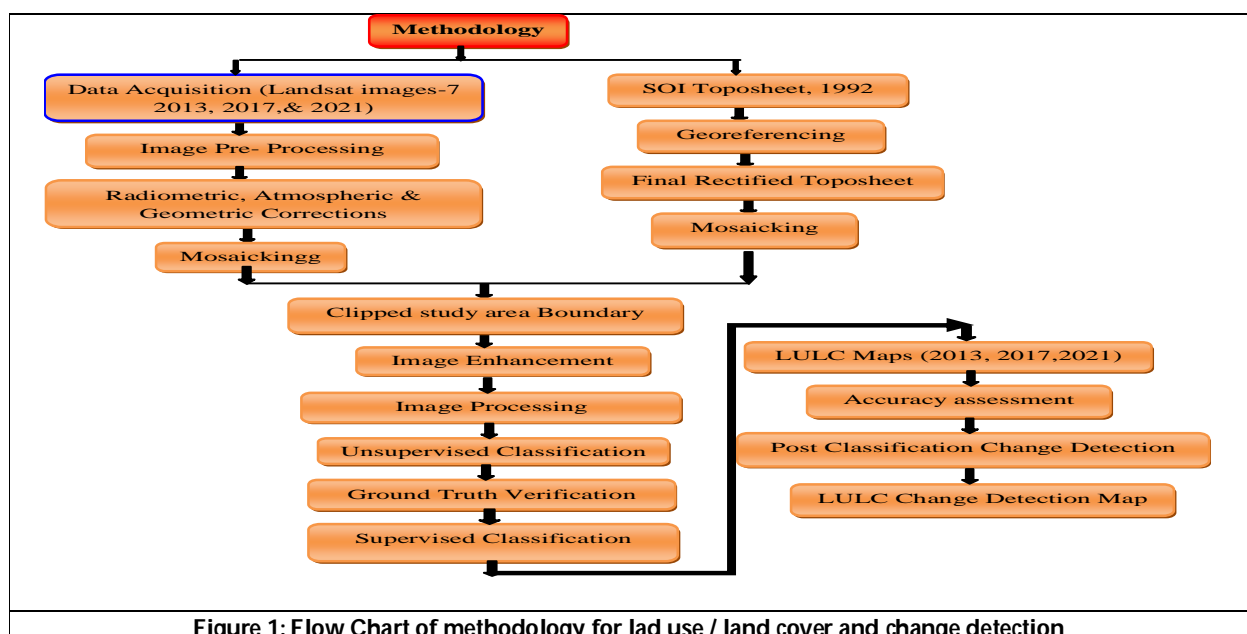


Figure 1: Flow Chart of methodology for land use / land cover and change detection





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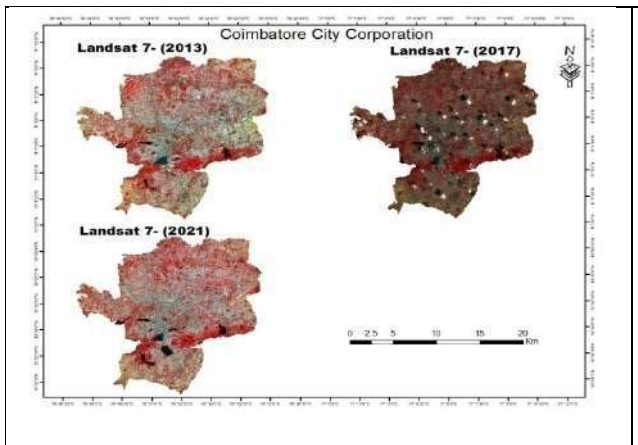


Figure 2: Landsat-7 satellite imagery scene of study area (2013, 2017 & 2021)

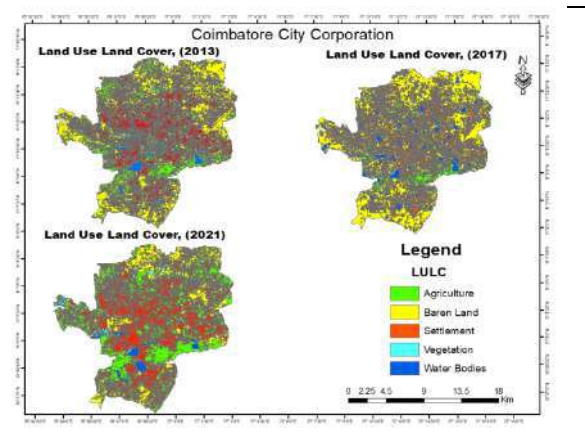


Figure 3. - Land use and Land cover map of Coimbatore City Corporation (2013, 2017 & 2021).

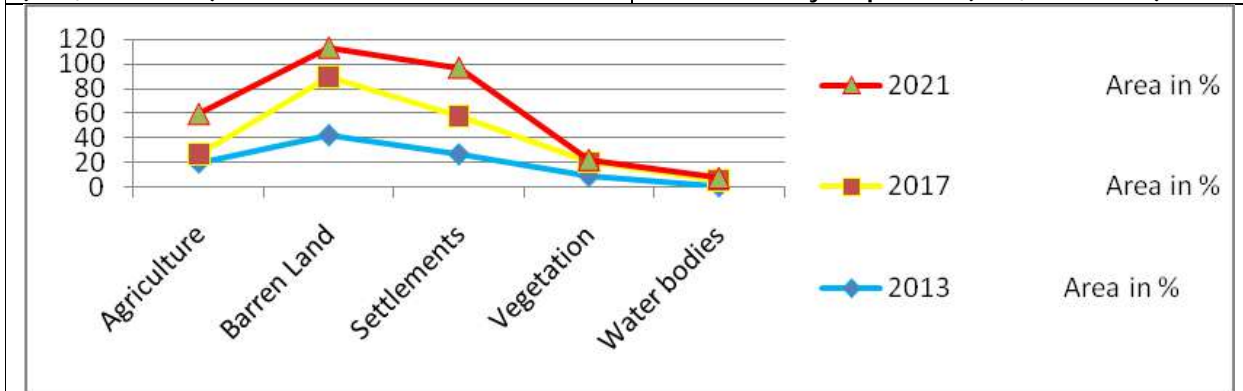


Figure 4 - Land use and Land cover map of Coimbatore City Corporation (2013, 2017 & 2021).





An Efficient Diagnosis System for Predicting the Cirrhosis Disease Detection using Ensemble Techniques of Machine Learning

S.Chithra*

Assistant Professor, Department of computer science and applications, Christ Academy Institutes for Advanced Studies, Bengaluru, Karnataka, India

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*Address for Correspondence

S.Chithra*

Assistant Professor,
Department of computer science and applications,
Christ Academy Institutes for Advanced Studies,
Bengaluru, Karnataka, India.



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ABSTRACT

Machine learning has recently developed into a simple method for predicting diseases in the healthcare industry. Predicting diseases from the vast medical database is a very difficult job for researchers. The use of automated decision-making tools and algorithms has rapidly increased in the medical industry. The rapid increase in the amount of obesity and a poor lifestyle ultimately reflects the probability and prevalence of liver-related diseases among the population. The most widespread form of chronic liver illness worldwide is cirrhosis. For effective treatment and the avoidance of grave health consequences, the capacity to predict the onset of liver cirrhosis disease is essential. The primary goal of this research project is to use classification algorithm to predict cirrhosis liver disease. A total of 424 patients have been used for this research. The suggested model used Decision tree, Naïve Bayes, SVM and Ensemble Boosted tree to predict liver cirrhosis illness. Ensemble boosted tree method yields the better accuracy out of all the techniques evaluated in this study.

Keywords: cirrhosis disease, Machine learning, Ensemble, boosted tree, performance metrics

INTRODUCTION

The metabolism of cholesterol, glucose (sugar), and iron, as well as blood clotting and protein synthesis, are all functions of the liver. It is necessary for life and carries out numerous functions, including cleansing the body. Losing those skills could cause major injury to the body. The liver, the second-largest internal organ in the body, is responsible for breaking down red blood cells and making a considerable metabolic contribution.[1]. Its approximate weight is three pounds. Numerous vital tasks linked to immunity, digestion, metabolism, and nutrient storage are carried out by the liver. Without the liver, body tissues would rapidly perish from a lack of nutrients and energy, making it a crucial organ. Traditionally, the blood's levels of various enzymes can be used to clinically identify liver

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disease[2]. The fundamental risk is the same whether the liver is harmed by chemicals, viruses, or the body's defence system: it will become so damaged that it will no longer be able to function to maintain life. The term "liver disease" is also used to describe hepatic disease. Typical liver disease signs include weakness, fatigue, nausea, and right upper quadrant abdominal discomfort. Jaundice, fatigue, migraine, nausea, backache, abdomen swelling, weight loss, fluid in an atypical cavity, general itching, pale stools, and expanded spleen and gallbladder are all signs of liver disease. [3]. Cirrhosis of the liver is a serious form of liver injury. It typically results from the long-term liver harm brought on by a variety of conditions and illnesses, including hepatitis, chronic alcoholism, and genetics. As the liver attempts to heal itself after each injury, fibrous scar tissue may be formed in place of the missing cells, resulting in the development of cirrhosis. Cirrhosis makes it harder for the liver to operate because more scar tissue develops as the condition worsens. Life-threatening hepatitis has advanced stages. Cirrhosis can also result in ascites, hepatorenal syndrome, portal hypertension, and liver encephalopathy in addition to fibrosis. The clinical picture and the histologic results of cirrhosis are poorly correlated. The possibility of liver cirrhosis spreading may rise with prolonged diagnostic delays.

Machine learning techniques are becoming increasingly common in medical diagnosis and disease prediction. A variety of practices, including diagnosis procedures, treatment, personalised medicine, and patient tracking and care, have benefited from the development of machine learning techniques. The disease-related mortality rate is rising to alarming levels. Early detection of the disease may minimise the complication of the disease's misfortune on patients. The ease of use of innovative technologies, like the one predicted in this study, may help to alleviate the difficulties of the delay in identifying and treating liver cirrhosis. The main aim of this research is to create and put into practise a diagnostic method that uses symptoms and risk factors to identify cirrhosis patients

RELATED WORKS

As a result of hazardous gas inhalation, contaminated food consumption, drug usage, and excessive alcohol consumption, liver disease is becoming more common among patients. An automatic classification tool might minimise the workload for doctors [4]. The classification methods were developed using datasets from patients with liver disease. He took into consideration four algorithms for the task: Naive Bayes classification, C4.5, the back propagation neural network algorithm, and support vector machines. These algorithms were assessed according to four parameters: accuracy, precision, sensitivity, and specificity. In contrast, Aneeshkumar employed a technique to classify the dataset of liver and non-liver diseases effectively. After data cleansing, a pre-processing technique is used to prepare the data for successful classification. Based on the average and standard deviation of each factor for both classes, he divided datasets into three different kinds of ratios and assessed the precision[5]. The early efforts on neural networks provide a fresh and significant way for intelligent medical diagnosis. Kiruba [6] suggested a model based on an intelligent agent-based system in order to create a precise and accurate diagnosis system. In order to predict, we use the C4.5 decision tree algorithm and the random tree method. The accuracy of the disease is predicted by combining two distinct types of liver disease disorder datasets. Finally, these two algorithms provide very high diagnostic accuracy for liver disease disorders. Hepatocellular carcinoma, fatty liver, congestive heart failure, hepatocellular abscess, and viral hepatitis are the most prevalent causes of hepatomegaly and are caused by amoebiasis.

Sumedh, Jay, and Reshul (2017) suggested two strategies with the end goal of ordering the eternal liver illness; one strategy is a characteristic way to deal with finding, and the second includes a hereditary way to deal with finding. Application of Multi-Layer Perceptrons and Artificial Neural Networks to Reduce Scale Array Analysis is the suggested method. They used these two methods to improve the accuracy of the Back Propagation and Support Vector Machine (SVM) calculations used to describe the liver condition[7]. Insha and Chiranjit (2018) suggested data mining techniques to identify liver disease caused by excessive alcoholism. Their research suggested using information mining algorithms to identify and predict liver disease before it occurs. After deciding on the guiding principles, they prepare and evaluate the dataset to identify the liver disease using a variety of information mining calculations. They focused on the information (Dataset) that was gathered from the UCI repository and consists of 7 distinct qualities with 345 occurrences and is reliant on laboratory findings [8].





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Gregory (2015) proposed combining two real-world datasets of liver patients to build classification algorithms that could predict the diagnosis of liver disease. Accuracy, precision, and recall were used to assess each classifier's effectiveness. The experimental results show that the FT Tree method performs better than other algorithms in terms of classification accuracy and enhanced performance with respect to the attributes.[9]. Using the Least Squares Support Vector Machine (LSSVM) and the Modified Particle Swarm Optimization algorithm, Omar and Eman (2014) suggested a hybrid classification system for HCV diagnosis. Utilizing the Standard Component Analysis method, feature vectors are extracted. The Modified-PSO Algorithm was employed to locate the ideal LS-SVM parameters in less iterations because the LS-SVM algorithm is sensitive to changes in parameter values. The suggested method was put into use and assessed using the benchmark HCV data set from the UCI machine learning database repository. It was related to a different categorization scheme that gave rise to PCA and LS-SVM. The experiment's results showed that the suggested system performed better in terms of classification accuracy than the other systems. [10]. Moloud, Mariam, Resul, and I-Hsien (2016) suggested a PC-aided diagnostic strategy using two novel tree-based calculations for liver infection prediction: the C5.0 calculation and the Chi-square Automatic Interaction Detector (CHAID) calculation. To achieve the highest level of accuracy and to generate guidelines for the liver disease dataset, they suggested that strategy developers use C5.0 calculation through boosting technique[11].

METHODOLOGY

Identifying the patient's liver condition is the major objective of this study. The effectiveness of several machine learning approaches is evaluated and some of the metrics are used to forecast liver illness.

Machine Learning

Machine learning is a process in which the machines are trained so that they can respond to a particular input or circumstance using prior inputs that they have learned. The main goal of machine learning is to grasp informational structure and incorporate it into models that people can use and understand. On the other hand, machine learning techniques modify computers to train on data inputs and apply applied mathematics analysis to produce values that fall inside a certain range. In order to automate decision-making based on information inputs, computers may now build models from example data with the use of machine learning. Computers are now able to act without being explicitly instructed thanks to machine learning.

Decision Tree

Decision trees divide information indefinitely according to a particular parameter, which could be a variety of supervised learning techniques. The two components that will be used to support the tree are nodes and branches. It is a tree-like pattern within the graphical illustration, and it makes use of a classification model to forecast the value of a target attribute supported by the number of characteristics input from an example assortment.

Naive Bayes Classification

The Naive Bayes Classifier is one of the most basic and reliable classification algorithms available today. It enables the rapid development of machine learning models capable of making accurate predictions. As a probabilistic classifier, it bases its predictions just on likelihood that an event will occur. The Naive Thomas Bayes Classifier, which is supported by the Naive Bayes theorem, calculates the likelihood of an occurrence A given an occurrence B. The Naive Thomas Bayes method is used in the categorization process.

Support Vector Machine

The primary aim of the svm classification machine algorithm is to find an N-dimensional hyperplane that clearly categorises the data points. The two groups of information points can be divided using a variety of different hyper planes. Finding a plane with the optimal divergence between information points from each category is the aim of SVM. Maximizing the margin distance adds some support, increasing the boldness with which future information points will be categorised.





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Ensemble technique

Ensemble methods combine multiple decision trees to generate superior predictive performance than a single decision tree. The central tenet of the ensemble model is that weak learners can be combined to create stronger learners. Boosting is an additional ensemble method for developing a set of indicators. This method entails gradually teaching learners, beginning with early learners fitting basic models to data and progressing to later learners checking the data for errors.

Dataset Description

A total of 418 PBC patients, referred to Mayo Clinic during that ten-year interval, met eligibility criteria for the randomized placebo-controlled trial of the drug D-penicillamine. fedesoriano. (August 2021) has been used for Cirrhosis Prediction Dataset. This data set has been retrieved from the Kaggle dataset. The data was categorised as cirrhosis disease patient status using a variety of machine learning methods in MATLAB. The results of each classification were then evaluated. In this research, total 19 Attributes are considered as Predictors and 1 response variable. The flow model for the suggested methodology is shown in Fig1

MODEL PREDICTION

In the proposed study, four classification algorithms—Logistic Regression, Decision Tree, Naive Bayes Classifier, and SVM—have been applied to the datasets. The outcomes have been compared using evaluation metrics such as Accuracy, Precision, Recall, and F1Score. Following the application of the algorithm method, the performance is evaluated using a variety of metrics, and these metrics are then compared. In this research, typical categorization metrics such as accuracy, specificity, sensitivity, time and AUC are used. The accuracy of a model determines whether it can categorise the data with accuracy [11].

Accuracy may be determined by applying the equation 1

$$Accuracy = \frac{X + Y}{U + V + X + Y}$$

Sensitivity may be determined by applying the equation 2

$$Sensitivity = \frac{X}{X + V}$$

Specificity may be determined by applying the equation 3

$$Specificity = \frac{Y}{Y + U}$$

X – True Positive Y - True Negative U -False Positive V – False Negative

ROC Curve

AUC-ROC curve helps us visualize how well our machine learning classifier performs. Although it works only for binary classification problems, we will see how we can extend it to evaluate multi-class classification problems

TIME

The training time of a model is the time it takes to train on a dataset, whereas the execution time is the overall time required for computations, which includes data splitting, data preprocessing, and model evaluation.

RESULTS AND DISCUSSION

The research study is divided into several stages to improve cirrhosis disease diagnosis accuracy and result interpretation. However, assessment results for the performance accuracy of the model were taken into





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consideration. The research's primary objective was to compare the effectiveness of the classifiers. In order to execute the prediction of cirrhosis disease, the algorithm with the best predictive model will be used. Table 1 shows the visual performance as well as the performance results of all the classifiers that were taken into account. The visual representation of the experiment's classifiers' performance accuracy is shown in fine detail in the following figures

CONCLUSION

The research used machine learning techniques to predict liver cirrhosis disease at an early stage, including decision trees, naive bayes classification, SVM, and ensemble boosted trees. Based on accuracy, sensitivity, precision, AUC, and runtime, these algorithms produce a variety of results. These methods' effectiveness was compared and assessed. According to the study's findings, the ensemble boosted tree outperforms other algorithms, with an accuracy of 80.1%. The chart lists the performance metrics that were used for comparison (Table1). The management of people's health will benefit from the use of ensemble methods among machine learning algorithms to forecast liver disease. To diagnose liver cirrhosis illness, however, we will in the future gather very large amounts of data from numerous locations around the globe.

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Table 1: Performance evaluation metrics

Classification Model	Sensitivity	Specificity	Accuracy	Time	AUC
Decision Tree	90%	10%	75.80%	3100	0.81
Naive Bayes	87%	13%	74.20%	1000	0.86
SVM	93%	7%	73.20%	1600	0.81
Ensemble Boosted Trees	94%	6%	80.10%	780	0.86

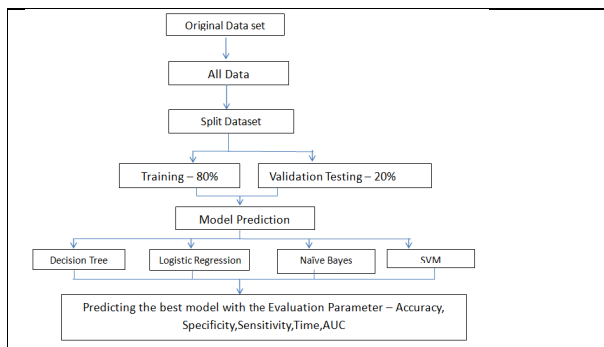


Fig. 1. Methodology

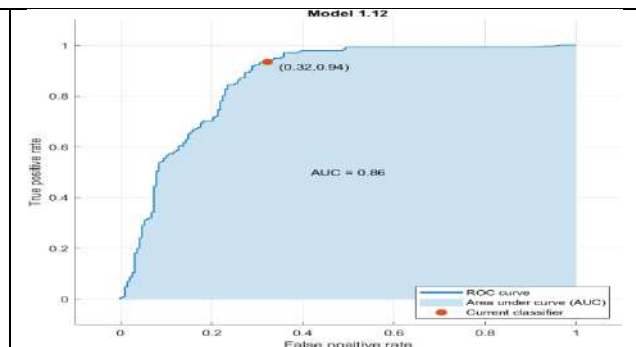


Fig. 2: ROC curve for Ensemble Techniques

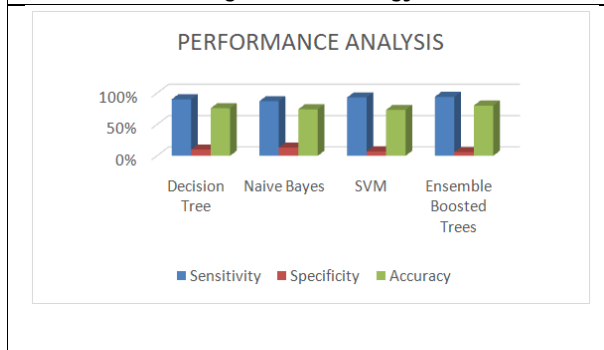


Fig 3. Comparison of Machine Algorithms According to Accuracy

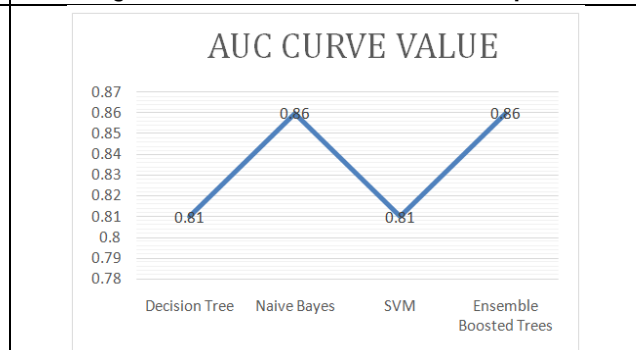


Fig 4. Comparison of Machine Algorithms According to AUC

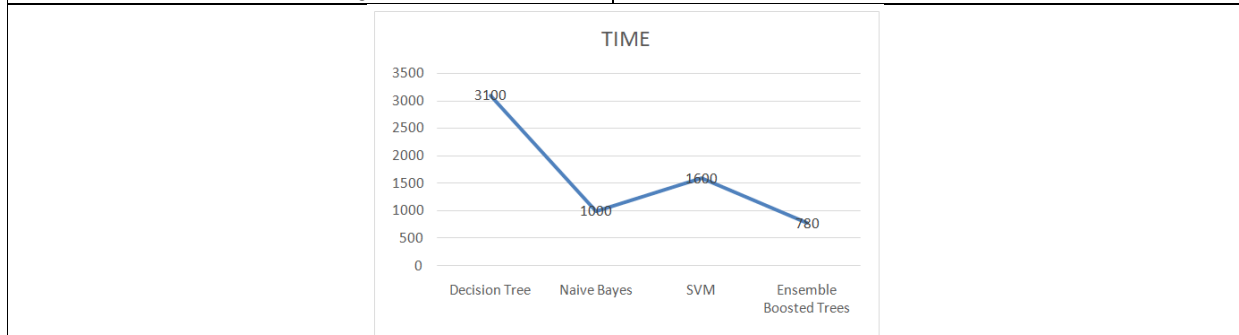


Fig 5. Comparison of Machine Algorithms According to Runtime





Third Eye Detection using IoT

Puja Shashi^{1*}, Ashok Kumar² and Meet Bundela²

¹Professor and Head, MCA Department, The Oxford College of Engineering, Bommanahalli, Bengaluru, Karnataka, India

²Student, MCA III sem, The Oxford College of Engineering, Bommanahalli, Bengaluru, Karnataka, India

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Accepted: 30 Mar 2023

*Address for Correspondence

Puja Shashi

Professor and Head,
MCA Department,
The Oxford College of Engineering,
Bommanahalli, Bengaluru, Karnataka, India
E. Mail : drpujashashi@gmail.com



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ABSTRACT

This project aims to design a motion detection system that can detect the presence of intruders in a house and send an alert to the house owner. Whenever the algorithm detects motion, it triggers an event internally and sends an alert to the house owner via Notification. The design uses readily available hardware components and software libraries, making it easy to implement and cost-effective. The results show that the system can accurately detect motion and send alerts in real-time, providing a reliable security solution for the house owner.

Keywords: Motion detection, Alert system, Intruder detection, Nord Microcontroller Unit (MCU), Blynk, Software, Home security, Embedded systems

INTRODUCTION

Security is a major concern for homeowners, and one of the best ways to ensure the safety of a property is to install a motion detection system. In this project, we propose a motion detection system that utilizes an infrared (IR) sensor, a Nord MCU (esp8266), and the Blynk platform to detect intruders and send alerts to the house owner. The IR sensor detects motion by detecting changes in the IR radiation levels in the surrounding environment. The esp8266 microcontroller processes the sensor data and sends an alert to the Blynk platform when motion is detected. Blynk is a platform that allows users to build graphical user interfaces for their Internet of Things (IoT) projects. In this project, the Blynk platform is used to send an alert to the house owner via customized Notifications. This motion detection system is a low-cost and easy-to-implement solution for home security. The combination of the IR sensor, esp8266 microcontroller, and Blynk platform provides a reliable and effective way to detect intruders and alert the





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house owner in real-time. In the following sections of this report, we will describe the design and implementation of the system in detail, including the hardware components, software libraries, and the results of our testing.

LITERATURE SURVEY

A study by Naik *et al.* (2021) proposed an IoT-based surveillance system that used NodeMCU and PIR sensor to detect motion and send alerts to the user's mobile phone. The system was also equipped with a GPS module, which could track the location of the intruder and provide real-time updates to the user. In a study by Hossain *et al.* (2021), an IoT-based smart home security system was proposed that used NodeMCU and PIR sensor to detect motion and send alerts to the user's mobile phone. The system was also equipped with a gas sensor, which could detect gas leaks and send alerts to the user's mobile phone. Another study by Sarkar *et al.* (2021) proposed a smart home security system that used NodeMCU and PIR sensor to detect motion and send alerts to the user's mobile phone. The system was also equipped with a camera that could capture images and videos of the intruder, which could be stored in the cloud for future reference.

Problem Statement

Existing

One existing system for motion detection and sending alerts to a house owner when an intruder is detected is a security camera system with motion detection capabilities. These cameras use advanced image recognition technology to detect movement and can be set up to send alerts via email, text message, or push notification to the homeowner's phone or computer. When motion is detected, the camera can start recording and send an alert to the homeowner. The homeowner can then view the live footage or review recorded footage to confirm if there is an intruder. Some systems also come with features such as two-way audio, allowing the homeowner to communicate with the intruder and deter them from entering the property further. This type of system typically requires a Wi-Fi connection, a power source for the cameras, and a subscription to a cloud storage service to store the recorded footage. Some systems also offer additional features such as night vision, facial recognition, and customizable motion detection zones.

Proposed System

Drawback of the existing camera system is that it detects the movement and turns on the camera but it can only be helpful to take snaps of the intruder if the internet connection is strong from both side or else it'll just create a havoc and alert the thieves as well. But, In our proposed system we're making the device to send notification directly which can be done with low latency and with agility to alert only the owner so in the time thieves make their move, meanwhile owner can take legal action instantly. Statistically nowadays most number of houses already having at least one security camera at their porches so, this can work as a better security system.

Circuit Diagram Figure :1

System Requirement

Node MCU The Node MCU is an open-source development board based on the ESP8266 microcontroller. It is designed for building Internet of Things (IoT) applications and is widely used for prototyping and development due to its low cost, small size, and compatibility with a variety of programming languages. The NodeMCU has built-in Wi-Fi connectivity, allowing it to connect to a network and send and receive data over the Internet. It also has a number of peripheral interfaces, such as GPIOs, ADC, I2C, and SPI, making it a versatile platform for building a variety of IoT applications. The NodeMCU is programmed using the Lua scripting language or using the Arduino Integrated Development Environment (IDE) with the Arduino Core for ESP8266. Overall, the Node MCU is a popular choice for IoT projects due to its ease of use, low cost, and wide range of features.

PIR Sensor A Passive Infrared (PIR) sensor is a type of sensor that detects the presence of a person or an object by measuring the infrared (IR) radiation that they emit. PIR sensors are commonly used in security systems, such as burglar alarms and motion-activated lighting systems, as they are able to detect movement within a defined area.





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Jumper Wires Jumper wires are short, flexible electrical wires that are used to make connections between different components in an electronics project. They are typically made of stranded copper wire with a plastic insulation coating, and are available in different lengths and colors. The wires have metal connectors on either end, called male headers or female headers, that allow them to be easily inserted into breadboards or other types of connectors.

Implementation

The motion detection and alert system is a combination of hardware and software components that work together to detect the presence of intruders and send an alert to the house owner. The design of the system can be divided into two parts: hardware design and software design.

Hardware Design:

Infrared (IR) Sensor: The IR sensor is the primary component that detects motion by measuring changes in the IR radiation levels in the surrounding environment. The sensor outputs a digital signal when motion is detected.

Microcontroller: The microcontroller is responsible for processing the sensor data and sending an alert to the house owner. A popular choice for this project is the NodeMCU, as it is low-cost and has built-in Wi-Fi connectivity.

Power Supply: The system requires a power supply to operate the IR sensor and the microcontroller. This can be provided by a battery or a wall adapter.

Jumper Wires: Jumper wires are used to connect the IR sensor, the microcontroller, and the power supply.

Software Design

Firmware: The firmware is the software that runs on the microcontroller and controls its behavior. The firmware receives data from the IR sensor and sends an alert to the house owner when motion is detected.

Blynk Platform: The Blynk platform is used to send the alert to the house owner. Blynk is a cloud-based platform that allows users to build graphical user interfaces for their IoT projects. The Blynk platform can be used to send a notification to the house owner when motion is detected. The overall design of the system is simple and straightforward. When motion is detected by the IR sensor, the microcontroller processes the sensor data and sends an alert to the house owner via the Blynk platform. The house owner can then view the live footage of the camera or access recorded footage to determine if an intruder is present. In conclusion, the motion detection and alert system provides a reliable and cost-effective solution for home security. By using readily available hardware components and software libraries, the system can be easily implemented and customized to meet the specific needs of the house owner.

RESULTS ANALYSIS

The result of a motion detection and alert system is a reliable and efficient security solution for homeowners. The system is designed to detect the presence of intruders and send an alert to the house owner, allowing them to take appropriate action in a timely manner. The system provides several benefits, including:

Early Detection: The motion detection system is able to detect intruders early, providing ample time for the house owner to take action and prevent any potential theft or damage.

Cost-Effective: The system uses low-cost hardware components and software libraries, making it an affordable solution for home security.

Convenient Alerts: The system sends alerts to the house owner via the Blynk platform, which can be configured to send email or SMS notifications. This allows the house owner to receive alerts on their phone or computer, regardless of their location.

Customizable: The system is highly customizable, allowing the house owner to configure the sensitivity of the IR sensor and the type of alert they receive.

Easy to Install: The system is easy to install and requires no professional assistance, allowing the house owner to set up the system quickly and easily.





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Overall, the motion detection and alert system provides a reliable and cost-effective solution for home security. The system is designed to detect intruders early and send alerts to the house owner, allowing them to take appropriate action in a timely manner.

Future Enhancements

The motion detection and alert system provides a reliable and cost-effective solution for home security, however, there is always room for improvement and further development. Some potential areas for future work include:

Integration with other Security Devices: The system could be integrated with other security devices, such as cameras and alarm systems, to provide a complete home security solution.

Machine Learning: The system could be enhanced with machine learning algorithms to improve the accuracy of motion detection and reduce false alarms.

Voice Alerts: The system could be enhanced to provide voice alerts in addition to email or SMS notifications. This would provide an additional layer of security for the house owner and make it easier for them to respond to alerts.

Remote Monitoring: The system could be enhanced to provide remote monitoring capabilities, allowing the house owner to monitor the system from their smartphone or computer.

User-Friendly Interface: The system could be enhanced to provide a user-friendly interface, allowing the house owner to easily configure and manage the system.

Overall, there is potential for significant improvements to the motion detection and alert system, including integration with other security devices, machine learning algorithms, voice alerts, remote monitoring, and a user-friendly interface. These enhancements would make the system even more reliable, efficient, and user-friendly, and provide additional peace of mind for the house owner.

CONCLUSION

In conclusion, the motion detection and alert system provides a reliable and cost-effective solution for home security. The system uses a passive infrared sensor to detect the presence of intruders and send alerts to the house owner via the Blynk platform. The system is highly customizable, allowing the house owner to configure the sensitivity of the IR sensor and the type of alert they receive. The system provides several benefits, including early detection, cost-effectiveness, convenient alerts, and easy installation. It has a wide range of applications in the field of home security and surveillance, including securing homes, businesses, and outdoor areas.

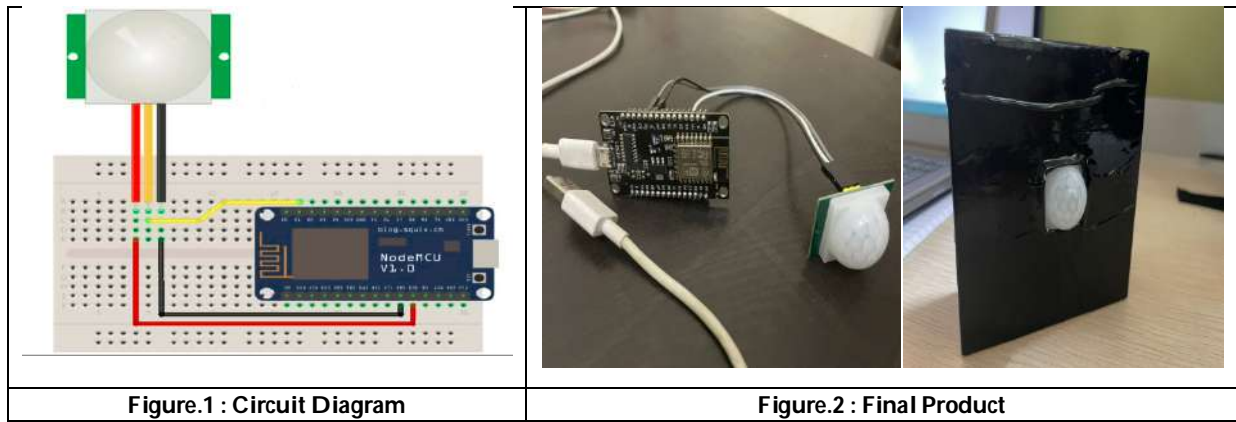
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Generalized Pentapartitioned Neutrosophic Set

Radhika.V R^{1*} and Mohana K²

¹Research Scholar, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Assistant Professor, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

Radhika.V R

Research Scholar,

Department of Mathematics,

Nirmala College for Women,

Coimbatore, Tamil Nadu, India.

E. Mail : radhikaramakrishnan2805@gmail.com



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ABSTRACT

This paper introduced and discussed the Generalized Pentapartitioned Neutrosophic Set and its attributes. The generalised quadripartitioned neutrosophic set and generalised pentapartitioned neutrosophic set are extensions of each other.

Keywords: Neutrosophic set, single valued neutrosophic set, pentapartitioned neutrosophic set and generalized neutrosophic set.

INTRODUCTION

Set theory is an extension of classical pure mathematics, and Zadeh first suggested fuzzy sets in 1965, which permit membership functions with values between 0 and 1. In contrast to the cantor set, the fuzzy set is able to deal with the concepts of ambiguity, clarity, and imprecision. In 1986, Atanassov introduced the intuitionistic fuzzy set (IFS), which is an extension of Zadeh's fuzzy set theory that comprises degree of membership and degree of non-membership and lies in the interval $[0,1]$. IFS theory is widely applied in logic programming, problem-solving, clustering analysis, and other fields. A "neutrosophic set," which offers insight into neutral mind by raising the novel challenge of "uncertainty within the set," was first proposed by Florentine Smar and ache in 1995. The neutrosophic set, which consists of the components of the truth membership function (T), indeterminacy membership function (I), and falsity membership function (F), individually, was created as a result. Neutrosophic sets deal with the $[0,1]$ non-normal interval. Since the neutrosophic set deals with the indeterminateness efficiently, it is particularly essential in a number of application fields, including information technology, decision support systems, diagnosis, multi-criteria higher cognitive process issues, etc.





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Smarandache's Neutrosophic Set (NS) was created to address the ambiguity, imprecision, and inconsistent nature of mathematical objects. It generalises fuzzy set [2] and intuitionistic fuzzy set [3] by adding levels of ambiguity and rejection (falsity or non-membership) as distinct components. 2010 saw the debut of Wang et al's Single Valued Neutrosophic Set (SVNS). In their definition of Quadripartitioned SVNS (QSVNS), which comprises truth, falsity, unknown, and contradiction, Chatterjee et al. [5] cited four valued logics [6, 7]. In this study, the generalised pentapartitioned neutrosophic set idea is proposed, and its features are explored.

Preliminaries

Definition [8]

Let X be a universe. A Neutrosophic set A on X can be defined as follows:

$$A = \{ \langle x, T_A(x), I_A(x), F_A(x) \rangle : x \in X \}$$

Where $T_A, I_A, F_A: U \rightarrow [0,1]$ and $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$

Single Valued Pentapartitioned Neutrosophic Set [7]

The term "pentapartitioned" means something that divided into five characteristic features. The indeterminacy is split into three parts signifying contradiction, ignorance and unknown respectively.

Definition [9]

Let X be a universe. A pentapartitioned neutrosophic set A on X is an object of the form

$$A = \{ \langle x, T_A, C_A, G_A, U_A, F_A \rangle : x \in X \}$$

$$0 \leq T_A + C_A + G_A + U_A + F_A \leq 5$$

Here $T_A(x)$, is the truth membership, $C_A(x)$ is contradiction membership, $G_A(x)$ is ignorance membership $U_A(x)$ is unknown membership, $F_A(x)$ is the false membership.

Definition [8]

Let X be a universe. A Generalized neutrosophic set A on X is an object of the form

$$A = \{ \langle x, T_A, I_A, F_A \rangle : x \in X \}$$

$$T_A + I_A + F_A \leq 0.5$$

Here, $T(x)$ is the truth membership,

$I(x)$ is the indeterminacy,

$F(x)$ is the false membership

Definition [9]

The complement of a pentapartitioned neutrosophic set A on R, denoted by A^c and is defined as $A^c = \{ \langle x, F_A(x), U_A(x), G_A(x), C_A(x) \rangle : x \in X \}$

Definition [9]

Let $A = \{ \langle x, T_A(x), C_A(x), G_A(x), U_A(x), F_A(x) \rangle \}$ and $B = \{ \langle x, T_B(x), C_B(x), G_B(x), U_B(x), F_B(x) \rangle \}$ are pentapartitioned neutrosophic sets. Then

$$A \cup B = \{ \langle x, \max(T_A(x), T_B(x)), \max(C_A(x), C_B(x)), \min(G_A(x), G_B(x)), \min(U_A(x), U_B(x)), \min(F_A(x), F_B(x)) \rangle \}$$

$$A \cap B = \{ \langle x, \min(T_A(x), T_B(x)), \min(C_A(x), C_B(x)), \max(G_A(x), G_B(x)), \max(U_A(x), U_B(x)), \max(F_A(x), F_B(x)) \rangle \}$$

Generalized Pentapartitioned Neutrosophic Set

Definition

Let X be a universe. A Generalized pentapartitioned neutrosophic set (GPN) A on X is an object of the form

$$A = \{ \langle x, T_A, C_A, G_A, U_A, F_A \rangle : x \in X \}$$

$$T_A + C_A + G_A + U_A + F_A \leq 5 \text{ and } T_A \wedge C_A \wedge G_A \wedge U_A \wedge F_A \leq 0.5$$

Here, $T_A(x)$ is the truth membership,

$C_A(x)$ is the contradiction membership,





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$G_A(x)$ is the ignorance membership,
 $U_A(x)$ is the unknown membership,
 $F_A(x)$ is the false membership

Example

Let $R = \{a,b,c\}$, and $A = \{(a,0.3,0.6,0.4,0.2,0.7), (b,0.5,0.2,0.4,0.3,0.5), (c,0.2,0.4,0.5,0.1,0.8)\}$. Then A is a Generalized pentapartitioned neutrosophic set on R .

Generalized pentapartitioned neutrosophic set A

R	$T_A(x)$	$C_A(x)$	$G_A(x)$	$U_A(x)$	$F_A(x)$	$T_A \wedge C_A \wedge G_A \wedge U_A \wedge F_A$
A	0.3	0.6	0.4	0.2	0.7	0.2
B	0.5	0.2	0.4	0.3	0.5	0.2
C	0.2	0.4	0.5	0.1	0.8	0.1

Definition

A Generalized pentapartitioned neutrosophic set A is contained in another Generalized pentapartitioned neutrosophic set B (i.e) $A \subseteq B$ if $T_A \leq T_B, C_A \leq C_B, G_A \geq G_B, U_A \geq U_B$ and $F_A \geq F_B$

Definition

The complement of a Generalized pentapartitioned neutrosophic set A on X denoted by $A^c(x)$ and is defined as $A^c(x) = \{ \langle x, F_A, U_A, 1 - G_A, C_A, T_A \rangle : x \in X \}$

Example

Let $X = \{a,b,c\}$, and $A = \{(a,0.6,0.4,0.3,0.2,0.3), (b,0.5,0.3,0.4,0.5,0.4), (c,0.3,0.7,0.5,0.2,0.4)\}$ is a Generalized pentapartitioned neutrosophic set on R . Then $A^c = \{(a,0.3,0.2,0.7,0.4,0.6), (b,0.4,0.5,0.6,0.3,0.5), (c,0.4,0.2,0.5,0.7,0.3)\}$

Definition

Let X be a non-empty set, $A = \langle x, T_A, C_A, G_A, U_A, F_A \rangle$ and $B = \langle x, T_B, C_B, G_B, U_B, F_B \rangle$ are two Generalized pentapartitioned neutrosophic sets. Then

$$A \cup B = \langle x, \max(T_A, T_B), \max(C_A, C_B), \min(G_A, G_B), \min(U_A, U_B), \min(F_A, F_B) \rangle$$

$$A \cap B = \langle x, \min(T_A, T_B), \min(C_A, C_B), \max(G_A, G_B), \max(U_A, U_B), \max(F_A, F_B) \rangle$$

Example

Let $R = \{a,b,c\}$, and $A = \{(a,0.6,0.4,0.3,0.2,0.3), (b,0.5,0.3,0.4,0.5,0.4), (c,0.3,0.7,0.5,0.2,0.4)\}$

$B = \{(a,0.7,0.2,0.4,0.3,0.5), (b,0.7,0.4,0.3,0.4,0.5), (c,0.6,0.5,0.6,0.4,0.3)\}$ are

Generalized pentapartitioned neutrosophic sets on R . Then

$$A \cup B = \{(a,0.7,0.4,0.4,0.3,0.5), (b,0.7,0.4,0.4,0.5,0.5), (c,0.6,0.7,0.6,0.4,0.4)\}$$

$$A \cap B = \{(a,0.6,0.2,0.3,0.2,0.3), (b,0.5,0.3,0.3,0.4,0.4), (c,0.3,0.5,0.5,0.2,0.3)\}$$

Theorem

Let A, B and C are three Generalized pentapartitioned neutrosophic sets over the universe X . Then the following properties hold true.

Commutative Law

a) $A \cup B = B \cup A$

b) $A \cap B = B \cap A$

Associative Law

c) $(A \cup B) \cup C = A \cup (B \cup C)$

d) $(A \cap B) \cap C = A \cap (B \cap C)$

Distributive Law

e) $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$

f) $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$





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Absorption Law

g) $A \cup (A \cap C) = A$

h) $A \cap (A \cup C) = A$

Involution Law

$(A^c)^c = A$

Law of Contradiction

$A \cap A^c = \emptyset$

De Morgan's Law

$(A \cup B)^c = A^c \cap B^c$

$(A \cap B)^c = A^c \cup B^c$

Theorem

Let K and L are two Generalized Pentapartitioned Neutrosophic sets over the universe X. Then the following are true.

$K \subseteq L \iff K \cap L = K$

$K \subseteq L \iff K \cup L = L$

Theorem

Let K be Generalized pentapartitioned neutrosophic set over the universe X. Then the following are true.

(i) $\emptyset \subseteq X$

(ii) $X \cap \emptyset = \emptyset$

(iii) $K \cup \emptyset = K$

(iv) $K \cup X = X$

(v) $K \cap \emptyset = \emptyset$

(vi) $K \cap X = K$

Proof: It is obvious

Definition

A Generalized pentapartitioned neutrosophic topology on a non-empty set X is a τ of Generalized pentapartitioned neutrosophic sets satisfying the following axioms.

$0_M, 1_M \in \tau$

The union of the elements of any sub collection of τ is in τ

The inter section of the elements of any finite sub collection τ is in τ

The pair (X, τ) is called an Generalized pentapartitioned neutrosophic Topological Space over X.

Note :

1. Every member of τ is called a GPN open set in X.
2. The set A_M is called a GPN closed set in X if $A_M \in \tau$, where $\tau^c = \{A_M^c : A_M \in \tau\}$.

Example

Let $M = \{b_1, b_2\}$ and Let A, B, C be Generalized pentapartitioned neutrosophic sets where

$A = \{ \langle b_1, 0.5, 0.1, 0.3, 0.7, 0.2 \rangle, \langle b_2, 0.7, 0.5, 0.3, 0.2, 0.1 \rangle, \langle b_3, 0.6, 0.5, 0.3, 0.4, 0.3 \rangle \}$

$B = \{ \langle b_1, 0.6, 0.7, 0.3, 0.1, 0.2 \rangle, \langle b_2, 0.2, 0.3, 0.4, 0.4, 0.7 \rangle, \langle b_3, 0.5, 0.6, 0.2, 0.1, 0.3 \rangle \}$

$C = \{ \langle b_1, 0.6, 0.7, 0.3, 0.1, 0.2 \rangle, \langle b_2, 0.7, 0.5, 0.4, 0.2, 0.1 \rangle, \langle b_3, 0.6, 0.6, 0.5, 0.1, 0.3 \rangle \}$

$\tau = \{A, B, C, 0_M, 1_M\}$ is an Generalized pentapartitioned neutrosophic topology on M.

Proposition

Let (M, τ_1) and (M, τ_2) be two Generalized pentapartitioned neutrosophic topological space on M, Then $\tau_1 \cap \tau_2$ is an Generalized pentapartitioned neutrosophic topology on M where $\tau_1 \cap \tau_2 = \{A_M : A_M \in \tau_1 \text{ and } B_M \in \tau_2\}$

Proof Obviously $0_M, 1_M \in \tau$.

Let $A_M, B_M \in \tau_1 \cap \tau_2$





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Then $A_M, B_M \in \tau_1$ and $A_M, B_M \in \tau_2$
 We know that τ_1 and τ_2 are two Generalized Pentapartitioned Neutrosophic topological space M.
 Then $A_M \cap B_M \in \tau_1$ and $A_M \cap B_M \in \tau_2$
 Hence $A_M \cap B_M \in \tau_1 \cap \tau_2$.
 Let τ_1 and τ_2 are two Generalized pentapartitioned neutrosophic topological spaces on X.
 Denote $\tau_1 \vee \tau_2 = \{A_M \cup B_M : A_M \in \tau_1 \text{ and } B_M \in \tau_2\}$
 $\tau_1 \wedge \tau_2 = \{A_M \cap B_M : A_M \in \tau_1 \text{ and } B_M \in \tau_2\}$

Example

Let A_M and B_M be two Generalized pentapartitioned neutrosophic topological space on X. Define $\tau_1 = \{0_M, 1_M, A_M\}$
 $\tau_2 = \{0_M, 1_M, B_M\}$
 Then $\tau_1 \cap \tau_2 = \{0_M, 1_M\}$ is a Generalized pentapartitioned neutrosophic topological space on M.
 But $\tau_1 \cup \tau_2 = \{0_M, A_M, B_M, 1_M\}$,
 $\tau_1 \vee \tau_2 = \{0_M, A_M, B_M, 1_M, A_M \cup B_M\}$ and
 $\tau_1 \wedge \tau_2 = \{0_M, A_M, B_M, 1_M, A_M \cap B_M\}$ are not Generalized pentapartitioned neutrosophic topological space on X.

Theorem

Let (M, τ) be a Generalized pentapartitioned neutrosophic topological space over M and Let $A_M \in$ Generalized pentapartitioned neutrosophic topological space. Then the following properties hold.
 $GPN Int(A_M) \subseteq A_M$
 $A_M \subseteq B_M$ implies $GPN Int(A_M) \subseteq GPN Int(B_M)$.
 $GPN Int(A_M) \in \tau$.
 A_M is a GQ Nopen set implies $GPN Int(A_M) = A_M$.
 $GPN Int(GPN Int(A_M)) = GPN Int(A_M)$

Theorem

Let (M, τ) be a Generalized pentapartitioned neutrosophic topological space over M and Let A_M is in the Generalized pentapartitioned neutrosophic topological space. Then the following properties hold.
 (i) $A_M \subseteq GPN CI(A_M)$
 (ii) $A_M \subseteq B_M$ implies $GPN CI(A_M) \subseteq GPN CI(B_M)$.
 (iii) $GPN CI(A_M)^c \in \tau$.
 (iv) \odot is a GPN closed set implies $GPN CI(\odot) = \odot$.
 (v) $GPN CI(GPN CI(\odot)) = GPN CI(A_M)$
 (vi) $GPN CI(0_M) = 0_M, GPN CI(1_M) = 1_M$.

CONCLUSION

We have created a generalised pentapartitioned neutrosophic set in this article. PNS and GQNS are both extensions of the generalised pentapartitioned neutrosophic set (GPNS). Future research may include examining other operators on the generalised pentapartitioned neutrosophic set that deal with real-world issues and applying them to challenges involving decision-making.

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Biostimulant Effect of Seaweed Liquid Fertilizers on Early Seed Germination and Growth Parameters in *Arachis hypogaea*

Kaviya.V¹, Mary Fabiola^{1*} and V.IIakkiya¹

Department of Zoology, Nirmala College for Women, Bharathiyar University, Coimbatore 18, Tamil Nadu, India.

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*Address for Correspondence

Mary Fabiola

Department of Zoology,
Nirmala College for Women,
Bharathiyar University,
Coimbatore 18, Tamil Nadu, India.
E. Mail: kavima26@gmail.com



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ABSTRACT

Inorganic fertilizers are excessively used in agriculture cultivation systems, resulting in higher production costs, lower farmer income, and soil depletion. We will have to find raw materials for developing organic Bio-stimulants and Bio-fertilizers that will induce essential element absorption, growth, and yield of plants, which will also adapt to our environment. Researchers have previously reported that seaweed extracts contain plant growth hormones and essential elements. This study investigated whether seaweed liquid fertilizers derived from *Sargassum cristaefolium* stimulated early seed germination and growth parameters in *Arachis hypogaea*. The present study shows that early seed germination is the fresh and dry weight of shoots and roots. As a result of these findings, seaweed liquid fertilizers can be recommended to farmers for influencing early seed germination and growth Parameters.

Keywords: Seaweed Liquid Fertilizers (SLF), Bio-Stimulant, *Arachis hypogaea*, Seed Germination, Growth Parameters.

INTRODUCTION

Fertilizer is perhaps of the main contribution to agricultural production. Different chemical fertilizers can lead to different environmental impacts and human diseases. Previous research has demonstrated that the negative effects of chemical fertilizers on the environment and human health can be direct or indirect [1]. Therefore, there is a need to understand the natural resources that can be used as sources for the development of organic biostimulants and biofertilizers that can adapt to our environment and support sustainable agriculture. Previous researchers reported





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that macroalgae contain phytohormones and essential elements that support plant growth and yield in liquid and solid extracts, respectively [2,3]. Seaweed is rich in micro- and macronutrients, and its extract contains polysaccharides, polyunsaturated fatty acids (PUFAs), coloring Contains nutrients, polyphenols minerals and plant growth hormones. [4,5]. Seaweed contains all trace elements and growth hormones that plants need. Recently, there has been growing concern about the use of liquid algae fertilizers [6,7]. The use of algal fertilizers as biostimulants, when applied to leaves and roots, improves plant development and results in increased yields [8]. Algae extracts contain plant growth hormones, regulators, carbohydrates, amino acids, auxins, gibberellins and vitamins to improve plant yield and quality, seed germination and resistance to frost, fungi and insects.(9) Algae fertilizers have been proven to be superior to chemical fertilizers [10]. Seaweed extract as an organic biostimulant is rapidly gaining acceptance in horticulture due to its beneficial effects [11]. Environmentally friendly algae liquid fertilizers for plants help growers achieve better germination, growth and yield. It helps to get Growing crops with organic fertilizers contributed to residue deposition and improved soil physical and chemical properties important for biological development. lettuce. Experimental studies have shown that seedling growth is stimulated by algal extracts of green algae (*Ulva lactuca*, *Caulerpa scalelliformis*) and brown algae (*Sargassum plagiophyllum*, *Turbinariaconoides*, *Padina tetrastromatica*, *Dictyota dichotama*). In today's world, algae fertilizers are often more successful than chemical fertilizers.(12) In view of the above facts, the present study, the applicability of *Sargassum cristaefolium* seaweed extracts was tested regarding stimulation of early seeds germination and growth parameters of the *Arachis hypogaea*.

MATERIALS AND METHODS

Collection of Seaweeds

A specimen of the brown algae *Sargassum cristaefolium* was collected from Manora Beach, Thanjavur District, Tamil Nadu, India (latitude: 10.2644°N and longitude: 79.2874°E). The collected algae were first washed with seawater to remove macroscopic epiphytes and sand particles, and finally with freshwater to remove adhering salt. Dried them in the shade for 4 days, followed by dried them in the oven for 12 hours at 60°C. These materials were then hand ground and ground into a coarse powder using a blender mill. This was mixed with distilled water in a 1:20 (w/v) ratio and autoclaved at 121° C. and 15 pounds per square inch for 30 minutes. The hot extract was filtered through cheesecloth and cooled to room temperature (13). Its concentration was calculated by holding a known volume (100 ml) in a convection oven at 60 °C until it showed a constant dry weight.

Field Trial

A field trial was conducted on Groundnut (*Arachis Hypogaea*). in Peravurani Block near Thanjavur, Tamil Nadu. Each plot covered an area of 12m² (4m x 3m) for him. The band was raised up to half a foot. Three replicates were kept for each experimental randomized plot. The experimental area (approximately 600m²) was sprinkled with approximately 200 kg of manure, plowed thoroughly twice, followed by a final plow, and peanut seeds were sown along the furrows at a distance of several feet and flattened.

Preparation of Seaweed Liquid Fertilizer

1.2 L of various concentrations of *Sargassum cristaefolium* SLF, namely 0.25, 0.5, and 1.0 w/v were prepared and diluted to 12 L using irrigation well water. Spraying 1 l diluted SLF/m² or 100 ml SLF/m² was applied evenly to each plot. The plot was watered weekly. 30-day-old plants were photographed for observation. Various parameters: total plant height, shoot height, root height (cm), gross and dry weight, shoot weight and dry weight, root weight and dry weight (g), number of branches and 3rd generation leaves Leaf area (cm²) was recorded.

RESULTS

Peanuts treated with four different concentrations of *Sargassum cristaefolium* SLF, namely 0.25%, 0.5% and 1.0%, showed that SLF increased the concentration of photosynthetic pigments. Maximum accumulation of the above





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parameters was recorded when plants were treated with 1.0% SLF for 30 days. Under this condition, 30-day-old plants showed an increase of over 65.0%, 87.0%, and 76.0%, respectively, compared to controls. Total plant height, shoot and root height (cm), total fresh weight, total shoot and root fresh weight, total dry weight, total dry weight, shoot and root dry weight (g), number of branches and leaf area Physical parameters such as (cm²) were also recorded, with the highest values recorded when the plants were treated with 1.0% *Sargassum cristaefolium* SLF. One-way analysis of variance for total plant height and total weight showed significance at the 1% level, respectively. (Table1). Different alphabets between concentrations denotes statistically significant based on multiple range test (Tukey -HSD test). NS (not significant)

DISCUSSION

Algae treatment of crops is growing in popularity, leading to the development of numerous algae-based products. These can be divided into three groups: powders for supplementing soil in bulk or powders, powder or liquid extracts for mixing into rooting media for greenhouse crops, and root baths, soil drenchers, and Concentrate used as a foliar spray. (14) Algal liquid fertilizers have been found to be superior to chemical fertilizers due to their high organic matter content. (15) This study showed that SLF treatment of algal extracts improved the growth characteristics such as plant height, fresh weight and leaf area of peanuts. It was shown that the application of Laminariaceae and algae extracts as a foliar spray on banana increased the average bunch weight of the fruit while decreasing the seed setting time. (16) In addition, soil application of algae significantly increased the average weight of maize. Yield increases have also been achieved in commercial trials on potatoes, sweet corn, peppers, tomatoes and oranges. Crouch et al. (17) also observed that the seaweed extract Kelpak significantly increased lettuce yield. Cytokinins in extracts of *Ulva lactuca* plant growth regulators examined in the current experiment, cytokinin abundance was found to be higher in both his SLFs compared to auxin. Experiments with ascophyllum and laminaria liquid fertilizers on potatoes, corn, peppers, pineapples, and oranges showed that lower concentrations of liquid fertilizer promoted growth more than higher concentrations in plants to which 1.0% SLF was applied in rice field. (18&19) In the present study, an increase in height and leaf area was observed in plants treated with 1.0% SLF. These treatments further improved the yield.

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Table 1: Effect of *Sargassum cristaefolium* SLF on the growth of *Arachis hypogaea* under field trial on 30th day

Parameters	F-Value	P-value	SLF Concentrations			
			Control	0.25%	0.5%	1.0%
Total plant height(cm)	10.23	0.00**	16.78±2.31 ^a	19.21±2.69 ^{ab}	21.24±0.90 ^{bc}	23.98±2.91 ^c
Shoot height(cm)	6.12	0.00**	12.87±2.64 ^a	14.00±2.72 ^{ab}	15.34±0.92 ^b	16.67±2.08 ^b
Root height(cm)	10.14	0.00**	5.64±0.65 ^a	5.92±0.34 ^{ab}	6.45±0.91 ^{bc}	7.38±0.82 ^c
Total Fresh weight(gm)	13.55	0.00**	20.84±0.97 ^a	25.61±2.26 ^b	26.28±3.91 ^b	29.14±0.98 ^b
Shoot Fresh weight(gm)	12.34	0.00**	19.81±0.98 ^a	24.89±2.09 ^b	25.78±3.92 ^b	27.22±0.89 ^b
Root fresh weight(gm)	16.11	0.00**	1.28±0.09 ^a	1.48±0.10 ^{ab}	1.54±0.19 ^b	1.72±0.12 ^c
Total Dry weight(gm)	57.89	0.00**	3.89±0.09 ^a	4.83±0.19 ^b	5.12±0.09 ^b	5.82±0.18 ^c
Shoot dry weight(gm)	60.57	0.00**	3.61±0.09 ^a	4.58±0.18 ^b	5.38±0.09 ^b	5.12±0.17 ^c
Root dry weight(gm)	4.56	0.01*	0.23±0.05 ^a	0.31±0.08 ^{ab}	0.28±0.04 ^{ab}	0.48±0.04 ^b
Number of Branches	0.74	0.77 ^{NS}	4.00±1.34	4.00±0.90	4.00±1.36	3.95±1.87
Leaf Area(cm ²)						

*(significant at 5% level) ** (significant at 1% level)





Study of Anti-Corrosive Activity of Benzopyranophenazine on Mild Steel Sulphuric Acid Interface

L. Saraswathi^{1*} and N. Gunavathy²

¹Ph D Research Scholar, Department of Chemistry, Nirmala College for Women, Coimbatore, Tamil nadu, India.

²Assistant Professor and Head, Department of Chemistry, Nirmala College for Women, Coimbatore, Tamil nadu, India.

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*Address for Correspondence

L. Saraswathi

Ph D Research Scholar,
Department of Chemistry,
Nirmala College for Women,
Red-fields, Coimbatore, Tamil Nadu, India.
E. Mail: sachuvichem@gmail.com



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ABSTRACT

Corrosion is a frequent issue in the steel industry. The cost and safety of a steel are directly impacted by corrosion. Organic compounds can be utilized as corrosion inhibitors in acidic conditions to significantly slow down the pace at which alloys corrode. There is proof that polar functional groups and conjugated double bonds in organic molecules with nitrogen, sulphur, and oxygen heterocycles can prevent mild steel corrosion. The main goal of the current study is to explore the production and anticorrosive action of 3-amino-1-(2-hydroxyphenyl)-1H-benzo[a]pyrano[2,3-c] phenazine-2-carbonitrile (BPP). In 1 M H₂SO₄ solutions at weight loss, temperature investigations, and electrochemical impedance spectroscopy that are used to investigate this molecule's potential to prevent the corrosion of mild steel at elevated temperatures (303 K-343K).The potential for enhanced inhibition led to the selection of benzopyranophenazine as a corrosion inhibitor. The molecule is more suitable for corrosion inhibition because heteroatoms have p-electrons and lone pairs of electrons. It is a one-step procedure that is economical, environmentally responsible, highly productive, and combined with a greener strategy using affordable beginning materials.

Keywords: Benzopyranophenazine, Mild Steel, Weight Loss, Temperature Studies, Langmuir Adsorption Isotherm





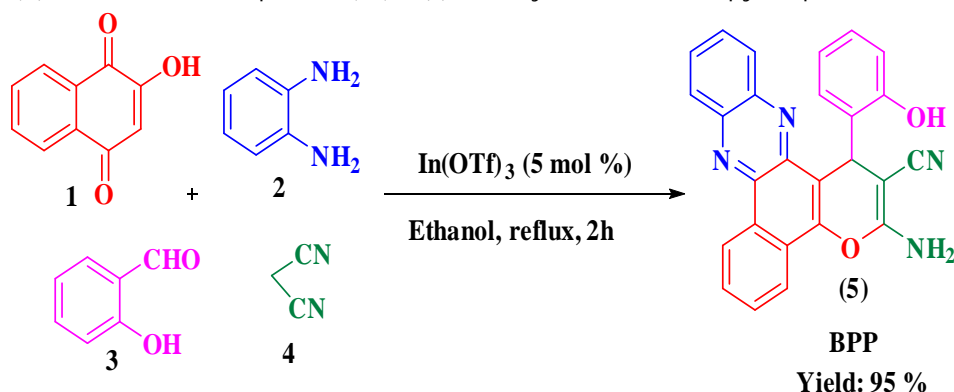
INTRODUCTION

A metal or its properties tend to decline due to corrosion when they are subjected to the aggressive environment within which they are situated. Corrosion is a typical issue with steel that has a significant impact on its price, safety, and cost of maintenance. By using organic compounds as corrosion inhibitors as the primary method of corrosion control in acidic conditions, alloy corrosion rates may be reduced [1]. According to reports, organic compounds with nitrogen, sulphur, and oxygen heterocycles that also have a conjugated double bond and a polar functional group can reduce the corrosion of mild steel. Research is also being done, for instance, Iron and steel rust differently in acidic environments, depending on the presence of organic nitrogen molecules. These organic nitrogen compounds are known for their quick activity [2,3] and are usually used in the chemical industry. There are three distinct ways that organic inhibitors might bind to the metal/solution interface: (a) the metal and charged molecules are attracted to each other electrostatically (b) interaction between pi-electrons and the metal, (c) interaction between uncharged electron pairs within the molecule.

MATERIALS AND METHODS

Preparation of Inhibitor

In this procedure, 2-hydroxynaphthalene-1,4-dione **1** (1.0mmol), benzene-1,2-diamine **2** (1.0mmol), salicylaldehyde **3** (1.0mmol), and malononitrile **4** (1.0mmol) are utilised as starting materials and refluxed for 2 hrs with Indium (II) trifluoromethanesulphonate ($\text{In}(\text{OTf})_3$) as catalyst to obtain Benzopyranophenazine with 95% yield.



Preparation of Specimen Coupons

A big piece of rectangular mild steel was cut into 5 x 1 x 0.2 cm pieces, and towards the 1.5 cm side end, a tiny hole for suspending was drilled with a 1.0 mm diameter.

Preparation of Medium

The acid medium of 1 M H_2SO_4 was prepared with the help of distilled water.

Weight Loss Method

The impact of organic compounds on mild steel in 1 M H_2SO_4 both in the presence and absence of BPP was calculated. A digital balance was used in order to accurately weigh the specimens made of mild steel. The initial weight of metal specimens and the final weight of metal specimens were recorded during each experiment. The corrosion rate and inhibition efficiency of metal coupons are measured. The experiment was performed for various parameters given below, Inhibitor concentrations (ppm): 50 ppm, 100 ppm, 250 ppm, 500 ppm, 750 ppm, 900 ppm

Time interval in hours : 1h, 3h, 5h, 7h, 24h

Temperature in kelvin : 303 K, 313 K, 323 K, 333 K, 343 K





RESULTS AND DISCUSSION

Weight Loss Method

The variation of inhibition efficiency with change in concentration of the inhibitor and various immersion time are presented in Table 1. The data clearly show that the inhibition efficiency increased as the inhibitor concentration increased for all immersion times (Figure 2). The adsorption of BPP on the mild steel surface, creates a barrier for mass and charge transfers and prevents further acid attack, was often attributed to the decrease in corrosion rate and rise in inhibitor efficiency [4,5].

Effect of Temperature on CR and IE of BPP on Mild Steel in 1 M H₂SO₄

The findings of weight loss studies on mild steel corrosion in 1 M H₂SO₄ with benzopyranophenazine inhibitor at temperatures between 303 K and 343 K were displayed in Table 2. The decrease in inhibiting efficiency or acceleration of corrosion that was observed on the mild steel surface suggested that at higher temperatures, the inhibiting film formed on the metal surface may not be as protective as it was at lower temperatures. [6]. It is most likely that at a higher temperature, the inhibitor molecules will be desorbed from the metal surface at a faster rate than at a lower temperature [7]. As the temperature rises, the inhibition action decreases, which could be attributed to the fact that the time lag between the adsorption and desorption processes of the metal surface remains exposed to the acid environment for a longer period of time. As a result, corrosion rates increase with the increase in temperature, and inhibition efficiency decreases as a consequence. Variation of CR of mild steel in 1 M H₂SO₄ with temperature for the various concentrations of the inhibitors are shown in Figure 3.

Adsorption Isotherm

The effectiveness of a corrosion inhibitor is primarily determined by its capacity for adhesion to metal surfaces. Therefore, understanding the adsorption mechanism is essential and adsorption isotherm that can provide insightful data on interaction of inhibitor and a metal surface. It was discovered that the pH has a significant impact on the quasi-substitution process of inhibitor molecule adsorption from aqueous solution [8]. The inhibitor molecule that adheres to the surface of mild steel, as well as ionisation and polarisation of the molecule, are all factors in surface protection [9,10]. In order to discover the optimal adsorption isotherm, the degree of surface coverage (θ) as a function of the inhibitor concentration (C) was visually analysed. It was discovered that the Langmuir adsorption isotherm can be expressed by following equation,

$$\frac{C_{inh}}{\theta} = \frac{1}{K_{ads}} + C \quad (1)$$

The surface coverage was graphically examined to observe appropriate adsorption isotherm fit. The plots of C/θ versus C generated straight lines with correlation coefficient (R^2) values that are close to unity (Figure 4) which indicate that the Langmuir adsorption isotherm was followed by the adsorption of BPP in 1 M H₂SO₄ medium on MS surface.

Electrochemical Impedance Spectroscopy (EIS)

Impedance Studies of Mild Steel in 1 M H₂SO₄

The Nyquist plots of mild steel in 1 M H₂SO₄ without and with the inhibitor BPP in Figure 5, showed that the semicircle diameters grow as the inhibitor concentration increased. The increasing value of R_{ct} indicated that when the concentration of the inhibitor on the MS surface increases, the area of adsorption expands. Since the inhibition procedure does not change the way that mild steel reacts to H₂SO₄, it was evident from impedance's appearance that corrosion of steel was controlled by a charge transfer process [11-16].

CONCLUSION

From the comprehensive analysis, it was determined that,



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- In a solution of 1 M H₂SO₄, the produced compound work well as mild steel corrosion inhibitor. The compound has inhibitory effect because they contain heteroatoms (N & O) and aromatic ring electrons that act as adsorption sites on metallic surfaces.
- As the concentration of the inhibitors increases, so does the effectiveness of their inhibition.
- As the temperature rises, the examined inhibitor effectiveness declines.
- The examined chemical adhered to Langmuir's adsorption isotherm when adsorbed onto mild steel.
- According to electrochemical impedance studies, an increase in inhibitor concentration results in higher charge transfer resistance (R_{ct}) values and lower double layer capacitance (C_{dl}) values because the adsorbed layer was thicker.

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Author's Contribution

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Table 1: IE % of BPP in 1 MH₂SO₄ Acid in Various Concentration and Immersion Period

Conc. of BPP in ppm	1 h		3 h		5 h		7 h		24 h	
	CR mm/y	IE %	CR mm/y	IE %	CR mm/y	IE %	CR mm/y	IE %	CR mm/y	IE %
Blank	36.34	-	24.04	-	24.59	-	26.26	-	27.43	-
50	29.31	19.34	16.60	25.47	19.92	19.00	21.38	18.59	21.16	22.73
100	27.93	23.12	10.41	69.62	15.48	37.04	17.35	33.95	16.25	40.68
250	19.60	46.05	4.99	78.40	9.10	63.01	5.45	79.25	8.51	68.92
500	3.79	89.57	3.53	79.17	4.24	82.75	1.79	92.77	4.03	85.30
750	2.66	92.67	3.42	83.10	2.82	88.51	1.51	94.26	2.87	89.50
900	1.46	95.98	0.19	94.02	0.47	98.06	0.60	97.72	0.71	97.39

Table 2: Effect of Temperature on Mild Steel Corrosion in 1 M H₂SO₄ in Absence and Presence of BPP

Conc of BPP in ppm	303 K		313 K		323 K		333 K		343 K	
	CR	IE %	CR	IE %	CR	IE %	CR	IE %	CR	IE %
Blank	0.618	-	0.712	-	0.889	-	1.197	-	2.493	-
50	0.264	57.33	0.327	54.09	0.439	50.55	0.611	48.99	1.352	45.78
100	0.102	83.45	0.295	58.51	0.424	52.37	0.536	55.28	1.160	53.46
250	0.092	85.20	0.270	62.04	0.349	60.65	0.467	61.05	1.097	56.01
500	0.081	86.79	0.194	72.76	0.275	69.12	0.396	66.97	0.915	63.29
750	0.056	91.00	0.186	73.89	0.252	71.64	0.359	69.96	0.896	64.06
900	0.030	95.07	0.163	77.04	0.243	72.65	0.348	70.94	0.830	66.69





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<p>RUST FORMATION</p>	<p>BPP - 1 M H₂SO₄</p>
<p>Figure 1: Formation of rust</p>	<p>Figure 2: Influence of Immersion Time on IE % of BPP in 1 M H₂SO₄ Medium</p>
<p>BPP - 1 M H₂SO₄</p>	<p>Langmuir Adsorption Isotherm BPP - 1 M H₂SO₄</p>
<p>Figure 3: Effect of Temperature on CR of BPP in 1 M H₂SO₄</p>	<p>Figure 4: Langmuir Adsorption Isotherm of BPP on the Mild Steel Surface in 1 M H₂SO₄ at Various Temperatures</p>
<p>BPP</p>	
<p>Figure 5: Nyquist plot of mild steel in 1 M H₂SO₄ Without and With Various Concentration of BPP</p>	





Antifeedant activity of Methanol Leaf Extract of *Vitex negundo* Against Fourth instar Larvae of *Helicoverpa armigera*

Sajanijose*

Associate Professor, PG and Research, Department of Zoology, Nirmala college for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

Sajanijose

Associate Professor,
PG and Research Department of Zoology,
Nirmala college for Women,
Coimbatore, Tamil Nadu, India.
E.Mail: sajanijose4@gmail.com



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ABSTRACT

In the present study, the selected plants leaf *Vitex negundo*, were screened for their phytochemical and antifeedant activity against fourth instar larvae of *Helicoverpa armigera* under laboratory conditions. The major bioactive constituents such as Alkaloids, Terpenoids, Phenolics, Tannins, Glycosides, Flavonoids, Carbohydrates and Sterols were analyzed qualitatively. All the constituents were detected in the methanol leaf extract of *V. negundo*. The methanol crude extracts of the selected plant leaf demonstrated a dose dependent bioactivity. The bioactivity of plants was significantly higher ($p \leq 0.05$) than the control and among the extracts of test concentration (250 ppm, 500 ppm, 750 ppm and 1000 ppm) the methanol extract of *V. negundo* demonstrated the highest feeding deterrence with reduction in larval feeding by 85.36% at 1000 ppm concentration followed by 59.12% at 750 ppm concentration, 33.39% at 500 ppm concentration and 18.15% at 250 ppm concentration respectively. Thus, it may be concluded that the selected plant leaf possesses antifeedant property and can be further investigated for the development of an ecofriendly potent natural botanical pesticides.

Keywords: *Vitex negundo*, quantitative analysis, feeding deterrence, antifeedant.

INTRODUCTION

Helicoverpa armigera (Hubner) (Lepidoptera: Noctuidae) is a polyphagous pest noctuid which is widespread in Asia [1]. It is known to cause serious damage to hundreds of economically important crops all over the world [2]. *Helicoverpa armigera* is a cosmopolitan pest widely distributed insect in the world and is a serious pest of all legumes.





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In India, it is reported that the pest feeds on 181 plant species across 47 families [3]. and causes an annual loss of about Rs. 2,000 crores [4]. The crops like sorghum, cotton, chickpeas, tomatoes, capsicum, maize, okras, cabbages, strawberries, tobacco, sunflowers etc were the host plants attacked by the pest [5].

Fifty percent of all insecticides used in India are to control *H. Armigera* but the continuous and indiscriminate use of insecticides over the years has resulted in developing resistance to certain molecules in *H. Armigera* [6]. The search for alternatives to chemical pesticides has focused the interest in pest management. Plant derived pesticides or Plant-based pesticides or botanical pesticides can be an alternative [7]. These pesticides can reduce the possibility of the development of resistance in pests, also act as target-specific and hence not harmful to humans and beneficial insects [8]. Since botanical pesticides are safe will not persist in nature and they are ecofriendly [9]. In the present investigation an attempt has been made to screen widely distributed plants, for their antifeedant activity against the larvae of *H. Armigera*, which has been reported as a major pest of tomato and chickpea in India [10]. Extracts of certain plants such as *Gynandropsis gynandra*, *Lantana camara*, and *Toddalia asiatica* have been reported to have larvicidal effect on *H. Armigera* [11]. and antifeedant properties [12]. The present investigation was carried out to evaluate the antifeedant, and larvicidal activities of petroleum ether and methanol leaf extract of *Vitex negundo*. Medicinal plants have played a vital role especially among the natives, tribes and remote lives where the speck of allopathy was invisible. It has been traditional for ages which have brought about a drastic change in the medical field, solving the hazardous challenges Investigations of plants are carried out to find new drugs or templates for the development of new remedial agents [13]. Medicinal plants have a remarkable capacity to produce a wide variety of bioactive secondary metabolites, like alkaloids, terpenoids, glycosides, saponins, flavonoids, steroids, tannins, quinones and coumarins from variety of natural resources like plant leaves, bark, berries, flowers and roots [14].

V. negundo is one of the most popular medicinal plants being used in all medicinal systems. Natural plant products can be the best alternative to synthetic pesticides because they are less toxic and biodegradable. Effective insecticidal properties were investigated in several plant species of various families [15]. Antifeedant compounds impair development or reproduction and may involve chronic as well as acute toxic effects over *H. Armigera*. In the present investigation, antifeedant effect of leaf extract of *V. negundo* leaf s was studied against the fourth instar larvae of *H. Armigera*. The present study aims not only on evaluation of the effectiveness of the selected botanicals in their antifeedant activity but also for secondary metabolites present in the selected plant leaf.

MATERIALS AND METHODS

Collection of Plants

The selected plants for this study were collected from in and around Coimbatore, Tamil Nadu. The selection of the plants was based on their local abundance, Antifeedancy, insecticidal properties and uses in traditional practices by the rural people. (Table 1). The samples were generally collected during the flowering and fruiting stage of the plants.

Extraction of *Vitex negundo* leaf

Tap water was used to completely clean the plant materials, which were then shade-dried at room temperature ($27.0 \pm 2^\circ \text{C}$. and $75 \pm 5\% \text{RH}$). The collected leaves were thoroughly dried before being pulverized with aid of an electric mixer and sieved through a small pore sized sieve. By using ethyl acetate as the solvent, 1000 g of plant powder was extracted using Soxhlet extraction process and filtered through Whatman's No. 1 filter paper. At room temperature, the solvent from the crude extract was evaporated before being air dried.

Rearing of test insects

Various stages of *H. armigera* larvae were collected from Tomato fields of Annur, Coimbatore, Tamil Nadu, India. The larvae were reared under laboratory conditions ($27.0^\circ\text{C} \pm 2^\circ\text{C}$; 70% RH) during the course of study. The experiments were conducted on healthy, uniformly sized fourth-instar larvae specifically, and the cultures were



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carefully maintained under the aforesaid conditions throughout the study period.

Antifeedant activity

The leaf disc no choice method was used to investigate crude extracts antifeedant activity (16Isman et al., 1990) of methanol crude extract of *V. negundo*. By dissolving the crude extracts in methanol and mixing them with dechlorinated water, the required crude extract concentration of 5% were performed. Using a cork borer, fresh cotton leaf discs of *H. armigera* (3cm diameter) were punched and dipped in 250, 500, 750, and 1000 ppm, and then air-dried for a period of 5 minutes. To prevent the treated leaf discs from drying out, they were placed in separate Petri dishes with wet filter paper (15 mm x 90 mm) after being completely air-dried. On each treated leaf disc, a single fourth instar larva of *H. armigera* was introduced that had already been pre-starved for 2 hours. Treatment with respective solvent alone served as positive control. For each treatment, five replicates were maintained. Using a leaf area meter, the larva gradually consumed leaf area over a 24-hour period in both the control and treatment groups by the larvae were calculated. The leaf area in control was adjusted for the plant extract treatments. The following formula was used to determine the percentage of antifeedant index 17 (Ben Jannet et al., 2000).

$$\text{Antifeedant activity} = \frac{\text{Control} - \text{Treatment}}{\text{Control} + \text{Treatment}} \times 100$$

Phytochemical Analysis of Plant Extracts

Qualitative phytochemical tests have been performed using the plant extract to identify the secondary metabolites, present in the plant. Preliminary phytochemical screening by Harborne's method has been done to trace out the chemical constituents like alkaloids, flavonoids, tannins, carbohydrates, phenolic compounds, terpenoids, glycosides and sterols. The solvent used for extraction of *Vitex negundo* leaf powder were methanol. Methanol extract of *Vitex negundo* contain all the components, such as Alkaloids, Terpenoids, Phenolics, Tannins, Glycosides, Flavonoids, Carbohydrates and Sterols were present.

DISCUSSION

Plant extracts have similar antifeedant, insecticidal, oviposition deterrent, ovicidal, and growth inhibition activities against lepidopteran pests, according to several authors [16]. Previously, Raja et al. 2005, assessed the antifeedant activity of *Hyptis suaveolens* fractions isolated from ethyl acetate extracts against *S. litura* and *H. armigera*, as reported in 2005. At a concentration of 2000 ppm, the fractions II and IV isolated from ethyl acetate extracts of *H. suaveolens* against armyworm and cotton bollworm contained the greatest percentage of feeding deterrent. The hexane, chloroform, and ethyl acetate extracts of *Atlantia monophylla* were tested against *H. armigera* for their feeding deterrent, larvicidal, and pupicidal properties. More than half of these three extracts were effective as a feeding deterrent. However, at concentrations of 5% and 5%, hexane extract of *A. monophylla* demonstrated significantly greater antifeedant activity against cotton bollworm (79.06 %). However, only at a concentration of 5% a higher percentage of larvicidal (Lc50 and Lc90 values obtained at 2.46 % and 5.41 %) and pupicidal (100%) activities were observed. Silica gel column chromatography was used to fractionate the active crude hexane extract. Once again, the ovicidal activity of twelve fractions was assessed. Among them, the ninth fraction of hexane extract disrupted adult emergence in *H. armigera* and demonstrated promising antifeedant, larvicidal, and pupicidal properties. In addition, the LC50 value for 100% pupal mortality and 384.57 ppm for larval mortality at 1000 ppm concentrations, respectively [17].

It is possible that the selected plants insecticidal property hindered the larvae's various metabolic activities during development, preventing the larvae from maturing and resulting in their death. This is consistent with previous findings [18] against *Locusta migratoria* in crude extracts and fractions of *Syzygium lineare* were tested for their antifeedant and growth inhibitory properties. *Pongamia pinnata* seed extracts insecticidal properties were evaluated against *H. armigera*. When tested against *H. armigera* fourth-instar larvae, immature seed extracts of *P. pinnata* caused





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the greatest percentage of larval mortality, while 5.0% concentrations also prevented more than 65% of feeding. At a concentration of 2.0 percent, in addition to mature seed extract, oviposition deterrence and egg hatchability were significantly reduced.

Due to the fact that insect growth regulator works on juvenile hormone, the properties of plant extracts that regulate insect growth are very interesting and one of a kind in nature. Ecdysis or moulting is the process by which old skin sheds, and the enzyme ecdysone plays a key role in shedding. Ecdysone's activity is suppressed when the active plant compounds enter the larvae's body, preventing the larva from maturing and ultimately dying. It was also reported that *Solanum pseudocapsicum* seed extracts were tested against *S. litura* and *H. armigera* for their antifeedant, insecticidal, and growth inhibition properties. Ethyl acetate extract's antifeedant and insecticidal properties against *S. litura* and *H. armigera* were found to be most promising. Ethyl acetate extract was found to have a higher percentage of malformed adults, larvae, and pupae than other solvent extracts [19].

Additionally, at concentrations of 5%, the same plant extract inhibited a significant portion of successful adult emergence in armyworm and cotton bollworm. The leaves of *Duranta erecta* were tested for biological activity against *S. litura* and *H. armigera*. At a concentration of 5%, ethyl acetate extract had the highest antifeedant activity on *S. litura* (80.37%) and *H. armigera* (78.18%), followed by chloroform extract and petroleum ether extract at the same concentration. At higher concentrations, ethyl acetate extracts significantly increased armyworm (69.88%) and cotton bollworm (63.2%) larval mortality. However, at a concentration of 5%, ethyl acetate extract produced the greatest deformities in larvae, pupae, and adults. Deformed adult moths were also identified by their relatively small body size, heavily curled wings, and undergrown wings [20].

CONCLUSION

From the present study it can be concluded that selected plant leaf, *Vitex negundo* have a promising antifeedant activity against *H. armigera* larvae. Further research on the bioactivity of this plant can lead to the development of a cost effective, eco-friendly formulation for crop protection, which can benefit the farmers.

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Table-1. Phytochemical analysis of *Vitex negundo* Methanol leaf Extract

S.No	Secondary metabolites	SOLVENT
		Methanol leaf extract
1	Alkaloids	+
2	Terpenoids	++
3	Phenolics	+++
4	Tannins	+++
5	Glycosides	++
6	Flavonoids	+
7	Carbohydrates	+
8	Sterols	++

(+)-Positive (-) Negative(+++) -Strongly positive



**Sajanijose****Table-2.** Antifeedant activity of crude leaf extract of *Vitex negundo* against third instar larvae of *Helicoverpa armigera*.

Antifeedant Activity	
Concentration	Methanol Crude extracts
250 ppm	18.15±3.26 ^b
500 ppm	33.39±2.21 ^b
750 ppm	59.12±4.02 ^a
1000 ppm	85.36±3.14 ^b





Efficient Base Catalysed Synthesis of Styryl Heterocycles

D. Sudha^{1*} and P.Dhivya²

¹Research Scholar, Department of Chemistry, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Assistant Professor, Department of Chemistry, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

D. Sudha

Research Scholar,
Department of Chemistry,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.



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ABSTRACT

In present investigation, we herein report the synthesis of coumarin derivatives by employing a simple and efficient methodology. The synthon, 7-hydroxy-4-methyl coumarin was prepared by earlier reported literature method. Having considerably synthesized 7- hydroxy-4-methy coumarin, the synthon is reacted with derivatives of benzaldehyde to yield derivatives of coumarin. The synthesized compounds were characterized by their physical constants, Infrared, NMR and mass spectral data.

Keywords: : 7- hydroxy-4-methycoumarin,benzaldehyde,coumarin, base

INTRODUCTION

Coumarins are polyphenolic compounds belonging to the group of oxygenated heterocyclic compounds [1,3]. Coumarin is an organic compound having the characteristic odour of new-mown hay, obtainable from the tonka tree (native to Guyana) or by chemical synthesis. Coumarin have characteristic benzopyrone structure, where the benzene ring is condensed with a pyrone ring[2]. The oxygen-containing heterocycles are vital compounds because of their natural abundance and diverse biological functions. More than 1300 coumarins have been identified as secondary metabolites from plants, bacteria, and fungi [3]. Coumarins have several attractive features, such as low molecular weight, simple structure, high bioavailability, high solubility in most of the organic solvents and low toxicity, which, together with their multifaceted biological activities, ensure them a prominent role as lead compounds in drug research and development [4]. As coumarins have proven to be effective pharmacophore, there is a growing demand for their synthesis. Coumarins possess antimicrobial activity such as antibacterial and antifungal. Numerous coumarin derivatives showed significant antioxidant activity⁴. Some coumarins are derived as acetylcholinesterase (AChE) inhibitors, which could be considered as a drug in Alzheimer disease treatment. There



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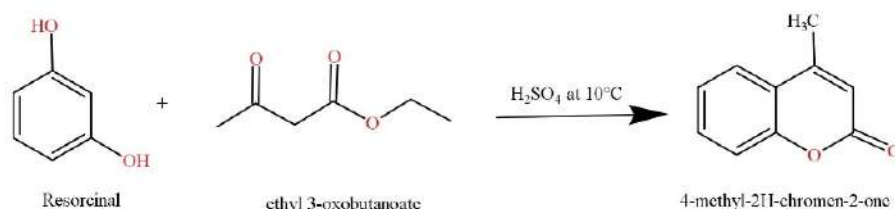
are many other biological activities that are associated with coumarins such as: anti-inflammatory, anti-HIV, anticancer, antituberculosis, anticoagulant, antiviral and antihyperglycemic⁵. Their importance is also clear in the food industry where their fungicide and antioxidant activities are investigated and exploited. Moreover, some natural benzocoumarins show anti-algal activity⁶. It is used in perfumes and flavourings and for the preparation of other chemicals. Despite being recognized for their biological activities, coumarins present another important characteristic widely explored by the industry for their luminescent properties [7]. The luminescence of some derivatives results from the intrinsic charge transfer properties of electron-rich conjugated systems. These compounds present a broad variety of applications, for example as photocleavable protecting groups or fluorescent probes [8]. In focus of the reported importance and our continued interest in building novel heterocycles for various applications, we herein report the base catalyzed synthesis of styryl derivatives [9].

MATERIALS AND METHODS

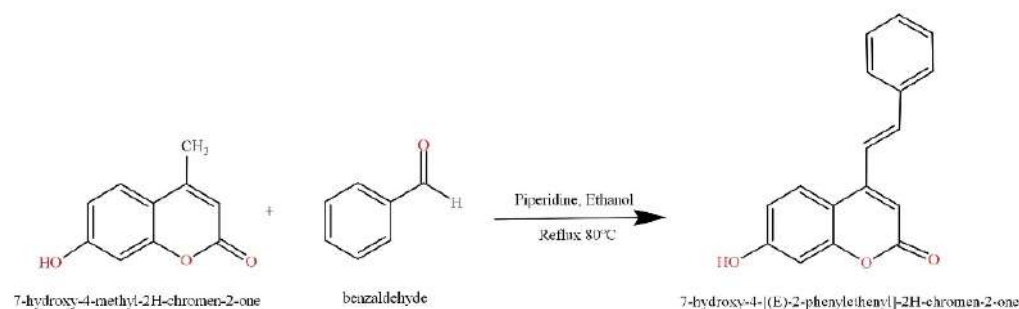
All chemicals and solvents were purchased from Sigma Aldrich, India. Melting points were determined on a Raga melting point apparatus (India) in open capillaries and are uncorrected. Infra-Red spectra were recorded on Shimadzu FT IR PC(S) 8201 spectrometer instrument in potassium bromide (KBr) pellets. Solvents were commercially available materials of reagent grade.

Synthesis of 7-hydroxy-4-methyl coumarin

A solution of 1.1 gram of resorcinol and 1.2 gram of Ethyl acetoacetate was added drop wise with stirring to 10ml of conc. H₂SO₄. The temperature of reaction mixture did not was not raised above the 10°C. After the complete addition of the solution, the reaction mixture was kept at ambient temperature for 18 hours and then poured with vigorous stirring to reaction mixture of ice and water. The precipitate was filtered off and wash with cold water then dried under reduced pressure offered the crude solid mass. On recrystallized from aq. alcohol gives final compound.

**Synthesis of derivatives of Coumarin**

Derivatives of Coumarin was prepared by the base catalyzed condensation of 7-hydroxy-4-methyl coumarin with benzaldehyde.

Synthesis of 7-hydroxy-4-styryl-2H-chromen-2-one (4a)

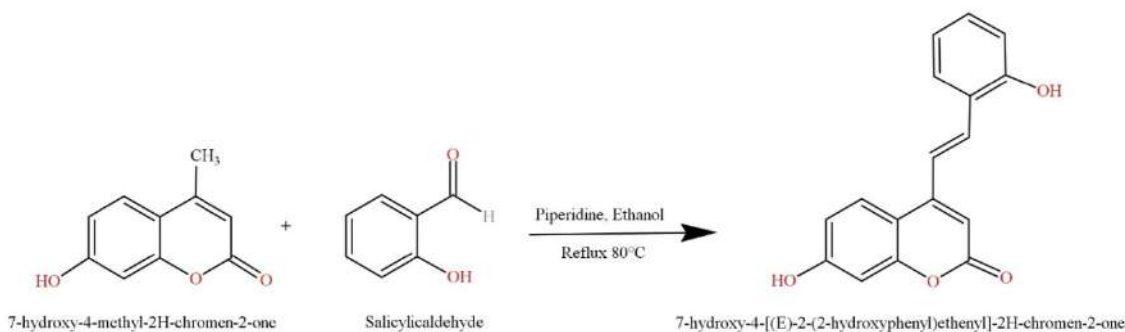


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Equimolar quantities of 7-Hydroxy-4-methyl-coumarin and benzaldehyde in ethanol was refluxed for about 8 hours with a 3-4 drops of piperidine. The completion of the reaction was monitored by TLC. The mixture was cooled and the resulting solid was filtered and purified by recrystallization. Purification of compounds was made by recrystallization in methanol.

Synthesis of 7-hydroxy-4-[(E)-2-(2-hydroxy phenyl)ethenyl]-2H-chromen-2-one (4b)

Equimolar quantities of 7-hydroxy-4-methyl-coumarin and salicylaldehyde in ethanol was refluxed for about 8 hours

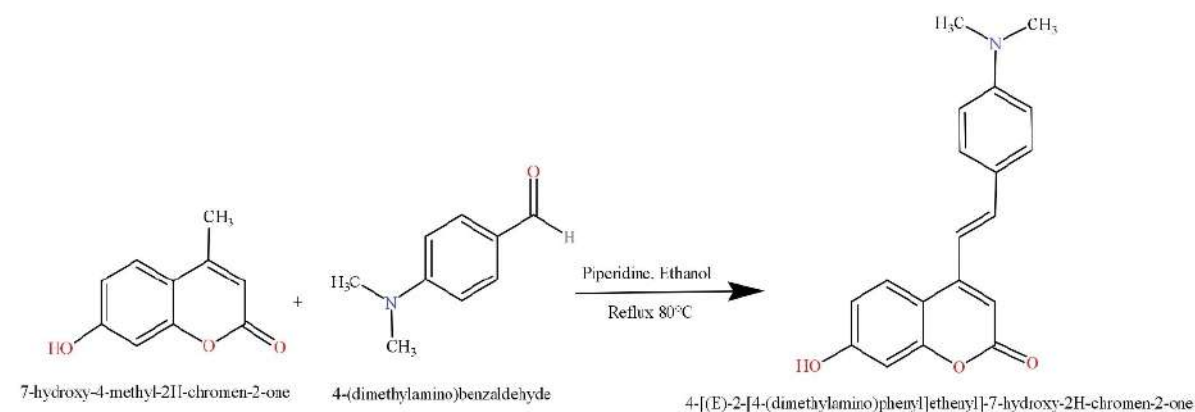


with a 3-4 drops of piperidine. The completion of the reaction was monitored by TLC. The mixture was cooled and the resulting solid was filtered and purified by recrystallization. Purification of compounds was made by recrystallization in methanol.

Synthesis of 7-hydroxy-4-[(E)-2-(4-(N,N-dimethyl amino phenyl)ethenyl]-2H-chromen-2-one (4c)

Equimolar quantities of 7-hydroxy-4-methyl-coumarin and 4-(N,N-dimethylamino) benzaldehyde in ethanol was refluxed for about 8 hours with a 3-4 drops of piperidine. The completion of the reaction was monitored by TLC. The mixture was cooled and the resulting solid was filtered and purified by recrystallization. Purification of compounds was made by recrystallization in methanol

RESULTS AND DISCUSSION



The Analytical data of the synthesized compounds are represented in **Table 1**. 1.1 gram of resorcinol and 1.2 gram of ethyl acetoacetate was made into a solution and the solution was added drop wise with stirring to 10ml of conc. H_2SO_4 in an ice cold bath. The temperature of reaction mixture was not raised above the 10°C . After the complete addition of the solution, the reaction mixture was kept at ambient temperature for 18 hours and then poured with vigorous stirring to reaction mixture of ice and water. The precipitate was filtered off and wash with cold water then dried under reduced pressure offered the crude solid mass. On recrystallized from aq. alcohol gives



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final compound. The next step involves the condensation of the aldehydic part of derivatives of benzaldehyde with the methyl part of 7-hydroxy-4-methyl-coumarin(**3**). The classic condensation was carried out in the presence of piperidine. Equal moles (0.005 mol) of 7-hydroxy-4-methyl-coumarin(**3**) and benzaldehyde were refluxed at 145°C with 2-3 drops of piperidine. After the completion of the reaction as monitored by thin layer chromatography, the reaction mixture was poured into crushed ice. The precipitate thus obtained was filtered, dried and column chromatographed. The product so formed was subjected to spectral studies. The IR spectrum of the synthesized compound (**4a**) showed absorption bands at 3657.04 cm⁻¹ is due to stretching of hydroxyl group. The band at 2978.09 cm⁻¹ is due to C–H stretching. The band at 1666.50 cm⁻¹ is due to C=O stretching of conjugated ketone. The band at 1597.06 cm⁻¹ is due to C=C stretching of cyclic alkene. The peak at 1273.02 cm⁻¹ indicates the C–O stretching. The absorption band at 979.84 cm⁻¹ indicates C=C bending. The absorption spectra of the 7-hydroxy-4-[(E)-2-(2-hydroxy styryl)]-2H-chromen-2-one(**4b**) shows band at 3657.04 cm⁻¹ which may be due to stretching of hydroxyl group. The band at 2978.09 cm⁻¹ is due to C–H stretching. The band at 1666.50 cm⁻¹ is due to C=O stretching of conjugated ketone. The band at 1597.06 cm⁻¹ is due to C=C stretching of cyclic alkene. The peak at 1388.47 cm⁻¹ represents the C–H stretching. The peak at 1273.02 cm⁻¹ indicates the C–O stretching of aromatic ester. The absorption band at 979.84 cm⁻¹ indicates C=C bending. The absorption spectra of the 7-hydroxy-4-[(E)-2-(4-dimethyl amino styryl)]-2H-chromen-2-one (**4c**) represents a band at 3718.76 cm⁻¹ and 3487.30 cm⁻¹ is due to stretching of hydroxyl group. The band at 2978.09 cm⁻¹ is due to C–H stretching. The band at 1666.50 cm⁻¹ is due to C=O stretching of conjugated ketone. The band at 1597.06 cm⁻¹ is due to C=C stretching of cyclic alkene. The peak at 1373.32 cm⁻¹ represents the C–H stretching. The band at 1234.44 cm⁻¹ is due to C–N stretching. The peak at 1273.02 cm⁻¹ indicates the C–O stretching of aromatic ester.

CONCLUSION

The vast and varied applications of coumarins from the literature prompted us to synthesis styryl coumarins. The efficient and effective base catalyzed synthesis of styryl coumarins provides an easy and highly efficient one-pot synthesis of styryl coumarins. The effect of substituted styrene having electron donating and withdrawing groups which provide driving force to accelerate the reaction under base-free condition may be studied in future.

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Table 1. Physical characteristics of the synthesized compounds

Compound	Molecular Formula	Molecular Weight	Yield (%)	M.Pt(°C)
4a	C ₁₇ H ₁₂ O ₃	264	82	224 °C
4b			86	> 300 °C
4c			78	> 300 °C

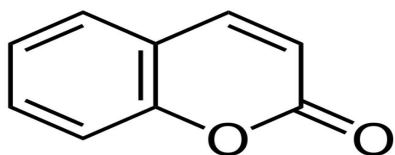


Fig.1. Structure of Coumarin



Fig.2. Synthesis of 7-hydroxy-4-methyl coumarin



Fig. 3. Synthesis of derivatives of styrylcoumarins4 (a-c)

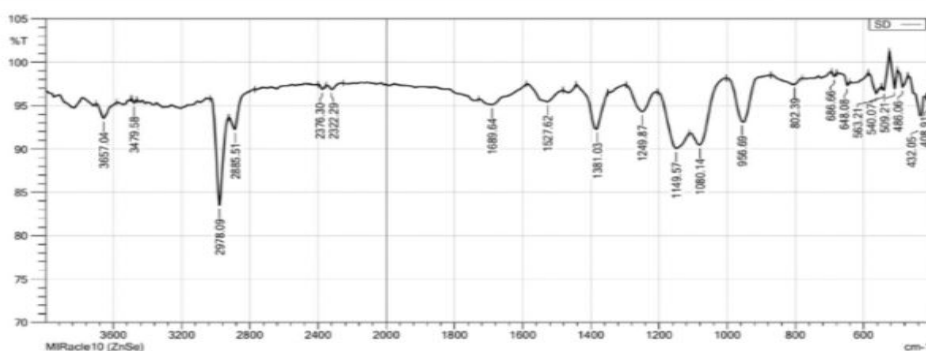


Fig.4. IR Spectrum of 7-hydroxy-4-[(E)-2-(2-hydroxy styryl)]-2H-chromen-2-one (4a)





Effect of Extraction Process on Agar Properties of *Gracilaria corticata* and *Gracilaria edulis* (Rhodophyta) Collected from the Mallipattinam Coast, India

V.Ilakkiya^{1*}, B.Dhanalakshmi¹ and V.Kaviya²

¹Assistant Professor, PG and Research Department of Zoology, Nirmala College for Women, Coimbatore -18, Tamil Nadu, India.

^{1,2} Research Scholar, PG and Research Department of Zoology, Nirmala College for Women, Coimbatore - 18, Tamil Nadu, India.

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*Address for Correspondence

V.Ilakkiya

Assistant Professor,
PG and Research Department of Zoology,
Nirmala College for Women,
Coimbatore -18, Tamil Nadu, India.
E. Mail : indurekaa@gmail.com



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ABSTRACT

Macro-algae are a eukaryotic organism that live in the salt waters of the sea and has been renowned as a probable resource of bioactive natural products. In India, seaweed is mostly used to attain alginate and agar. Agar, a hydrophilic colloid, was the foremost phycocolloid to be used in the food industry, accounting for 80% of its utilization and the enduring 20% for biotechnology applications. The use of agar in a range of products depends on its chemical composition, including sulfate, sugar and methoxyl content. Agar source is mainly extracted from *Gelidium* and *Gracilaria* species. Therefore, in this study, we compare the extraction methods, yields and physicochemical properties of polysaccharides from seaweed. *Gracilaria edulis*, an algal species of *Gracilaria corticata*, was collected from his Mallipattinam on the southeast coast of India, Thanjavur district. *Gracilaria edulis* and *Gracilaria corticata* were used for agar extraction by acid and alkali treatment. As a result, the the agar yield (16.6%) of acid-treated *Gracilaria edulis* was higher than that of *Gracilaria Verucosa*. The viscosity of crude agar extracted from *G. edulis* was 150 cp which is significantly higher than that of *G. verrucosa*. The obtain results may provide to make use of the seaweeds in traditional medication.

Keywords: Agar, alkaline, crude extract and *Gracilaria*





INTRODUCTION

Marine organisms are a source of structurally distinct natural products with pharmacological and biological properties. Among marine organisms, macroalgae play an important role in the production of biomedical compounds [1]. Around 2400 natural products derived from macro-algae of the classes Rhodophyceae, Phaeophyceae, and secondary metabolites have been isolated. *Gracilaria* species are the most important agar sources worldwide [2], and numerous studies on their agar yield and quality from various geographical areas have been conducted [3][4].

Gracilaria edulis grows attached to rocks and grows submerged, just below the level of the lowest low water spring tide. The mature plant can reach a length of 50 cm and is freely branched, with the branches being cylindrical and generally tapering to a point. The plants are dark purplish red in colour and have a cartilaginous consistency. Young plants of these algae can be seen in nature during the months of June and July, as well as December, January, and February. Seaweeds have long been used in human and animal nutrition. Seaweeds are high in bioactive compounds like carotenoids, fibre, protein, essential fatty acids, vitamins, and minerals [5].

Agar is a phycocolloid that is widely used as a gelling agent in the food industry, biotechnology, and cosmetics [6]. It is derived from red seaweeds known as agarophytes. Agar is primarily derived from algae of the genera *Gelidium* and *Gracilaria*. Agar, the main component of these algae's cell walls, is a polysaccharide composed primarily of a succession of agarobiose units, namely 3,6-anhydro-4-O—D-galactopyranosyl-L-galactose. Industrial agar extraction consists of several steps, the first of which is an alkaline treatment, which results in the desulfation of this polymer and, as a result, an improvement in its gelling properties [7]. Following alkaline treatment, several rinses are required before agar is solubilized with hot water under pressure. This extraction process produces a large amount of byproducts, which are typically discarded because they are considered waste. Food processing by-products derived from plants or algae, on the other hand, are recognized as potential and significant sources of valuable compounds [8][9]. Therefore, the current study on agar content and physical properties of agar from *Gracilaria corticata* and *Gracilaria edulis*.

MATERIALS AND METHODS

Selection of Sampling Site and Collection of Experimental Species

The seaweed used in the experiment was collected in Mallipattinam, Thanjavur district, on the south east coast of Tamil Nadu, India. To avoid other micro-algal contamination, alive and healthy macro-algae sample was collected manually by handpicking method at a depth of 1-2m at 6.30 am during the lowest tide of chart datum from seaweed infested locations exclusively from the intertidal rocky and other substratum.

Transportation and Preservation of Macro-Algae

Handpicked seaweed was immediately washed in seawater to remove all impurities such as epiphytes, extraneous matter, coarse sand, and other calcareous impurities. Later, they were packed in pre sterilized polythene bags half-filled with seawater and transported to the laboratory for 5 to 6 hours conditioned under ice at 20°C to avoid decomposition and metabolite loss, in preparation for identification and future wet lab characterization.

Preparation of Algal Powder and Crude Extract

Following identification, the algal sample was thoroughly sterilized with tap water to remove unwanted impurities, adhering sand particles, and extraneous matter such as epiphytes, pebbles, and surface salty mature shells. The seaweeds were rinsed three times in sterile distilled water to remove excess sand and dust. The algae was then cut into small pieces and scattered over filter paper for a few hours to absorb excess water. For two weeks, the algal





samples were shade dried. The samples were then ground into coarse powder using an electric mixer grinder. The powdered sample was properly packaged in zip lock bags and refrigerated at 4° C.

Effect of Alkali Treatment

The alkaline treatment and agar extraction were carried out with some modifications to the method described by Freile-Pelegri and Robledo [10]. To rehydrate the seaweed, 25 grams of *Gracilaria edulis* and *Gracilaria corticata* were soaked in 500 ml of 7% NaOH at room temperature (22°C) for 12 hours. The solution was then heated in a water bath at 85°C for 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 hours with constant agitation.

Agar Extraction

In alkali treatment, each sample was washed three times with 500 ml of distilled water for 5 minutes each, followed by two hours of constant agitation with 500 ml of 0.025% H₂SO₄. To remove excess acid, samples were washed for 10 minutes in 500 ml of distilled water. The algae were immersed in 900 ml of hot distilled water while being constantly agitated. When the solution reached 80°C, the pH was adjusted with 10% phosphoric acid to 6.2-6.5. For 1.5 hours, the algae were boiled. The extract was mixed with diatomaceous earth (Celite) and vacuum-filtered. The filtrate was allowed to gel on plastic trays at room temperature before being frozen overnight and thawed at room temperature. Finally, the agar was washed with ethanol, dried for 24 hours in an oven at 55°C, cooled, and weighed to determine the percentage yield of agar [11].

Determination of Physical, Chemical and Nutritional Parameters

The method that yielded the highest yield was used to extract agar samples, which were then compared to physical and chemical parameters with marketable products. The protein, fat, carbohydrate, moisture, and ash contents were determined using the AOAC [12] method. The gel pH was determined using an electronic pH meter and the AOAC Method [13]. Guisaly method [14] was used to calculate the melting and gelling points.

RESULTS AND DISCUSSION

Quality Index of *Gracilaria verrucosa* and *Gracilaria edulis*

Table 1 shows the variation in quality of two different seaweed species, *Gracilaria corticata* and *Gracilaria edulis*. Data analysis revealed that there were no significant differences between the moisture percentage and the purity percentage of agarophytes. *Gracilaria edulis* had the highest percentage of total impurities (13.34 ± 1.4), while *Gracilaria corticata* species had the lowest percentage of impurities. *Gracilaria edulis* had the lowest percentage of DDMS (16.14 ± 0.05) and *Gracilaria corticata* had the highest percentage of DDMS (10.7 ± 4.6). In addition, the *Gracilaria edulis* had a high percentage of insoluble matters and a low percentage of total soluble matters (9.58%) [15]. Effect of different extraction methods on quality of Agar Table 2 compares the physical properties of agar extracted from *G. corticata* and *G. edulis* pretreated with alkaline and acids. *G. edulis* crude agar had a viscosity of 150.37, which was significantly higher than *G. corticata*. *Gracilaria edulis* had the highest viscosity (197.58) in alkaline treatment. This demonstrates that acid treatment causes a significant increase in viscosity. Acid pretreatment improves the viscosity of both species, resulting in greater thickening ability. The pH values of crude, acid, and alkaline treated agar extracted from *Gracilaria corticata* and *Gracilaria edulis* species, respectively, were 6.37, 6.6, 4.3, 4.25, 8.5, and 8.67. [16][17] *Gracilaria corticata* and *Gracilaria edulis* extracts treated with acid yielded lower gel strength than alkaline treated samples. When compared to acid and alkaline treated (1.5%) gel, crude agar from *G. corticata* and *Gracilaria edulis* had the highest gel strength, indicating 472 g/cm² and 356 g/cm² respectively. When agar extracted from alkaline treated *Gracilaria edulis* was compared to acid treated once, the gel strength increased by 65%. The gel strength of commercial agar was two times that of crude agar. Agar gel strength in *Gracilaria* species is higher in wild or older plants than in younger or cultivated plants [18]. In terms of yield, agar extracted from *Gracilaria corticata* yielded the least (18.6%).



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The alkaline treated *Gracilaria corticata* and *Gracilaria edulis* yielded 18.6% and 21.5%, respectively. When compared to alkaline treatments, acid-treated *Gracilaria edulis* significantly increases agar yield from 77% to 80%. These findings are consistent with those of [19], who claims that acid-treated wild samples yield the highest agar yield due to higher hydrolysis of the seaweed in acid than in alkaline. *Gracilaria* species used as a raw material for agar extraction typically yield 10-25% [20]. The melting point of *Gracilaria corticata* and *Gracilaria edulis* agar extracted using alkaline treatments increased by 15% and 4%, respectively. When compared to acid-treated agar, the melting point of agar extracted from alkaline-treated *Gracilaria edulis* increased by (26%). Acid treated agar extracted from *G. corticata* had the highest gelling point (43°C), which increased by 34% when compared to alkaline treatments. The time required for alkaline treatment increased the gelling point of *Gracilaria edulis* from 31°C to 42°C [21]. According to the study, the gelling point varies with alkaline strength and treatment time

Proximate composition of *Gracilaria edulis*

As shown in Table 3, all polysaccharides contain more than 40% carbohydrates. The extracted *Gracilaria edulis* agar had the highest carbohydrate value (53.85), while commercial agar had the lowest value. The carbohydrate content of extracted polysaccharides was found to be significantly higher than that of commercial products. Polysaccharides are more abundant in protein, fat, moisture, and ash than in commercial agar. Polysaccharide extraction differs depending on the seaweed species [22], but in general, laboratory agar extracted using alkali treatment from *Gracilaria edulis* is followed by hot water extraction. Commercial agar had twice the gel strength of laboratory extracted agar.

Physical Properties of *Gracilaria edulis*

The laboratory prepared agar had the highest viscosity (156 5.5) compared to the commercial product. Alkaline treatments increased the melting points to 86°C 1.37, but they were still lower than those of commercial agar. When compared to commercial agar, laboratory prepared agar had the lowest gelling point. Carrageenan extraction from alkaline (6% KOH) treatments improved gel strength twice as much as commercial carrageenan. As previously stated, alkali treatments cause a chemical change in agar (formation of 3,6-anhydro-galactopyranose), resulting in increased gel strength for carrageenan. The viscosity of laboratory-prepared carrageenan was greater than that of commercial carrageenan. Table 4. The gelling point of commercial carrageenan was higher, while the melting point of both carrageenans was lower than that of agar. Alkaline treatments increased agar properties such as gel strength while maintaining gelling properties, whereas others decreased hydrocolloid yield and interfered with hydrocolloid gelling abilities. Acid treatments increased hydrocolloid yield and viscosity while lowering gel strength. High viscosity hydrocolloids are in demand in the food industry, while low viscosity hydrocolloids are in demand in the textile industry.

CONCLUSION

In functional properties, seaweed is a unique source of valuable hydrocolloids and is important in the food, medicinal, and biotechnological industries. To improve the functional properties of these hydrocolloid polysaccharides, it is necessary to identify more sustainable chemical uses and more selective extraction techniques. The current literature focuses primarily on the hydrolysis of the hydrocolloid agar; two seaweed specific by acid and alkaline have been identified that degrade the hydrocolloid polysaccharides and thus change the yield and gel strength of agar. Agar extracted from *Gracilaria edulis* treated with alkaline had superior physical properties to agar extracted from *Gracilaria corticata*. High viscosity hydrocolloids are in demand in the food industry, while low viscosity hydrocolloids are in demand in the textile industry.





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Table 1: Effect of different extraction methods on quality of seaweed polysaccharides

Species	Parameters					
	Moisture (%)	Total soluble matter(%)	Insoluble matter (%)	DDMS	Purity	Total impurities (%)
<i>Gracilariacorticata</i>	9.37 ±0.07	9.58 ±4.7	20.22 ±4.9	10.70 ±4.6	84.73 ±5.2	13.34 ±1.4
<i>Gracilariaedulis</i>	12.39±0.16	12.97 ±8.3	16.14 ±0.05	9.27 ±2.8	98.66 ±6.8	23.38 ±1.5

*Each value is mean ± S.E

Table 2: Effect of different extraction methods on quality of Agar

Parameters	Polysaccharides	
	Extractedagar (<i>Gracilaria edulis</i>)	Commercial agar
	Mean ± SE	Mean ± SE
Protein (%)	7±0.27	5.3±0.09
Fat (%)	1.2±0.19	1.3±0.13
Moisture (%)	18.1±0.61	16±2.06
Ash (%)	4.294±0.13	2.9±3.4
Carbohydrate(%)	53±8.5	50±3.6

*Each value is mean ± S.E

Table 3: Proximate composition of *Gracilaria edulis* and commercial purchased of agar

Species	Extraction methods					
	Crude extract		Acid treatment,(1.5%agargel)		Alkaline treated agar(1.5%agar)	
	<i>Gracilaria corticata</i>	<i>Gracilaria edulis</i>	<i>Gracilaria corticata</i>	<i>Gracilaria edulis</i>	<i>Gracilaria corticata</i>	<i>Gracilaria edulis</i>
Viscosity (cp)	97.5 ±0.76	150 ±1.37	195.17±0.43	160±1.03	124±0.50	197.58±0.6
Gel strength (g/cm ²)	469 ±4.2	369±0.66	69±1.0	23±0.1	326±6.4	472±0.76
pH	6.37±1.8	6.6±0.8	4.3±0.14	4.25±9.4	8.5±0.069	8.67±0.15
Yield (%)	15.7±6.9	17.6±0.9	30±0.069	36±0.30	18.6±0.154	21.5±0.40
Melting Point (°C)	82.2±0.09	88±0.03	86 ±0.48	75±0.73	92.6±0.154	92.2±0.03
Gelling point (°C)	31°C±0.06	30°C ±0.04	42°C±0.3	35°C±0.3	32°C±0.13	30°C±0.7

*Each value is mean ± S.E

Table 4: Comparison of physical properties of extracted seaweed polysaccharides with commercial purchased polysaccharides

Parameters	Products
	Extracted Agar (<i>Gracilaria edulis</i>)
Parameter Solubility	Boiling water
Gel strength (g/cm ²)	472±1.16
Viscosity (cp)	156±5.5
Melting point(0 ^h)	86°C±1.37
Gelling point(0 ^h)	32°C±1.09
Colour	Pale yellow

*Each value is mean ± S.E





Structural Characterization and Molecular Docking of Biologically Active Complex

J.Johncy Caroline*

Assistant Professor, Department of Chemistry, Nirmala College for Women, Coimbatore-18, Tamil Nadu, India.

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*Address for Correspondence

J.Johncy Caroline*

Assistant Professor,
Department of Chemistry,
Nirmala College for Women,
Coimbatore-18, Tamil Nadu, India.
E.Mail: johncyever@gmail.com



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ABSTRACT

The primary amine and an aldehyde condense to form Schiff base or ketone. Significant ailments can be cured using the particular class of organic compound. Where in large number of ligands has been derived from complexes of amino acids. The antimicrobial activity of five membered ring compounds have been a promising feature. Benzoyl hydrazone plays a vital role antimicrobial activity against many organisms. From the elemental analysis stoichiometry of ligands was confirmed. Compounds of both types of ligands were compared for their activities. FTIR spectrum showed peaks for respective functional groups of the ligands. The antibacterial activity of both the ligands with *Escherichia coli* was compared and the results gave an outline that ligand was more efficient against the bacterial strain. Docking studies was done in ligand along with 3-hydroxy-3-methylglutaryl-coenzyme. Both the synthesized compounds exhibit enhancement in the expression of HMGCS2. The compounds were docked with HMG CoA Synthase2 whose structure was retrieved from PDB. A synthase 2 enzyme, showed good binding characteristics. The predicted activity of the compounds is HMGCS2 expression enhancer. This ligand can be further subjected to cell line studies since it shows very good anticancer activities. It stands out in the recent advancements in the Schiff-base coordination chemistry domain and its future prospects as a potential bioactive core.

Keywords: Schiff bases, *Escherichia coli*, Benzoyl hydrazone, docking studies, cell line studies



**Johny Caroline**

INTRODUCTION

Coordination compounds play an important role in our daily lives, with applications ranging from biology to industry. The biological properties of cobalt complexes differ significantly based on the chelation strategy. Antimicrobials, anticancer agents, and protein aggregation inhibitors are only a few of the possible therapeutic activities of cobalt-Schiff base complexes. Because of their high selectivity and target specificity in treating a variety of life-threatening diseases, coordination complexes are now replacing traditional organic drugs in biology. Metals, such as copper, calcium, iron, zinc, and cobalt, are important elements that have enormous biological activity when combined with certain metal proteins that help transport oxygen and are also useful in electronic transfer reactions and ion storage. Over the years, the chemistry of Schiff base complexes has progressed quickly, finding solutions in coordination and stereochemistry [1,2]

MATERIALS AND METHODS

PREPARATION OF LIGANDS

Preparation of Ligand (L1)

STAGE: 1

4-nitrobenzoic acid (0.01mole) and thiosemicarbazide (0.01mole) and phosphorous oxychloride (5ml) was made into a mixture and heated under reflux for 3 hours. After 3 hours the mixture was cooled and 50ml of distilled water was added to it and it was again heated under reflux for 4 hours. The obtained filtrate was neutralized with potassium hydroxide. Then the precipitate was filtered and washed with cold- distilled water and recrystallized by using ethanol to obtain 5-(4-nitrophenyl)-1, 3, 4- thiadiazol-2-amine.

STAGE: 2

5-(4-nitrophenyl)-1, 3, 4-thiadiazol-2-amine (0.01mole) was taken along with salicylaldehyde (0.01mole) and was allowed to heat under reflux for 3 hours and a yellow precipitate was obtained. The precipitate obtained was filtered and crystallized from ethanol to give the respective 2N-salicylidene-5-(p-nitrophenyl)-1, 3, 4- thiadiazole (L1)

Preparation of Ligand (L2)

Salicylaldehyde (0.01mole) and 4-chlorobenzhydrazide (0.01mole) were dissolved in ethanol 30ml separately in 1:1 molar ratio. The ethanolic solutions were mixed together. The mixture was kept in a stirrer for about an hour. A crystalline compound was separated by filtration and then the crystals are separated and washed with ethanol and dried. The Schiff base ligands synthesized were stable at room temperature and soluble in solvents like methanol, ethanol, chloroform, DMSO etc. The ligands were characterized by elemental analysis and spectral analysis. According to the Biological activity of the ligands, L2 was taken into consideration for the preparation of complex.

Preparation of complex

An ethanolic solution of the metal ion was made by dissolving the metal salt in ethanol (30mL) and Salicylaldehyde-4-chlorobenzoylhydrazone was dissolved in 30mL ethanol. Both the mixtures were mixed in the metal-ligand molar ratio (1:1). This mixture was stirred for 2 hours A crystalline complex was separated by filtration and the crystals were washed and dried. The complex synthesized was soluble in DMSO, Chloroform like solvents and was stable at room temperature. It was characterized by elemental analysis and also spectral analysis.





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RESULTS AND DISCUSSION

From the Elemental analysis of L1 and L2, the stoichiometry of ligands was confirmed. The analysis was found to be in agreement with the proposed structure of the ligands⁽⁹⁾. The Analytical and Physicochemical data are listed in Table below.

SOLUBILITY

The ligands were tested for their solubility (Table 1).

FLUORESCENCE

The fluorescent nature of the compounds was noted by dissolving it in ethanol.(Figure:1) The compounds showed fluorescent nature by absorption at 254nm in Short range UV light and long range UV light and no absorption was found in visible light.

CHARACTERIZATION OF THE SYNTHESIZED LIGANDS: UV-Visible spectroscopy

UV- Visible spectroscopy is based on Beer-Lambert law that states that the absorbance of a substance is directly proportional to the amount and intensity of the light passing through the sample. This ratio is called Transmittance and it is usually expressed in percentage (%T) [4]. As concentration varies absorbance also varies. The absorbance is based on the transmittance that is expressed in the spectrum. L1 showed characteristic peak at 320 nm with a single band at very low intensity which corresponds to $n-\pi^*(C=O, C=N)$ transition and L2 showed characteristic peak at 360 nm with a single band.

FT-IR Analysis

Anti-bacterial activity

The preliminary *in vitro* antibacterial screening activities of the ligands are given in the table above. The synthesized compounds were screened against Escherichia coli bacterial strains by Inhibition zone method.

COMPARATIVE STUDY OF BOTH THE LIGANDS

The two Salicylaldehyde based thiadiazole and benzoylhydrazone ligands showed distinct bands in UV-Visible spectrum. They also showed peaks for respective groups in the infrared spectra. The ligands were tested for their antibacterial activity. They were inoculated in plates that was prepared aseptically, and placed in a petri dish with one part as sample and the other part as standard Cuproflaxacin and kept at 34°C for 24 hours. The preliminary screening results revealed that the ligands showed a moderate activity. This may also be due to the bulkiness of the molecule with a complicated structure which in turn restricts their mobility to the target cells or the active site. The results concluded that Ligand 2 was more efficient [5]. Since ligand 2 was more efficient it was subjected to complexation and docking studies.

COMPLEXATION

Salicylaldehyde-4-chlorobenzoylhydrazone was made into a complex in ethanol medium by refluxing and it was characterized by UV-Visible, IR and Antibacterial studies.

ANTIBACTERIAL ACTIVITY OF THE COMPLEX

From the Table and Figure antibacterial activity, complex of the ligand showed more inhibition than the ligand itself.

MOLECULAR DOCKING

Table 3 Drug Likelihood of the compound

TPSA-Total Polar Surface Area; RB-Number of Rotatable bonds; HBA- Number of Hydrogen Bond Acceptors; HBD-Hydrogen Bond Donor; MW-Molecular Weight. It could be found from Table 1 that compound1 follow Lipinski's





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rule of 5 and is a potential drug candidate [6,7]. The biological activity of Compound 1 is given. The binding energy of different conformations ranges between -5.98 to -3.15 kcal/mol. Among the ten different docked conformations, conformation 3, 4 and 6 had binding energies -5.24, -4.59, -4.55kcal/mol with two hydrogen bond respectively. The other conformations had binding energies within the range and had one hydrogen bond.

CONCLUSION

The complex were characterized by UV, IR techniques. UV- Visible Spectrum showed distinct bands for both the compounds C=O and C=N transitions at 320 and 365 respectively. FTIR spectrum showed peaks for respective functional groups of both the ligands. The Antibacterial activity of both the ligands with *Escherichia coli* was compared and the results gave an outline that L2 was more efficient against the bacterial strain. Since L2 was found to have most efficiency against the strains it was further subjected to complexation and docking studies. Cu complex was prepared using L2 in ethanolic medium and the complex was characterized by UV-Vis, FTIR, and antibacterial studies. The UV AND FTIR spectrum showed distinct peaks for the complex. The antibacterial results revealed that the complex of L2 had more efficient against *Escherichia coli* than the ligand itself. Docking studies was done in L2 along with 3-hydroxy-3-methylglutaryl- coenzyme A synthase 2 enzyme, showed good binding characteristics. The studies revealed the binding nature of all compounds. The synthesized compounds possess pharmaceutical Drug designing properties. With further investigation the compound can be further subjected to cell line studies since it shows very good anti-cancer activities.

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Table: 1 Solubility of ligands in various solvents.

S.NO	COMPOUND	DMSO	Ethanol	Petroleum Ether	Acetic Acid	EthylAcetate	Distilled water
1.	L1	Soluble	Soluble	Insoluble	Soluble	Soluble	Insoluble
2.	L2	Soluble	Soluble	Insoluble	Soluble	Soluble	Insoluble





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Table 2. Antibacterial activity of complex.

S.No	ORGANISM	Zone of Inhibition(mm)	
		STD CIPROFLOXACIN (10µg/disc)	SAMPLE (100µg/disc)
1.	<i>Escherichia coli</i>	46	38

Table 3. Drug Likeliness of the compound

Compound	Volume (A3)	TPS A (A2)	R B	HB A	HB D	MW (Da)	Log P	No. of non H atoms	Lipinski's Violation
Compound 1	292.35	89.46	4	7	3	330.08	2.31	23	0

TPSA-Total Polar Surface Area; RB-Number of Rotatable bonds; HBA- Number of Hydrogen Bond Acceptors; HBD- Hydrogen Bond Donor; MW-Molecular Weight

Table 4. Activity of the compound

Pa	Pi	Activity
0.781	0.005	HMGCS2 expression enhancer
0.734	0.015	Glucan endo-1.6-beta-glucosidase inhibitor
0.683	0.005	UGT2B12 substrate
0.674	0.008	Laccase inhibitor
0.723	0.060	Ubiquinol-cytochrome-c reductase inhibitor

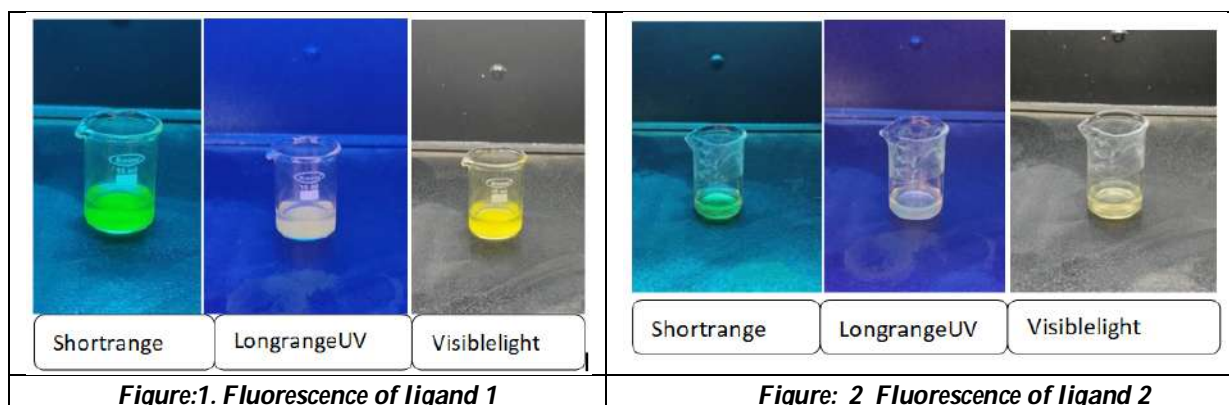


Figure:1. Fluorescence of ligand 1

Figure: 2 Fluorescence of ligand 2





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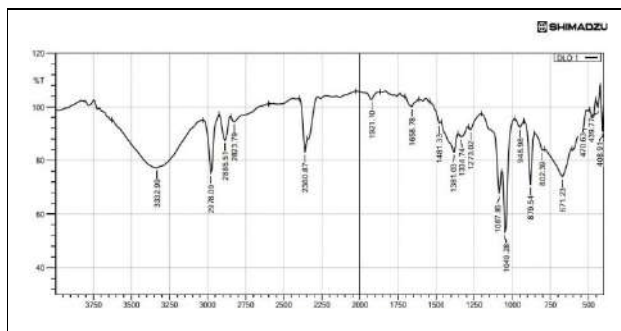


Figure 3: FT-IR Spectrum of Ligand 1

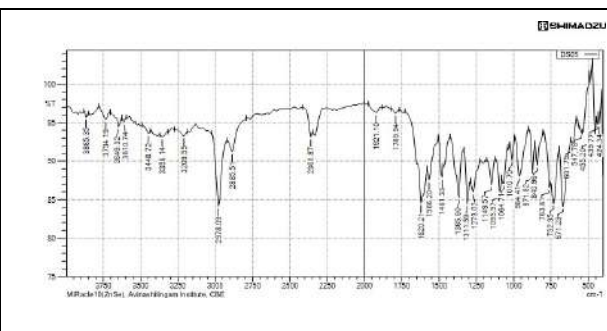


Figure 4: FT-IR Spectrum of Ligand 2



Figure 5. Antibacterial activity of L1

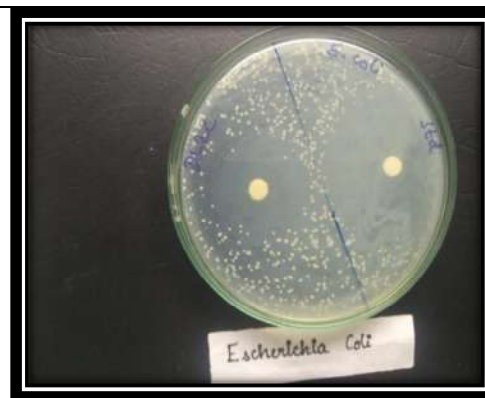


Figure 6. Antibacterial activity of L2

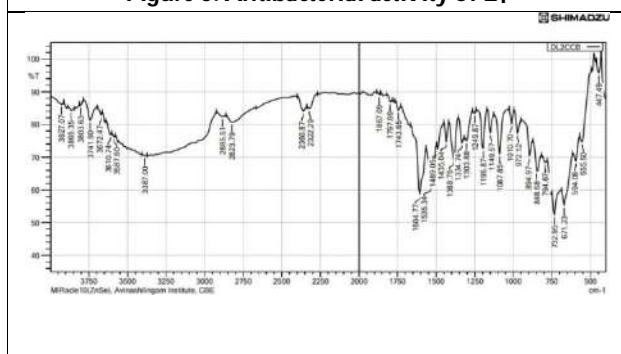


Figure 7: FT-IR spectrum of the Cu complex.

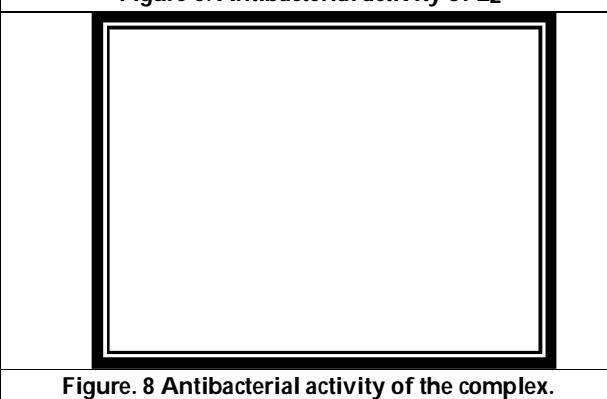
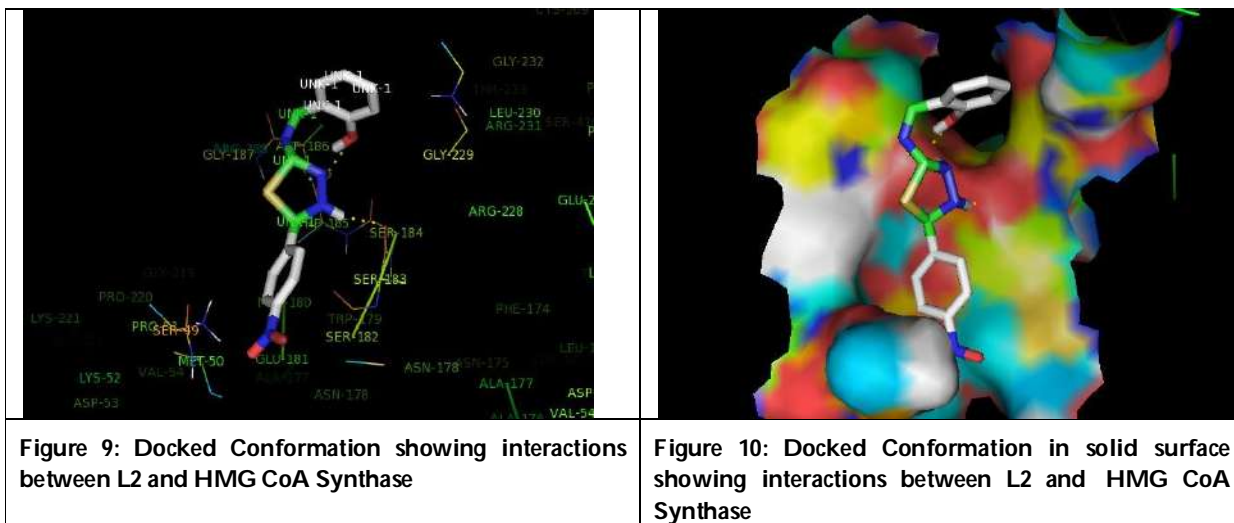


Figure 8 Antibacterial activity of the complex.





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Dimensions of Regional Disparity and Socio-Economic Conditions of Scheduled Tribes in Different Regions of Salem District, Tamil Nadu

N. Srinath^{1*} and T. Ponnarasi²

¹Ph.D Research Scholar, Department of Agricultural Economics, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India.

²Associate Professor, Department of Agricultural Economics, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India.

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*Address for Correspondence

N. Srinath

Ph.D Research Scholar,
Department of Agricultural Economics,
Faculty of Agriculture, Annamalai University,
Annamalai Nagar, Chidambaram,
Tamil Nadu, India.

E.Mail: srinathpaari132497@gmail.com



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ABSTRACT

The Scheduled Tribe population is one of the most economically impoverished and minority group in India. According to 2011 census, Tribal population contributed 8.6 per cent of the total population of the country. Tamil Nadu has the lowest percentage of scheduled tribes, at 1.1 per cent compared to other states of India. Salem district has the largest tribal population distribution in Tamil Nadu, with 15.02 per cent and has the 4th highest tribal concentration in the district, at 3.43 per cent to district total. This paper aims to identify the region-wise Intra-regional disparities in education (literacy) of Scheduled Tribes and regional disparity between workers and non-workers of Scheduled Tribes in Salem district. A dominant and distinctive economic activity of tribes and its level in different regions has been identified by Nelson's method. The study found that Scheduled Tribes female literacy rates lagged behind Scheduled Tribes male literacy rates in the regions of the study area. Sophers' disparity index revealed that, the highest tribal concentrated region which is western region is having low educational disparity among tribes. Work participation rate for Scheduled Tribes of male, female and total were 63.23 per cent, 59.01 per cent and 61.15 per cent respectively. Sophers' disparity index revealed that, western region is having high Scheduled Tribes regional disparity between workers and non-workers in the study area.

Keywords: regions, socio-economic, tribes, regional disparity, literacy, workers, dominant function



**Srinath and Ponnarasi****INTRODUCTION**

India has a diverse population of indigenous people. The Scheduled Tribe population is one of the most economically impoverished and minority group in India. The tribal communities have been identified by the Government of India on the basis of (a) pre agricultural level of technology, (b) extremely low level of literacy; and (c) small, stagnant or diminishing population[1]. There are 550 different tribes in India and they vary from each other, geographically, culturally and in terms of their levels of social as well as economic and educational development, and their problems vary from region to region within their own groupings. Since independence, the Indian government has taken numerous steps to improve tribal livelihoods. Several commissions and committees have recently advocated a number of initiatives to address the social and economic disparities among tribes, as well as to break down the tribal territories' long-standing psychological barriers. According to 2011 census, Tribal population contributed 8.6 per cent of the total population of the country. Rural areas accounted for 11.3 per cent of the total tribal population, while urban areas accounted for 2.8 per cent. As per 2011 Census, Tamil Nadu ranks 22nd among tribal population in India. In percentage, it has the lowest tribal concentration in its population with 1.10 per cent of tribal population in Tamil Nadu to total population of Tamil Nadu and 0.8 per cent Scheduled Tribes in the Tamil Nadu to total Scheduled Tribes population in India [2]. Based on different socio-economic conditions, there are significant disparities in the state among the districts. In this research paper, an attempt has been made to investigate to identify the region-wise Intra-regional disparities in education (literacy) of Scheduled Tribes and regional disparity between workers and non-workers of Scheduled Tribes in Salem district. Major Tribal communities in Tamil Nadu, are Irulars, Malayalis, Muthuvans and Kattunayakans who are repeated to have been cultivating traditional cultivars of paddy, millets, pulses and vegetables (Anburaja, 2012)[3]. There are also 36 sub tribes in Tamil Nadu, with predominant occupation as cultivators, agricultural labourers, or forest dwellers.

In terms of total population, the Salem district ranked 5th in the state. The district has recorded population density of 665 persons/sq km. Salem district has the largest tribal population size in Tamil Nadu with 15.02 per cent (highest number of population among districts) and has the 4th highest tribal concentration in the district, i.e. 3.43 per cent to district total. Salem is the seventh largest district in Tamil Nadu, in terms of area. Salem district has four Municipalities, 13 Taluks, and 21 Blocks, 33 Town panchayats, 385 Village panchayats and 640 Revenue villages. Two blocks namely Pethanaickenpalayam and Yercaud are fully inhabited by the tribes. Major tribes in Salem district are Malayali, Kondareddies, Kurumans and Malakkuravan. They have been cultivating traditional cultivars of pulses, millets, minor millets, vegetables and fruit crops. Even though they are cultivators and workers, they are suffered for education, health care, basic amenities, electricity and road connectivity due to their residence in hill region. Absence of urban centre, inaccessible physiographic conditions, unemployment, unavailability of facilities, and non-accessibility of different sources in tribal areas are the problems faced by the Scheduled Tribes in Salem district. Geographical area map of Salem district with blocks is given in Figure 1. For better understanding and interpretation, the district was further classified into regions based on the geographical direction and the list of Taluks, Community development blocks and Regions of Salem district has been given in Table 1.

Kalrayan hills is in the north-eastern part of the district. Nagaramalai, Jarugumalai, Kanjamalai, Godumalai, Kalrayan Malai, Pachamalai, Shervaroyan hills, Eastern ghats, Sankari malai, Paalamalai, Thenmalai, and Kumaragiri hills are hills in the district. Nagaramalai to the north, Jarugumalai to the south, Kanjamalai to the west, Godumalai to the east, and the Shervaroyan hills to the northeast encircle Salem city. The Kariyaperumal hill is located towards the southwest of the city. The Northern region comprises of Ayothiyapattinam, Mecheri, Omalur, Yercaud, and Kadaiyampatti blocks, and the Southern region comprises of Salem, Veerapandi, Panamarathupatti, Mac.Donal Choultry, and Tharamangalam blocks. The blocks Pethanaickenpalayam, Vazhapadi, Attur, Gangavalli, and Thalaivasal forms the Western region, and blocks forms the Eastern region. Of these four regions the Eastern region has higher number of tribal villages, and tribal population.



**Srinath and Ponnarasi****Objectives**

The specific objectives of the study undertaken are:

- To study the concentration and distribution pattern of Scheduled Tribes population in the study area.
- To analyse the region-wise Intra-regional disparities in education (literacy) and Regional disparity between workers and non-workers of Scheduled Tribes in the study area.
- To identify the dominant and distinctive economic activity of tribes and its level in different regions in the study area.

MATERIALS AND METHODS

Salem district was purposively selected for this study, since it has the largest tribal population in Tamil Nadu with 15.02 per cent and has 4th highest proportion of Scheduled Tribes with 3.43 per cent of total ST population in Tamil Nadu. The research methods followed in this work includes data collection from secondary sources, and statistical analysis. Secondary data obtained from different sources includes (i) District Statistical Handbook, Salem: 2021, (ii) Tamil Nadu Government Portal (<http://www.tn.gov.in>), (iii) Census of India: 2011, (iv) Government of Tamil Nadu, Department of Tribal Welfare, and (v) www.census.tn.nic.in. For better understanding of the interpretation of socio-economic conditions and disparities among the Scheduled Tribes of Salem District, we use different statistical techniques like

(a) Descriptive Analysis

The descriptive analysis was undertaken using simple averages and percentage analysis to study the concentration of population, distribution of population, spatial disparity in literacy, educational disparity between tribes and others, workers participation, dominant economic activity and distinctive economic activity of Scheduled Tribes at region level in Salem district.

(b) Sopher's Disparity Index:

David E Sopher (1974)[4] developed Sopher's Disparity Index to measure the disparity between two groups in their possession of a particular property in terms of the logarithm of the odds ratio. The objective of taking log is to reduce the leveling of effect that is regions with higher rate of the indicator may show a lower level of disparity than the region having low rate of indicator even though the gap is the same for both region. This index will be to identify the disparity between rural-urban literacy group, the disparity between male-female literacy, the disparity between rural-urban population, and the disparity between workers and non-workers population etc.

Disparity Index (DI) = $\text{Log}(X_2/X_1) + \text{Log}(100-X_1)/(100-X_2)$

Where, DI = Disparity Index,

X1 = Percentage of Female or Percentage of Non-Workers Literacy (ST),

X2 = Percentage of Male or Percentage of Workers Literacy (ST),

i.e. $X_2 > X_1$

The value of Disparity Index is zero in case of perfect equality. Thus, the greater the value of Disparity Index, higher is the extent of disparity, and lower the value, lower is the disparity (Sopher, 1980) [5].

(c) Nelson's Method to identify dominant and distinctive functions

Harris (1943)[6] made the first attempt towards identification of the dominant economic characteristics of an area. H. J. Nelson (1955)[7] used almost similar method with a threshold which could be worked out from the mean and standard deviation (SD) of the occupational structure of a given area (Jana and Ghosh, 2015)[8]. According to Nelson's method, first percentages of each occupation to the total labour force of the area are worked out for each unit area. The mean and standard deviation of these percentages among all the unit area is then calculated separately for each economic activity. Dominant function means the attribute which shares the highest proportion (percentage)



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is identified as the dominant one. So, each region has its own dominant function. The characteristics of different economic activities have been given in Table 2. The areas are then classified according to their percentage of each economic activity / occupation being more than or equal to Mean + SD, Mean + 2SD, Mean + 3SD. Distinctiveness is a character which makes an area/region different from others. According to him, distinctive functions can be identified with the help of arithmetic mean and standard deviation. Nelson considered any function having percentage of workers greater than arithmetic mean +1 Standard Deviation as the benchmark for being considered as a distinctive function. The percentage of a function less than its Mean+SD is not considered as significant. According to Nelson, the scale of distinctiveness has been given in Table 3.

(d) Work Participation Rate:

Work Participation Rate is defined by following formula, $WPR = \frac{\text{Percentage of Scheduled Tribes Total Workers (Main + Marginal)}}{\text{Total Scheduled Tribes Population}} \times 100$

Statistical tables, chart diagrams, calculations and graphs have been prepared based on secondary data using the help of Microsoft Office Excel v.2007. The field survey for the secondary data as well as this work was conducted during the months of April to August 2022.

RESULTS AND DISCUSSION**Region-wise Concentration of Scheduled Tribes in Salem District**

According to 2011 census, among 32 districts of Tamil Nadu, Salem district has the 4th highest concentration of Scheduled Tribes with 3.43 per cent to district total. Region-wise concentration pattern of Scheduled Tribes population to total population in Salem district have been worked out and given in Figure 2. It could be seen from the Figure 2 that, the concentration pattern of Scheduled Tribes varies from region to region in Salem district. The Eastern region of Salem district which has the highest concentration is identified as tribal dominated region. The concentration pattern of Scheduled Tribes population was found more in Eastern region (11.29 per cent) followed by Northern region (7.04 per cent), Western region (2.16 per cent) and Southern region (1.51 per cent). The concentration pattern of tribal male population found more in Eastern region (11.32 per cent) followed by Northern region (6.87 per cent), Western region (2.11 per cent) and Southern region (1.46 per cent). And the concentration pattern of tribal female population was found more in Eastern region (11.27 per cent) followed by Northern region (7.24 per cent), Western region (2.22 per cent) and Southern region (1.57 per cent).

Region-wise Spatial Distribution of Scheduled Tribes in Salem District

Among 32 districts of Tamil Nadu, Salem district has the highest distributional pattern of Scheduled Tribes with 15.02 per cent. Region-wise distributional pattern of Scheduled Tribes population to total Scheduled Tribes population in Salem district have been worked out and given in Figure 3. It could be seen from the Figure 3 that, the spatial distributional pattern of Scheduled Tribes varies from region to region in Salem district. The Eastern region of Salem district which has the highest distributional pattern is identified as tribal dominated region. The distributional pattern of Scheduled Tribes person population was found more in Eastern region (48.28 per cent), Northern region (37.76 per cent), Western region (7.47 per cent) and Southern region (6.49 per cent) in that order. The distributional pattern of tribal male population was found more in Eastern region (48.29 per cent) followed by Northern region (37.73 per cent), Western region (7.53 per cent) and Southern region (6.44 per cent). And the distributional pattern of tribal female population was found more in Eastern region (48.27 per cent) followed by Northern region (37.79 per cent), Western region (7.40 per cent) and Southern region (6.54 per cent).

Region and Gender-wise Spatial Disparity in Literacy Rate

As per 2011 census, literacy rate of Tamil Nadu Scheduled Tribes is 54.34 per cent which is below the national average of 59 per cent, and overall literacy rate of the country is 73 per cent. In Salem district Scheduled Tribes total literacy rate is 51.85 per cent whereas the rural Scheduled Tribes literacy rate is 49.83 per cent and having 25th rank



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among districts of Tamil Nadu. In the study area, tribal male literacy rate is 60.39 per cent (rural-58.44 per cent) and whereas the tribal female literacy rate is 43.17 per cent (rural-41.10 per cent). Region and gender-wise literacy rate of Scheduled Tribes in Salem district in percentage has been given in Figure 4.

It could be seen from the Figure 4 that the overall literacy rates of tribes in the regions of the study area ranges from 48.53 per cent in Eastern region to 56.41 per cent in Southern region. The tribal male literacy rates ranges from 56.49 per cent in Eastern region to 64.25 per cent in Southern region. The tribal female literacy rate ranges from 40.48 per cent in Eastern region to 48.54 per cent in Southern region. This signals that rural female literacy rates in all regions are less than the rural male literacy rate, which indicates that overall tribal female literacy rates lagged behind tribal male literacy rates in the regions of Salem district.

Region- and Gender-wise Educational Disparity of Scheduled Tribes in Salem District:

It could be seen from the table 4 that, Northern region of the study area is having medium disparity among tribes. According to Sophers Disparity Index, the regions of Eastern, Western, and Southern are having low level tribes educational disparity. The highest tribal concentrated region of the study area that is Eastern region is having low level tribal educational disparity. However, this region is having low female tribal literates than male tribal literates. The literacy rates of females belonging to Scheduled Tribes continues to be a major problem in this study district.

Work Participation of Scheduled Tribes in Salem District

The issue of livelihood security of tribes is closely linked to employment status of the people. As per the 2001 Census, the work participation rate of tribes in Salem district was 46.23 per cent. With the control of birth rate, the value increased to 61.18 per cent in 2011 census. In the study district, the work participation rate of tribal population and that of total, male and female are 61.15 per cent, 63.23 per cent and 59.01 per cent respectively. Regional differences in terms of work participation rate ranges from 58.59 per cent in Southern region to 64.46 per cent in Western region. Work participation rate (workers) and non-workers of tribes in different regions of the study area has been given in Table 5.

It may be observed from the Table 5 that, the work participation rate or workers population in the study area for tribal population is high in Western region (64.46 per cent) followed by Eastern region (62.84 per cent), Northern region (58.77 per cent) and Southern region (58.59 per cent). In study district the percentage of non-workers population of tribal population is high in Southern region (41.41 per cent) followed by Northern region (41.23 per cent), Eastern region (37.16 per cent) and Western region (35.54 per cent). The highest tribal concentrated region of Salem district that is Eastern region is having high male tribal workers population and high female tribal non-workers population.

Region-wise Regional Disparity of Workers and Non-Workers of Scheduled Tribes in Salem District

In the study area, the percentages of tribal workers population of total, males and females are 61.15 per cent, 63.23 per cent and 59.01 respectively. The percentages of tribal non-workers population of total, males and females are 38.85 per cent, 36.77 per cent and 40.99 per cent respectively.

It could be seen from the table 6 that, regions of Eastern and Western regions are having high regional disparity between workers and non-workers of tribal population. According to Sophers Disparity Index, the regions of Northern and Southern are having medium regional disparity between workers and non-workers of tribal population. The highest tribal concentrated region of the study area that is Eastern region is having high regional disparity between workers and non-workers of tribal population.

Dominant and Distinctive Economic Activity of Scheduled Tribes in Salem District

Dominant and Distinctive analysis are an important technique to study and identify the dominant and distinctive functions from the tribal population group of attributes in a particular region. Based on the percentage of different types of workers among tribes, we have tried to identify the dominant and distinctive functions in different regions



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of the study district. In this regard, we have used H.J. Nelson's Method (1955) to identify dominant and distinctive functions. According to Nelsons' method, if percentages of cultivator of a particular region leave behind the overall mean plus standard deviation value, then that region will be considered as cultivator dominant region. If the value surpasses the overall mean plus one standard deviation values, then it will be CL1 or the region's economy is depended on Cultivation. If the percentages of different types of workers such as Cultivators (CL), Agricultural Labourers (AL), Household Industry Workers (HIW) and Other Workers (OW) did not cross the overall mean plus standard deviation value, then it will be a region with diversified economy.

It could be seen from the table 7 that, the dominant economic activity of tribes in Eastern region is cultivation, and this region having CL1 distinctive function with dependency of cultivators. The dominant economic activity of tribes in Western region is agricultural labour work, and this region having AL1 distinctive function with dependency of agricultural labourers. The dominant economic activity of tribes in Northern region is household industry work, and having HIW1 distinctive function with dependency of household industry workers. And the dominant economic activity of tribes in Southern region is other work, and having OW1 distinctive function with dependency of other workers. According to Nelsons' method, the highest tribal concentrated region of the study area that is Eastern region comes under dominant and distinctive economy of cultivation.

CONCLUSION

At present, Salem district has enriched with various natural resources and one of the industrialised districts in Tamil Nadu. However, it has not yet been developed on the tribal areas as expected. In the case of tribal households living in the hilly region of Salem district, physical barriers and insufficient infrastructure such as road communication, railway links, telecommunication facilities and lack of education using modern technology have been identified as constraints for establishing large industries and sustainable rural livelihoods. Powerful democratic responsibility at the government level was indeed urgently required to enhance services to the community. The allocation of qualified and experienced female teachers, along with established infrastructure and awareness of accessibility of going to schools and colleges for girls will assist in increasing female literacy levels. Since, the highest tribal concentrated region of Salem district comes under dominant and distinctive economy of cultivation which indicates that the region having lower economic condition. Efforts should be taken exclusively for this Eastern region for enhancing the capabilities of the tribes to participate in other economic activities also. Infrastructural development on the tribal areas will support in the development of large industries, which will generate career opportunities for Scheduled Tribes. Finally, it should have been noted that improved educational infrastructure on a wider scale is preferable. Instead that, the district's and state's rapid economic development will be brought to a halt, and tribal groups will continue to stay a most ignored group in society. In this circumstance, expanding education by providing various tribes art and craft seem to be essential for tribes' social and economic development. Several factors may have contributed to their local knowledge's persistence. The lack of modern and government facilities, as well as the various tribes area's remote geographical features, as well as a strong belief in folk knowledge, all make a contribution to their priority for traditional knowledge for their culture.

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Abbreviations: ST – Scheduled Tribes, DI – Disparity Index, SD – Standard Deviation, WPR – Work Participation Rate, CD – Community Development, CL - Cultivators, AL – Agricultural Labourers, HIW – Household Industry Workers, OW- Other Workers.

Table 1 List of Taluks, Blocks and Regions in Salem District

S. No	Name of Taluks	S. No	Name of CD Blocks	Regions
1	Mettur	1	Salem	Southern Region
2	Omalur	2	Veerapandi	
3	Edappadi	3	Panamarathupatti	
4	Sankari	4	Mac.Donal Choultry	
5	Salem	5	Tharamangalam	
6	Yercaud	6	Vazhapadi	Eastern Region
7	Vazhapadi	7	Pethanaickenpalayam	
8	Attur	8	Attur	
9	Gangavalli	9	Gangavalli	
		10	Thalaivasal	Northern Region
		11	Ayothiyapattinam	
		12	Mecheri	
		13	Omalur	
		14	Yercaud	
		15	Kadaiyampatti	
		16	Sankari	Western Region
		17	Edappadi	
		18	Konganapuram	
		19	Kolathur	
		20	Nangavalli	
		21	Not under any community development block	

(Source: Statistical Hand Book, Salem District)





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Table 2 Characteristics of Different Economic Activities to identify the Dominant Function

S. No	Economic Activity	Characteristics
1.	Cultivators	Cultivator is a person who is engaged as worker in cultivation of certain crops on land owned by him or held by him for payment in money, kind and share. Cultivators include supervision or directions of cultivation.
2.	Agricultural Labourers	Agricultural labourer is a person working in another person's land for wages in cash or kind. He has no risk of cultivation.
3.	Household Industry Workers	Household industry worker is a person who works for a major part in household industry. Household industry relates to production, processing, servicing, repairing or making and selling of goods.
4.	Other Workers	Other worker is a person who is engaged in the activities other than cultivation, agricultural labourer and household industry.

(Source: Statistical Hand Book, Salem District)

Table 3 Scale of Distinctiveness to identify the Distinctive Function

S. No	Range of percentage of workers	Scale of distinctiveness
1.	Mean + SD to Mean + 2SD	1 st Order
2.	Mean + 2SD to Mean + 3SD	2 nd Order
3.	Above Mean + 3SD	3 rd Order

(Source: Nelson, 1955⁽⁷⁾)

Table 4. Region-wise Educational Disparity Scheduled Tribes in Salem District

S.No	Regions of Salem District	Disparity Index Value	Category
1.	Eastern Region	0.28	Low Disparity
2.	Western Region	0.28	Low Disparity
3.	Northern Region	0.35	Medium Disparity
4.	Southern Region	0.28	Low Disparity

(Source: Authors Calculation)

Table 5. Work Participation Rate and Non-workers of Scheduled Tribes in Different Regions of Salem District (in percentage)

S. No	Regions of Salem District	Tribes Workers (WPR)			Tribes Non-Workers		
		Total	Male	Female	Total	Male	Female
1.	Eastern Region	62.84	63.22	62.45	37.16	36.78	37.55
2.	Western Region	64.46	68.36	60.39	35.54	31.64	39.61
3.	Northern Region	58.77	61.97	55.48	41.23	38.03	44.52
4.	Southern Region	58.59	64.71	52.42	41.41	35.29	47.58
Total		61.15	63.23	59.01	38.85	36.77	40.99

(Source: Authors Calculation)

Table 6. Regional Disparity of Workers and Non-Workers of Scheduled Tribes in Salem District

S.No	Regions of Salem District	Disparity Index Value	Category
1.	Eastern Region	0.46	High Disparity
2.	Western Region	0.52	High Disparity
3.	Northern Region	0.31	Medium Disparity
4.	Southern Region	0.30	Medium Disparity

(Source: Authors Calculation)



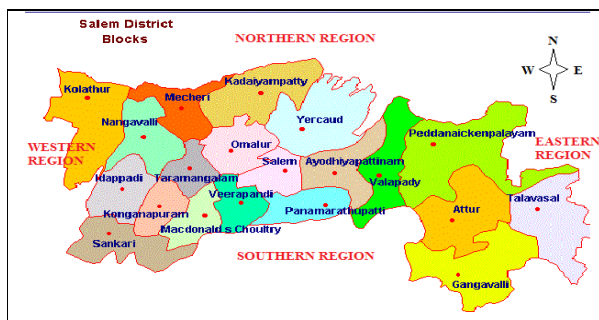


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Table 7. Region-wise Dominant and Distinctive Economic Activity of tribal Workers in the Salem District

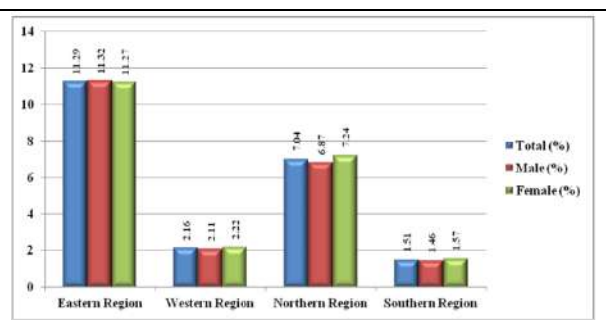
S. No	Regions of Salem District	Percentage of Tribal Workers				Dominant Function	Distinctive Function
		CL	AL	HIW	OW		
1.	Eastern Region	55.70	39.37	0.82	4.11	CL	CL1
2.	Western Region	27.43	63.15	0.22	9.20	AL	AL1
3.	Northern Region	20.17	31.37	0.39	48.07	OW	OW1
4.	Southern Region	34.49	49.71	1.91	13.89	HIW	HIW1
	Mean	34.45	45.90	0.84	18.82		
	Standard Deviation (SD)	15.32	13.73	0.76	19.91		
	Mean + SD (1 st order)	49.77	59.63	1.60	38.72		
	Mean + 2SD (2 nd order)	65.10	73.36	2.36	58.63		
	Mean + 3SD (3 rd order)	80.42	87.10	3.12	78.54		

(Source: Authors Calculation)



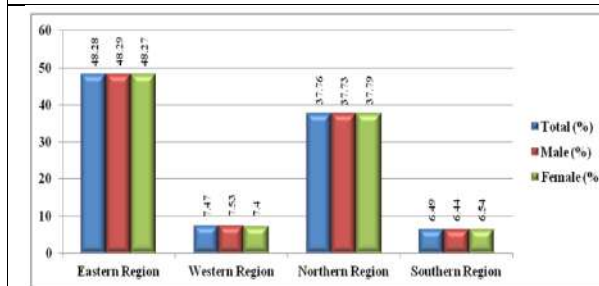
(Source: Statistical Hand Book, Salem District)

Fig. 1 Blocks and Regions of Salem District, Tamil Nadu



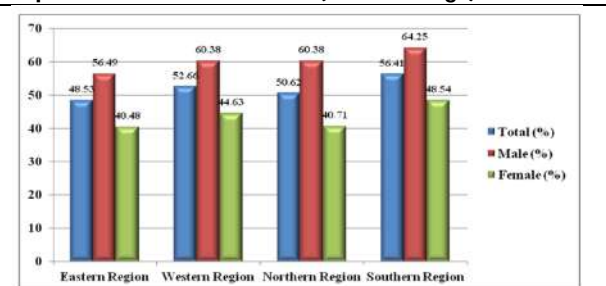
(Source: Figures - Authors)

Fig. 2 Region-wise Concentration of Scheduled Tribes Population in Salem District (in Percentage)



(Source: Figures - Authors)

Fig. 3 Region-wise Spatial Distribution of Scheduled Tribes Population in Salem District (in Percentage)



(Source: Figures - Authors)

Fig. 4 Region and Gender-wise Literacy Rate of Scheduled Tribes in Salem District (in percentage)





Deblurring of Images using Interval Valued Neutrosophic Numbers

R.Gokilamani^{1*} and A.Sahaya Sudha²

¹Associate Professor, Department of Mathematics, Sri Ramakrishna College of Arts and Science for Women, Coimbatore-44, Tamil Nadu, India

²Assistant Professor, Nirmala College for Women, Coimbatore -18, Tamil Nadu, India

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*Address for Correspondence

R.Gokilamani

Associate Professor,

Department of Mathematics,

Sri Ramakrishna College of Arts and Science for Women,

Coimbatore-44, Tamil Nadu, India

E. Mail : gokila70@gmail.com



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ABSTRACT

Interval Neutrosophic Sets (INSs) have been proposed exactly to address issues with a set of numbers in the real unit interval. In this paper we have introduced Interval valued Double Refined Triangular Neutrosophic Numbers (IVDRTrNN) and proposed an algorithm to deblur the images by using the defined membership function. The efficacy of the algorithm is verified by using a blurred image.

Keywords: Interval Neutrosophic Set , Interval Valued Double Refined Indeterminate Neutrosophic Set , Interval Valued Double Refined Indeterminate Triangular Neutrosophic Number , Deblur

INTRODUCTION

Interval-valued neutrosophic sets (IVNS) was introduced by Wang et al. [C1] as a suitable way to denote uncertain, incomplete, imprecise, and inconsistent information. Since IVNS shows greater flexibility and precision than single-valued neutrosophic sets [C2], IVNS applications became the object of interest for many researchers. The credibility of the interval-valued neutrosophic sets (IVNS) was demonstrated by [C3–C5]. Said BROUMI et al [C6] implemented a variety of operations on interval valued neutrosophic matrices using a new Matlab' package. Bhimraj Basumatary and Said Broumi[C7] proposed an interval-valued triangular neutrosophic number to solve the neutrosophic linear programming problem. In [C8] [C9] Broumi et al. solved Shortest Path Problem using single valued and triangular and trapezoidal interval valued neutrosophic environments. Deli [C10] derived aggregation operators for interval valued generalised single valued neutrosophic trapezoidal and applied in decision-making problem. In this paper we have introduced interval valued double refined indeterminate triangular neutrosophic numbers.





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Preliminaries

Interval Valued Neutrosophic Set (IVNS)

There is space X of the certain objects where the separate generic elements $x \in X$. An interval-valued neutrosophic set (IVNS) $N \subset X$ has the form of $N = \{(x, T_N(x), I_N(x), F_N(x)) : x \in X\}$ (1) where $T_N(x) : X \rightarrow [0, 1]$, $I_N(x) : X \rightarrow [0, 1]$ and $F_N(x) : X \rightarrow [0, 1]$ with $0 \leq T_N(x) + I_N(x) + F_N(x) \leq 3$ or all $x \in X$.

The variables $T_A(x)$, $I_A(x)$ and $F_A(x)$ define truth-membership degree function, the indeterminacy-membership degree function and the falsity-membership degree function of x to N , respectively. For the case of the interval neutrosophic set, these functions must be described as $T_N(x) = [T_N^L(x), T_N^U(x)] \subseteq [0, 1]$, $I_N(x) = [I_N^L(x), I_N^U(x)] \subseteq [0, 1]$, $F_N(x) = [F_N^L(x), F_N^U(x)] \subseteq [0, 1]$ and the sum of these functions satisfy the condition $0 \leq T_N^U(x) + I_N^U(x) + F_N^U(x) \leq 3$.

Comparison of IVNS

Let $N_1 = \{(T_{N_1}^L(x), T_{N_1}^U(x)), [I_{N_1}^L(x), I_{N_1}^U(x)], [F_{N_1}^L(x), F_{N_1}^U(x)]\}$ and $N_2 = \{(T_{N_2}^L(x), T_{N_2}^U(x)), [I_{N_2}^L(x), I_{N_2}^U(x)], [F_{N_2}^L(x), F_{N_2}^U(x)]\}$ are two interval valued neutrosophic numbers, then N_1 is contained in N_2 , $N_1 \subseteq N_2$ iff $T_{N_1}^L(x) \leq T_{N_2}^L(x)$, $T_{N_1}^U(x) \leq T_{N_2}^U(x)$, $I_{N_1}^L(x) \geq I_{N_2}^L(x)$, $I_{N_1}^U(x) \geq I_{N_2}^U(x)$, $F_{N_1}^L(x) \geq F_{N_2}^L(x)$, $F_{N_1}^U(x) \geq F_{N_2}^U(x)$

Equality of IVNS

Two interval valued neutrosophic numbers N_1 and N_2 are equal, $N_1 = N_2$ iff $N_1 \subseteq N_2$ and $N_2 \subseteq N_1$

Interval Valued Double Refined Indeterminate Triangular Neutrosophic Numbers

Interval Valued Double Refined Indeterminate Neutrosophic Set (IVDRNS)

An interval Valued Double Refined Indeterminate Neutrosophic set is defined by

$$\begin{aligned} \check{A}_{IN} &= \{(x, T_{\check{A}_{IN}}(x), IT_{\check{A}_{IN}}(x), IF_{\check{A}_{IN}}(x), F_{\check{A}_{IN}}(x)) : x \in X\} \text{ where} \\ T_{\check{A}_{IN}}(x) &= [T_{\check{A}_{IN}}^L(x), T_{\check{A}_{IN}}^U(x)] \subseteq [0, 1], IT_{\check{A}_{IN}}(x) = [IT_{\check{A}_{IN}}^L(x), IT_{\check{A}_{IN}}^U(x)] \subseteq [0, 1], \\ IF_{\check{A}_{IN}}(x) &= [IF_{\check{A}_{IN}}^L(x), IF_{\check{A}_{IN}}^U(x)] \subseteq [0, 1], F_{\check{A}_{IN}}(x) = [F_{\check{A}_{IN}}^L(x), F_{\check{A}_{IN}}^U(x)] \subseteq [0, 1] \\ \text{and } 0 &\leq T_{\check{A}_{IN}}^U(x) + IT_{\check{A}_{IN}}^U(x) + IF_{\check{A}_{IN}}^U(x) + F_{\check{A}_{IN}}^U(x) \leq 4. \end{aligned}$$

Where $T_{\check{A}_{IN}}(x)$, $IT_{\check{A}_{IN}}(x)$, $IF_{\check{A}_{IN}}(x)$, $F_{\check{A}_{IN}}(x)$ represents truth membership, indeterminacy leaning toward truth membership, indeterminacy leaning toward falsity membership and falsity membership respectively.

Comparison of IVDRNS

If $\check{A}_{IN} = \{(T_{\check{A}_{IN}}^L(x), T_{\check{A}_{IN}}^U(x)), [IT_{\check{A}_{IN}}^L(x), IT_{\check{A}_{IN}}^U(x)], [IF_{\check{A}_{IN}}^L(x), IF_{\check{A}_{IN}}^U(x)], [F_{\check{A}_{IN}}^L(x), F_{\check{A}_{IN}}^U(x)]\}$ and $\check{B}_{IN} = \{(T_{\check{B}_{IN}}^L(x), T_{\check{B}_{IN}}^U(x)), [IT_{\check{B}_{IN}}^L(x), IT_{\check{B}_{IN}}^U(x)], [IF_{\check{B}_{IN}}^L(x), IF_{\check{B}_{IN}}^U(x)], [F_{\check{B}_{IN}}^L(x), F_{\check{B}_{IN}}^U(x)]\}$ are two interval valued double refined indeterminate neutrosophic numbers then $\check{A}_{IN} \subseteq \check{B}_{IN}$ if and only if $T_{\check{A}_{IN}}^L(x) \leq T_{\check{B}_{IN}}^L(x)$, $T_{\check{A}_{IN}}^U(x) \leq T_{\check{B}_{IN}}^U(x)$, $IT_{\check{A}_{IN}}^L(x) \leq IT_{\check{B}_{IN}}^L(x)$, $IT_{\check{A}_{IN}}^U(x) \leq IT_{\check{B}_{IN}}^U(x)$, $IF_{\check{A}_{IN}}^L(x) \geq IF_{\check{B}_{IN}}^L(x)$, $IF_{\check{A}_{IN}}^U(x) \geq IF_{\check{B}_{IN}}^U(x)$, $F_{\check{A}_{IN}}^L(x) \geq F_{\check{B}_{IN}}^L(x)$, $F_{\check{A}_{IN}}^U(x) \geq F_{\check{B}_{IN}}^U(x)$

Equality of two interval valued double refined indeterminate neutrosophic numbers

Two interval valued double refined indeterminate neutrosophic numbers \check{A}_{IN} and \check{B}_{IN} are equal, $\check{A}_{IN} = \check{B}_{IN}$ if and only if $\check{A}_{IN} \subseteq \check{B}_{IN}$ and $\check{B}_{IN} \subseteq \check{A}_{IN}$.

Operations on interval valued double refined indeterminate neutrosophic numbers

If $\check{A}_{IN} = \{(T_{\check{A}_{IN}}^L(x), T_{\check{A}_{IN}}^U(x)), [IT_{\check{A}_{IN}}^L(x), IT_{\check{A}_{IN}}^U(x)], [IF_{\check{A}_{IN}}^L(x), IF_{\check{A}_{IN}}^U(x)], [F_{\check{A}_{IN}}^L(x), F_{\check{A}_{IN}}^U(x)]\}$ and $\check{B}_{IN} = \{(T_{\check{B}_{IN}}^L(x), T_{\check{B}_{IN}}^U(x)), [IT_{\check{B}_{IN}}^L(x), IT_{\check{B}_{IN}}^U(x)], [IF_{\check{B}_{IN}}^L(x), IF_{\check{B}_{IN}}^U(x)], [F_{\check{B}_{IN}}^L(x), F_{\check{B}_{IN}}^U(x)]\}$ are two interval valued double refined indeterminate neutrosophic numbers





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$$\begin{aligned} \lambda \ddot{\mathcal{A}}_{IN} &= \left[1 - \left(1 - T_{\ddot{\mathcal{A}}_{IN}}^L(x) \right)^\lambda, 1 - \left(1 - T_{\ddot{\mathcal{A}}_{IN}}^U(x) \right)^\lambda \right], \left[1 - \left(1 - IT_{\ddot{\mathcal{A}}_{IN}}^L(x) \right)^\lambda, \right. \\ &1 - \left. \left(1 - IT_{\ddot{\mathcal{A}}_{IN}}^U(x) \right)^\lambda \right], \left[\left(IF_{\ddot{\mathcal{A}}_{IN}}^L(x) \right)^\lambda, \left(IF_{\ddot{\mathcal{A}}_{IN}}^U(x) \right)^\lambda \right], \left[\left(F_{\ddot{\mathcal{A}}_{IN}}^L(x) \right)^\lambda, \left(F_{\ddot{\mathcal{A}}_{IN}}^U(x) \right)^\lambda \right] \\ (\ddot{\mathcal{A}}_{IN})^\lambda &= \left\langle \left[\left(T_{\ddot{\mathcal{A}}_{IN}}^L(x) \right)^\lambda, \left(T_{\ddot{\mathcal{A}}_{IN}}^U(x) \right)^\lambda \right], \left[\left(IT_{\ddot{\mathcal{A}}_{IN}}^L(x) \right)^\lambda, \left(IT_{\ddot{\mathcal{A}}_{IN}}^U(x) \right)^\lambda \right], \left[1 - \left(1 - IF_{\ddot{\mathcal{A}}_{IN}}^L(x) \right)^\lambda, \right. \right. \\ &\left. \left. - \left(1 - IF_{\ddot{\mathcal{A}}_{IN}}^U(x) \right)^\lambda \right], \left[1 - \left(1 - F_{\ddot{\mathcal{A}}_{IN}}^L(x) \right)^\lambda, 1 - \left(1 - F_{\ddot{\mathcal{A}}_{IN}}^U(x) \right)^\lambda \right] \right\rangle \\ \ddot{\mathcal{A}}_{IN} \oplus \ddot{\mathcal{B}}_{IN} &= \left\langle \left[T_{\ddot{\mathcal{A}}_{IN}}^L(x) + T_{\ddot{\mathcal{B}}_{IN}}^L(x) - T_{\ddot{\mathcal{A}}_{IN}}^L(x)T_{\ddot{\mathcal{B}}_{IN}}^L(x), T_{\ddot{\mathcal{A}}_{IN}}^U(x) + T_{\ddot{\mathcal{B}}_{IN}}^U(x) - T_{\ddot{\mathcal{A}}_{IN}}^U(x)T_{\ddot{\mathcal{B}}_{IN}}^U(x) \right], \left[IT_{\ddot{\mathcal{A}}_{IN}}^L(x) + IT_{\ddot{\mathcal{B}}_{IN}}^L(x) \right. \right. \\ &\left. \left. - IT_{\ddot{\mathcal{A}}_{IN}}^L(x)IT_{\ddot{\mathcal{B}}_{IN}}^L(x), IT_{\ddot{\mathcal{A}}_{IN}}^U(x) + IT_{\ddot{\mathcal{B}}_{IN}}^U(x) - IT_{\ddot{\mathcal{A}}_{IN}}^U(x)IT_{\ddot{\mathcal{B}}_{IN}}^U(x) \right], \left[IF_{\ddot{\mathcal{A}}_{IN}}^L(x) * IF_{\ddot{\mathcal{B}}_{IN}}^L(x), IF_{\ddot{\mathcal{A}}_{IN}}^U(x) \right. \right. \\ &\left. \left. * IF_{\ddot{\mathcal{B}}_{IN}}^U(x) \right], \left[F_{\ddot{\mathcal{A}}_{IN}}^L(x) * F_{\ddot{\mathcal{B}}_{IN}}^L(x), F_{\ddot{\mathcal{A}}_{IN}}^U(x) * F_{\ddot{\mathcal{B}}_{IN}}^U(x) \right] \right\rangle \\ \ddot{\mathcal{A}}_{IN} \otimes \ddot{\mathcal{B}}_{IN} &= \left\langle \left[T_{\ddot{\mathcal{A}}_{IN}}^L(x) * T_{\ddot{\mathcal{B}}_{IN}}^L(x), T_{\ddot{\mathcal{A}}_{IN}}^U(x) * T_{\ddot{\mathcal{B}}_{IN}}^U(x) \right], \left[IT_{\ddot{\mathcal{A}}_{IN}}^L(x) * IT_{\ddot{\mathcal{B}}_{IN}}^L(x), IT_{\ddot{\mathcal{A}}_{IN}}^U(x) * IT_{\ddot{\mathcal{B}}_{IN}}^U(x) \right], \left[IF_{\ddot{\mathcal{A}}_{IN}}^L(x) + IF_{\ddot{\mathcal{B}}_{IN}}^L(x) \right. \right. \\ &\left. \left. - IF_{\ddot{\mathcal{A}}_{IN}}^L(x)IF_{\ddot{\mathcal{B}}_{IN}}^L(x), IF_{\ddot{\mathcal{A}}_{IN}}^U(x) + IF_{\ddot{\mathcal{B}}_{IN}}^U(x) - IF_{\ddot{\mathcal{A}}_{IN}}^U(x)IF_{\ddot{\mathcal{B}}_{IN}}^U(x) \right], \left[F_{\ddot{\mathcal{A}}_{IN}}^L(x) + F_{\ddot{\mathcal{B}}_{IN}}^L(x) \right. \right. \\ &\left. \left. - F_{\ddot{\mathcal{A}}_{IN}}^L(x)F_{\ddot{\mathcal{B}}_{IN}}^L(x), F_{\ddot{\mathcal{A}}_{IN}}^U(x) + F_{\ddot{\mathcal{B}}_{IN}}^U(x) - F_{\ddot{\mathcal{A}}_{IN}}^U(x)F_{\ddot{\mathcal{B}}_{IN}}^U(x) \right] \right\rangle \\ (\ddot{\mathcal{A}}_{IN})^c &= \left\langle \left[F_{\ddot{\mathcal{A}}_{IN}}^L(x), F_{\ddot{\mathcal{A}}_{IN}}^U(x) \right], \left[IF_{\ddot{\mathcal{A}}_{IN}}^L(x), IF_{\ddot{\mathcal{A}}_{IN}}^U(x) \right], \left[IT_{\ddot{\mathcal{A}}_{IN}}^L(x), IT_{\ddot{\mathcal{A}}_{IN}}^U(x) \right], \left[T_{\ddot{\mathcal{A}}_{IN}}^L(x), T_{\ddot{\mathcal{A}}_{IN}}^U(x) \right] \right\rangle \end{aligned}$$

Interval Valued Double Refined Indeterminate Triangular Neutrosophic Numbers

Interval Valued Double Refined Indeterminate Triangular Neutrosophic Numbers whose truth membership function $\mathcal{J}\zeta_{\ddot{\mathcal{A}}_{INTr}}(x)$, indeterminacy leaning towards truth membership function $\mathcal{J}\xi_{\ddot{\mathcal{A}}_{INTr}}(x)$, indeterminacy leaning towards falsity membership function $\mathcal{J}\tau_{\ddot{\mathcal{A}}_{INTr}}(x)$ and falsity membership function $\mathcal{J}\varphi_{\ddot{\mathcal{A}}_{INTr}}(x)$ are defined as follows:

$$\mathcal{J}\zeta_{\ddot{\mathcal{A}}_{INTr}}(x) = \begin{cases} \frac{(x-a)\mathcal{J}p_{\ddot{\mathcal{A}}_{INTr}}}{b-a} & a \leq x < b \\ \mathcal{J}p_{\ddot{\mathcal{A}}_{INTr}} & x = b \\ \frac{(c-x)\mathcal{J}p_{\ddot{\mathcal{A}}_{INTr}}}{c-b} & b < x \leq c \\ 0 & \text{Otherwise} \end{cases}$$

$$\mathcal{J}\xi_{\ddot{\mathcal{A}}_{INTr}}(x) = \begin{cases} \frac{(x-a)\mathcal{J}q_{\ddot{\mathcal{A}}_{INTr}}}{b-a} & a \leq x < b \\ \mathcal{J}q_{\ddot{\mathcal{A}}_{INTr}} & x = b \\ \frac{(c-x)\mathcal{J}q_{\ddot{\mathcal{A}}_{INTr}}}{c-b} & b < x \leq c \\ 0 & \text{Otherwise} \end{cases}$$

$$\mathcal{J}\tau_{\ddot{\mathcal{A}}_{INTr}}(x) = \begin{cases} \frac{b-x + \mathcal{J}r_{\ddot{\mathcal{A}}_{INTr}}(x-a)}{b-a} & a \leq x < b \\ \mathcal{J}r_{\ddot{\mathcal{A}}_{INTr}} & x = b \\ \frac{x-b + \mathcal{J}r_{\ddot{\mathcal{A}}_{INTr}}(c-x)}{c-b} & b < x \leq c \\ 1 & \text{Otherwise} \end{cases}$$

$$\mathcal{J}\varphi_{\ddot{\mathcal{A}}_{INTr}}(x) = \begin{cases} \frac{b-x + \mathcal{J}s_{\ddot{\mathcal{A}}_{INTr}}(x-a)}{b-a} & a \leq x < b \\ \mathcal{J}s_{\ddot{\mathcal{A}}_{INTr}} & x = b \\ \frac{x-b + \mathcal{J}s_{\ddot{\mathcal{A}}_{INTr}}(c-x)}{c-b} & b < x \leq c \\ 1 & \text{Otherwise} \end{cases}$$





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An interval Valued Double Refined Indeterminate Triangular Neutrosophic number can be represented by $\ddot{j}_{NT^r} = \langle (a, b, c) : \mathcal{J}p_{\ddot{j}_{NT^r}}, \mathcal{J}q_{\ddot{j}_{NT^r}}, \mathcal{J}r_{\ddot{j}_{NT^r}}, \mathcal{J}s_{\ddot{j}_{NT^r}} \rangle$

Where $\mathcal{J}p_{\ddot{j}_{NT^r}} = [T_{\ddot{j}_{NT^r}}^L, T_{\ddot{j}_{NT^r}}^U]$, $\mathcal{J}q_{\ddot{j}_{NT^r}} = [IT_{\ddot{j}_{NT^r}}^L, IT_{\ddot{j}_{NT^r}}^U]$, $\mathcal{J}r_{\ddot{j}_{NT^r}} = [IF_{\ddot{j}_{NT^r}}^L, IF_{\ddot{j}_{NT^r}}^U]$, $\mathcal{J}s_{\ddot{j}_{NT^r}} = [F_{\ddot{j}_{NT^r}}^L, F_{\ddot{j}_{NT^r}}^U]$, $T_{\ddot{j}_{NT^r}}^L, IT_{\ddot{j}_{NT^r}}^L, IF_{\ddot{j}_{NT^r}}^L, F_{\ddot{j}_{NT^r}}^L$ being the lower bounds and $T_{\ddot{j}_{NT^r}}^U, IT_{\ddot{j}_{NT^r}}^U, IF_{\ddot{j}_{NT^r}}^U, F_{\ddot{j}_{NT^r}}^U$, the upper bounds for the truth, indeterminacy leaning toward truth membership, indeterminacy leaning toward falsity membership and falsity membership degrees.

Deblurring

Blur Blur can be defined as unwanted transition made into the original image due to various reasons like motion between camera and an object, atmospheric turbulence, out-of-focus of the camera, taking picture in fog etc. Following are the types of blur:

Average blur: Average blur occurs on entire image. Average blur can be scattered in a vertical and horizontal direction [C11] and it can be circular averaging by radius R which can be calculated by the following formula: $R = \sqrt{g^2 + f^2}$ Where, g is the horizontal size blurring direction and f is the vertical blurring size direction and R is the radius size of the circular averaging blurring [C2].

Motion Blur: Motion blurs [C12], [C13], [C14], [C15] can be caused by relative motion between camera and scene during the exposure time. It can occur in various forms like rotation, translation, sudden change of the scale, or the combination of these [C2].

Defocus Blur: Photographical defocusing is another common type of blurring, known as defocus blur, mainly due to the finite size of the camera aperture [C16]. Defocus blur [C14], [C16], [C17], [C18] is caused by an optical imaging system. Defocus blur is employed to blur a background and “pop out” the main object using large aperture lenses.

Gaussian Blur: In this blur type, pixel weights are unequal. Gaussian blur is simulated by Gaussian function. The blur is high at the centre and decreased at the edges following bell shaped curve [C11], [C19], [C20].

Atmospheric Turbulence Blur: Blur introduced by atmospheric turbulence depends on a variety of factors such as temperature, wind speed, exposure time.

Deblurring

An image deblurring is a recovering process that recovers a sharp latent image from a blurred image, which is caused by camera shake or object motion. Image deblurring have wide applications from consumer photography, e.g., remove motion blur due to camera shake, to radar imaging and tomography. Deblurring is the process of removing blurring artifacts from images. The performance of the deblurring algorithm is evaluated using different metrics such as

- Mean – Square Error
- Peak Signal –to –Noise ratio
- Structure Similarity Index Method

Deblurring using Interval Valued Double Refined Indeterminate Triangular Neutrosophic Number

In this section an Interval Valued Double Refined Indeterminate Neutrosophic algorithm was utilised to process images. The Interval Valued Double Refined Indeterminate Neutrosophic set split the membership into upper bound and lower bound for increase the veracity of data. The upper and lower bound values must be in between the interval (0, 1). Now we get the Truth membership, Falsity membership, indeterminate toward falsity and indeterminate towards truth membership with upper and lower bounds. Since we got upper and lower bound values using those values and following the procedure the images are processed. Images that require processing are imported into system memory and then transformed into M-N-3 matrices. On the imported image, Interval Valued Double Refined Indeterminate Neutrosophic Sets are applied. In Deblurring process of image the IVDNRINS





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members obtained are deconvoluted using blind deconvolution filter. Blind deconvolution filter weights were used to restore the images.

Steps involved in Deblurring

1. Importing blurred image into memory.
2. Rescaling and matrix conversion.
3. Applying Interval Valued Double Refined Indeterminate Neutrosophic set in image matrix.
4. Applying blind deconvolution in IVDRINSS applied image.
5. Finding edge location using indeterminate membership (IFL& ITL).
6. Combining edges and deconvoluted images.
7. Export deblurred images into local memory

CONCLUSION

A blur image is used to test the efficacy of the proposed algorithm. Fig 1(a) is the blurred image taken as the Input image. The image is imported in the MATLAB and output is obtained under Neutrosophic domain [Fig 1(b)], Double Refined Indeterminate Triangular Neutrosophic environment [Fig 1(c)] and in Interval Valued Double Refined Indeterminate Triangular Neutrosophic environment [Fig 1(d)]. The metric values are tabulated in table. Our proposed method generate finer result with less MSE and more PSNR and SSIM values.

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Table 1. Deblurring

Metric	MSE	PSNR	SSIM
Neutrosophic domain	0.02042	16.9	0.6077
DRITrN domain	0.0009416	30.26	0.9369
IVDRITrN domain	0.0000697	41.57	0.9897





Growth and Characterization of A_2BX_4 Type Inorganic – Organic Hybrid Single Crystals by Slow Evaporation Method

S. Valli*

Assistant Professor, Department of Chemistry, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

S. Valli

Assistant Professor,
Department of Chemistry,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.
E. Mail: Sku4valli@gmail.com



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ABSTRACT

The inorganic and organic hybrid crystals of A_2BX_4 (Bis – Tetrabutylammonium tetrabromocobaltate II – [Bis-TBATBr – Co II]) type has been successfully synthesized by slow evaporation growth technique at room temperature using water as a solvent. The elemental analysis is used to confirm the stoichiometry of the crystal. FTIR is utilized to analyse the modes of vibration of different molecular group present in the sample. The formation of [Bis-TBATBr–Co II] was confirmed by comparing the 1H NMR spectrum with ^{13}C NMR spectrum. The thermal stability of the grown crystal were studied by TG/DTA. The powder x-ray diffraction reveals that the sample is crystalline with good quality. The Single crystal XRD is used to find the structure and Crystal packing.

Keywords: Hybrid crystal, [Bis-TBATBr – Co II], growth from solution, room temperature, crystalline.

INTRODUCTION

Due to surging energy prices and an increase in environmental awareness there is a growing need for sustainable designs. Crystals can act as the feedstock for such sustainable designs. Crystal growth has become important in today's technological system in the field of chemistry, physics, engineering, transportation, medical and safety technologies, etc.,[6],[7] Recently single crystals have more attention than poly crystals because single crystal's has excellent optoelectronic properties, low cost growing and stability compared to other poly crystalline films which are used for various applications such as solar cells, laser, and radiation detection. Alkyl substituted ammonium derivatives of A_2BX_4 type compounds have been extensively investigated in recent years [1]. Alkyl substituted ammonium derivative crystals of the type A_2BX_4 (Where A= Univalent cation, B= Divalent transition metal cation



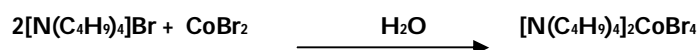


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and X=Halogen) exhibit phase transitions mainly due to the rotational and conformational motion of the alkyl groups [2],[8]. The A₂BX₄ family of compounds manifest a wide range of physical properties, including transparent conductivity, ferromagnetism, and superconductivity [3],[5]. Hence it finds wide range of application in the industries such as fibre optic communication, electronic and photonic etc as these industries depend on crystals or materials like semiconductors, superconductors, solid state lasers, polarizers, transducers, ultrasonic amplifiers, non-linear optics, electro-optics, photosensitive, piezo-electric, crystalline films for computer and microelectronic industries [4],[9],[10].

MATERIALS AND METHODS

Bis-Tetrabutylammonium tetrabromo Cobaltate(II) [Bis-TBATBr-Co(II)] complex was prepared by mixing Tetrabutylammonium bromide and cobalt bromide in 2:1 molar ratio respectively using triple distilled water. The two solutions were mixed together thoroughly in acidic medium by using 1ml of HBr. Then the resulting solution was filtered through whatmann42 filter paper. The solution was kept at room temperature for preparation of solids by slow evaporation. The crystals obtained were bluish green in colour.



RESULTS AND DISCUSSION

Elemental Analysis The result of elemental analysis (C,H,N) [Bis-TBATBr-Co(II)] of crystal is given in [Table 1]. For comparison, theoretical values are also given The experimental percentage composition values of carbon, hydrogen and nitrogen are very close to the theoretical values based on A₂BX₄ formula and within the experimental error. The elemental analysis thus confirms the stoichiometry of the [Bis-TBATBr-Co(II)] compound.

FT-IR Analysis The broad band around 3376 cm⁻¹ is due to the trapped water molecules in the crystal. No strong band is observed above 3000 cm⁻¹ excluding the presence of groups like -OH, -NH₂, -NHR, HC=C-R, R₂C=CHR, aromatic system. It confirms the presence of nitrogen in tertiary or quaternary state. The band at 2959 cm⁻¹ is due to C-H asymmetric stretching vibration of methyl group. The band at 2932 cm⁻¹ is due to C-H asymmetric stretching vibration of methylene group. The δ asymmetric stretching vibration of methyl and methylene groups is seen at 2872 cm⁻¹ and 2700 cm⁻¹ respectively. Weak band at 1637 cm⁻¹ is due to asymmetric bending vibration of O-H group. Band at 1467 cm⁻¹ is due to methyl and methylene asymmetric deformation. C-H inplane symmetrical bending vibration of methyl group is observed as a strong band at 1379 cm⁻¹. This band is due to methyl group and not methylene group.

A common feature of IR spectra is that groups like -CH₃, -CH₂, -CH have more or less the same frequency irrespective of molecular environment. These groups vibrate independently from the rest of the molecule. These frequencies are known as group frequencies. The C-C stretching vibrations are weak which appear in the broad region between 1200 cm⁻¹ and 800 cm⁻¹ and it is not so useful. C-H stretching and bending vibrations are useful. Twisting and wagging are of less diagnostic value because of their instability. The instability is due to strong coupling to the remainder of the molecule. Overtone of C-H bending is also observed as weak band in this region. Because of these reasons weak bands appear in the IR spectra between 1150 cm⁻¹ and 803 cm⁻¹. The methylene and methyl twisting modes are observed as weak bands at 1244 cm⁻¹ and 1165 cm⁻¹, respectively. Methyl and methylene rocking modes are observed at 1107 cm⁻¹ and 1065 cm⁻¹, respectively. Bands appear at 1032 cm⁻¹ and 926 cm⁻¹ which are due to C-C-N and C-N-C stretching vibrations. The bands also confirm the presence of unconjugated C-C-N linkage in the compound. The symmetrical stretching C-C vibration is observed at 880 cm⁻¹. C-H out of plane bending mode appears at 803 cm⁻¹. CH₂ in-plane bending vibration is found at 740 cm⁻¹. The peak is also due to C-C-N and C-N-C deformation vibration. The FTIR spectra of TBATBr-Co(II) is shown in [Figure 1].





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NMR Spectral Studies The proton NMR spectrum of Bis-TBATBr-Co(II) is shown in [Figure 3]. The structure of the compound is shown in [Figure 2]. In proton NMR spectrum, four different signals are observed at different δ values for the methyl and methylene groups present in the butyl groups of the compound. The expected δ values for methylene and methyl protons are 1.2 to 1.4 ppm and 0.7 to 1.1 ppm respectively. In this NMR spectrum higher δ value is obtained. This is due to the deshielding effect which confirms the presence of positive charge on the nitrogen of tetrabutylammonium group. The NMR spectrum cannot be taken for the negative ion $(\text{CoBr}_4)^{2-}$ because of the absence of hydrogen. The signal at -0.836δ is due to methyl group protons (I). Peak at 1.3δ is due to methylene protons (II). The signal for methylene protons (III) appear at 1.560δ . The methylene protons (IV) signal appears at a higher δ value of 3.160 . The higher δ value is due to deshielding effect because of the electropositive nitrogen adjacent to it. The deshielding effect decreases as we go from methylene protons IV to methyl protons I. This is because the distance between nitrogen and the protons increases resulting in diminishing deshielding effect. Also, the intensity of the peak is higher for methyl protons (I) and the intensity of all other peaks are similar confirming the presence of three methylene groups in the compound. All the butyl groups are in the same magnetic and chemical environment.

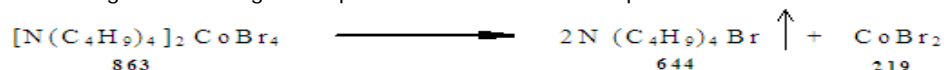
In Bis-TBATBr-Co(II) compound apart from the signals from the two identical methyl carbon atoms of DMSO there are four signals observed [Figure 4]. Since nitrogen has positive charge in the tetrabutylammonium group of the compound, there is more deshielding for the carbon atom nearer to the nitrogen atom. This deshielding in the carbon atoms diminishes as we move further away from the nitrogen atom leading to a decrease in the δ values consequently. Hence the methylene carbon nearer to the nitrogen atom has a higher δ value of 57. For the second methylene carbon atom from the nitrogen atom the δ value is 22. For the third methylene carbon atom from the nitrogen atom the δ value decreases further leading to a value of 18. Since the methyl group carbon atom is far away from the positively charged nitrogen atom the deshielding effect is very minimum leading to a δ value of 13. Though there are four n-butyl groups in the tetrabutylammonium group only four signals for four different carbon atoms are observed. This leads to the conclusion that all the eight n-butyl groups are identical. If they are not identical we must have got more than four signals for the carbon atoms of the eight n-butyl groups.

Powder XRD Analysis

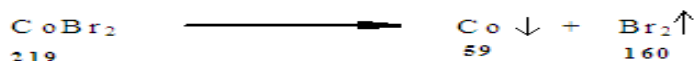
The X-ray powder diffraction pattern of [Bis-TBATBr-Co(II)] crystal is shown in [Figure 5]. The X-ray powder diffraction pattern shows well defined Bragg peaks at specific 2θ angles which reveal that this is a crystalline sample with high quality.

Thermal Analysis

The TG-DTA thermogram of the compound Bis-tetrabutylammonium tetrabromocobaltate(II) is shown in [Figure 6]. The TG-DTG curve shows a two stage weight loss when heated between 40 and 800°C . The first stage decomposition starts at 253°C and ends at 370°C . There is a weight loss of 70% which can be accomplished by formulating the following decomposition reaction of the compound.



Theoretical weight loss of 74.6% is observed whereas the experimental loss observed is 70% . The difference of 4.6% may be attributed to the incomplete decomposition of small amount of the compound. In the second stage we have only cobalt bromide at 370°C . When the temperature is increased there is decomposition of cobalt bromide from 370 to 666°C with a weight loss of 22% . This weight loss can be accounted for by formulating the following decomposition reaction.



According to the above equation, cobalt bromide has completely decomposed into gaseous bromine and cobalt residue. Thus there is loss of all the 219 units of cobalt bromide into cobalt residue and of gaseous bromine. The





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theoretical loss of weight of 160 units leads to the loss of 18.5% of the original compound. The difference of 3.5% between the theoretical and experimental value is due to the decomposition of small amount of the Bis - TBATBr-Co(II) left in the first stage. Thus the compound decomposes in two stages. The decomposition starts at 253°C and gets completed at 667°C. The melting point of cobalt is 1495°C. So cobalt remains as residue after the second stage of decomposition. It does not vapourise even after 836°C. Here, the theoretical percentage value of cobalt residue is 6.84. The experimental percentage value is 8. The experimental and theoretical values are in agreement with each other with a difference of 1.16% which is within experimental error. Thus the thermogram confirms the stoichiometry of the compound which is evident from the decomposition patterns. The DTG curve of the cobalt compound involves four peaks. They occur at temperatures 98.3°, 253.6°, 370.6° and 666.7 °C. The 98.3°C peak is attributed to the presence of moisture in the crystal which is lost at this temperature. The first stage decomposition occurs between 253.6° and 370.6°C. The second stage decomposition occurs between 370.6° and 666.7 °C. Thus the TG and DTG curves agree with each other for the decomposition pattern of the compound.

Single Crystal XRD The structure of the compound was determined by single crystal X-ray diffraction technique. The X-ray data for the compound were collected at 293 K using the $M\alpha$ radiation ($\lambda = 0.71073 \text{ \AA}$). For X-ray data collection, a crystal of approximately 0.10 x 0.10 x 0.20 mm was used. The unit cell parameters of the crystal were determined by least square method using several reflections. The structure was solved by using SHELXS-97 and refined by full-matrix least square method. The intensity data were collected for $h = 0$ to 9, $k = 0$ to 6, $l = -16$ to 16. The crystal structure data are presented in [Table 2] The ORTEP plot of the molecule with 50% probability was given in [Figure 7] The compound $[\text{N}(\text{C}_4\text{H}_9)_4]_2\text{CoBr}_4$, crystallized with needle habits is bright and transparent. The structure of the compound was determined as monoclinic with space group P21/n. the unit cell dimensions are $a = 16.5255 \text{ \AA}$, $b = 15.5263 \text{ \AA}$, $c = 18.6371 \text{ \AA}$ with $Z = 4$. The co-ordination around Co atom is tetrahedral. The structure of the compound also shows hydrogen bonds between bromide and hydrogen of the butyl groups.

The structure of the cobalt compound is $[\text{NBu}_4]_2\text{CoBr}_4$. Totally there are eight butyl groups in the compound. Due to the bulky butyl groups, the molecule is under high stress. Due to the stress and strain, one of the butyl groups C5 - C6 - C7 - C8 does not have a fixed position i.e. it is not able to fit in a position. At one time the C6, C7, C8 carbons are in position C6A, C7A, C8A and at another time it is in positions C6B, C7B and C8B. According to the positions of carbon, the positions of hydrogens also vary. Thus disorder exists in the compound and one of the butyl group is wagging between positions A and B. The bond distance between Br - Co is given in the [Table 3]. In the CoBr_4 tetrahedra group a bond length of 2.4030 Å to 2.418 Å is observed for all the Co-Br bonds. The Co-Br bond length is greater compared to C-H, C-N and C-C bond lengths. The hydrogen bonds present between the hydrogen of the methyl group and bromine of the CoBr_4 group leads to a stronger interaction between the two tetrahedra NBu_4 and CoBr_4 . The two tetrahedra are linked via the hydrogen bonding between the two.

CONCLUSION

The single crystals of Bis - Tetrabutylammonium tetrabromocadmiate (II) was synthesized by Slow Evaporation technique. The grown crystals were characterized using CHN analysis, Powder X-ray diffraction, Thermogravimetry (TG), Differential thermal analysis (DTA), FTIR, ^1H NMR, ^{13}C NMR and Single crystal X-ray structure determination. The following conclusions were arrived. The CHN analysis data obtained for this compound confirm their molecular formulae. The FTIR spectra of all the compounds were similar and confirm the presence of alkyl group in this compounds. The IR spectra also confirm the presence of C-C and C-N bonds. The ^1H NMR and ^{13}C NMR spectra suggest the presence of alkyl in this compound. TG-DTA indicates 100% decomposition of the compound. The crystalline nature of the prepared compounds from aqueous solution is confirmed by getting well defined peaks at different 2θ values in Powder XRD. The structure of the compound was determined as monoclinic with space group P21/n. the unit cell dimensions are $a = 16.5255 \text{ \AA}$, $b = 15.5263 \text{ \AA}$, $c = 18.6371 \text{ \AA}$ with $Z = 4$. The TG and DTA studies confirm the stoichiometric formula of the compound. The thermal hysteresis observed in low temperature and high temperature DSC curves indicates a phase transition in the compound.





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Table 1: Elemental analysis of [Bis-TBATBr-Co(II)]

SAMPLE NAME	CARBON%		HYDROGEN%		NITROGEN%	
	EXP	THEO	EXP	THEO	EXP	THEO
Bis - TBATBr-Co(II)	43.45	44.50	8.96	8.34	3.15	3.245

Table 2: The crystal structure data

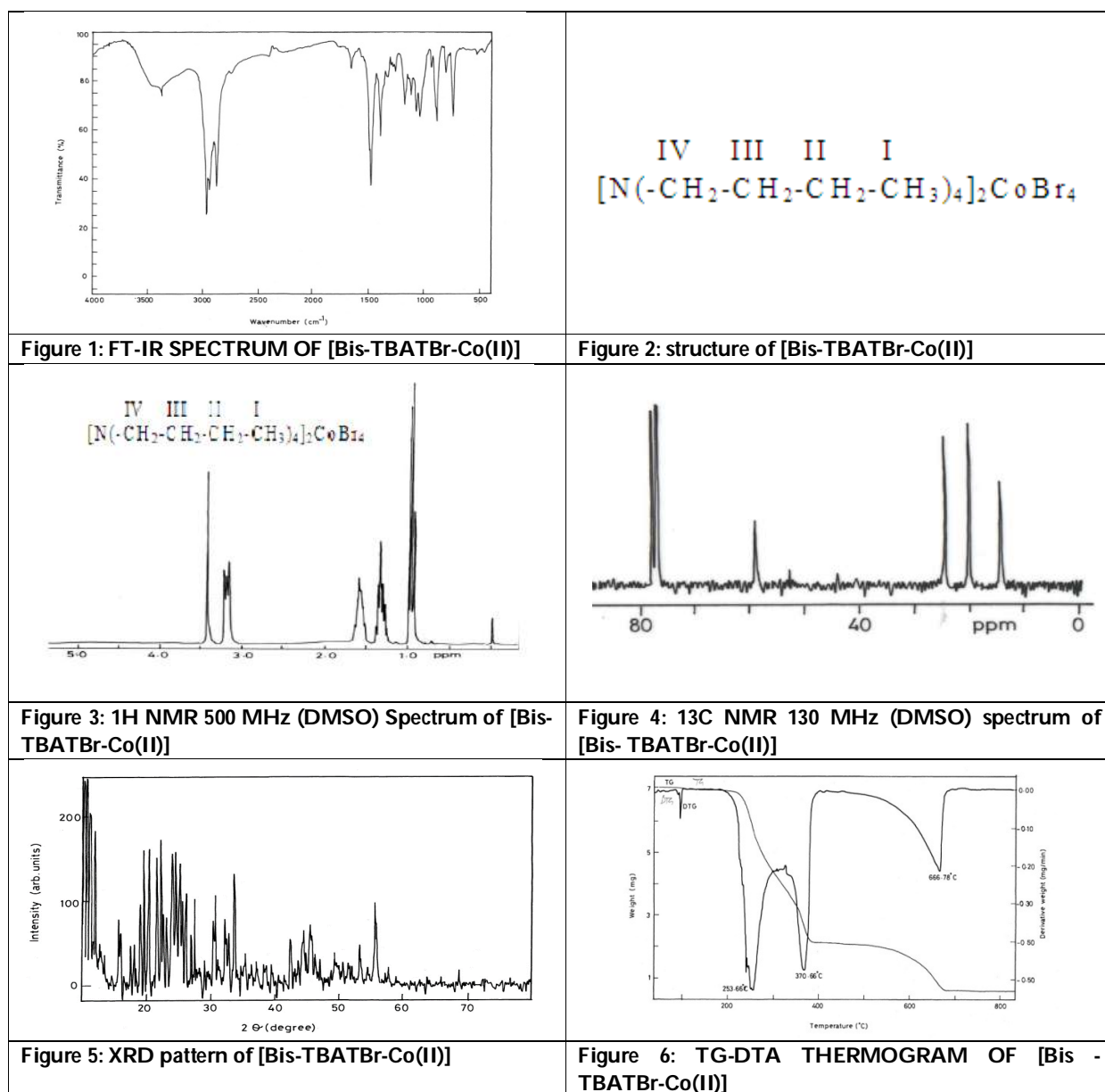
EMPIRICAL FORMULA	$\text{C}_{32}\text{H}_{72}\text{CoBr}_4\text{N}_2$
FORMULA WEIGHT	863.49
TEMPERATURE	293 K
WAVELENGTH	0.71073 Å
CRYSTAL SYSTEM	MONOCLINIC
SPACE GROUP	P21/n
CELL DIMENSIONS	$a=16.5255 \text{ Å}; b=15.5263 \text{ Å}; c=18.6371 \text{ Å}$ $\alpha = 90^\circ; \beta = 116.027^\circ; \gamma = 90^\circ$
VOLUME	$4297, 4782 \text{ Å}^3$
Z	4
DENSITY	1.335 g / cm^3
CRYSTAL SIZE	0.10 x 0.10 x 0.20 mm
THETA RANGE FOR DATA COLLECTION	2.2° to 25.6°
INDEX RANGES	$0 \leq h \leq 9, 0 \leq k \leq 6, -16 \leq l \leq 16$





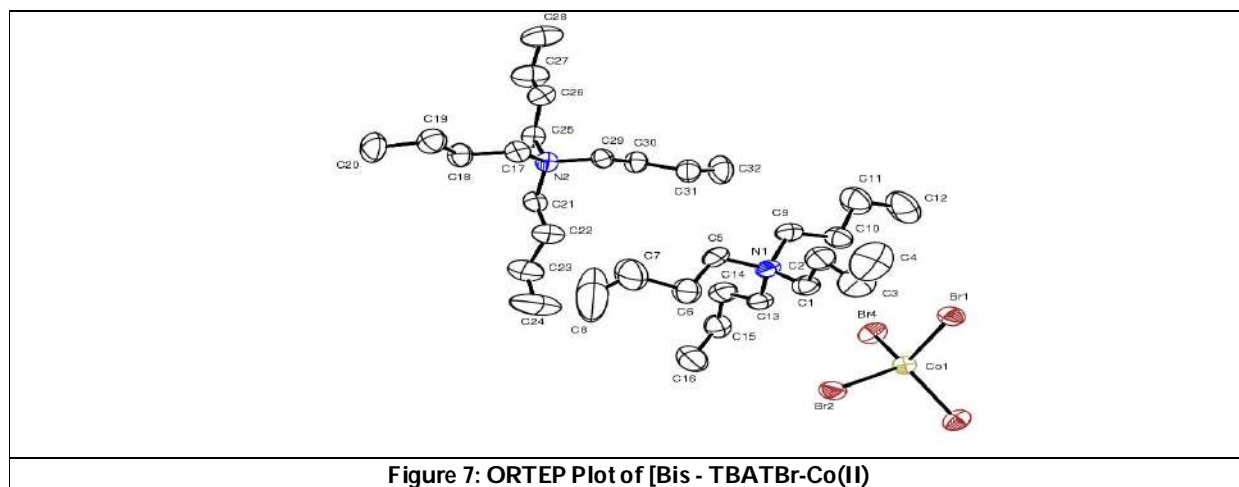
Table 3: Bond distance between Br – Co

Group	Bond distance (Å)
Br1 – Co1	2.4142
Br2 – Co1	2.4180
Br3 – Co1	2.4030
Br4 – Co1	2.4049





Valli





Biochemical Composition of Marine Edible Crab Species from Pamban, Rameswaram Island, South East Coast of India

Merline.X¹ and Chitra.G^{2*}

¹Department of Zoology, Nirmala College for Women, Coimbatore - 641018, Tamil Nadu, India.

²Assistant professor, Department of Zoology, Nirmala College for Women, Coimbatore - 641018, Tamil Nadu, India.

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*Address for Correspondence

Chitra.G

Assistant Professor,
Department of Zoology,
Nirmala College for Women,
Coimbatore - 641018
E. Mail : chitradayalu@gmail.com



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ABSTRACT

Crabs are the most interesting groups among decapods crustaceans. Crabs are highly nutritious and healthy owing to its protein content, unsaturated fatty acids, carbohydrates and mineral composition. Therefore, determining the proximate composition of crab species have a great importance due to the good effect on human health. The present study was focussed to know the biochemical composition of commercially available marine crab species *Portunus trituberculatus*, *P. sanguinolentus*, *P. pelagicus* and *Charybdis natator* collected from Pamban, Rameswaram Island, South East Coast of India. The results of proximate composition in four crab species were recorded, *P. trituberculatus* had the maximum percentage of protein (24.63%), followed by *P. sanguinolentus* (19.4%), *C. natator* (17.10%) and lowest protein content was *P. pelagicus* (12.66%). *P. trituberculatus* (1.60%) had the highest carbohydrate content and the lowest in *P. sanguinolentus* (0.18%). Lipid content showed that the value ranged from 3.0 to 5.0%. *P. pelagicus* had the highest lipid (5.0%) content and *P. trituberculatus* had the lowest lipid content (3.0%). The highest ash content was found to be *P. sanguinolentus* (7.0%) and lowest content in *P. pelagicus* (2.1%). This study showed that among the four different species studied, *P. trituberculatus* is the best for meeting the protein requirement where as *P. pelagicus* can supply much of carbohydrate and lipid.

Keywords: *Portunus trituberculatus*, *Portunus sanguinolentus*, *Portunus pelagicus*, *Charybdis natator*, Biochemical composition.



**Merline and Chitra****INTRODUCTION**

Brachyurans which are true crabs hold more than 6500 species and are the biggest branch of the decapod Crustacea [1]. At present there are more than 6700 known species of brachyuran crabs (both marine and freshwater), out of which over 1,300 species are true freshwater crabs. Crustaceans like shrimps, lobsters and crabs contribute 16% of the total marine fish production, of which the share of crab fishery is 9.6%. Crabs support a sustainable fishery of appreciable importance, although they occupy the third position as a delicacy after shrimps and lobsters [2]. Among crustaceans, marine crabs are the most diverse group and have great demand as food. The marine crab fishery is supported mostly by the edible crabs belonging to the family Portunidae represented mainly by *P.pelagicus*, *P. anguinolentus*, *Charybdis* species [3]. In India, conventional edible varieties of crabs contributing to the fishery economy are dominated by the spotted crab *P. sanguinolentus* and the blue swimmer crab *P. pelagicus*. *Charybdis lucifera*, *C. annulata* and *C. natator* have also been identified as edible varieties in different coastal areas of the country [4]. Crabs are the fundamental parts of the ecosystem; they are supposed to be good for human consumption and taken as food in many countries. Crabs are considered as healthy food for humans because they contain high quality protein and less amount of fat [5]. Crustaceans are not only a direct source of food, but they are also used as food preservative and fertilizer, particularly crab waste materials (such as crab shell) are used as feed stabilizer [6]. When we compare crab with other aquatic animals, we see that crab meat is a superb source of high quality nutrients due to its high protein content and less amount of fat [7]. The nutritional quality of the crab protein was comparatively very favourable than that of muscle meat of mutton, chicken duck and fish. The crab meats contain many nutrients like vitamins, carbohydrates, minerals and free amino acids, many therapeutic properties are attributed to the crab meat and it is used to cure asthma and chronic fever.

The knowledge of the chemical composition of any edible organism is extremely important since its nutritive value is reflected in its biochemical contents. A seafood species should be recommended for human consumption only after assessing the nutritive value of the species with regards to its nutritional merits. Even though large numbers of marine crabs are suitable for human consumption, our knowledge of their nutritive value is fragmentary. A great number of studies, in different parts of the world, have examined the proximate composition of different crab species. But only limited data are available on the proximate composition of the crab *P. trituberculatus*, *P. sanguinolentus*, *P. pelagicus* and *C. natator* of Rameswharam Island coastal area. The aim of the present study is to determine the proximate composition of the four common edible crabs available in the Pamban, Rameswaram Island, South East Cost of India.

MATERIALS AND METHODS**Sample Collection and Experimental Procedure**

Samples of four marine crabs *P.trituberculatus*, *P.sanguinolentus*, *P.pelagicus*, *C. natator* were collected from the Pamban, Rameswaram Island, South East Coast of India and brought immediately to the laboratory for further studies. The crabs were kept in glass trough in tap water for 24 hours, for emptying and cleaning the gut. The shells were removed and the entire body tissue was dried at 500°C (constant temperature) for 24 hours in the hot air oven. Then, the dried meat was powdered and the required quantity of powder was taken for the estimation of biochemical composition.

Biochemical Analysis

Biochemical composition such as total protein, carbohydrate, lipid, ash and moisture contents were estimated [8] in the edible portion of selected crabs.



**Merline and Chitra****RESULTS**

The biochemical composition of the crab species *P.trituberculatus*, *P.sanguinolentus*, *P.pelagicus*, *C.natator* collected from the Pamban, Rameswaram Island, South East Coast of India are shown in table 1. The highest moisture content was recorded in the crab species *P.pelagicus* (85.16%) followed by the *C. natator* (78.49%) and *P. sanguinolentus* (75.8%). The lowest moisture content was reported in *P. trituberculatus* (66.50%). The protein content of crab species ranged from 12.66 to 24.63%. The results showed that among the four different species, *P. trituberculatus* (24.63%) had the highest protein content followed by *P. sanguinolentus* (19.4%) and *C. natator* (17.10%). *P. pelagicus* showed the lowest value of protein content (12.66%). The lipid content ranged from 3.0 to 5.0%. The highest lipid content was recorded in *P. pelagicus* (5.0%) followed by *P. sanguinolentus* (3.9%) and *C. natator* (3.5%) and the lowest lipid content were recorded in *P. trituberculatus* (3.0%). *P. trituberculatus* (1.60%) recorded the highest carbohydrate content followed by *C. natator* (1.41%) and *P. pelagicus* (1.0%). *P. sanguinolentus* was found to have the least carbohydrate content (0.18%). From the present results highest ash content noted in *P. sanguinolentus* (7.05%). The ash content recorded in *C. natator* and *P. trituberculatus* were 3.87 and 3.5 respectively and the lowest ash content (2.1%) was recorded in *P. pelagicus*.

DISCUSSION

Biochemical studies are very important from the nutritional point of view. The biochemical constituents in animals are known to vary with season, size of the animal, stage of maturity, temperature, and availability of food, and so forth [9]. The variation in moisture content may be attributed to the influence of the season and to the water temperature. The high water content may be a disadvantage too in terms of the shelf life of the sample. In this study, the moisture content was appreciable in the selected samples. This high moisture content in organisms is considered to be advantageous because of its contribution to the stabilization of the organisms during movements [10]. In the present study the protein content was recorded as 24.63% in *P. trituberculatus*, 19.4% in *P. sanguinolentus*, 17.10% in *C. natator* and 12.66% in *P. pelagicus* respectively. The present results were supported by the previous findings in which protein content in blue crab was 17.17% [11]. Indeed, the protein content varied from 0.47% to 15.91% in *P. pelagicus* and from 12.81% to 13.6% in *P. sanguinolentus* [12]. It clearly indicates that the potential sources for the proximate composition for human consumption. The variations in protein contents in edible muscle tissues of marine organisms might be attributed to the physiological, genotype and phenotype differences or might be due to the proteins are subject to periodic fluctuations influenced by environmental variables like temperature or influenced with the presence of pollutants in the surrounding water [13]. Also, the quantities of protein constituents in edible muscle vary considerably from genera to genera, species to species, size, sex feeding season, physical activity, reproductive stage and different stages of life cycle of marine organisms. The result in the present work revealed that the crab *P. trituberculatus* tissue is value food due to high quality proteins.

Lipids are highly efficient biochemical components as sources of energy and they contain more than twice the energy of carbohydrate and proteins. Furthermore, lipids played an important role for maintaining structural and physiological integrity of cellular and sub cellular membranes [14]. Generally, in marine invertebrates, the lipid is the most variable fraction and marine invertebrates have lesser lipid content, and it varies with the seasons. The lipid percentage in the present study had the maximum percentage in the edible muscle tissues of *P. pelagicus* (5.0%) and lowest in *P. trituberculatus* (3.0%). The present results were parallel with previous findings in which 5.65% of lipid content was recorded in hard-shell crabs [15]. In crustaceans, lipids are not only the principal organic reserve and source of metabolic energy, but also indispensable in maintaining cellular integrity. Lipids as a general rule act as major food reserve along with protein and are subject to periodic fluctuations influenced by environmental variables like temperature [16]. Carbohydrates constitute only a minor percentage of total biochemical composition. Carbohydrates in fishery products contain no dietary fiber but only glucides, the majority of which consist of glycogen. They also contain traces of glucose, fructose, sucrose and other mono and disaccharides [17]. In the present study, carbohydrate content was higher in *P. pelagicus* (1.60%). The previous study was suggested that the





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carbohydrate content in the muscle tissues varied from 2.4 to 3.4% in *C. smithii* [18]. The variations in the carbohydrate level in edible tissues of different marine crustacean organisms were reported, this variation may be due to the accumulation of glycogen at different stages of gametogenesis and spawning. The variation of carbohydrates content as the result of various factors which change carbohydrates percentage in edible muscles of crustacean animal, such as starvation, rest, exercise, gonad development and other physiological stages [19]. Ash is one of the least studied biochemical constituents in fish and shell fish and it is a measure of the mineral content of any food including fish. The ash content changes with the time of storage due to absorbance of moisture and loss of protein. In the present study the mean values of the ash content in the muscle tissues of edible crabs varied from 2.1% to 7.0% which was in the range given by the earlier authors. Similarly, 2.4 g/100g of ash content was recorded in *P. pelagicus* [20] and 2.2 g/100g in green crab (*Carcinus maenus*) [21].

CONCLUSION

As the world population is growing, the per capita consumption of seafood is also increasing rapidly. Because of health consciousness, the modern-day man is interested in taking seafood more in view of its nutritional superiority than all other sources of food accessible to him. Crabs are good source of elements such as phosphours, calcium and zinc and also rich in carbohydrates, lipids, fatty acids and amino acids. Certain species of crabs are in addition rich in vitamin A, B, C etc. Many of these species has also therapeutic properties. Due to the nutritional richness, nutritional values of crabs are being assessed extensively in the coastal regions of Japan, Spain, Canada and other foreign countries. Hence there is the need for the study of nutritive value of crabs along the coastal regions of our locality. In the present work, nutritional analysis of muscle tissues of *P. trituberculatus*, *P. sanguinolentus*, *P. pelagicus*, *C. natator* crabs indicates that the protein is the most prominent biochemical component of edible muscle of all studied samples that in turn reflected their high nutritive quality and could be employed this species of crab as an alternative dietary supplement of protein for human. This study showed that among the four different species studied, *P. trituberculatus* is the best for meeting the protein requirement where as *P. pelagicus* can supply much of carbohydrate and lipid. The problem of malnutrition in our country can be overcome by the effective utilization of nutrient-rich crab seafood.

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Table 1: Biochemical Composition of crab species collected from Pamban, Rameswaram Island, South East Coast of India.

S.No	Parameters	<i>Portunus trituberculatus</i>	<i>Portunus sanguinolentus</i>	<i>Portunus pelagicus</i>	<i>Charybdis natator</i>
1	Moisture (%)	66.50	75.80	85.16	78.49
2	Protein (%)	24.63	19.40	12.66	17.10
3	Carbohydrate (%)	01.60	00.18	01.00	01.41
4	Lipid (%)	03.00	03.90	05.00	03.50
5	Ash (%)	03.50	07.00	02.10	03.87





A Study on the Impact of Economic Status in the Academic Performance of Undergraduate Female Students

L.Elвина Mary*

Assistant Professor, PG and Research Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

L.Elвина Mary

Assistant Professor,
PG and Research Department of Mathematics,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.



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ABSTRACT

The purpose of this study is to ascertain the link between students' academic performance and economic status. The research done enables us to comprehend that there is a strong correlation between economic status and academic achievement. To this end, this study suggests and develops a framework for helping students make decisions about how much differing levels of the engagement of some economic considerations can have an overall negative impact on academic performance. The information was gathered from the undergraduate students using a questionnaire. As a result, it was determined that parental economic status, including their ability to support their children financially and morally, their ability to provide a conducive learning environment at home, and their ability to provide incentives, all have an impact on their children's academic performance.

Keywords: Parental economic Status, Academic Performance, Higher education

INTRODUCTION

The financial means a parent has to provide for the requirements of the family is referred to as their economic standing. Basic requirements including food, clothing, shelter, and education for their kids are included in the necessities. According to experts, pupils from poor socioeconomic level perform worse academically because their requirements are not effectively satisfied. Recent research in educational sociology confirms a strong link between students' academic success and their family's economic situation. Research has demonstrated that economic position is connected with health, cognitive and socioemotional outcomes. In general, it has been demonstrated that family background affects educational results in a wide variety of nuanced and complex ways.





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Dealings defining parental education, employment, and income characterise a single SES variable (Saifi, S., & Mehmood, T. (2011)). When analysing a family's economic status, the mother's and father's education and occupation are examined, as well as the combined income, versus with an individual, when their own attributes are assessed. Economic status is a combined measure of an individual's or family's economic and social position relative to others, based on income, education, and occupation. This study's main objective is to demonstrate the link between students' academic achievement and their socioeconomic level. Studies suggest that students from low socioeconomic households have fewer academic possibilities than students from better socioeconomic homes; however, not all of these findings address cultures and ethnicities among all children from low socioeconomic backgrounds. To serve these children more effectively, increase their access to school, and advance social justice, further study on this subject is required.

Objective of the Study

The study's goal was to determine how parents' financial circumstances affected the academic performance of female undergraduate students.

The study specifically aimed to respond to the following questions:

1. How do the students' financial circumstances compare to the following criteria

- Educational background of the parents
- Parents' Occupation
- Monthly income for a family
- Family size

2. What is the students' degree of academic achievement?

3. Does the students' financial situation have a substantial impact on their academic success?

Methodology

The study employed the descriptive survey research design. Instead of manipulating variables, this method describes the phenomenon and analyses activities as they occur. By obtaining respondents' opinions or attitudes towards a situation at a specific time, the design is suitable for examining the prevalence of a phenomenon, situation, problem, or attitude.

Sampling Procedure and Sample Size

123 female students were randomly selected and they completed the questionnaire. The target population included first year, second year, and third year under graduate students.

Data Collection and Analysis

Data gathered in the field was checked for consistency and sanitised before being analysed. To interpret the findings, descriptive and inferential statistics were used. Means, frequencies, and percentages were among them. In order to determine if female undergraduate students' academic performance was influenced by their parents' economic situation, the researchers also utilised correlation analysis.

Factors effecting Economic Status

Education

The frequency and percentage distribution of the student respondents' economic situation in relation to their parents' level of education is shown in Table 1. The chart demonstrates that the parents of 60 students, or 48.78 percent of respondents, achieved or completed high school, while 18 students, or 14.63 percent, had earned a college degree. However, only 45, or 36.59 percent, have completed primary school.

Occupation

Table 2 presents the frequency and percentage distribution of the student-respondents economic status relative to father's occupation. As seen from the table, parents of 69 or 56.09 percent of the student-respondents are going for daily wages and 28 or 22.76 percent are private employees, 16 or 13.02 percent are unemployed, 10 or 8.13 percent



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are government employees. The data shows that majority of the father's of the student-respondents are going for daily wages and minimum wage earners. The data further affirm the findings related on family income, wherein majority belongs to the below the poverty line as seen by the occupation of the parents of the student-respondents. Table 3 presents the frequency and percentage distribution of the student-respondents economic status relative to mother's occupation. As seen from the table, parents of 64 or 52.03 percent of the student-respondents are unemployed and 43 or 34.96 percent are going for daily wages, 14 or 11.38 percent are private employees, 2 or 1.63 percent are government employees. The data shows that majority of the mother's of the student-respondents are unemployed. The data further affirm the findings related on family income, wherein majority belongs to the below the poverty line as seen by the occupation of the parents of the student-respondents.

Income

The table 4 reveal that majority of 78 or 63.41 percent of the student-respondents have their monthly family income below 20,000 and 32 or 26.02 percent have monthly income of between 20,001 to 50,000. Only 13 or 10.57 percent have monthly family income of above 50,001. The result shows that majority of the student-respondents have monthly family income below the poverty line.

Family Size

Table 5 presents the frequency and percentage distribution of the student-respondents economic status relative to family size. It can be seen from the table that 10 or 8.13 percent of the respondents have a family size of 2 and below; 32 or 26.01 percent have 3-4 members in the family; majority of 78 or 63.42 percent belong to a family with 5-6 members; 3 or 2.44 percent have 7-8 members in the family. The table shows that majority of the respondents belong to a family with an average of five or six members.

Student Academic Achievement Level

Table 6 presents the frequency and percentage distribution of the student-respondents Academic Achievement Level. Out of the 123 total respondents, 4 or 3.25 percent falls under the below average; majority of them belongs to the average level of 60% -89% with a percentage of 81.30 or 100 students; 14 or 11.38 percent belongs to the average level of 50% -59% and 4 or 3.25 percent belongs to the average level of less than 50% .

Economic Status Versus Academic Achievement**Parents' Educational Attainment and Students Academic Achievement**

The table reveals the correlation between the student respondents parents' educational attainment and students' academic achievement. As revealed above, the values of correlation coefficient which is 0.71573 suggests a significant relationship exists between Parents' Educational Attainment and Students Academic Achievement.

Parents' Occupation and Students Academic Achievement

The table reveals the correlation between the student respondents parents' Occupation and students' academic achievement. The table above indicates that there is a relationship between parents occupation and students academic achievement as indicated by correlation coefficient of 0.026229. This implies that the academic achievement of students is greatly affected by the parents occupation.

Family Monthly Income and Students Academic Achievement

The table reveals the relationship between the student respondents family monthly income and students' academic achievement. As revealed above, the value of correlation coefficient which is 0.022366 shows a significant relationship exists between the family monthly income and students' academic achievement.. This implies that the academic achievement of students is greatly affected by the monthly family income.

Family Size and Students Academic Achievement

The table reveals the relationship between the student respondents family monthly income and students' academic achievement. As revealed above, the value of correlation coefficient which is 0.121239 shows a significant





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relationship exists between the family size and students' academic achievement.. This implies that the academic achievement of students is greatly affected by the family size.

RECOMMENDATIONS AND CONCLUSION

In the light of the foregoing findings, the researcher has the following recommendations to offer:

1. The students can be given more training programmes to improve their communication skills which in turn help them to get part time jobs.
2. Employ other important variables to determine the economic status of the students that would enhance the results.
3. The government can offer more scholarship schemes to the poor.
4. Establish a linkage with various foundations and other NGOs that would help needy but deserving students.
5. Part time jobs can be offered through consultancy services from the institution.

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Table 1. Frequency and Percentage Distribution of Respondents Relative to Parents' Educational Attainment

Parent Educational Attainment	Frequency	Percentage
Elementary	45	36.59
High School	60	48.78
College	18	14.63
Total	123	100





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Table 2. Frequency and Percentage Distribution of Respondents Relative to Father's Occupation

Father's Occupation	Frequency	Percentage
Government	10	8.13
Private	28	22.76
Daily Wages	69	56.09
Unemployed	16	13.02
Total	123	100

Table 3. Frequency and Percentage Distribution of Respondents Relative to Mother's Occupation

Mother's Occupation	Frequency	Percentage
Government	2	1.63
Private	14	11.38
Daily Wages	43	34.96
Unemployed	64	52.03
Total	123	100

Table 4. Frequency and Percentage Distribution of Respondents Relative to Family Monthly Income

Family Monthly Income	Frequency	Percentage
Below 20,000	78	63.41
Between 20,001 to 50,000	32	26.02
More than 50,001	13	10.57
Total	123	100

Table 5. Frequency and Percentage Distribution of Respondents Relative to Family Size

Family Size	Frequency	Percentage
2 and below	10	8.13
3 - 4	32	26.01
5-6	78	63.42
7-8	3	2.44
Total	123	100

Table 6 Frequency and Percentage Distribution of Respondents Relative to the Academic Achievement Level

Academic Grade Range	Frequency	Percentage
Above 90%	5	4.07
Between 60% -89%	100	81.30
Between 50% -59%	14	11.38
Less than 50%	4	3.25
Total	123	100

Table 7. Test the correlation between the Student-respondents Parents' Educational Attainment and Students Academic Achievement

Correlation Coefficient	0.71573
Number of cases	123

Table 8. Test the correlation between the Student-respondents Parents' Occupation and Students Academic Achievement

Correlation Coefficient	0.026229
Number of Cases	123





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Table 9. Test the correlation between the Student-respondents Family Monthly Income and Students Academic Achievement

Correlation Coefficient	0.022366
Number of Cases	123

Table 10. Test the correlation between the Student-respondents Family Size and Students Academic Achievement

Correlation Coefficient	0.121239
Number of Cases	123

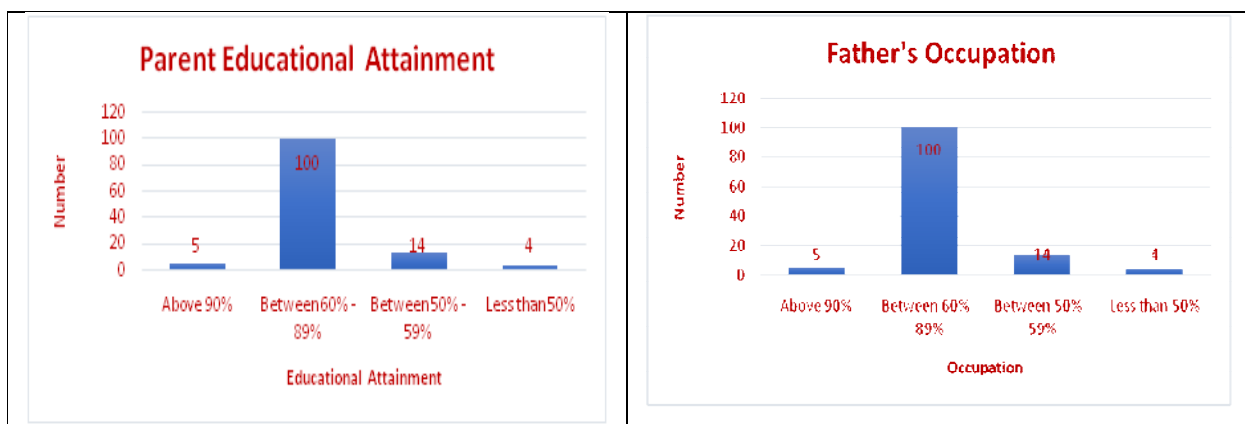


Figure 1 Frequency and Percentage Distribution of Respondents Relative to Parents' Educational Attainment

Figure 2 Frequency and Percentage Distribution of Respondents Relative to Father's Occupation

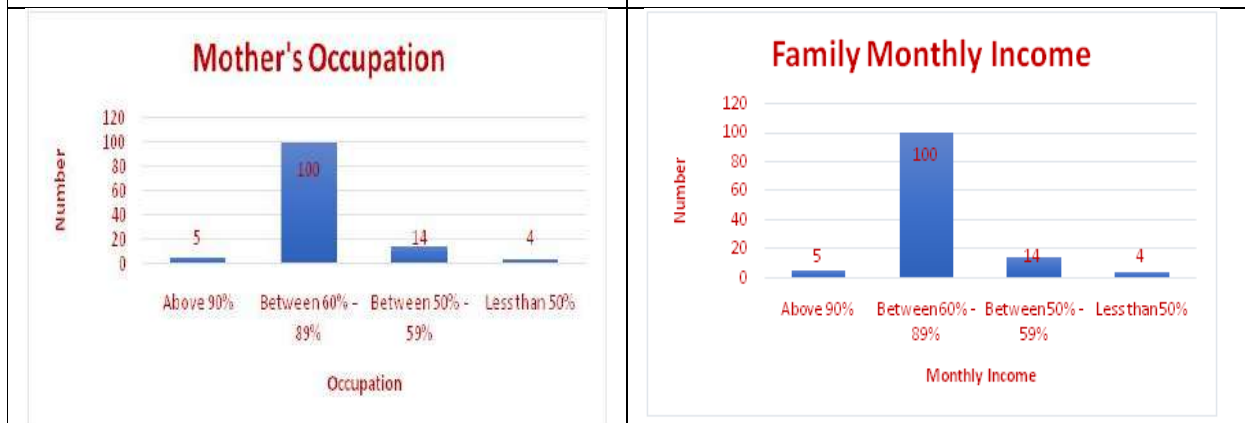


Figure 3 Frequency and Percentage Distribution of Respondents Relative to Mother's Occupation

Figure 4 Frequency and Percentage Distribution of Respondents Relative to Family Monthly Income





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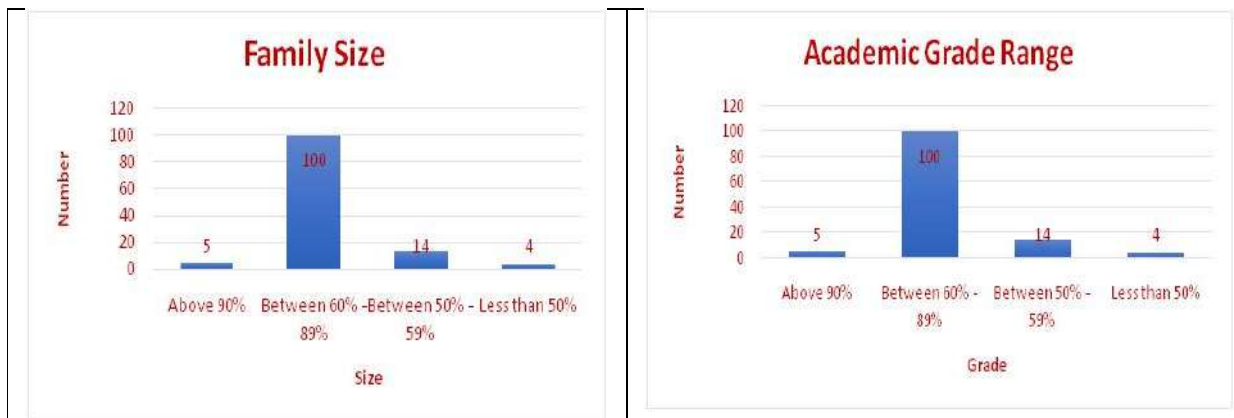


Figure 5 Frequency and Percentage Distribution of Respondents Relative to Family Size

Figure 6 Frequency and Percentage Distribution of Respondents Relative to the Academic Achievement Level





An Insight into the Phytochemical Profiling, *In-Vitro* Biological Activities and *In Silico* Molecular Docking Studies of *Setaria italica* Extract

S. Valli*, S.Durgadevi and K. Anbarasi

Assistant Professor, Department of Chemistry, Nirmala College for Women, Coimbatore-18, Tamil Nadu, India.

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*Address for Correspondence

S. Valli

Assistant Professor,
Department of Chemistry,
Nirmala College for Women,
Coimbatore-18,
Tamil Nadu, India
E. Mail: Sku4valli@gmail.com



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ABSTRACT

The occurrence of cancer and carcinogenic disorders are increasing in an exponential manner globally and to battle them, a raise in demand for food containing complex carbohydrates with higher levels of dietary fibers, antioxidants and health beneficial phytochemicals has been in demand. Consumption of whole grain food has been proposed to decrease the risks of cancer. In this study, foxtail millet was taken in consideration and analysed for various phytochemical compounds present, antioxidant, anti-bacterial properties. GC-MS analysis was done to identify the phytochemical compounds present in the alcoholic extract. Antioxidant activity were tested using 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay, antimicrobial properties were studied using Kirby Bauer well diffusion method, it showed antimicrobial activity on *Escherichia coli*, *Staphylococcus aureus*. *In silico* docking studies were performed using iGEMDOCK 2.0 against HER2 breast cancer causing protein. From the observation, it could be inferred that finger millet could be used as a natural source of antimicrobials and antioxidants, especially for minimizing the risk of carcinogenic diseases.

Keywords: Foxtail millet, GC-MS analysis, Antioxidant, iGEMDOCK, Breast cancer.





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INTRODUCTION

Consumption of Millets in food preparations is increasing worldwide, since they are rich sources of phytochemicals, antioxidants, minerals and dietary fibers which offers prominent health benefits and proved to reduce the risk of several chronic diseases, and cancers [1]. Foxtail millet (*Setaria italica*) is one of the most significant food crops in the world. It was originated from China, and is now established all over the world. It plays a very important role in the agriculture. It is used as human food of many developing countries because of its ability to grow under adverse heat and limited rainfall conditions [2]. Nutritionally, foxtail millet's grains are superior to rice and wheat, and therefore provide cheap proteins, minerals, and vitamins to the poor where the necessity for such nutrients are on high demand [3]. Foxtail millet is a drought-resistant plant and it is one of the easily cultivated whole grains. It belongs to the *Setaria* genus of Poaceae family and subfamily Panicoideae. Foxtail millet are rich in dietary fibers, phytochemicals, peptides, proteins, minerals, amino acids, phenolic compounds, sterols, tocopherols, phytic acids, carotenoids, unsaturated fatty acids, and several anti-nutritive compounds. Foxtail millet exhibit variety of health benefits, such as hypoglycemic effect and cancer prevention effect including anti-hyperglycemia, antifungal and antioxidant effects. Increased consumption of foxtail millet plays an important role in reducing risks of chronic diseases. Foxtail millet protein hydrolysates are helpful for lowering blood pressure, and a daily consumption of 50 g whole foxtail millet significantly reduces blood pressure. Foxtail millet shows antidiabetic, antioxidant, anti-inflammatory, and antimicrobial potential. Phenolic acid in foxtail millet also has an antiproliferative effect against various cancer cells [4].

MATERIALS AND METHOD

Foxtail millet (*Setaria italica*) was collected commercially from Coimbatore, Tamil Nadu, India. The seeds of foxtail millet were cleaned and powdered by using a mechanical grinder. The powdered samples were used for further process. The powdered foxtail millet, 30 gram was refluxed with 100ml of ethanol at constant temperature for 3 hours. The extract was kept overnight, filtered and concentrated at room temperature. The Foxtail millet Extract (FOE) was used for further studies.

Preliminary Phytochemical Screening

Preliminary phytochemical screening tests were conducted to identify presence of active phytochemicals present in FOE extracts by using standard reagents.

GC-MS Analysis

The Clarus 680 GC was used in the GC-MS analysis employed a fused silica column, packed with Elite-5MS (5% biphenyl 95% dimethylpolysiloxane, 30 m × 0.25 mm ID × 250 μm df) and the components were separated using Helium as carrier gas at a constant flow of 1 ml/min. The injector temperature was set at 260°C during the chromatographic run. The 1 μL of FOE extract injected into the instrument the oven temperature was as follows: 60 °C (2 min); followed by 300 °C at the rate of 10 °C min⁻¹; and 300 °C, where it was held for 6 min. The mass detector conditions were: transfer line temperature 240 °C; ion source temperature 240 °C; and ionization mode electron impact at 70 eV, a scan time 0.2 sec and scan interval of 0.1 sec. The fragments from 40 to 600 Da. Total GC running time is 32.00 min. The relative percentage amount of each component was calculated by comparing its average peak area to the total areas. Software adopted to handle mass spectra and chromatograms was a Turbo Mass Ver 5.4.2. The spectra of the components were compared with the database of spectrum of known components stored in the GC-MS National Institute Standard and Technology (NIST 2008) library. The Name, Molecular weight and structure of the components of the test materials were ascertained.

Antioxidant Assay

The 2,2-Diphenyl-1-picryl-hydrazyl free radicals can be used to evaluate the antioxidant activities in a relatively short time. The absorbance decreases as a result of a colour change from purple to yellow as radical is scavenged by



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antioxidants [5]. To perform this (DPPH) antioxidant assay, ascorbic acid (10 mg/ml) was used as the standard and 10 mg/ml of FOE extract was used for the assay. 100 µl of 0.1 mM DPPH, various concentrations (µl) of FOE extract and 1800 µl of methanol was added to the reaction mixture. This mixture was incubated in dark for 30 min and absorbance was read at 517 nm which is standard for DPPH, Percent inhibition or percent scavenging activity was calculated based on the following formula:

$$\% \text{ inhibition} = \frac{[(\text{Control OD} - \text{Sample OD}) / \text{Control OD}] \times 100}$$

Antibacterial Assay

Antibacterial activity was determined by the disk diffusion method of Kirby Bauer. The bacteria used as test organisms in this study were *Escherichia coli* and *Staphylococcus aureus*.

Inoculum Preparation

The inoculum was prepared by taking three to five well-isolated colonies of the same morphological type selected from an agar plate culture. The top of each colony was touched with a loop, and the growth was transferred into a tube containing 4 to 5 ml of a suitable broth medium, such as Nutrient broth [6]. The broth culture was incubated at 35°C to achieve or exceed the turbidity (usually 2 to 6 hours). The turbidity of the actively growing broth culture was adjusted with sterile saline or broth to obtain the turbidity. This resulted in a suspension containing approximately 1 to 2 x 10⁸ CFU/ml for *Escherichia coli* and *Staphylococcus aureus*.

Inoculation of Test Plates

Optimally, within 15 minutes after adjusting the turbidity of the inoculum suspension, a sterile cotton swab was dipped into the adjusted suspension. The swab was rotated several times and pressed firmly on the inside wall of the tube above the fluid level to remove excess inoculum from the swab. The dried surface of the nutrient agar plate was inoculated by streaking the swab over the entire sterile agar surface. As a final step, the rim of the agar was swabbed. The lid was left ajar for 3 to 5 minutes, but not more than 15 minutes, to allow for any excess surface moisture to be absorbed before applying the drug impregnated disks. The media was punctured by making a well of 6 mm in diameter and filled with 20 µl of FOE sample. Further the petriplates were placed inversely for complete diffusion. Rifampicin served as standard and DMSO served as negative control. Inhibition zones were examined by measuring the diameter (mm) formed around the well after 24 hrs incubation at 37°C. The zones were measured by using standard (Hi-Media) scale.

Molecular Docking Studies

Molecular docking prediction is a method for predicting the interactions of intermolecular complexes, such as ligands (drugs) and receptors (target proteins) [7]. The iGEMDOCKv2.1 was used to undertake docking studies for natural molecules (ligands) from the foxtail millet with Human epidermal growth factor receptor 2-positive (HER2). In iGEMDOCK, drug screening was used as default settings with population size 200, 70 generations, and 2 numbers of solutions. iGEMDOCK scoring function was chosen along with ligand interaction energy with hydrophobic and electrostatic preference both as 1.

Preparation of the Protein Structure

The protein needed for the docking research was downloaded from the Protein Data Bank with a resolution of 1.3 Å root mean square deviations (RMSD), representing the three-dimensional structure of target HER2 which is responsible for the breast cancer.

Preparation of Ligands

For the docking process, the major chemical constituents present in the chromatogram of foxtail millet were used to make the ligand molecules. The chemical structures were found in the PubChem database. The compounds structures were downloaded in (.sdf) layout and renewed to (.mol) format with the help of Open Babel Software [8]. The binding affinities are calculated in kcal/mol and the docking run time were calculated using docking between Protein and Inhibitor. The best inhibitor was chosen as the one with the lowest binding energy [9].





RESULTS AND DISCUSSION

Preliminary Phytochemical Screening

The preliminary phytochemical screening results of FOE extract was given in (Table 1), it showed the presence of flavonoids, sterols and carbohydrates.

GC-MS Analysis

The GC-MS analysis of FOE extract revealed the presence of six active phytochemical compounds that could contribute to the medicinal property of the plants. On comparison of the mass spectra of phytochemical constituents with the NIST library, all these compounds were characterised and identified. The active principles with their Retention time (RT), Molecular formula, Molecular weight (MW) and peak area in percentage are presented in (Table 2). The results revealed that L-Leucine, N-(Trifluoroacetyl)-, Octadecyl Ester (50.25 %), was found to be major component present in FOE extract followed by Pentadecane, 2-Methyl- (25.87 %), Dichloroacetic Acid, Tridec-2-ynyl Ester (12.93 %), Tridecane, 7-Hexyl- (4.44 %), Docosane, 9-Butyl- (2.53 %), Docosane, 7-Hexyl- (1.69 %). The compounds present in ethanolic extract of FOE were tested for its potent interaction with HER2 target protein via *In-silico* molecular docking technique.

Antioxidant Assay

DPPH Radical Scavenging Activity

The free radical scavenging activity of FOE extract was analysed by taking different concentrations and is shown in the (Table 3). % Inhibition values were calculated. The higher % inhibition value indicates the higher DPPH radical scavenging activity. DPPH free radical scavenging assay of FOE extract showed maximum antioxidant potential of 72.95% at 250 µl concentration. The effective antioxidant potential of extract was confirmed by taking Ascorbic acid as a standard. (Figure 8) The high antioxidant property could be a contribution to flavonoids, sterols and amino acid present in the extracts. From the result obtained foxtail millet have free radical quenching activity. This suggests that the extract may also have potent anticancer properties, thus further *In-silico* molecular docking studies were done against breast cancer causing proteins.

Antibacterial Assay

The ethanolic FOE were examined for its antibacterial properties against different organisms such as *Staphylococcus aureus*, and *Escherichia coli*, by agar well diffusion method and the results were recorded in (Table 4). The drug Rifampicin was served as positive control and DMSO was used as negative control. The Foxtail millet extract showed zone of inhibition of 16mm and 12mm against *S. aureus* and *E. coli*, while the control drug Rifampicin had 35mm and 18mm inhibition against *S. aureus* and *E. coli* respectively. The extracts showed good inhibition property.

Molecular Docking Studies

Docking analysis of compound Pentadecane, 2-Methyl- (Figure 10) identified from GC-MS analysis of FOE was docked with HER2 protein (Figure 9) using iGEMDOCK docking server. The drug's fitness to the target molecules is aided by the maximum binding energy of receptor ligand interactions. The binding energy change has a negative value, indicating that the process of binding is spontaneous. Lower the binding energy, the more possibly the molecule will be taken as a medication [10]. Pentadecane, 2-Methyl- present in FOE showed the lowest binding energy (i.e.) Docking fitness of -65.08 kcal/mol with HER2. The best-docked conformation of Pentadecane, 2-Methyl- with HER2 (Figure 11) showed, Vander wall forces with the active residue amino acids V-S-LYS-16, V-S-GLU-20, V-S-ARG-23, V-S-TYR-46, V-S-PHE-89. (Table 5) From the docking results we can know that the interaction of ligand against HER2 receptor, were energetically favourable.





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CONCLUSION

The FOE extract was subjected to *in vitro* DPPH free radical scavenging assay, it exhibited significant scavenging activity when compared with the standard drug. The phytochemical screening indicated the presence of flavonoids and sterols present in the extract. These active constituents could be responsible for antioxidant activity of FOE extracts. The result obtained from the GC-MS analysis of FOE extract showed major phytochemical compounds present in the extracts. Thus, this type of GC-MS analysis is the first step towards understanding the nature of active principles of medicinal plants and this type of study will be helpful for further detailed study. *In silico* Molecular docking study revealed that the active phytochemical compound present in both extracts could be used as a drug for the treatment of breast cancer as they showed potent docking fitness against the HER2 protein. So further work can be carried out to isolate the active phytochemicals present in the extracts to determine their anticancer potentials.

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Table 1: Preliminary Phytochemical Screening of FOE Extracts

Metabolite	FOE
Alkaloids	-
Flavonoids	+
Sterols	+
Terpenoids	-
Antraquinone	-
Anthocyanin	-
Proteins	-
Phenolic compounds	-
Quinones	-
Carbohydrates	+
Tannin	-
Saponins	-
Phytates	-
Cardiac glycosides	-
Glycoside	-
Lignin	-
Coumarins	-
Volatile oils	-





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Table 2: Phytoconstituents Identified in The FOE Extract by GC-MS Analysis

S.no	Retention Time (RT)	Chemical Components	Molecular Formula	Molecular Weight	Peak Area %
1	19.806	Dichloroacetic Acid, Tridec-2-Ynyl Ester	C ₁₅ H ₂₄ O ₂ Cl ₂	306	12.930
2	27.159	2-Methyl Pentadecane	C ₁₆ H ₃₄	226	25.879
3	28.159	L-Leucine, N(Trifluoroacetyl) Octadecyl Ester	C ₂₆ H ₄₈ O ₃ NF ₃	479	50.251
4	28.510	9-Butyl Docosane	C ₂₆ H ₅₄	366	2.539
5	29.135	7-Hexyl Tridecane	C ₁₉ H ₄₀	268	4.443
6	29.435	7-Hexyl Docosane	C ₂₈ H ₅₈	394	1.696

Table 3: DPPH Radical Scavenging Activity of FOE

Concentration (µl)	% Inhibition of FOE
10	52.46
50	54.92
150	56.56
250	72.95
350	59.84
500	54.10
750	50.82

Table 4: Antibacterial activity of FOE

Sample	Zone of Inhibition (mm)	
	<i>Staphylococcus aureus</i>	<i>E.coli</i>
Standard (Rifampicin)	35mm	18mm
Negative control (DMSO)	0mm	0mm
FOE	16mm	12mm

Table 5: The fitness and interaction profile for HER2 receptor with the ligands

Compound Name	Total Binding Energy (kcal/mol)	Vander Waal's Force (kcal/mol)	H –Bond Energy (kcal/mol)	Electrostatic Force (kcal/mol)
Pentadecane, 2-Methyl-	-65.08	-65.08	0	0





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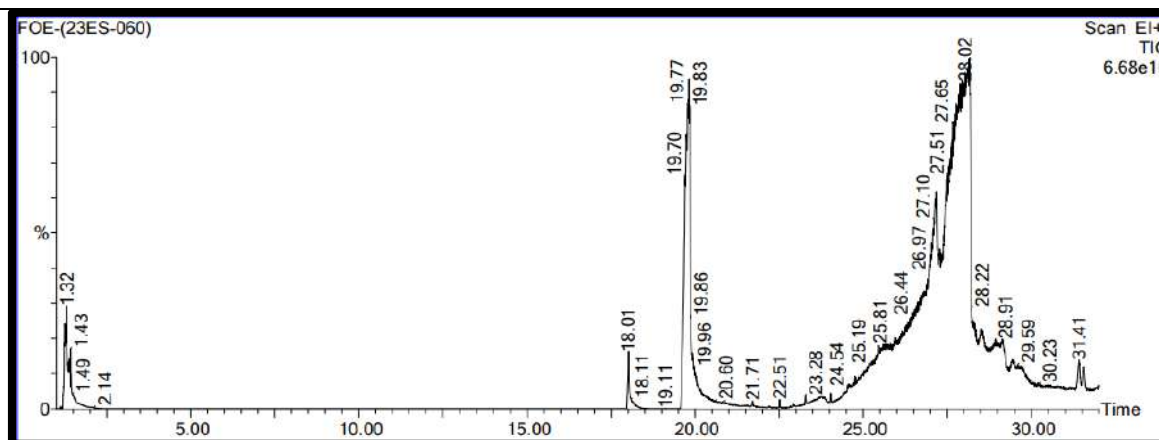


Fig. 1: Gas Chromatogram of FOE Extract

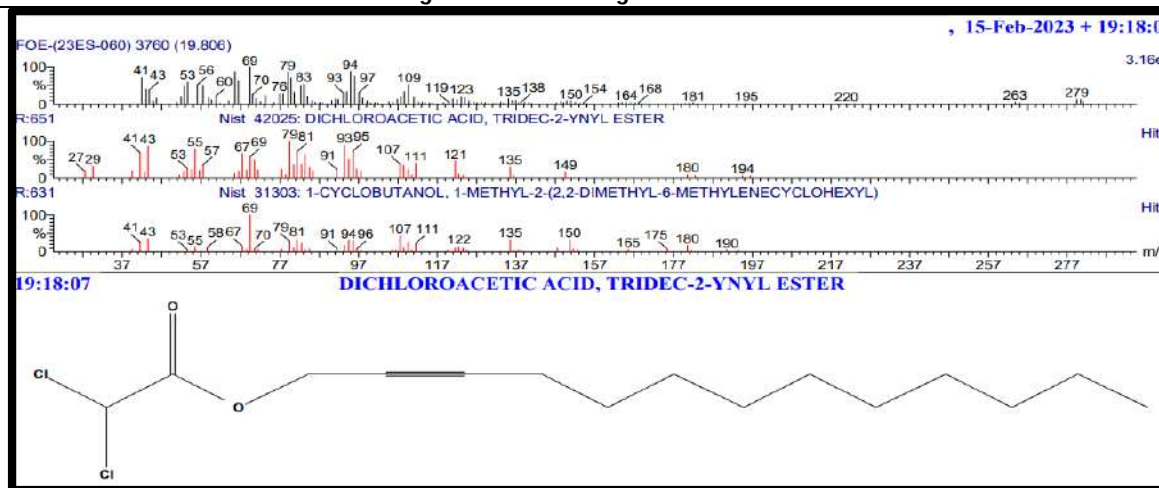


Fig. 2: Mass Spectrum of Dichloroacetic Acid, Tridec-2-ynyl Ester

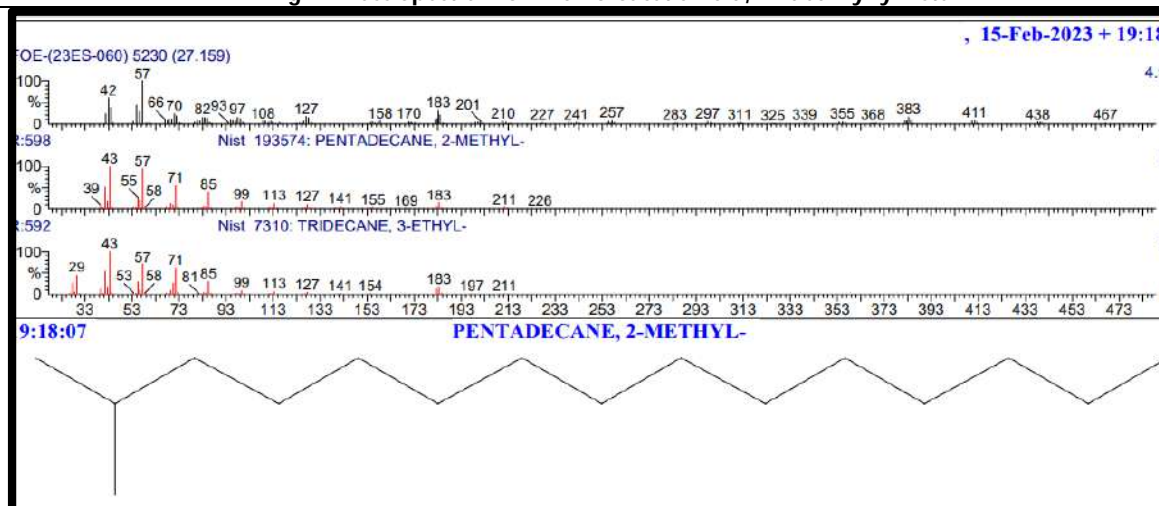


Fig. 3: Mass Spectrum of Pentadecane, 2-Methyl-





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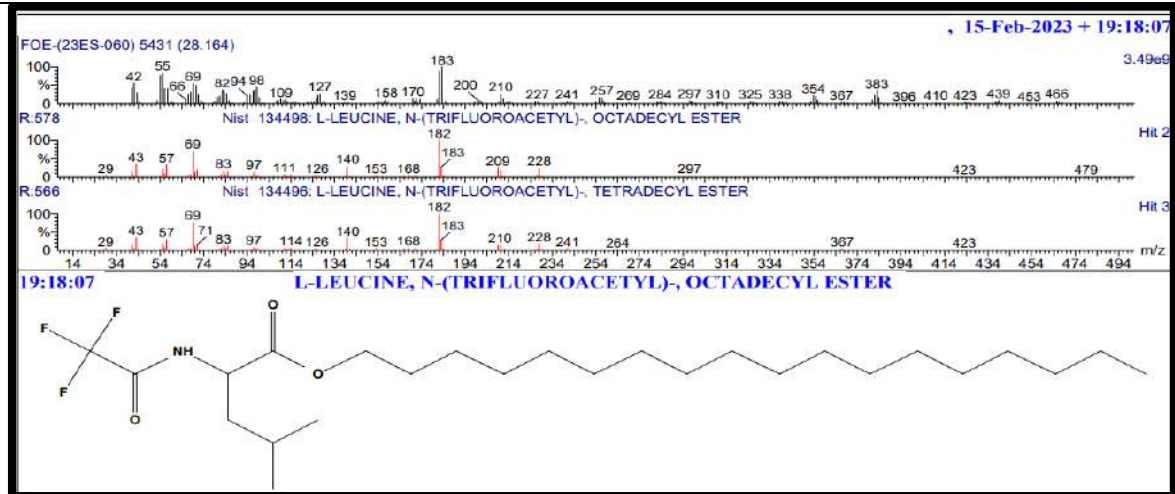


Fig. 4: Mass Spectrum of L-Leucine, N-(Trifluoroacetyl)-,Octadecyl Ester

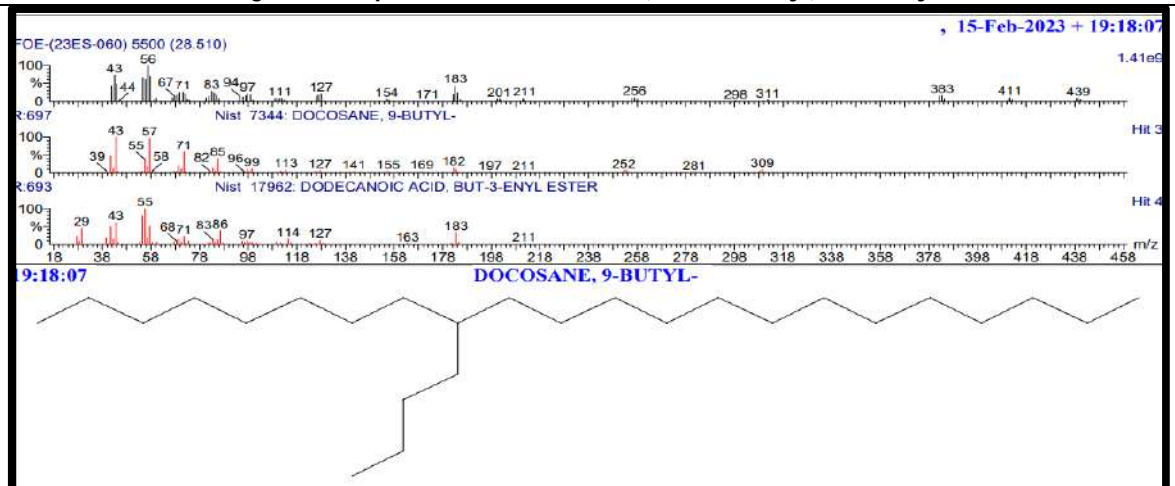


Fig. 5: Mass Spectrum of Docosane, 9-Butyl-

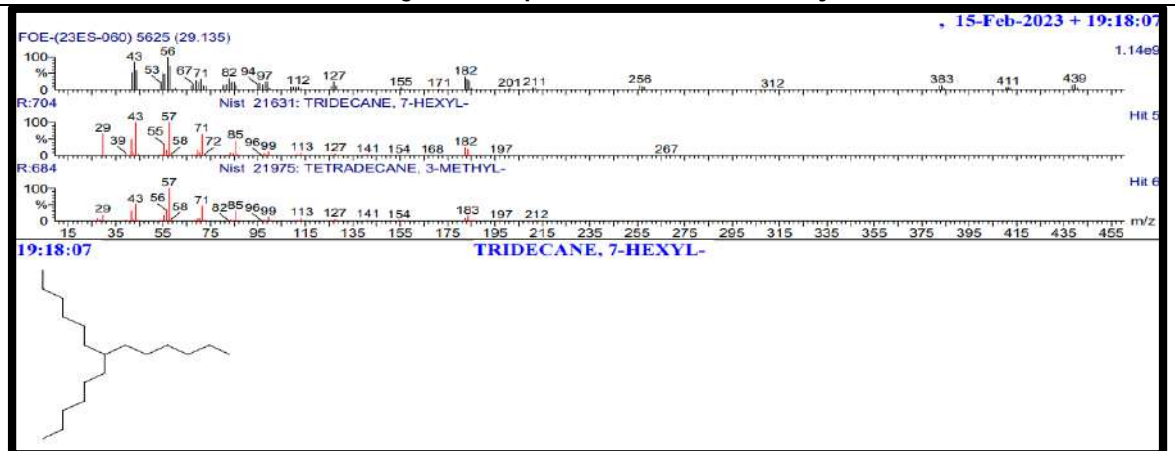


Fig. 6: Mass Spectrum of Tridecane, 7-Hexyl-





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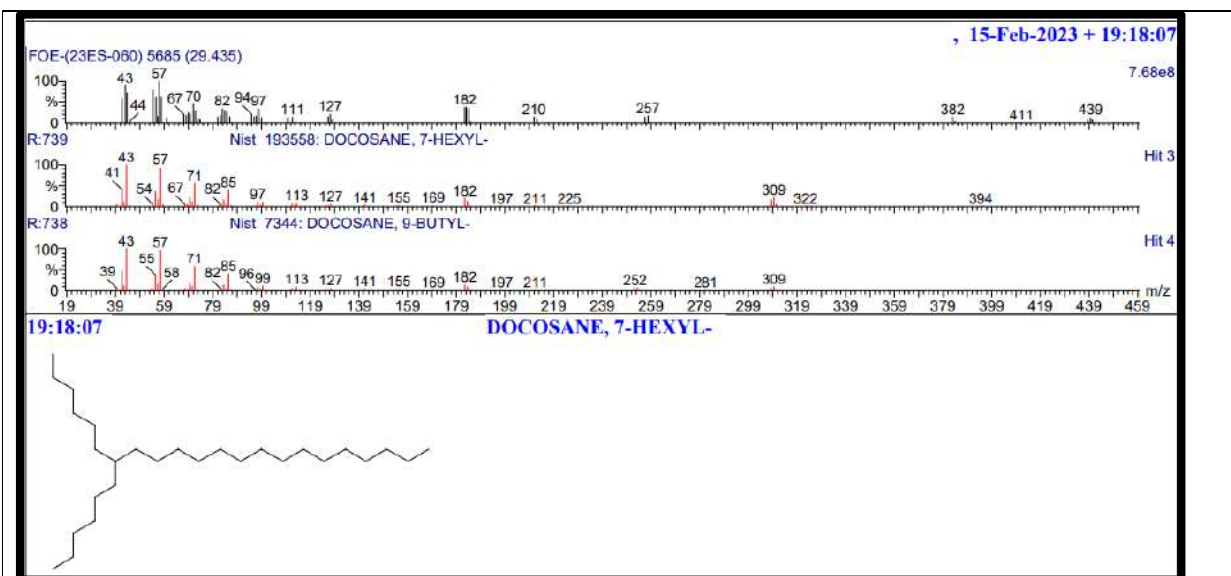


Fig. 7: Mass Spectrum of Docosane, 7-Hexyl-

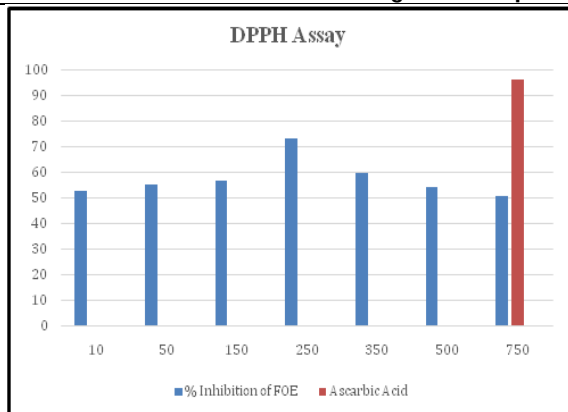


Fig 8: DPPH Radical Scavenging Activity of FOE

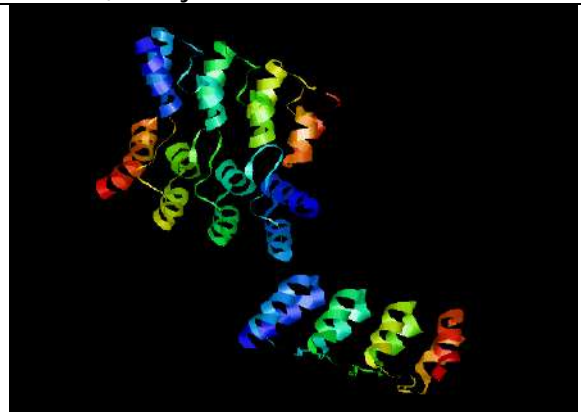


Fig. 9: Structure of Human Epidermal Growth Factor Receptor 2 (HER2)

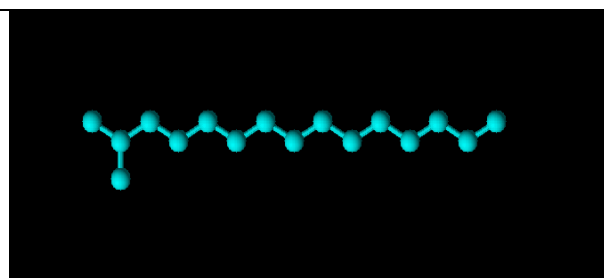


Fig. 10: 3D structure of Pentadecane, 2-Methyl-

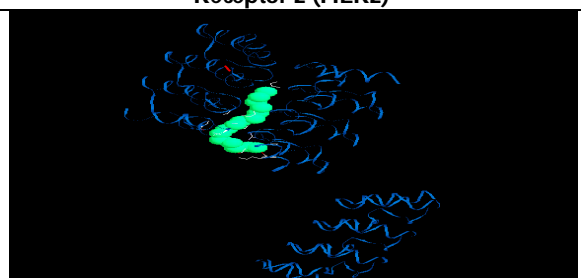


Fig. 11: Interaction of Pentadecane, 2-Methyl-with HER2 Protein





Mild Steel Corrosion Inhibition by *Opuntia cochenillifera* Stem Extract as a Green Corrosion Inhibitor

S. Gladiyarani^{1*} and N. Gunavathy²

¹Ph.D. Scholar, Department of Chemistry, Nirmala College for Women, Coimbatore - 641018, Tamil Nadu, India.

²Assistant Professor and Head, Department of Chemistry, Nirmala College for Women, Coimbatore - 641018, Tamil Nadu, India

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*Address for Correspondence

S. Gladiyarani

Ph.D. Scholar,
Department of Chemistry,
Nirmala College for Women,
Coimbatore - 641018, Tamil Nadu, India.
E. Mail: gladiyarani416@gmail.com



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ABSTRACT

Inhibition efficiency of acid extract of *Opuntia cochenillifera* (OC) stem in 1N hydrochloric acid on mild steel surface was investigated by weight loss, potentiodynamic polarization and electrochemical impedance spectroscopy methods. Weight loss measurement results revealed that corrosion inhibition increased with increase in inhibitor concentration in 2.50 % v/v concentration of stem extract. Electrochemical impedance results showed that the *Opuntia cochenillifera* (OC) stem extract increased the resistance of mild steel towards corrosion. The mild steel surface in the absence and presence of the inhibitor was analysed by scanning electron microscopy (SEM). Adsorption isotherms were tested and the experimental data fit well with the Langmuir adsorption. The studies revealed the corrosion potential of stem extract which follows Langmuir adsorption isotherm. Gas chromatography - Mass Spectroscopy (GCMS) a combined analytical technique was used to determine and identify compounds present in plant materials.

Keywords: *Opuntia cochenillifera* (OC), Hydrochloric acid, Langmuir adsorption, SEM.

INTRODUCTION

Metals are laid low with distinctive kinds of corrosion in numerous environments. The exposures can be most severe, but in many cases the corrosion may be controlled by means of inhibitors [1]. Green corrosion inhibitors have the advantage of being inexpensive, non-toxic and eco-friendly. These advantages have numerous and intensive searches on the use of naturally occurring substances or their extracts for the inhibition of the corrosion of metals [2,3]. Mild steel in acid solution are widely used in various industrial processes and corrosion occurs in this

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environment. The applications of inhibitors are a useful method for corrosion protection especially in acid media to avoid dissolution [4]. Most of the well-known acid inhibitors are organic compounds containing N, O and S in their functional groups with their aromatic and hetero cyclic rings. These organic compounds get absorbed on the metal surface and block the active sites on the surface, forming a protective barrier and reduce the corrosion rate [5]. In light of these, several plants extracts have been investigated and their corrosion inhibition properties are often attributed to its phytochemical constituents. Present study has been made to investigate the inhibition action of *Opuntia cochenillifera* (OC) stem extract as corrosion inhibitor in 1N hydrochloric acid medium for various concentrations over a range of temperature (303 K - 343 K).

MATERIALS AND METHODS

Preparation of Plant Extract

Study was carried out using *Opuntia cochenillifera* (OC) stem extract. Stem were collected from Panjampatti, Dindigul District, TamilNadu, cleaned and shade dried and powdered in an electric blender. 25 gm of this powder was refluxed with 1N HCl acid for 3h and left overnight to extract the phytonutrients. The extract was filtered and the filtrate volume was made up to 500 mL using the same acid and stored. From this 5 % stock solution was diluted with appropriate quantity of 1 N HCl to obtain test solution ranging from 0.10 % to 2.50 % v/v concentration [6].

Preparation of Experimental Specimen

The mild steel specimens of size 5 x 1 x 0.2 cm were degreased with acetone to remove grease, oil, dust and then washed with distilled water and dried. The coupons were then mechanically polished with 400 and 600 grade emery papers, cleaned, dried and then stored in desiccators. The prepared mild steel specimens were weighed in an electronic balance and immersed in 100 mL of 1N HCl without and with various concentrations of stem extract (0.10 to 2.5 % v/v). After 1 h of immersion in the test solution the specimens were removed, washed with distilled water, dried and weighed. The experiment was carried out at various immersion periods (1 h, 3 h, 5 h, 7 h, 24 h) for various concentrations of the inhibitor at 303 K. Corrosion inhibition studies were also carried out at temperature range 303 K - 343 K in the absence and presence of OC extract in 1 N HCl for 1 h duration.

From the weight loss, percentage inhibition was calculated using the following formula (1),

$$\text{Inhibition Efficiency (IE \%)} = \frac{W_{\text{blank}} - W_{\text{inh}}}{W_{\text{blank}}} \times 100 \quad (1)$$

Where, W_{blank} and W_{inh} are weight loss without and with stem extract respectively.

Electrochemical Study

Potentiodynamic Polarization Measurement

The polarisation measurements were carried out to evaluate the corrosion current (I_{corr}), corrosion potential (E_{corr}) and Tafel slopes b_a and b_c . Experiments were carried out in a conventional three electrode cell assembly. Mild steel rod of 15 cm and 5 mm diameter mounted on a Teflon leaving 0.19625 cm² of surface area exposed to solution was used as working electrode. It was polished with 200, 400, 600, 800, 1000 grade emery papers, cleaned with acetone, washed with distilled water and dried at room temperature, before it was immersed in test solution.

From the polarisation curves, Tafel slopes, corrosion potential (I_{corr}) and corrosion current (E_{corr}) were analysed using computer software [7]. The inhibition efficiency by Tafel method was calculated using equation(2),

$$\text{Inhibitor Efficiency (\%)} = \frac{I_{\text{corr}}(\text{Blank}) - I_{\text{corr}}(\text{Inh})}{I_{\text{corr}}(\text{Blank})} \times 100 \quad (2)$$

Where,

$I_{\text{corr}}(\text{Blank})$ = Corrosion current without inhibitor

$I_{\text{corr}}(\text{Inh})$ = Corrosion current with inhibitor



**Gladiyarani and Gunavathy****Surface Examination Studies**

Surface analysis studies of mild steel specimens were done in order to study the changes that occur during the corrosion of mild steel in the presence and absence of the inhibitor in acid medium. The nature of the metal surface was analyzed by Scanning Electron Microscope (SEM) technique. The mild steel specimens were immersed in 1N hydrochloric acid solution in the absence and presence of 2.50 % v/v concentration of the inhibitor for a period of 3 h at 303 K. The specimen was removed after the specified time, washed carefully with distilled water without disturbing the surface and dried. SEM micrograph of the samples were taken to examine the nature of corrosion product formed on the surface of mild steel specimens using the JEOL- JSM- 6390 at Karunya University, Coimbatore, India.

Gas Chromatography-Mass Spectrometry (GCMS) Analysis

Identity of components changed into executed based totally on their retention indices and interpretation of mass spectrum became performed the use of the database of National Institute of Standards and Technology (NSIT). The database includes greater than 62,000 patterns of known compounds. The spectra of the unknown components of OC stem extract obtained were compared with the standard mass spectra of known components stored in NSIT library.

RESULTS AND DISCUSSION**Weight Loss Method**

The weight loss method of monitoring corrosion has been useful because of its simple applications. Maximum inhibition efficiency was shown at 2.50 % v/v concentration. Increase in inhibition efficiency with increase in concentration indicates strong adsorption of phytoconstituents present in the extract on the surface of the mild steel [8]. Table 1 gives percentage inhibition efficiency obtained in 1N HCl in absence and presence of OC stem extract at 303 K for immersion period from 1 h to 24 h. The inhibition efficiency increased with increase in concentration of the inhibitor. Maximum inhibition efficiency of 97.65% was observed for 2.50 %v/v concentration at 5 h of immersion period. Effect of immersion time on inhibition efficiency of mild steel in 1N HCl without and with OC stem extracts are shown in Figure 1.

Effect of Temperature

To evaluate the stability of the adsorbed film on the mild steel, weight loss was carried out over a range of 303 K - 343 K in presence and absence of the inhibitor for an immersion period of 1 h. The results obtained are listed in Table 2. In extract, IE increases with increasing inhibitor concentrations. This observation confirms the mode of corrosion inhibition by plant extracts being attributed to physical adsorption of the plant constituents. The maximum inhibition efficiency of 97.07% was observed at 2.50 % v/v extract concentration for OC stem extract in 1N HCl. Effect of temperature on inhibition efficiency of mild steel in 1N HCl without and with OC stem extracts are shown in Figure 2.

Adsorption Isotherm

The extent of corrosion inhibition depends on the surface condition and mode of adsorption of the inhibitor. The surface coverage (θ) values for various concentrations of the inhibitor in hydrochloric acid medium were evaluated from the weight loss data. A plot of C/θ against C generated a straight line (Figure 3) with slope close to unity and coefficient greater than 0.9 indicating strong adherence to Langmuir adsorption isotherm [9,10].

Potentiodynamic Polarization Studies

The cathodic and anodic polarisation curves recorded for mild steel in 1N HCl solutions with out and with various concentration of OC stem extract has been illustrated in Figure 4. Electrochemical corrosion kinetic parameters acquired through Tafel extrapolation technique are given in Table 3. The addition of OC stem extract to hydrochloric acid solution consequently reduces the anodic dissolution of metallic and also retards the cathodic evolution





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reaction. The inhibition efficiencies calculated from the corrosion current density and the polarisation resistance extended with the inhibitor concentration reaching a maximum value at 2.50 % v/v.

Surface Examination Studies

The SEM image in Figure 5a) shows that the surface of mild steel was damaged and roughened in the absence of the extract. Figure 5b) clearly showed that the mild steel surface was covered with the protective layer formed by the inhibitor which prevents the metal from further attack of acid medium thus inhibiting corrosion [11].

Gas Chromatography-Mass Spectrometry (GCMS) Analysis

Presence of different phytochemical compounds of the ethanolic extracts of stem OC were analysed by using GCMS. The chromatograms of the extracts are shown in Figure 6. GCMS chromatogram of OC stem extract showed 33 peaks which indicated the presence of 40 different phytochemical compounds. The following bioactive compounds were present in GC-MS analysis carried on ethanol fraction of OC stem extract, Nonyne, 2-Methoxy-4-vinyl phenol, 7H-benzocyclo hepten-7-one, Carbamicacidmethylester, Cholesta-4,6-dien-3-ol, cholesterol, Ergosta-5,7, dien-3beta, Ethanone, Indene and Vitamin E.

CONCLUSION

Value of Inhibition efficiency increased with increase in the inhibitor concentration and decreased with rise in the temperature. In immersion study, maximum inhibition efficiency was found to be 97.65 % in case of OC stem extract in 1N HCl for immersion period of 5h at a concentration of 2.5 % v/v. Temperature studies reveal maximum inhibition efficiency of 97.07 % at 2.5 % v/v extract concentration for OC stem extract in 1N HCl. The corrosion of mild steel in the HCl acid medium was significantly reduced upon the additions of OC stem extract. The inhibition efficiency increased with the increasing concentration of inhibitor. Tafel plots were found to be lowest for corrosive acid medium with high inhibitor concentration. Corrosion rate of mild steel was found to decrease with increase in extract concentrations. Thus, inhibitor obeys the Langmuir adsorption isotherm. The surface analysis by SEM confirms the presence of protective film on mild steel surface in the presence of inhibitors. The GC-MS analysis showed that 33 phytochemical constituents were present in OC stem extract.

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Table1. Inhibition Efficiency of OC Stem Extract in 1N Hydrochloric Acid of Various Concentration and Immersion Periods

Conc. Of Extract (% v/v)	Inhibition Efficiency (IE %)				
	1 h	3 h	5 h	7 h	24 h
Blank	-	-	-	-	-
0.10	91.80	93.03	94.58	93.01	91.75
0.50	94.42	95.75	96.22	96.15	93.59
1.00	95.41	96.09	96.83	96.61	94.34
1.50	95.74	97.02	97.19	96.69	94.88
2.00	96.07	97.11	97.39	96.95	95.29
2.50	96.39	97.53	97.65	97.07	95.78

Table2. Effect of Temperature on Mild Steel Corrosion in 1N HCl in Absence and Presence of OC Extract

Conc. Of Extract (% v/v)	Inhibition Efficiency (IE %)				
	303 K	313 K	323 K	333 K	343 K
Blank	-	-	-	-	-
0.10	89.65	90.69	93.90	89.82	88.57
0.50	91.13	93.02	95.06	94.07	90.49
1.00	93.10	94.35	95.45	94.18	93.03
1.50	94.09	95.51	96.76	95.69	94.48
2.00	94.58	95.85	96.84	96.48	94.55
2.50	95.07	96.51	97.07	96.76	94.88

Table 3. Potentiodynamic Polarization Parameters of Mild Steel in 1N HCl in Absence and Presence of OC Stem Extract

Conc. %v/v	E_{corr} (V vs SCE)	Tafel Slope		I_{corr} mAmp/cm ²	IE% Tafel	R_p Ohmcm ²	IE% Linear
		b_a	b_c				
Blank	-0.501	0.069	0.135	0.000282	-	70.35	-
0.5	-0.4762	0.066	0.108	0.000119	57.8	150.5	53.3
1.5	-0.4513	0.067	0.142	9.00×10^{-5}	68.1	220.6	68.1
2.5	-0.4425	0.067	0.139	8.43×10^{-5}	70.1	234.3	70.0





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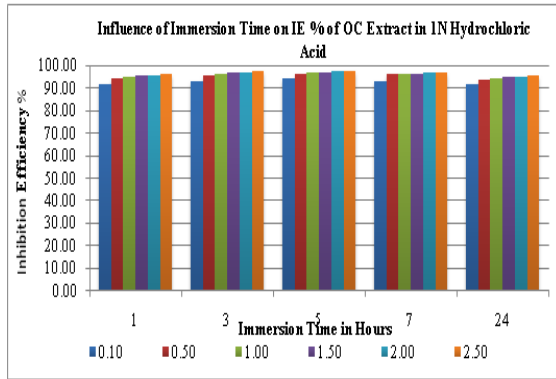


Figure 1. Effect of Immersion Time on Inhibition Efficiency of Mild Steel in 1N HCl Without and With OC Stem Extract

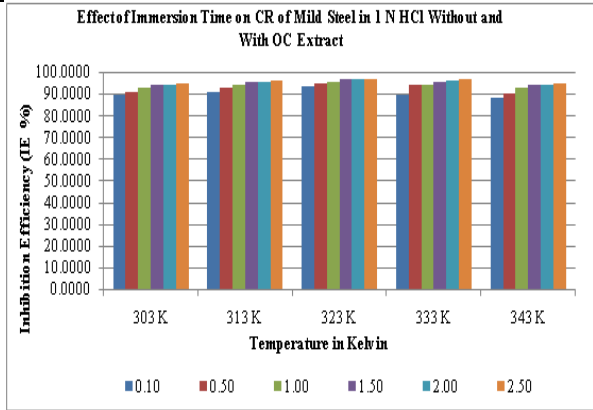


Figure 2. Effect of Temperature on Inhibition Efficiency of Mild Steel in 1N HCl Without and With OC Stem Extract

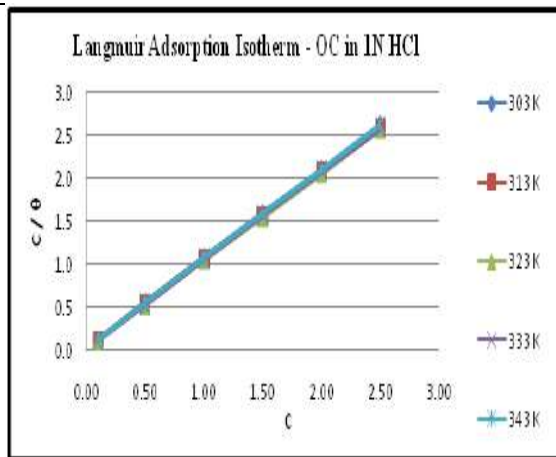


Figure 3. Langmuir Adsorption Isotherms for OC Extract in 1N HCl on Mild Steel

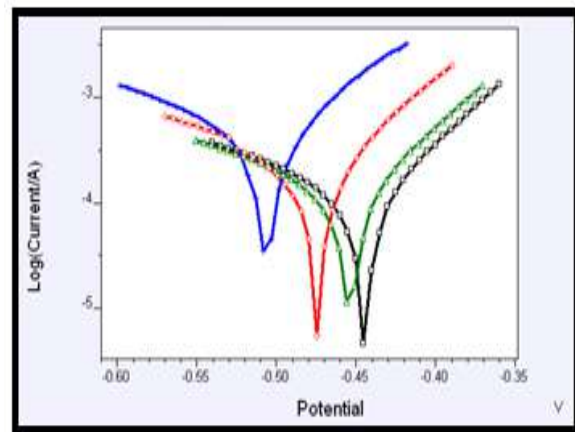


Figure 4. Tafel Plots Showing Effect of Increasing Concentration of OC Stem Extract

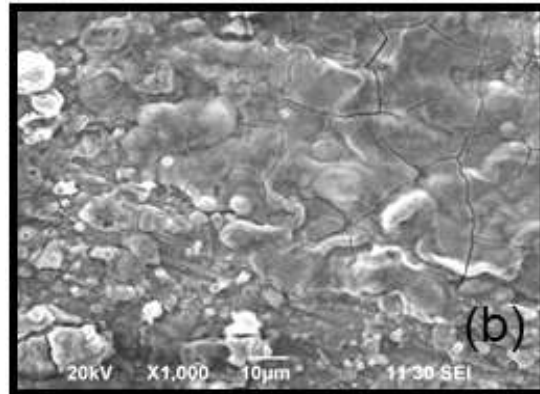
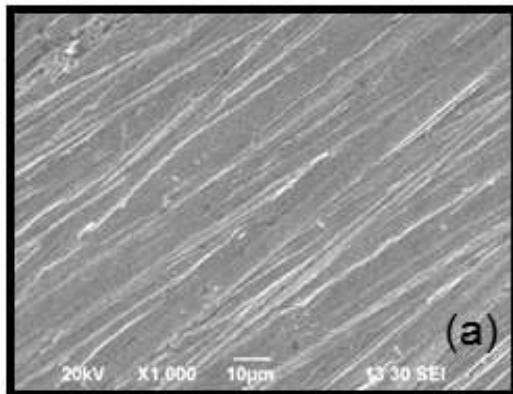


Figure 5. SEM Image of Mild Steel Surface a) in 1N HCl b) in 1N HCl Solution with 2.5 % v/v of OC Stem Extract





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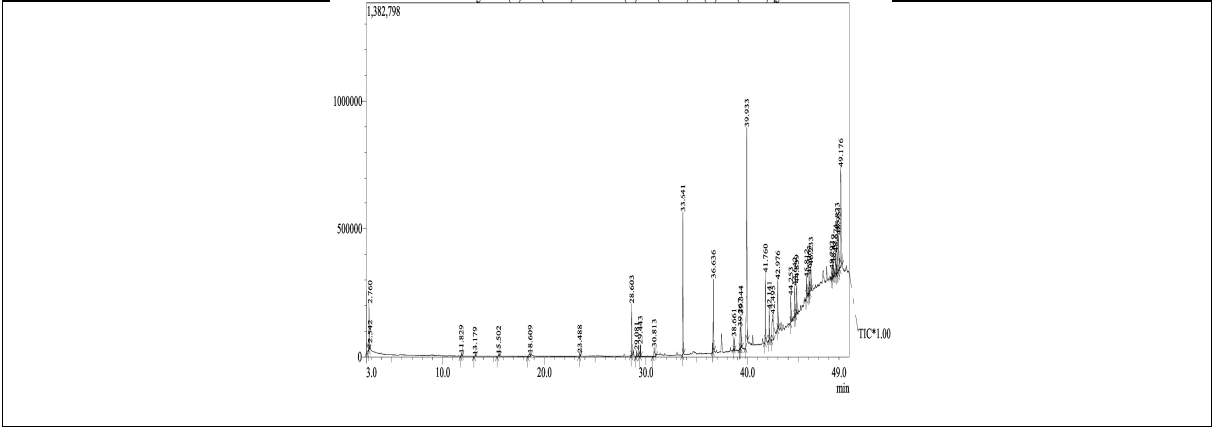


Figure 6. GC-MS Peak Analysis of OC Stem Extract





Bounds on Minimum Neighborhood Domination in Graphs

W.Anjaline^{1*} and A.Stanis Arul Mary²

¹Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Assistant Professor, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

W.Anjaline

Department of Mathematics,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.



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ABSTRACT

The aim of this paper is on investigating the properties of minimum neighbourhood domination and exploring the computation of bounds for the minimum neighbourhood domination number by utilizing various parameters.

Keywords: Dominating set, Dominating number, minimum neighborhood dominating set, minimum neighborhood dominating number,.

INTRODUCTION

Let $G = (V, E)$ be a non-trivial simple connected graph with $|V| = t$, $|E| = k[1]$. Let D be the subset of V is a dominating set if every vertex in $V - D$ is adjacent to at least one element in D . The minimum cardinality of dominating set is called the domination number and it is denoted by $\gamma(G)$ is discussed in [2-5]. Various families of graphs and derived graphs are studied in [6,7]. A subset $D \subseteq V(G)$ is a minimum neighbourhood domination set (mND- set) if D is a dominating set and if for every $v_i \in D$, $|\cap_{i=1}^n N(v_i)| < \delta(G)$. holds. The minimum cardinality of the minimum neighbourhood domination set (mND- set) of a graph G is called as minimum neighbourhood domination number and it is denoted by $\gamma_{mN}(G)$ is defined and studied in [8-10]. One real-life application for this definition can be in the context of network security. Suppose we have a network represented by a graph G and we want to ensure that any attempt to breach the security of the network is detected and dealt with promptly. One way to achieve this is to have a set of monitoring points in the network, represented by a mND-set D , such that any attempt to breach the security must pass through at least one of these monitoring points. The condition that $|\cap_{i=1}^n N(v_i)| < \delta(G)$ ensures that the monitoring points are spread out throughout the network and are not clustered together in a small region. This makes it harder for an attacker to avoid detection by bypassing the monitoring points. Thus, the concept of mND-sets can be used to design effective network security systems that are resistant to attacks and can quickly detect any attempts to breach the security. In this paper we find various bounds for $\gamma_{mN}(G)$.





MAIN RESULTS

Theorem 2.1 Every graph G has a mND- set.

Proof. We will prove the statement by induction on the number of vertices of G . If $|V(G)| = 2$, then any subset of $V(G)$ is a dominating set, and since $\delta(G) \leq 1$, any subset of $V(G)$ is also an mND-set.

Now suppose $|V(G)| > 2$. Let v be any vertex in G , and let $G' = G - v$ be the graph obtained by deleting v and its incident edges. By induction hypothesis, G' has an mND-set D' .

We consider two cases:

Case 1: $|N(v)| \geq \delta(G)$.

In this case, let $S = \{u \in N(v) : |u \cup N(u) \cap V(D')| < \delta(G)\}$. If S is nonempty, then let u be any vertex in S , and let $D = (D' \cap V(G')) \cup u$. We claim that D is an mND-set of G .

First, note that D is a dominating set of G , since every vertex in G is either in G' and is dominated by D' , or is adjacent to v and is dominated by u .

Now let $v_i \in D$. If $v_i \in D'$, then we have $N(v_i) \subseteq N(G')$. If $v_i = u$, then we have $N(u) \subseteq N(v) \cup N(G')$, and thus $|\cap_{i=1}^n N(v_i)| \leq |N(u)| + |\cap_{i=1}^{n-1} N(v_i) \cap N(G')| < \delta(G)$, since $u \in S$ and $|u \cup N(u) \cap V(D')| < \delta(G)$. Therefore, D is an mND-set of G .

If S is empty, then for any $u \in N(v)$, we have $|u \cup N(u) \cap V(D')| \geq \delta(G)$. It follows that $|\cap_{i=1}^n N(v_i)| \geq |N(v)| - \delta(G) + |\cap_{u \in N(v)} N(u) \cap V(D')| \geq \delta(G) - 1$, where $v_i \in D'$. Therefore, D' is also an mND-set of G .

Case 2: $|N(v)| < \delta(G)$.

In this case, let u be any vertex in G such that $u \notin N(v)$ (such a vertex exists because $|V(G)| > 2$). Let $D = (D' \cap V(G')) \cup u$. We claim that D is an mND-set of G .

First, note that D is a dominating set of G , since every vertex in G is either in G' and is dominated by D' , or is v or adjacent to v and is dominated by u .

Now let $v_i \in D$. If $v_i \in D'$, then we have $N(v_i) \subseteq N(G')$. If $v_i = u$, then we have $N(u) \subseteq N(G') \cup v$, and thus $|\cap_{i=1}^n N(v_i)| \leq |\cap_{i=1}^{n-1} N(v_i) \cap N(G')| \leq \delta(G) - 1$, since D' is an mND-set of G' . Therefore, D is an mND-set of G .

In either case, we have constructed an mND-set of G , completing the proof by induction.

Theorem 2.2 Let G be a graph having no isolated vertices. If D is a minimal mND-set, then V/D is a minimum neighbourhood dominating set of G

Proof. To prove that V/D is a mND-set of G , we need to show that it satisfies the two conditions of a mND-set:

- (i) V/D is a dominating set of G ;
- (ii) For every $v_i \in V/D$, $|\cap_{i=1}^n N(v_i)| < \delta(G)$

(i) Let u be any vertex in G . Since D is a dominating set, there exists a vertex $v \in D$ such that u is adjacent to v . Since D is a minimal mND-set, removing v from D would violate the mND condition for some vertex $w \in D \setminus v$. Hence, w must have a neighbor outside $N(v)$. This means that u is also adjacent to some vertex $w \in D \setminus v$, and so u is dominated by V/D . Therefore, V/D is a dominating set of G .

(ii) Let v_1, v_2, \dots, v_n be vertices in V/D . Then, for each i , there exists a vertex $d_i \in D$ such that v_i is adjacent to d_i . Let $S = \cap_{i=1}^n N(d_i)$ be the common neighborhood of the vertices d_1, d_2, \dots, d_n . Since D is a mND-set, we have $|S| < \delta(G)$. We claim that S is also the common neighborhood of v_1, v_2, \dots, v_n . To see this, suppose there exists a vertex $u \in S \setminus (\cap_{i=1}^n N(v_i))$. Then, u is adjacent to all the vertices d_i , but not to some vertex v_j . Since v_j is adjacent to d_j , we have $d_j \in N(u) \cap S$. But this contradicts the fact that S is the common neighborhood of d_1, d_2, \dots, d_n , so our claim holds. Therefore, we have $|\cap_{i=1}^n N(v_i)| = |S| < \delta(G)$, and so V/D satisfies the mND condition. Hence, V/D is a mND-set of G .

Theorem 2.3 If G is a connected graph of order $t > 2$ then $\gamma_{mN}(G) \leq \lfloor \frac{t}{2} \rfloor$

Proof. Let D be a minimal mND-set of G .

As G is connected and $t > 2$, which implies G has no isolated vertices. We know that "Let G be a graph having no isolated vertices. If D is a minimal mND-set, then V/D is a minimum neighbourhood dominating set of G ".





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Since D is a minimal mND-set, we know that D is also a dominating set. Therefore, every vertex in G either belongs to D or is adjacent to at least one vertex in D .

Consider the set V/D consisting of all the vertices in G that are not in D . Since D is a dominating set, we know that every vertex in V/D is adjacent to at least one vertex in D .

Now, suppose that there exist s vertices in V/D whose neighbourhoods have a non-empty intersection. Let v_1, v_2, \dots, v_s be these vertices, and let u be a vertex in D such that u is adjacent to v_i for all $1 \leq i \leq s$. Then, we have $\cap_{i=1}^s N(v_i) \subseteq N(u)$ which contradicts the fact that D is a minimal mND-set and hence $|\cap_{i=1}^s N(v_i)| < \delta(G)$. Therefore, there are at most $\lfloor \frac{t}{2} \rfloor$ vertices in V/D whose neighbourhoods have a non-empty intersection.

Thus, V/D is an mND-set of G , and since $|V/D| = t - |D|$, we have $\gamma_{mN}(G) \leq t - |D| = \frac{t}{2} + \frac{t}{2} - |D| \leq \lfloor \frac{t}{2} \rfloor$, as desired.

Theorem 2.4 For any graph G , $\lfloor \frac{t}{1+\Delta(G)} \rfloor \leq \gamma_{mN}(G)$.

Proof. Let D be a mND- set of G . We know that every vertex $v \in V(G)$ can dominate almost itself and its neighbourhood vertices in G . That is every vertex dominates, $|N[v]| \leq \Delta(G)$. Therefore to cover every vertex of G we need at least $\lfloor \frac{t}{1+\Delta(G)} \rfloor$ neighbourhoods. Hence $\lfloor \frac{t}{1+\Delta(G)} \rfloor \leq \gamma_{mN}(G)$.

Theorem 2.5 Let G be a graph and let D be a mND- set of G . Then $|D| \leq \frac{1}{2}(t + 1)$, where $t \geq 2$ is the number of vertices in G .

Proof. To prove that $|D| \leq \frac{1}{2}(t + 1)$, we will use contradiction. Suppose that $|D| > \frac{1}{2}(t + 1)$. Let $S = V(G) \setminus D$ be the set of non-dominated vertices. Since D is a dominating set, we have $S \subseteq \cup_{v \in D} N(v)$.

Now, let v_1, v_2, \dots, v_n be the vertices in D in some order, and let $S_i = N(v_i) \cap S$ for each $i \in [n]$. Note that S_i is the set of non-dominated vertices that are adjacent to v_i . By the assumption that D is an mND-set, we have $|S_1 \cap S_2 \cap \dots \cap S_n| < \delta(G)$.

On the other hand, we have $|S_1 \cap S_2 \cap \dots \cap S_n| \geq |S| - \sum_{i=1}^n |N(v_i) \setminus S|$. To see why, note that any vertex in S that is not in $S_1 \cap S_2 \cap \dots \cap S_n$ must have a neighbor in at least one of the sets $N(v_i) \setminus S$, and there are at most $\sum_{i=1}^n |N(v_i) \setminus S|$ such neighbors.

Combining these inequalities, we have $\delta(G) > |S_1 \cap S_2 \cap \dots \cap S_n| \geq |S| - \sum_{i=1}^n |N(v_i) \setminus S|$. Since $|D| > \frac{1}{2}(t + 1)$, we have $|S| \leq \frac{1}{2}(t - 1)$, and $|N(v_i) \setminus S| \geq 1$ for each $i \in [n]$. Therefore, we have $\delta(G) > \frac{1}{2}(t - 1) - n$, or equivalently, $n > \frac{1}{2}(t - 1 - \delta(G))$.

But this contradicts our assumption that D is an mND-set, since k is the size of a dominating set and $|D| > \frac{1}{2}(t + 1) > \frac{1}{2}(t - 1 - \delta(G))$. Therefore, we must have $|D| \leq \frac{1}{2}(t + 1)$, as desired.

Proposition 2.6 Let x be a vertex in G , then $V(G)/N(x)$ is a mND- set of G .

Proof. To show that $V(G)/N(x)$ is a mND-set of G , we need to show that it satisfies the two properties of a mND-set:

- (i) $V(G)/N(x)$ is a dominating set of G .
- (ii) For every $v_i \in V(G)/N(x)$, $|\cap_{i=1}^n N(v_i)| < \delta(G)$.

Let's prove each of these properties:

(i) To show that $V(G)/N(x)$ is a dominating set of G , we need to show that every vertex $v \in V(G)$ is either in $V(G)/N(x)$ or has a neighbor in $V(G)/N(x)$. If $v \in V(G)/N(x)$, we are done. So, let's consider the case where $v \notin V(G)/N(x)$. This means that v has a neighbor in $N(x)$. But since $N(x) \subseteq V(G)/N(x)$, this neighbor is also in $V(G)/N(x)$, and therefore $V(G)/N(x)$ is a dominating set of G .

(ii) Let $v_i \in V(G)/N(x)$ for some i . Then, by definition of $V(G)/N(x)$, we have $v_i \notin N(x)$. This means that $x \cup N(v_i) \subseteq V(G) \setminus (V(G)/N(x))$, i.e., all the neighbors of v_i in G (including x) are outside $V(G)/N(x)$. Therefore, for any collection of vertices v_1, v_2, \dots, v_n in $V(G)/N(x)$, we have $|\cap_{i=1}^n N(v_i)| \leq |N(x)| < \delta(G)$, since x has at most $\delta(G) - 1$ neighbors in G (by definition of $\delta(G)$).

Therefore, $V(G)/N(x)$ satisfies both properties of a mND-set, and is indeed a mND-set of G .

Theorem 2.7 For any graph G , $\gamma_{mN}(G) \leq t - \Delta(G)$.

Proof. Let D be a mND- set of G .





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Then for any vertex v in G , $V(G)/N(x)$ is a mND- set of G .

$$\begin{aligned} \gamma_{mN} &\leq |V/N(x)| \\ \gamma_{mN} &\leq |V| - |N(x)| \end{aligned}$$

Since $|N(x)| \leq \Delta(G)$

$$\gamma_{mN} \leq t - \Delta(G)$$

Theorem 2.8 Let D be a mND- set with $\gamma_{mN}(G)$ as its cardinality. Then there is a spanning tree T of G such that $\gamma_{mN}(G) = \gamma_{mN}(T)$.

Proof. Let D be a mND- set in G with $|D| = \gamma_{mN}(G)$. We need to show that there exists a spanning tree T of G such that D is a mND- set in T and $|D| = \gamma_{mN}(T)$.

Let T be a spanning tree of G . We first show that D is a dominating set in T . Since D is a dominating set in G , for any vertex $v \in V(G)$, either $v \in D$ or there exists a vertex $u \in D$ such that u is adjacent to v . Since T is a spanning tree of G , every vertex in G is reachable from any other vertex in G through a path in T . Therefore, for any vertex $v \in V(T)$, either $v \in D$ or there exists a vertex $u \in D$ such that u is adjacent to v . Hence, D is a dominating set in T .

Next, we show that D satisfies the mND- set property in T . Let v_1, v_2, \dots, v_s be the vertices in D and let $N_T(v_i)$ be the set of neighbors of v_i in T . Since T is a tree, $N_T(v_i) \subseteq N(v_i)$, where $N(v_i)$ is the set of neighbors of v_i in G . Therefore, we have $|\cap_{i=1}^s N_T(v_i)| \leq |\cap_{i=1}^s N(v_i)| < \delta(G)$, where the last inequality holds since D is a mND- set in G . Hence, D satisfies the mND- set property in T .

Therefore, we have shown that D is a mND- set in T and $|D| = \gamma_{mN}(G)$. Since any spanning tree of G can be used to construct a mND- set in T , we have $\gamma_{mN}(T) = \gamma_{mN}(G)$. Hence, we conclude that $\gamma_{mN}(G) = \gamma_{mN}(T)$ for any non-trivial simple graph G .

Theorem 2.9 For a connected graph G , $\gamma_{mN}(G) \geq \lceil \frac{\text{diam}(G)+1}{3} \rceil$.

Proof. Let D be a mND- set of G .

Take a spanning tree T of G such that $\gamma_{mN}(G) = \gamma_{mN}(T)$.

On the contrary, suppose $\gamma_{mN}(G) < \frac{1}{3}(\text{diam}(G) + 1)$.

Since $\gamma_{mN}(G) = \gamma_{mN}(T)$ and $\gamma_{mN}(T) \geq 0$.

We get, $\gamma_{mN}(G) < \frac{1}{3}(\text{diam}(G) + 1)$.

Consider a path P of T with a length equal to $\text{diam}(T)$. If $\gamma_{mN}(T) < \frac{1}{3}(\text{diam}(T) + 1)$ holds, then there will be a vertex x of T such that $|V(P) \cap N[x]| \geq 4$. Since path P of T is also a tree.

Therefore $\gamma_{mN}(T) < \frac{1}{3}(\text{diam}(T) + 1)$ is impossible.

Hence $\gamma_{mN}(T) \geq \lceil \frac{\text{diam}(T)+1}{3} \rceil$.

So $\gamma_{mN}(G) \geq \lceil \frac{\text{diam}(G)+1}{3} \rceil$.

Proposition 2.10 Let G be a graph with $\Delta(G) = t - 1$. Then $\gamma_{mN}(G) = 2$.

Proof. Let $v \in V(G)$ and $\text{deg } v = t - 1$. Then $\{u, v\}$, where $u \in V - \{v\}$ is a mND- set of G . so that $\gamma_{mN}(G) = 2$.

Theorem 2.11 Let G be a graph with no isolated vertices, then $2 \leq \gamma_{mN}(G) \leq t$.

The proof of the theorem follows from the definition.

Theorem 2.12 If G is a graph, then $\gamma(G) \leq \gamma_{mN}(G)$.

Proof. Clearly, every mND- set of a graph G is a dominating set of a graph G . Hence $\gamma(G) \leq \gamma_{mN}(G)$.

Proposition 2.13 If G is any graph with an isolated vertex, then there is no mND- set.

Proof. Let the isolated vertex of a graph G be v , which implies v belongs to every dominating set D of a graph G . Since v is a isolated vertex, $N(v) = 0$ and $\delta(G) = 0$, we get $|N(v_1) \cap \dots \cap N(v_i) \cap N(v)| = 0 < \delta(G), v_i \in D$. Therefore there is no mND- set for any graph with isolated vertices.





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Theorem 2.14 *If G is a graph, then $\frac{t}{\Delta(G)+1} \leq \gamma_{mN}(G) \leq \frac{t\Delta(G)}{\Delta(G)+1} + 1$.*

Proof. We know that $\gamma(G) \leq \gamma_{mN}(G)$ and $\frac{t}{\Delta(G)+1} \leq \gamma(G)$, which implies $\frac{t}{\Delta(G)+1} \leq \gamma_{mN}(G)$.

Since $\gamma_{mN}(G) \leq t - \gamma(G) + 1$ and $\frac{t}{\Delta(G)+1} \leq \gamma(G)$, we get $\gamma_{mN}(G) \leq t - \frac{t}{\Delta(G)+1} + 1$, which can be written as $\gamma_{mN}(G) \leq \frac{t\Delta(G)}{\Delta(G)+1} + 1$. Hence $\frac{t}{\Delta(G)+1} \leq \gamma_{mN}(G) \leq \frac{t\Delta(G)}{\Delta(G)+1} + 1$.

Theorem 2.15 *Let G be any graph, then $\gamma_{mN}(G) \leq \beta + 1$, where β is the size of a minimum vertex cover of G .*

Proof. Let C be a minimum vertex cover of G . We construct a dominating set D as follows:

For each vertex $v \in C$, add v to D . For each edge uv not covered by C , add u or v (whichever is not already in D) to D . It's clear that D is a dominating set: every vertex in G either belongs to C , in which case it is dominated by D , or is adjacent to a vertex not in C , in which case it is dominated by the corresponding vertex in D .

We will now show that D satisfies the mND-condition. Let v_1, v_2, \dots, v_n be vertices in D , and let $S = \bigcap_{i=1}^n N(v_i)$ be the set of neighbors of all v_i 's. We want to show that $|S| < \delta(G)$.

Note that S must be a subset of the set of vertices not covered by C . If $|S| \geq \delta(G)$, then there must be at least $\delta(G)$ vertices in S that are not covered by C , and therefore at least $\delta(G)$ vertices in G that are adjacent to all of v_1, v_2, \dots, v_n and not covered by C . But this contradicts the fact that C is a vertex cover. Therefore, we must have $|S| < \delta(G)$, and D satisfies the mND-condition.

Since D is a dominating set and satisfies the mND-condition, we have $\gamma_{mN}(G) \leq |D|$. We have $|D| = |C| +$ (the number of edges not covered by C). Since C is a vertex cover, every edge not covered by C must be incident to at least one vertex in D . Therefore, we have $|D| \leq \beta + 1$, and so $\gamma_{mN}(G) \leq \beta + 1$, as claimed.

Proposition 2.16 *Let G be any graph, then $\gamma_{mN}(G) \leq t - \delta(G) + 1$.*

Proof: Let the vertex cover of a graph G be S , then $\gamma_{mN}(G) \leq \beta + 1$. We also know that $\beta(G) \leq t - \delta(G)$. Therefore $\gamma_{mN}(G) \leq t - \delta(G) + 1$.

Proposition 2.17 *Let G be any graph, then $\gamma_{mN}(G) \leq t - \kappa(G) + 1$, $\kappa(G)$ is the vertex connectivity of G .*

Proof. We know that $\gamma_{mN}(G) \leq \beta + 1$ and since $\beta(G) \leq t - \kappa(G)$. Hence $\gamma_{mN}(G) \leq t - \kappa(G) + 1$.

Proposition 2.18 *Let G be any graph, then $\gamma_{mN}(G) \leq t - \lambda(G) + 1$, $\lambda(G)$ is the edge connectivity of G .*

Proof. We know that $\gamma_{mN}(G) \leq \beta + 1$ and since $\beta(G) \leq t - \lambda(G)$. We get $\gamma_{mN}(G) \leq t - \lambda(G) + 1$.

Theorem 2.19 *If G is a nontrivial tree, then $1 + \Delta(G) \leq \gamma_{mN}(G)$.*

Proof. Consider a nontrivial tree G with a mND- set D . Then D has all support vertices of G . Hence $\gamma_{mN}(G) \geq 1 + \Delta(G)$.

Theorem 2.20 *For any nontrivial connected graph G , $\gamma_{mN}(G) \leq 2k - t + 2$.*

Proof. Consider a nontrivial connected graph G . Then $k \geq t - 1$. Also, we know that $\gamma_{mN}(G) \leq t$. Hence it can be rewritten as $\gamma_{mN}(G) \leq 2(t - 1) - t + 2$, which implies $\gamma_{mN}(G) \leq 2k - t + 2$.

Theorem 2.21 *If G is a graph with $\Delta(G) = t - 1$, then $\gamma_{mN}(G) \geq \gamma(G) + 1$.*

Proof. Let the maximum degree of graph G be $t - 1$. Then $\gamma(G) = 1$. Since $\gamma_{mN}(G) \geq 2$ we get $\gamma_{mN}(G) \geq \gamma(G) + 1$.

CONCLUSION

This paper provides an in-depth analysis of the bounds of the minimum neighbourhood dominating number for various graph classes. By utilizing different parameters, the computation of these bounds is explored, contributing to a better understanding of the minimum neighbourhood domination concept. The insights gained from this study can be applied to the design and analysis of algorithms and networks that rely on minimum neighbourhood domination.





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Overall, this paper adds to the body of knowledge in graph theory and offers new directions for future research in the field.

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Biological Activity of Aqueous Root Extract of *Cyclea peltata* (Lam) Hook. F and Thomson- A Traditional Medicinal Plant from Ayurveda.

U. Danya^{1*} and Sr.Manju Mathew²

¹Assistant Professor, Department of Botany, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Research Scholar, Department of Botany, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

U. Danya

Assistant Professor,
Department of Botany,
Nirmala College for Women,
Coimbatore, Tamilnadu, India.
E. Mail: danya.bio@gmail.com



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ABSTRACT

Medicinal plants have been discovered and used in traditional medicine practices since prehistoric times. *Cyclea peltata* is one of the important member of the family, Menispermaceae is selected for the current study. The phytochemical screening was done by the standard procedures and the result shows that the alkaloids, glycosides, terpenoids, phenols and steroids are significantly present in the extract. The LC-MS analysis was performed on a Shimadzu liquid chromatography modular system which helps to identified the seventeen phytochemicals. The antimicrobial and in vitro cytotoxicity studies proved that the *C. peltata* has significant pharmacological activities. Minimum percentage of lung cancer cell line viability is $43 \pm 1 \mu\text{g/mL}$. This could be used for developing new therapeutic agents for treating different health problems such as infectious diseases.

Keywords: *Cyclea peltata*, root, aqueous, phytochemical, LC-MS, antimicrobial and cytotoxicity.

INTRODUCTION

Plants have been considered as part of the evolution of human health care for thousands of year. The medicinal effect of the drug plant is due to the presence of some chemical substances in the plant tissues, which produce a definite physiological action on the human body. These phytochemicals impart the specific characteristics and properties of plants. Nowadays, the 80% of people in the world using these type of medicinal plants to treat illness [1]. Cancer is the second largest killer in the world nearly 2 million people affected. The resistance of antibiotics is another important public health threat in India like countries [2]. This leads to think of other alternatives like new potential



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drugs from the sources of medicinal plants [3]. *Cyclea peltata* (Lam) Hook. f & Thomson is slender twining shrub, frequently observed as using small trees as support to grow[4]. In ayurveda *C.peltata* known as Rajapatha and it is used in the disease like fever, diarrhea, pruritus, dermatoses, worms, asthma, tumors, heart disease and wounds. Therefore the present study was considered to evaluate the biological activity of aqueous root extract of *C.peltata*.

MATERIALS AND METHODS

Cyclea peltata (Lam) Hook. f & Thomson was selected for the study. The plant material collected from Mangalam Dam, Kerala. The specimen was identified and authenticated by Botanical Survey of India, Tamil Nadu Agricultural University, Coimbatore, Tamilnadu, India (Ref. BSI/ SRC/5/23/2810/Tech).

Preparation of Extracts**Aqueous Extract**

30 g of root powder was mixed with 375 ml of distilled water. The solution was heated in water bath for 15 minutes with continuous stirring. The extract obtained was filtered with Whatman No.1 filter paper and concentrated. The collected extract was used for further analysis.

Preliminary Qualitative Phytochemical Screening

All qualitative tests were done to find the presence of the active phytochemical constituents after the methods of Harbone[5] and Wagner.[6]

Liquid Chromatography-Mass Spectroscopy Analysis

LC-MS analysis was done on a Shimadzu liquid chromatography modular system consisting of two LC- 10AD pumps coupled to an LC/MS QP 8000 quadrupole detector. The data were processed using Shimadzu's Class-8000 system. Analysis using the APCI (atmospheric pressure chemical ionization) interface were performed in a reverse phase C-18 column (25cmx2.5mm) fitted with a guard column (C-18, 20 mm x 4.0 mm x 5 µm), both Supelco, at an oven temperature of 35°C. The samples were introduced using a Rheodyne injection valve fitted with a 20 µL loop. The mobile phase consisted of aqueous and methanol (50:50) at a flow rate of 2mL min⁻¹. The mass detector was operated in both positive and negative mode with nitrogen as the nebulizer gas at a flow rate of 2ml/ min, under the following conditions: the capillary temperature was 230°C; deflector voltage, + 47 V; CDL voltage and temperature, - 28 V and 250°C; probe voltage and temperature, +3.5 V and 400°C; acquisition range, 100 -700 m/z at 2.0 scan s⁻¹. Analysis using ESI (electrospray ionization) interface were done under the same chromatographic conditions as described for APCI analysis, except for the guard column, which was not used in the ESI analysis. The mass detector conditions were: nitrogen as the nebulizer gas at a flow rate of 4.5 L min⁻¹; deflector voltage, + 54 V; CDL voltage and temperature, - 10 V and 230°C; probe voltage, +4.5 V; acquisition range, 50-800 m/z for negative and 50-950 m/z for positive at 2.0 scan s⁻¹. The sample extract was dissolved in 10ml methanol. It was filtered through 0.2mm membrane filter and used for analysis. 10µl of the filtered sample was injected to the manual injector using a microsyringe. The mobile phase used was water: methanol (50:50) in an isocratic mode. The column used was RPC-18. The separated components were then ionized using APCI method and the split mode (50:50). The flow rate was maintained to 2ml/min with a temperature of 25±2°C. The classVP integration software was used for the data analysis.

Antimicrobial Study**Microorganisms**

The following bacterial strains were used in the study; *Escherichia coli* (gram negative) and *Stephylococcus aureus* (Gram positive) and Ciprofloxacin (10µg) used as standard. The antifungal study was carried out by *Aspergillus niger* and *Candida albicans*. Fluconazole (10µg) used as standard. Disc diffusion technique [7] is used for the antimicrobial analysis.



**Danya and Manju Mathew****Procedure for Disc Diffusion Technique [7]**

The standardized inoculum is incubated in the plates by dipping a sterile swab in the inoculum removing the excess of inoculum by passing by pressing and rotating the swab firmly against the side of the culture tube above the level of the liquid and finally streaking the swab all over the surface of the medium 3 times rotating the plate through an angle of 60° after each application. Finally pass the swab the edge of the agar surface. Leave the inoculum to dry at room temperature with the lid closed. Each Petri dish is divided into 3 parts, in each part samples disc such as MCP, ACP (100µg) disc (discs are soaked overnight in sample solution) and standard Ciprofloxacin for bacterial strains and standard fluconazole for fungal strains 10µg, are placed in the plate with the help of sterile forceps. Then Petri dishes are placed in the refrigerator at 4°C or at room temperature for 1 hour for diffusion. Incubate at 37°C for 24 hours. Observe the zone of inhibition produced by different samples. Measure it using a scale and record the average of two diameters of each zone of inhibition.

Cytotoxicity Analysis**Cell culture**

The human lung cancer cells were purchased from the National Center for Cell Sciences (NCCS), Pune, India. The cancer cells were maintained in Dulbecco's modified eagle's medium (DMEM) supplemented with 2mM 1-glutamine and balanced salt solution (BSS) adjusted to contain 1.5 g/L glucose, 10 mM nonessential amino acids, 1mM sodium pyruvate, 2mM 1- glutamine, 1.5g/L glucose, 10 mM 4-(2- hydroxyethyl)-1-piperazineethane sulfonic acid) (HEPES) and 10% fetal bovine serum (GIBCO,USA). Penicillin and Streptomycin (100 IU/100µg) were adjusted to 1mL/L. The cells were maintained at 37°C with 5% CO₂ in humidified CO₂ incubator.

MTT Assay [8]

The inhibitory concentration (IC₅₀) value was evaluated using an MTT [3-(4, 5-dimethylthiazol-2-yl)-2, 5 diphenyltetrazolium bromide] assay. Cancer cells were grown (1×10⁴ Cell/well) in 96 –well plate for 48 hrs in to 75% confluence. The medium was replaced with fresh medium containing serially diluted synthesized compounds, and the cells were further incubated for 48 hrs. the culture medium was removed, and 100µL of the MTT[3-(4,5-dimethylthiazol-2-yl)-2,5 diphenyl tetrazolium bromide](Hi-Media) solution was added to each well and incubated at 37°C for 4h. After removal of the supernatant, 50µL of DMSO was added to each of the wells and incubated for 10 min to solubilize the formazan crystals. The optical density was measured at 620 nm in an ELISA multiwell plate reader (Thermo Multiskan EX, USA). The OD value was used to calculate the percentage of viability using the following formula.

Percentage of viability = OD value of experimental sample/ OD value of experimental control × 100

Standard Used: Doxorubicin

Statistics: All the *in vitro* experiments were done in triplicate, and the experiments were repeated at least thrice. The statistical software SPSS version 17.0 was used for the analysis. P value <0.01 was considered significant.

II.2 Fluorescence Microscopic Analysis of Apoptotic Cell Death

Approximately 1µL of a dye mixture (100 mg/mL Acridine Orange (AO) and 100 mg/mL Ethidium bromide (Et Br) in distilled water) was mixed with 9mL of cell suspension (1×10⁵cell/ mL) on clean microscope cover slips. The selected cancer cells were collected, washed with phosphate buffered saline (PBS)(pH7.2) and stained with PBS (5 min each) and visualized under a fluorescence microscope (Nikon Eclipse, Inc, Japan)At 4×magnification with an excitation filter at 480 nm. Likewise the cells were placed on glass cover slip in a 24 –well plate and treated with complex for 24hrs. The fixed cells were permeabilized with 0.2% triton X-100 (50µL) for 10 min at room temperature and incubated for 3 min with 10µL Of DAPI by placing a cover slip over the cells to enable uniform spreading of the stain. The cells were observed under Nikon Eclipse, Inc, Japan) Fluorescent microscope.





RESULT AND DISCUSSION

Phytochemical Analysis

Qualitative phytochemical screening of *C. peltata* root extract revealed the presence of secondary metabolites like alkaloids, glycosides, terpenoids, saponins, phenol and steroids. The result obtained from this study support the results of previous researchers [9,10,11]. (Table 1). Alkaloids have many therapeutic properties including antihypertensive effects, anti-malarial activity and anticancer activity. Genus *Cyclea* and family Menispermaceae are reported to have different alkaloids [12]. Phenolic compounds have been found as one the major group of functional macronutrient in *Cyclea peltata*. Phenols increase bile secretion, reduces blood cholesterol and lipid levels and they have antimicrobial activity against some strains of bacteria such as *staphylococcus aureus*. They also used as antiulcer, anti-inflammatory, antioxidant, cytotoxic and antitumor, antispasmodic and antidepressant agents [13].

LC-MS Analysis

The root extract of *Cyclea peltata* was analyzed for the presence of volatile as well as non-volatile polar compounds by Liquid chromatography-Mass spectroscopy (LC-MS) technique. The result of bioactive compounds identified by LC-MS analysis is represented in the Table-2. Mass spectroscopy analysis using Metwin 2.0 Library and retention time programme confirmed the presence of 17 compounds (Table-2 & Plate-1). The pharmacological activities of some identified compounds were also confirmed by the PASS results (Table-3). LC-MS has been playing a more significant role in plant medicine research because the technique can characterize active components ranging from small molecules to macromolecules and recent scientific results and publications show that application of LC-MS has been rapidly expanding into the area of structure elucidation and characterization of active components, in addition to valuable quantitative analysis. [14] Already, thirteen compounds were identified from the menispermaceae member *Stephania wightii* by Gas Chromatography-Mass Spectrometry (GC-MS) analysis. The major components present in the tuber of *S. wightii* were (1H) Indolo(2,1-a) isoquinoline, 5,6,11,12-tetrahydro-2,3,8,9-tetramethoxy (59.98%), 6H Dibenzo (a,g) quinolizine, 5, 8, 13, 13a-tetrahydro-2, 3, 9,10-tetramethoxy (ñ)- (34.86%) and 1, 3-propanediol, 2-(hydroxymethyl) -2-nitro-(2.89%) [15]. Separation and analysis of polar compounds from the polar fraction of *Stephania yunnanensis* was reported [16]. They analyzed the both major components and minor components by counter-current chromatography combined with liquid chromatography tandem mass spectrometry (LC-MS) and from 50 mg polar fraction of crude extract, 15.2mg corydine and 4.8mg stepharine. Aristolochic acid I (AAI), tetrandrine and fangchinoline were isolated from the roots of *Stephania tetrandra* confirmed using LC-MS/MS. The amount of obtained tetrandrine and fangchinoline were 0.26 and 0.27 $\mu\text{mol/L}$, respectively by liquid chromatography with electrochemical detection [17].

Antimicrobial Activity

In vitro antimicrobial efficacy of the crude extracts of *C. peltata* root was qualitatively assessed on the basis of zone of inhibition by disc diffusion method. The antibacterial activity of the extracts studied against both gram positive and Gram negative. The antibacterial activity was compared with that of standard antibiotic ciprofloxacin. The result revealed variability in inhibitory zone extract against the tested bacteria strains. Aqueous extract exhibited zone of inhibition was 9mm zone of inhibition against *Staphylococcus aureus* and 14 mm zone of inhibition against *Escherichia coli* (Table-4). Antifungal activity evaluated on the basis of zone of inhibition by comparing the zone of inhibition of standard. Antifungal agent Flucanazole was used as standard. In this study aqueous extracts has the potential against fungi. The results reveal the variability in the antifungal activity of the samples towards different tested organisms by the size of the zone of inhibition. The aqueous extract showed 9mm of inhibition against *Aspergillus niger*, 8mm against *Candida albicans* (Table- 4).

Each species of pathogen has a distinguishing spectrum of inter-action with its human hosts. Antibacterial activity of *C. peltata* has been reported by previous studies [18]. Antibacterial activity *C. peltata* root may be due to the presence of one or more biomolecules such as alkaloids, glycosides, steroids and saponins in it. Based on this study, it is suggested that *C. peltata* can also be used to treat other diseases which are caused by bacteria. The same family



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member *Tinospora crispa* possess a wide spectrum of antibacterial activity. Local people use this plant for the treatment of skin diseases and wound cleansing agent for chronic rheumatic wounds [19]. The medicated oil of *T. cordifolia* is effectively used to treat skin diseases. Antimicrobial activity of aqueous leaf and callus extracts of *T. cordifolia* was studied against Gram positive and Gram negative bacteria. The presence of additional compounds in callus extract may attribute to its activity against Gram positive organisms [20]. The anti-microbial activity of *T. cordifolia* was observed in root, stem and leaf extracts on pathogenic microorganisms [21],[22]. However, the crude methanolic extract of *T. cordifolia* along with its petroleum ether, carbon tetrachloride and chloroform soluble fractions were subjected to have antimicrobial action [23].

Cytotoxicity of Aqueous and Methanol Extracts by MTT Assay

The present study examined the effect of synthesized compounds on the cell response of the Human lung cancer (A-549) cell line by using the MTT assay. The effectiveness of anticancer drugs can be evaluated based on its ability to inhibit the cancer cells. The result shows that *C. peltata* root extract exhibited concentration depend toxicity in A549 cell line. When cells are treated with different concentrations of extracts such as 0µg/mL (control), 10µg/mL, 25µg/mL and 50µg/mL for 48 hrs, the minimum viability was observed at high concentration. The percentage of viability was increased with lower concentration of extracts. At the high concentration of *C. peltata* aqueous extract shows percentage of viability is 43±1µg/mL.

Fluorescence Microscopy Analysis of Nuclear Fragmentation**Acridine Orange /Ethidium Bromide (AO/EtBr) Staining Method**

In order to elucidate the apoptotic activity of synthesized compounds apoptotic staining fluorescence microscopic analysis carried out on selected cancer cell. AO/EtBr staining was performed. Acridine orange stains viable cell's DNA in bright green color, while apoptotic cell's DNA was stained by Ethidium Bromide and forms orange to red spectra. Fluorescence microscopy images of A-549 cancer cells in the absence of extracts (control) and in the presence of extracts the different in color shown in Plate 2(i). It can be observed that with the addition of extracts to the cancer cells, the green color of cells is converted into orange/red color cells due to the apoptotic activity of the extracts. Figs. b, c & d also show that compounds were significantly inducing the apoptosis in selected cancer cells.

DAPI Staining Method

The cytotoxicity of extracts the nuclear condensation and fragmentation of selected cancer cells were evaluated by the DAPI staining method. This method used to detect the morphological changes in the selected cells. The nuclear condensation and fragmentation of treated cancer cells were evaluated by this method. The fluorescent dye 4',6-Diamidine -2-Phenylindole dihydrochloride (DAPI) binds selectively to DNA and forms strongly fluorescent DNA-DAPI complex with high specificity. Fluorescence microscopy images of Lung cells after 24hrs stained with DAPI in the absence and the presence of extract shown in plate: 2. In plate:2 figures (a) were the untreated cells didn't show any significant changes where as extracts treated cancer cells (Figs b, c & d) shows bright fetches which indicates the condensed chromatins and nuclear fragmentation in the cancer cells. Thus the results from MTT assay and fluorescence microscopy analysis, shows that the extracts can be used as potent therapeutic agents.

Cancer may be uncontrollable and incurable and may occur at any time, at any age and in any part of the body. It is caused by a complex, poorly understood interplay of genetic and environmental factors [24]. Synthetic anticancer drugs cause non specific killing of cells, whereas natural products offer protective and therapeutic actions to all cells with low cytotoxicity [25]. Therefore there is a need for new prototypes, new templates to be used in the design of potential chemotherapeutic agents [26]. Plants exhibit cytotoxic effects either by damaging DNA or by blocking the formation of mitotic spindle during stages of cell division [27]. A number of reports point out that flavanoids, alkaloids, phenolics, terpenoids and steroids of natural products exert multiple biological effects because of their antioxidant and free radical scavenging abilities. These phytochemical constituents produced protective effects against cancer, tumor, heart diseases and certain other pathologies [28]. The present study agrees with the report of Meena and Suganthi [29] MCF-7cells showed growth inhibition in a dose dependent manner when treated with



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methanolic extract of *C. peltata* at different concentrations. While methanolic extract of *C. peltata* shows cytotoxic activity against breast cancer cell lines with an IC50 value 67.28µg/ml [29].

CONCLUSION

Based on the results, it may be suggested that *C. peltata* could be used for developing new therapeutic agents for treating different health problems such as infectious diseases. However the exact mechanism is not clear and further biochemical and pharmacological investigations are needed to isolate and identify the active ingredient in the extract. It may be used for the society to lead a better and healthy life.

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Table 1 show Phytochemicals present in the *Cyclea peltata* root extracts

Sl.No	Phytoconstituents	Aqueous extract
1.	Alkaloids	+
2.	Glycosides	+
3.	Flavonoids	-
4.	Terpenoids	+
5.	Saponin	+++
6.	Phenol	+
7.	Tannin	-
8.	Steroids	+
9.	Gums	-

(+++ indicates strongly present, ++ indicates moderately present, – indicates absent)

Table 2 shows phytochemical components identified in the root extract of *C. peltata* by LC-MS technique

SL.NO	COMPOUND NAME	LIB;SQ:NO	MOLECULAR MASS
1	VALINE	MTW/UM/2.1/4654/10	117.05
2	VANILLIN	MTW/UM/2.1/3564/10	152.15
3	INDOLE ACETIC ACID	MTW/UM/2.1/8797/10	175.19
4	HYDROXYL TRYPTOPHAN	MTW/UM/2.1/9765/10	220.23
5	FLAVIDIN	MTW/UM/2.1/4667/10	240.26
6	B-ALANINE	MTW/UM/2.1/4488/10	89.1
7	CYCLOEUDSMOL	MTW/UM/2.1/9958/10	222.37
8	ALPHACYCLOCOSTUNOLIDE	MTW/UM/2.1/8757/10	232.33
9	METHYL PHENOL	MTW/UM/2.1/6666/10	108.14





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10	PASORBIC ACID	MTW/UM/2.1/8907/10	112.13
11	ASPARATIC ACID	MTW/UM/2.1/2345/10	133.11
12	METHOXY CINNAMALDEHYDE	MTW/UM/2.1/7654/10	162.19
13	METHYL N-METHYLANTHRANILATE	MTW/UM/2.1/2345/10	165.19
14	DIMETHOXY BENZOQUINONE	MTW/UM/2.1/9087/10	168.15
15	TRIGONELLINE CHLORIDE	MTW/UM/2.1/4637/10	173.60
16	AMINO-B- OXALYLAMINOPROPINOIC ACID	MTW/UM/2.1/3554/10	176.13
17	7-METHOXYCOUMARIN	MTW/UM/2.1/5554/10	176.17

Table 3 shows the phytochemical components identified in the root extract of *C. peltata* by LC-MS technique with their pharmacological activity.

SL.NO	COMPOUND NAME	SECONDARY METABOLITE	PHARMACOLOGICAL ACTIVITY
1	VALINE	Amino acid	Stimulant, Antibacterial agent
2	VANILLIN	Phenol	Flavoring agent
3	INDOLE ACETIC ACID	Amino acid	Plant growth regulator
4	HYDROXYL TRYPTOPHAN	Amino acid	Anti-depressant, appetite suppressant, sleep aid
5	FLAVIDIN	Phenol	Antioxidant
6	B-ALANINE	Amino acid	Food additives, Flavoring agent
7	CYCLOEUDSMOL	Terpenoids	Antimicrobial agent
8	ALPHACYCLOCOSTUN-OLIDE	Terpenoids	Antihelmintic, Antineoplastic, cytotoxic.
9	METHYL PHENOL	Phenol	Synthetic intermediates to other material such as plastic, pesticides.
10	PASORBIC ACID	Amino acid	Antioxidant
11	ASPARATIC ACID	Amino acid	Neurotransmitter
12	METHOXY CINNAMALDEHYDE	Flavanoids	Flavoring agent
13	METHYL -N- METHYLANTHRANILATE	Ester of Anthranilic acid	Flavoring agent
14	DIMETHOXY BENZOQUINONE	Phenol	Antibacterial, Cytotoxic, genotoxic, Hepatotoxic
15	TRIGONELLINE CHLORIDE	Alkaloid	Antiviral
16	AMINO-B- OXALYLAMINOPROPINOIC ACID	Carboxylic acid	Food additives
17	7-METHOXYCOUMARIN	Alkaloid	Antimicrobial activity

Table 4 shows Antibacterial activity of aqueous root extract of *C. peltata*

SI.No	ORGANISMS	ZONE OF INHIBITION (mm)	
		Standard CIPROFLOXACIN (10µg/disc)	PLANT EXTRACT(100µg/disc) Aqueous
	Bacterial strains		
1.	<i>Staphylococcus aureus</i>	40	09
2.	<i>Escherichia coli</i>	45	14





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	Fungal strains	Standard FLUCCANAZOLE (10µg/disc)	
1.	<i>Aspergillus niger</i>	10	09
2.	<i>Candida albicans</i>	10	08



(i)Habit of *C. peltata*

(ii) Dried roots

(iii) Powdered root

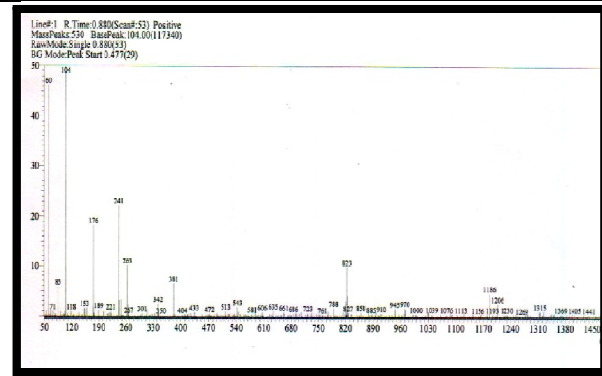
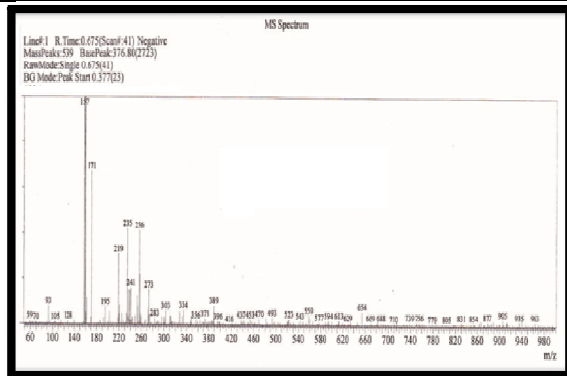
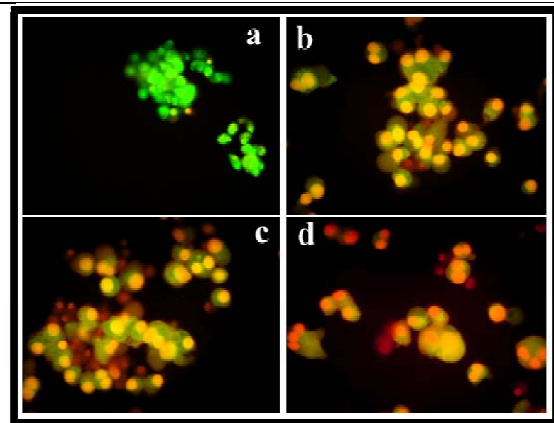
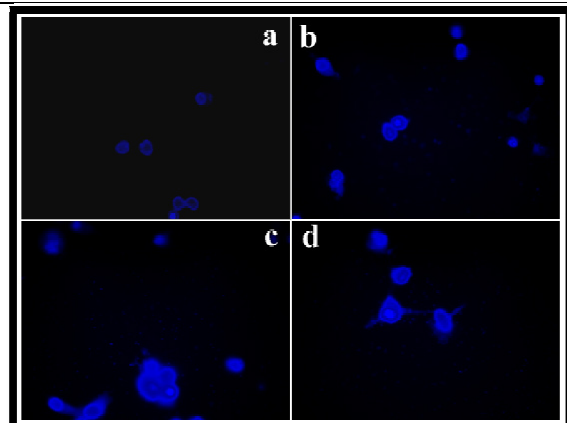


Plate 1: LC-MS analysis of root extract of *Cyclea peltata*



(i) Acridine orange /EtBr2 staining

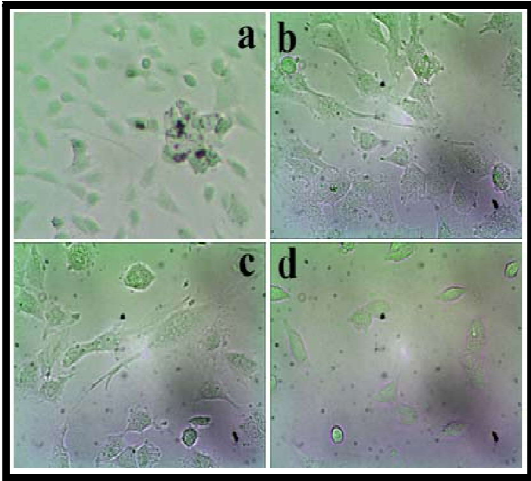


(ii) DAPI staining

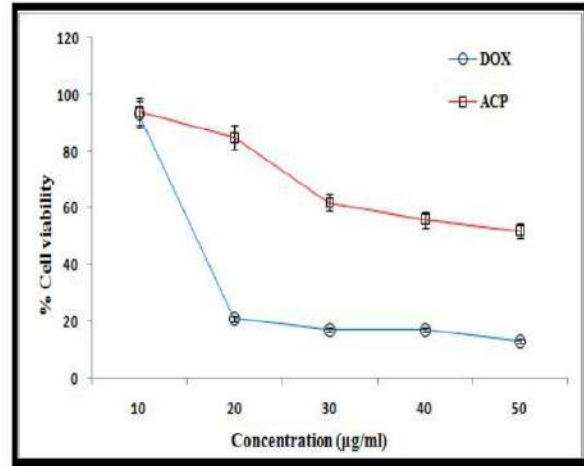




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a- Normal cell line b, c & d- Treated with plant aqueous extract
(iii) PHASE OF AQUEOUS EXTRACT



(iv) CELL VIABILITY

Plate 2: *In vitro* cytotoxic effect on aqueous extract of *C. peltata* root on human lung cancer cell line





Pentapartitioned Neutrosophic Strongly Irresolvable Spaces

R. Radha^{1*} and A. Stanis Arul Mary²

¹Assistant Professor, Department of Science and Humanities, Karpagam College of Engineering, Coimbatore, Tamil Nadu, India.

²Assistant Professor, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

R. Radha

Assistant Professor,
Department of Science and Humanities,
Karpagam College of Engineering,
Coimbatore, Tamil Nadu, India.
E. Mail: radharmat2020@gmail.com



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ABSTRACT

The aim of this paper is to develop many characterizations of Pentapartitioned Neutrosophic (PN) strongly irresolvable spaces and its properties is also studied. Several characterizations of Pentapartitioned Neutrosophic strongly irresolvable spaces are investigated in this study. Also examined are the conditions under which Pentapartitioned Neutrosophic strongly irresolvable spaces become Pentapartitioned Neutrosophic first category spaces, Pentapartitioned Neutrosophic Baire spaces and Pentapartitioned Baire spaces.

Keywords: Pentapartitioned neutrosophic set, pentapartitioned neutrosophic resolvable space, pentapartitioned neutrosophic irresolvable spaces, pentapartitioned neutrosophic strongly irresolvable spaces.

INTRODUCTION

Zadeh [17] proposed the fuzzy set concept in 1965 as a new technique to modelling uncertainties. Researches revealed the value of the fuzzy concept and have effectively used it to all fields of mathematics. Topology provides the most natural framework for fuzzy set theories to flourish in mathematics. Chang [3] first suggested the method of fuzzy topological space in 1968. Chang's paper established the stage for the tremendous growth of several fuzzy topological concepts that followed. Several mathematicians have continued to integrate all of the key notions of general topology to fuzzy circumstances, resulting in the development of a current theory of fuzzy topology. Today, fuzzy topology has been firmly established as one of the basic disciplines of fuzzy mathematics. Atanassov and





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plenty of researchers [1] worked on intuitionistic fuzzy sets within the literature. Florentin Smarandache [14] introduced the idea of Neutrosophic set in 1995 that provides the information of neutral thought by introducing the new issue referred to as uncertainty within the set. Thus neutrosophic set was framed and it includes the parts of truth membership function(T), indeterminacy membership function(I), and falsity membership function(F) severally. Neutrosophic sets deals with non normal interval of]-0 1+[. Pentapartitionedneutrosophic set and its properties were introduced by Rama Malik and SurpatiPramanik [13]. In this case, indeterminacy is divided into three components: contradiction, ignorance, and an unknown membership function. The concept of Pentapartitioned neutrosophicpythagorean sets was initiated by R. Radha and A. Stanis Arul Mary [7]. The concept of intuitionistic fuzzy almost resolvable spaces and irresolvable spaces was introduced by Sharmila s [15].R. Radha and A.Stanis Arul Mary introduced Pentapartitionedneutrosophicpythagorean resolvable and irresolvable spaces. Also we have studied the concept of Pentapartitionedneutrosophicpythagorean almost resolvable and irresolvable spaces. Now we extend the concepts to pentapartitionedneutrosophic strongly irresolvable spaces andstudied relations with other pentapartitioned neutrosophic baire spaces, first category set, second category set and hyper connected spaces.

Preliminaries

Definition [14]

Let X be a universe. A Neutrosophic set A on X can be defined as follows:

$$A = \{ \langle x, T_A(x), I_A(x), F_A(x) \rangle : x \in X \}$$

Where $T_A, I_A, F_A: U \rightarrow [0,1]$ and $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$

Here, $T_A(x)$ is the degree of membership, $I_A(x)$ is the degree of indeterminacy and $F_A(x)$ is the degree of non-membership.

Definition [13]

Let P be a non-empty set. A Pentapartitionedneutrosophic set A over P characterizes each element p in P a truth - membership function T_A , a contradiction membership function C_A , an ignorance membership function G_A , unknown membership function U_A and a false membership function F_A , such that for each p in P

$$T_A + C_A + G_A + U_A + F_A \leq 5$$

Definition [7]

The complement of a pentapartitionedneutrosophic set A on R Denoted by A^c or A' and is defined as

$$A^c = \{ \langle x, F_A(x), U_A(x), 1 - G_A(x), C_A(x), T_A(x) \rangle : x \in X \}$$

Definition [7]

Let $A = \langle x, T_A(x), C_A(x), G_A(x), U_A(x), F_A(x) \rangle$ and $B = \langle x, T_B(x), C_B(x), G_B(x), U_B(x), F_B(x) \rangle$ are pentapartitioned neutrosophic sets. Then

$$A \cup B = \langle x, \max(T_A(x), T_B(x)), \max(C_A(x), C_B(x)), \min(G_A(x), G_B(x)), \min(U_A(x), U_B(x)), \min(F_A(x), F_B(x)) \rangle$$

$$A \cap B = \langle x, \min(T_A(x), T_B(x)), \min(C_A(x), C_B(x)), \max(G_A(x), G_B(x)), \max(U_A(x), U_B(x)), \max(F_A(x), F_B(x)) \rangle$$

Definition [7]

A PN topology on a nonempty set R is a family of a PN sets in R satisfying the following axioms

- 1) $0, 1 \in \tau$
- 2) $R_1 \cap R_2 \in \tau$ for any $R_1, R_2 \in \tau$
- 3) $\cup R_i \in \tau$ for any $R_i: i \in I \subseteq \tau$

The complement R' of PN open set (PNOS, in short) in PN topological space [PNTS] (R, τ) , is called a PN closed set [PNCS].

Definition [7]

Let (R, τ) be a PNTS and L be a PNTS in R. Then the PN interior and PN Closure of R denoted by

$$Cl(L) = \cap \{K: K \text{ is a PNCS in } R \text{ and } L \subseteq K\}.$$

$$Int(L) = \cup \{G: G \text{ is a PNOS in } R \text{ and } G \subseteq L\}.$$





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Definition [11]

Let (R, τ) be a PNTS and K be a PN set in (R, τ) . Then the PN closure operator satisfy the following properties.

$$1\text{-PNCl}(K) = \text{PNInt}(1-K)$$

$$1\text{-PNInt}(K) = \text{PNCl}(1-K)$$

Definition [11]

A PN A in PNTS (R, τ) is called PN dense if there exists no PNCS L in (R, τ) such that $K \subseteq L \subseteq 1$. That is $\text{PNCl}(K) = 1$.

Definition [11]

A PN A in PNTS (R, τ) is called PN nowhere dense if there exists no nonzero PNOS L in (R, τ) such that $L \subseteq \text{PNCl}(K)$. That is $\text{PNInt}(\text{PNCl}(K)) = 0$.

Definition [11]

A PNTS (R, τ) is called PN resolvable if there exists a PN dense set K in (R, τ) such that $\text{PNCl}(1-K) = 1$. Otherwise (R, τ) is called PN irresolvable.

Definition [11]

A PNTS (R, τ) is called PN submaximal if $\text{PNCl}(K) = 1$ for any non-zero PN set K in (R, τ) .

Definition [11]

A PNTS (R, τ) is called a PN open hereditarily resolvable if $\text{PNInt}(\text{PNCl}(K)) \neq 0$ for any PN set K in (R, τ) .

Definition [11]

APNTS (R, τ) is called PN first category if $\bigcup_{i=1}^{\infty} K_i$, where K_i 's are PN nowhere dense sets in (R, τ) . A PNTS which is not first category is said to be PN second category.

Definition [11]

A PNTS (R, τ) is called a PNbaire space if $\text{PNInt}(\bigcup_{i=1}^{\infty} K_i) = 0$, where K_i 's are PN nowhere dense sets in (R, τ) .

Definition [12]

A PN K in a PNTS (R, τ) is called PNR_1 if $K = \bigcap_{i=1}^{\infty} K_i$ where each $K_i \in \tau$.

Definition [12]

A PN K in a PNTS (R, τ) is called PNR_2 if $K = \bigcup_{i=1}^{\infty} K_i$ where each $K_i \in \tau$.

Definition [12]

A PNTS (R, τ) is called a PN hyper- connected space if every PN open set is PN dense in (R, τ) . That is $\text{PNCl}(K_i) = 1$ for all $K_i \in \tau$.

Definition [12]

A PNTS (R, τ) is called Pentapartitioned Neutrosophicnodec space, if every non-zero PN nowhere dense set in (R, τ) is PN closed.

Pentapartitioned Neutrosophic(PN) Strongly Irresolvable Spaces**Definition**

A Pentapartitioned Neutrosophictopological space PNTS (R, τ) is called a Pentapartitioned Neutrosophicstrongly irresolvable space if $\text{PNCl}(K) = 1$ for any non-zero Pentapartitioned neutrosophic set K in (R, τ) implies that $\text{PNCl}(\text{PNInt}(K)) = 1$.

Example

Let $R = \{p\}$. Let A and B be the PN sets defined on R as follows.





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$$A = \{p, 0.4, 0.3, 0.3, 0.5, 0.4\}$$

$$B = \{p, 0.5, 0.6, 0.5, 0.2, 0.3\}$$

Then, clearly $\tau = \{0, A, 1\}$ is a PN topology on R.

Then, $\text{PNCl}(A) = 1$ and $\text{PNCl}(\text{PNInt}(A)) = 1$,

$\text{PNCl}(B) = 1$ and $\text{PNCl}(\text{PNInt}(B)) = 1$.

Hence (R, τ) is a PN strongly irresolvable space.

Theorem

If (R, τ) is a PN strongly irresolvable space and if $\text{PNInt}(K) = 0$ for any non-zero PN set K in (R, τ) , then $\text{PNInt}(\text{PNCl}(K)) = 0$.

Proof Let K be a non-zero PN set in (R, τ) such that $\text{PNInt}(K) = 0$. Then $1 - \text{PNInt}(K) = 1$ which implies that $\text{PNCl}(1-K) = 1$. Since (R, τ) is PN strongly irresolvable space, we have $\text{PNCl}(\text{PNInt}(1-K)) = 1$ which implies that $1 - \text{PNInt}(\text{PNCl}(K)) = 1$. Therefore $\text{PNInt}(\text{PNCl}(K)) = 0$.

Theorem

If (R, τ) is a PN strongly irresolvable space and if $\text{PNInt}(\text{PNCl}(K)) \neq 0$ for any non-zero PN set K in (R, τ) then $\text{PNInt}(K) \neq 0$.

Proof Let K be a non-zero PN set in (R, τ) such that $\text{PNInt}(\text{PNCl}(K)) \neq 0$. We claim that $\text{PNInt}(K) \neq 0$. Suppose that $\text{PNInt}(K) = 0$. Then $1 - \text{PNInt}(K) = 1$. Now $\text{PNCl}(1-K) = 1$. Since (R, τ) is a PN strongly irresolvable space, we have $\text{PNCl}(\text{PNInt}(1-K)) = 1$. Hence $1 - \text{PNInt}(\text{PNCl}(K)) = 1$ implies that $\text{PNInt}(\text{PNCl}(K)) = 0$, which is a contradiction. Hence we must have $\text{PNInt}(K) \neq 0$.

Theorem

If (R, τ) is a PN strongly irresolvable space, then (R, τ) is a PN irresolvable space.

Proof Let K be a non-zero PN set in (R, τ) such that $\text{PNCl}(K) = 1$. We claim that $\text{PNInt}(K) \neq 0$. Suppose that $\text{PNInt}(K) = 0$, then $1 - \text{PNInt}(K) = 1$, which implies that $\text{PNCl}(1-K) = 1$. Then $\text{PNInt}(\text{PNCl}(1-K)) = \text{PNInt}(1) = 1$. This implies that $1 - \text{PNCl}(\text{PNInt}(K)) = 1$. Then we have $\text{PNCl}(\text{PNInt}(K)) = 0$ which is a contradiction to (R, τ) is a PN strongly irresolvable spaces. Hence our assumption $\text{PNInt}(K) = 0$ is wrong. Hence we must have $\text{PNInt}(K) \neq 0$ for all PN dense sets K in (R, τ) . Therefore (R, τ) must be a PN irresolvable space.

Theorem

If (R, τ) is a PN strongly irresolvable space, then $\text{PNInt}(K_1) \subseteq 1 - \text{PNInt}(K_2)$ for any two dense sets K_1, K_2 in (R, τ) .

Proof Let K_1 and K_2 be any two non-zero PN dense sets in (R, τ) . Then $\text{PNCl}(K_1) = 1$ and $\text{PNCl}(K_2) = 1$ which implies that $\text{PNInt}(\text{PNCl}(K_1)) \neq 0$ and $\text{PNInt}(\text{PNCl}(K_2)) \neq 0$. Since (R, τ) is a PN strongly irresolvable space, by theorem 3.4, we have $\text{PNInt}(K_1) \neq 0$ and $\text{PNInt}(K_2) \neq 0$. By theorem 3.5, (R, τ) is a PN irresolvable space, But (R, τ) is PN irresolvable if has a pair of dense sets, $K_1 \& K_2 \exists K_1 \subseteq K_2$. Now $\text{PNInt}(K_1) \subseteq K_1 \subseteq 1 - K_2 \subseteq 1 - \text{PNInt}(K_2)$. Therefore we have $\text{PNInt}(K_1) \subseteq K_1 \subseteq 1 - \text{PNInt}(K_2)$ for any two PN dense sets K_1, K_2 in (R, τ) .

Theorem

If a PNDS (R, τ) is a PN submaximal space, then (R, τ) is a PN strongly irresolvable space.

Proof Let (R, τ) be a PN submaximal space and K be a PN dense set in (R, τ) . Since K is a PN dense set in (R, τ) , $\text{PNCl}(K) = 1$, which implies $\text{PNInt}(1-K) = 1-1 = 0$. Therefore $\text{PNCl}(\text{PNInt}(1-K)) = 0$. That is $1 - \text{PNCl}(\text{PNInt}(K)) = 1$, which implies $1 - \text{PNInt}(\text{PNCl}(1-K)) = 1$. Hence $\text{PNCl}(\text{PNInt}(K)) = 1$. Therefore (R, τ) is a strongly irresolvable space

Theorem

If K is a PN nowhere dense set in a PN topological space (R, τ) , then $(1 - K)$ is a PN dense set in (R, τ) .

Proof Let K be a PN nowhere dense set in (R, τ) . Then we have $\text{PNInt}(\text{PNCl}(K)) = 0$. Now $1 - \text{PNInt}(\text{PNCl}(K)) = 1 - 0 = 1$. Then $\text{PNCl}(1 - \text{PNCl}(K)) = 1$, which implies that $\text{PNCl}(1 - \text{PNInt}(1-K)) = 1$. But $\text{PNCl}(1 - \text{PNInt}(1-K)) \subseteq \text{PNCl}(\text{PNCl}(1-K))$. Hence $1 \subseteq \text{PNCl}(\text{PNCl}(1-K))$. Therefore $\text{PNCl}(1 - \text{PNInt}(1-K)) = 1$. Also $1 - \text{PNInt}(\text{PNCl}(K)) = 1 - 0 = 1$.





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Then we have $PNCI(1-PNCI(K)) = 1$, which implies that $PNCI(PNInt(1-K)) = 1$. But $PNCI(PNInt(1-K)) \subseteq PNCI(PNCI(1-K))$. Hence $1 \subseteq PNCI(PNCI(1-K))$. That is $PNCI(PNCI(1-K)) = 1$. Therefore $1-K$ is a PN dense set in (R, τ) .

Theorem

If a PNTS (R, τ) is a PN submaximal space, then (R, τ) is a PNnodec space.

Proof Let (R, τ) be a PN submaximal space and K be a PN nowhere dense set in (R, τ) . Then by theorem 3.8, $1-K$ is a PN dense set in (R, τ) . Since (R, τ) is a PN submaximal space, $1-K$ is a PN open set in (R, τ) . This implies that K is a PN closed set in (R, τ) . Hence each PN nowhere dense set is a PN closed set in (R, τ) and therefore (R, τ) is a PNnodec space.

Theorem

If (R, τ) is a PN strongly irresolvable then (R, τ) is a PNbair space if and only if $PNCI(\bigcap_{i=1}^{\infty} K_i) = 1$.

Proof Let (R, τ) be a PN strongly irresolvable space. Suppose that K_i 's are PN dense set in (R, τ) , then $PNCI(PNInt(K_i)) = 1$. Now $1 - PNCI(PNInt(K_i)) = 1-1 = 0$. Then we have $PNInt(PNCI(1-K_i)) = 0$. Hence $(1-K_i)$'s are PN nowhere dense sets in (R, τ) . Now $PNCI(\bigcap_{i=1}^{\infty} K_i) = 1$ implies that $1 - PNCI(\bigcap_{i=1}^{\infty} K_i) = 0$ and hence $PNInt(1 - (\bigcap_{i=1}^{\infty} K_i)) = 0$ and hence $PNInt(\bigcup_{i=1}^{\infty} (1-K_i)) = 0$, where $(1-K_i)$'s are PN nowhere dense sets in (R, τ) and therefore (R, τ) is a PNbair space.

Conversely, Let K_i 's be PN nowhere dense sets in a PN strongly irresolvable space and PNbair space (R, τ) . Since (R, τ) is a PNbair space, $PNInt(\bigcup_{i=1}^{\infty} K_i) = 0$. Then $1 - PNInt(\bigcup_{i=1}^{\infty} K_i) = 1$. This implies that $PNCI(\bigcap_{i=1}^{\infty} (1 - K_i)) = 1$ (1)

Since K_i 's be PN nowhere dense sets in a PN strongly irresolvable space then by theorem 3.8, $(1-K_i)$'s are PN dense sets in (R, τ) . Let $B_i = 1-K_i$. Then from (1), $PNCI(\bigcap_{i=1}^{\infty} B_i) = 1$, where B_i 's are PN dense sets in (R, τ) .

Theorem

If (R, τ) is a PN strongly irresolvable and $K = \bigcap_{i=1}^{\infty} K_i$ be a PN dense set in (R, τ) . Then $1 - K$ is a PN first category set in (R, τ) ,

Proof Let $K = \bigcap_{i=1}^{\infty} K_i$ be a PN dense set in (R, τ) . Then $PNCI(\bigcap_{i=1}^{\infty} K_i) = 1$. But $PNCI(\bigcap_{i=1}^{\infty} K_i) \subseteq \bigcap_{i=1}^{\infty} PNCI(K_i)$. Thus $1 \subseteq PNCI(\bigcap_{i=1}^{\infty} K_i) \subseteq \bigcap_{i=1}^{\infty} PNCI(K_i)$. Then $\bigcap_{i=1}^{\infty} PNCI(K_i) = 1$. This implies that $PNCI(K_i) = 1$. Thus K_i 's are PN dense set in (R, τ) . Since (R, τ) is PN strongly irresolvable, by theorem 3.8, $(1 - K_i)$'s are PN dense sets in (R, τ) . Therefore, we have $1 - K = \bigcup_{i=1}^{\infty} (1-K_i)$, where $(1-K_i)$'s are PN nowhere dense sets. Hence $1 - K$ is a PN first category set in (R, τ) .

Theorem

If (R, τ) is a PN strongly irresolvable space and $K = \bigcap_{i=1}^{\infty} K_i$ be a PN dense set in (R, τ) . Then K is a PN residual set in (R, τ) .

Proof Let $K = \bigcap_{i=1}^{\infty} K_i$ be a PN dense set in (R, τ) . Since (R, τ) is a PN strongly irresolvable space, by theorem 3.11, $1 - K$ is a PN first category set in (R, τ) . Therefore K is a PN residual set in (R, τ) .

Theorem

Let (R, τ) be a PN strongly irresolvable space. If K is a PN dense set in (R, τ) , then $1 - K$ is a PN nowhere dense set.

Proof Let K be a PN dense set in (R, τ) . Since (R, τ) is a PN strongly irresolvable space, $PNCI(PNInt(K)) = 1$. This implies that $1 - PNCI(PNInt(K)) = 0$. Therefore $PNInt(PNCI(1-K)) = 0$ and hence $1 - K$ is a PN nowhere dense set in (R, τ) .

Theorem

If (R, τ) is a PN strongly irresolvable and PNnodec space, then (R, τ) is a PN submaximal space,

Proof Let (R, τ) be a PN strongly and PNnodec space. Let K be a PN dense set in (R, τ) . Since (R, τ) is a PN strongly irresolvable, by theorem 3.13, $1-K$ is a PN nowhere dense set in (R, τ) . Since (R, τ) is a PNnodec space, $1-K$ is a PN closed set in (R, τ) . Then K is a PN open set in (R, τ) . Hence every PN dense set is PN open set in (R, τ) . Therefore (R, τ) is a PN submaximal space.





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Theorem

If (R, τ) is a PN strongly irresolvable and PN second category space, then $\bigcap_{i=1}^{\infty} K_i \neq \emptyset$ where K_i 's are PN dense sets in (R, τ) .

Proof Let (R, τ) be a PN second category space. Let us assume that $\bigcap_{i=1}^{\infty} K_i = \emptyset$. Since K_i 's are PN dense sets in (R, τ) , by theorem 3.12, $(1 - K_i)$'s are PN nowhere dense sets in (R, τ) . Now $1 - \bigcap_{i=1}^{\infty} K_i = 1$, implies that $\bigcup_{i=1}^{\infty} (1 - K_i)$ and $(1 - K_i)$'s are PN nowhere dense sets in (R, τ) . Hence (R, τ) is a PN first category space, which is a contradiction. Therefore $\bigcap_{i=1}^{\infty} K_i \neq \emptyset$, where K_i 's are PN dense sets in (R, τ) .

Theorem

If (R, τ) is a PN submaximal space and K is a PN first category set, then $1 - K$ is a PNR_2 set in (R, τ) .

Proof Let K be a PN first category set in (R, τ) . Then $K = \bigcup_{i=1}^{\infty} K_i$, where K_i 's are PN nowhere dense sets in (R, τ) . Therefore, by theorem 3.8, $(1 - K_i)$'s are PN dense sets in (R, τ) . Since (R, τ) is a PN submaximal space, $(1 - K_i)$'s are open set in (R, τ) . Also $1 - K = 1 - (\bigcup_{i=1}^{\infty} K_i) = \bigcap_{i=1}^{\infty} (1 - K_i)$, where $(1 - K_i)$'s are PN open sets in (R, τ) . Therefore $1 - K$ is a PNR_2 set in (R, τ) .

Theorem

If (R, τ) is a PN submaximal space, then every PN first category set is a PNR_1 set in (R, τ) .

Proof Let K be a PN first category set in (R, τ) . Since (R, τ) is a PN submaximal space, by theorem 3.16, $1 - K$ is a PNR_2 set in (R, τ) and hence K is a PNR_1 set in (R, τ) .

CONCLUSION

In this paper, it is established that in PN strongly irresolvable spaces, the condition under which PN topological spaces become PN strongly irresolvable spaces is obtained by means of the PN denseness of PN open sets. It is proved that PN first category sets are PN closed sets in a PN Baire, PN nodec and PN strongly irresolvable spaces. It is established that PN resolvable and PN irresolvable spaces are not PN strongly irresolvable spaces. The conditions under which PN strongly irresolvable spaces become PN Baire spaces are also obtained. In future study, we can study about filters and ultra filters in PN irresolvable space.

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One-Pot Hydrothermal Synthesis of Reduced Graphene Oxide Composites with Tungsten Transition Metal Dichalcogenides

J. Antonette Luciana Sherryn*

Department of Chemistry, Nirmala College for Women, Coimbatore- 641018, Tamil Nadu, India

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*Address for Correspondence

J. Antonette Luciana Sherryn
Department of Chemistry,
Nirmala College for Women,
Coimbatore- 641018, Tamil Nadu, India
E. Mail: sherrynpraveen94@gmail.com



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ABSTRACT

Transition metal dichalcogenides has been of major interest in the current trend. Unlike graphene, the TMDs have a finite band gap covering all visible and IR range with the choice of the transition metal. The synthesis of TMDs expose the catalytically active sites of the materials by careful planning and engineering the preparation process. In the recent time, care has been taken to produce high quality TMDs with unique size, controllable thickness and excellent electronic properties. Herein, tungsten dichalcogenides WSSe and WSSe/rGO composites are synthesized via simple one-pot hydrothermal method.

Keywords: TMDs, one-pot hydrothermal method

INTRODUCTION

The world is in need to opt for a source of energy which is non-toxic, eco-friendly and also available in abundance. Presently, hydrogen is found to be a reliable and tempting carrier of energy, alternative to the fossil fuels.[1] It has got the efficiency to be a zero-emission, renewable fuel.[2] Due to its high energy density and eco-friendly advantages, it is becoming one of the prominent energy carriers.[3] Its prevalent nature, makes it possible to store energy from renewable sources like solar and wind safely for off-grid applications.[4] Hydrogen is a dependable energy carrier all around the globe because, it has the capability of storing solar and electric energy by the formation of chemical bonds between the hydrogen atoms.[5] The framework of hydrogen is a repetition in which electricity is obtained from hydrogen fuel cells, and by-products of water are dissociated into hydrogen and oxygen.[6] One mole of hydrogen can produce 286 kJ energy through reaction with oxygen [$2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$] ($\Delta\text{H} = -286 \text{ kJ/mol}$). Thus the unceasing approach to produce hydrogen can possibly solve the problem of energy crisis. Authentically, water is an approved resource for being the bountiful supply of hydrogen that is efficiently used to produce



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hydrogen via electrocatalytic or photocatalytic water splitting.[7] Electrochemical water splitting has been an effective way for the production of hydrogen. As the demand for the energy sources have raised during the recent decades, HER has paved the way for utilizing fuel cells as green devices for the storage of energy. HER has been studied by different materials from noble metals, metal sulfides, metal selenides, metal phosphides, metal carbides, metal nitrides and metal carbides etc. Among the various materials for HER, noble metals like Pt, Ru and Pd exhibits outstanding electrochemical performances. However, the high cost of materials is a restricting factor for the usage of these materials.[8] Presently, TMDs have gained attraction in the HER. Out of the many, molybdenum based TMDs and tungsten based TMDs play a vital role. The tungsten chalcogenides are noticeable for the large size of the W metal which greatly alters the 2D structure. The Vander Waal's force of attraction holding the W-TMDs are more than the Mo-TMDs. This paves the way for good energy storage, optoelectronic and magnetic applications.[9] The interaction energy between the atoms decrease for heavier chalcogens due to long distance.[10]

MATERIALS AND METHODS**Synthesis of improved GO**

The synthesis of GO was carried out using improved GO synthesis. Briefly, graphite flakes (1wt. equiv) and KMnO_4 (6 wt. equiv) were taken in a round bottomed flask. To this mixture, 9:1 mixture of conc. H_2SO_4 : H_3PO_4 was added. The above mixture was heated up to 50 °C and stirred for 12 h. The reaction was then cooled to room temperature (RT) and subsequently poured into ice bath along with 30 % H_2O_2 . The filtrate was centrifuged at 4000 rpm and the supernatant was decanted away. The residue was washed with water, 30 % HCl and ethanol (two times each) and dried overnight at 60 °C. Thus, GO was obtained.

Synthesis of WSSe and WSSe-rGO composite

Sodium tungstate dihydrate (1mmol), thiourea (1mmol) and selenium black powder (2mmol) dissolved in hydrazine hydrate (10 ml) were taken in a round bottomed flask. The reaction mixture was stirred at room temperature (RT) for an hour. It was then transferred to a teflon lined autoclave for hydrothermal treatment, which was heated at 250 °C for 16 h. The obtained precipitate was centrifuged, washed with ethanol and water and dried at 60°C overnight to obtain the WSSe composite. The WSSe-rGO composite was synthesized with the inclusion of GO dispersion which was sonicated for about an hour for uniform dispersion (100 mg in 100 ml DD water). Hydrothermal treatment was carried at 230 °C for 12 h. The precipitate was washed and dried.

RESULTS AND DISCUSSION**SEM analysis of WSSe and WSSe-rGO samples**

Sodium tungstate dihydrate (1mmol), thiourea (1mmol) and selenium black powder (2mmol) dissolved in hydrazine hydrate (10 ml) were taken in a round bottomed flask. The reaction mixture was stirred at room temperature (RT) for an hour. It was then transferred to a teflon lined autoclave for hydrothermal treatment, which was heated at 250 °C for 16 h. The obtained precipitate was centrifuged, washed with ethanol and water and dried at 60°C overnight to obtain the WSSe composite. The WSSe-rGO composite was synthesized with the inclusion of GO dispersion which was sonicated for about an hour for uniform dispersion (100 mg in 100 ml DD water). Hydrothermal treatment was carried at 230 °C for 12 h. The precipitate was washed and dried.

X-Ray Diffraction Studies**XRD studies of WSSe, rGO and WSSe-rGO nanocomposites**

X-ray diffraction studies of WSSe, rGO and WSSe-rGO composites were shown in Figure 3.2. The WSSe composite was compared with the XRD patterns of WSe_2 and WS_2 . Some of the partially formed WS_2 and WSe_2 are obtained which are resulted in the formation of WSSe crystals with highly intense diffracted peaks. The diffraction peaks broadened in the WSSe-rGO composite due to the addition of rGO nanosheets Thereby, the structural crystallinity is reduced. Table 1 shows the average particle size of WSSe nanostructured composites calculated as 3.5590 nm in the





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absence of rGO whereas Table 2 shows the particle size of WSSe increased to 4.6055 nm with the introduction of rGO. This can be easily identified with the broadening of diffraction peak in WSSe-rGO composites.

CONCLUSION

The WSSe and WSSe/rGO were successfully prepared via one-pot hydrothermal method followed by the preparation of the composites according to their corresponding procedures. The formation of the Tungstosulfoselenide @reduced graphene oxide composites were characterized using Scanning Electron Microscopy, X-ray Diffraction studies and EDAX.

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Table 1 Calculation of particle size of WSSe nanostructured materials from XRD pattern.

Material	Peak position	FWHM (radians)	Cos Bragg's Angle θ (radians)	Particle size (nm)
WSSe	12.9	0.1707	0.9936	4.6822
	23.6	0.2489	0.9788	3.2605
	29.8	0.2181	0.9663	3.7683
	43.74	0.3390	0.9280	2.5251
Average particle size				3.5590 nm

Table 2 Calculation of particle size of WSSe-rGO nanocomposite from XRD pattern.

Material	Peak position	FWHM (radians)	Cos Bragg's Angle θ (radians)	Particle size (nm)
WSSe-rGO	13.7	0.100152	0.993194	13.0939
	32.4	0.064145	0.620976	2.2493
	38.6	0.094019	0.946454	1.5582
	57.5	0.1015	0.880158	1.5204
Average particle size				4.6055 nm





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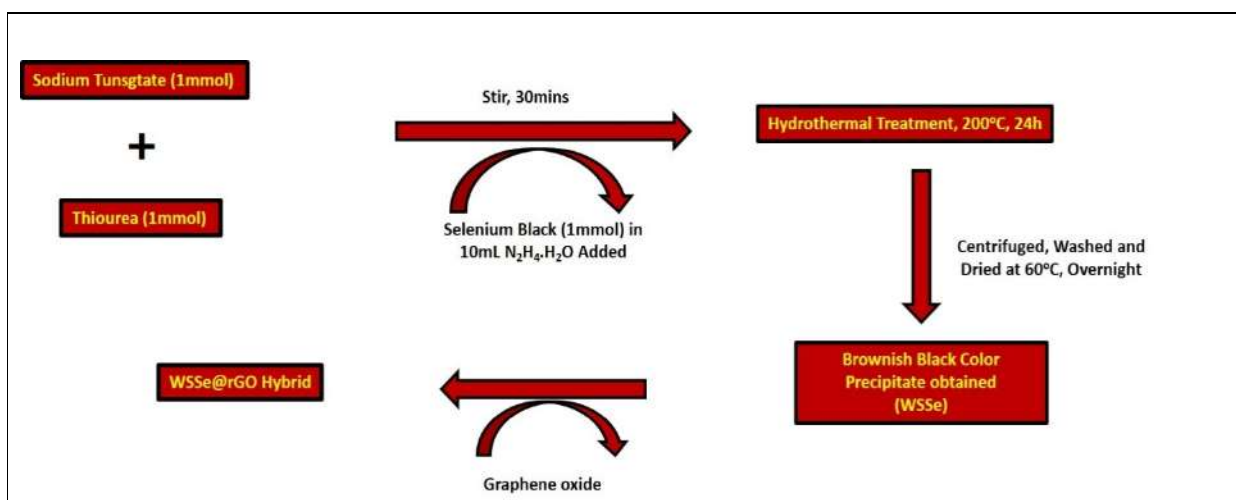


Fig. 1 : Synthesis of WSSe and WSSe/rGO composites

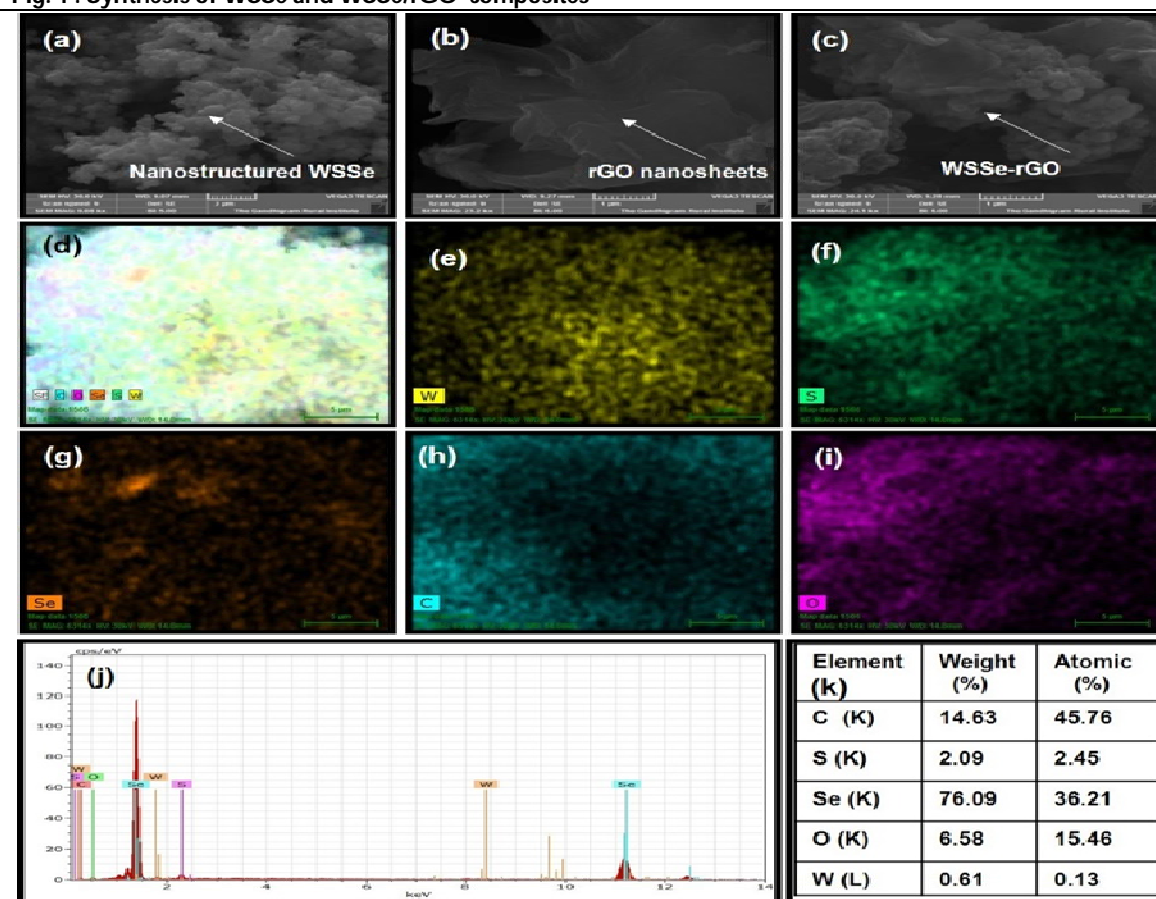


Fig.2 :SEM images of WSSe (a) and rGO nanosheets (b) and WSSe-rGO composite (c). Elemental mapping of WSSe-rGO composite (d). Individual elemental mapping of Tungsten (e), Sulfur (f), Selenium (g), Carbon (h), Oxygen (i) EDAX analysis of WSSe-rGO composite (j) and their atomic and weight % (k).





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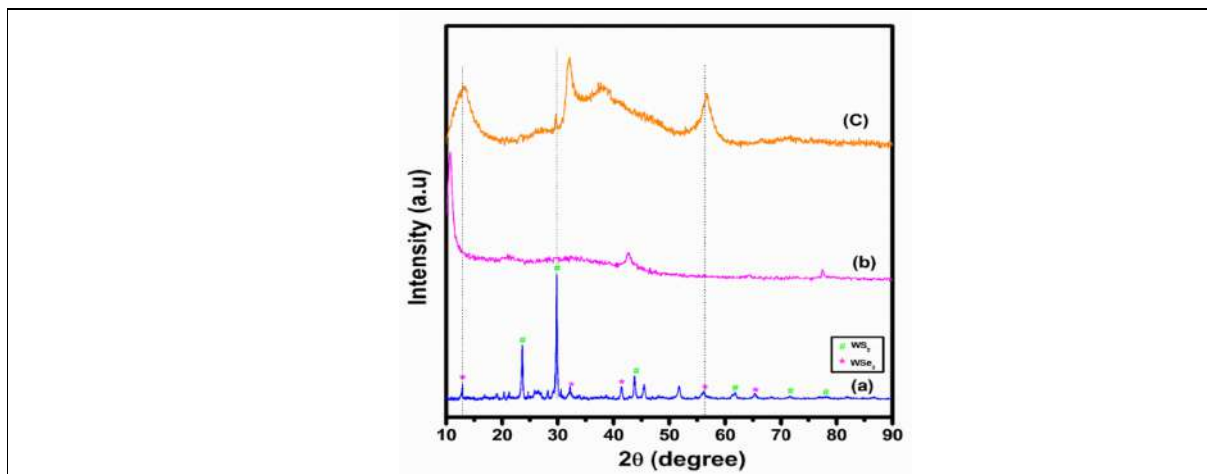


Fig 3: The XRD patterns of WS₂ nanoparticles(a), rGO nanosheets(b)andWS₂-rGO composite (c).





Extended Hausdorff Distance and Similarity Measures for Quadripartitioned Single Valued Neutrosophic Refined Sets and Its Application in Medical Diagnosis

Arokia Pratheesha.S V^{1*} and Mohana K²

¹Research Scholar, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Assistant Professor, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

Arokia Pratheesha.S V

Research Scholar,

Nirmala College for Women,

Coimbatore, Tamil Nadu, India.

E.Mail: pratheesha555@gmail.com



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ABSTRACT

In this paper, we present a new distance measure between Quadripartitioned single valued neutrosophic refined sets on the basis of extended hausdorff distance neutrosophic refinedsets and study some of their basic properties. Using this distance, the similarity measure between Quadripartitioned single valued neutrosophic refined sets are proposed. Finally, using the extended hausdorff distance and similarity measure, the application of medical diagnosis is presented.

Keywords: Neutrosophic refined sets, Quadripartitioned single valued neutrosophic refined sets, Extended hausdorff distance

INTRODUCTION

In 1965, Zadeh [18] proposed the fuzzy set. In 1986, K. Atanassov [1] introduced the intuitionistic fuzzy set, a generalization of fuzzy sets. Neurothosophic sets, which are an extension of intuitionistic fuzzy sets and fuzzy sets, were proposed by Smarandache[12]. The uncertainty factor is dealt with in neutrosophic set theory. Single-valued neutrosophic sets, which are a generalizationof intuitionistic fuzzy sets, fuzzy sets, and the classic set, were proposed by Wang [14]. Chatterjee [10] introduced quadripartitioned single valued neutrosophic sets with four components: truth, contradiction, unknown, and falsity membership function. Broumi and others [3] looked into some of the fundamental properties of several similarity measures. Between interval neutrosophicsets, Ye [16] presented the Hamming, Euclidean distance, and similarity measures. J.Ye [17] provided the generalized weighted distance and similarity measures between neutrosophic sets. In addition, the same author applied the Jaccard, Dice, and cosine





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similarity measures for SVN to multicriteria decisionmaking problems using simplified neutrosophic information and proposed three vector similarity measures for simplified neutrosophic sets (SNSs). As a result, S.Broumi et al. [4] included interval neutrosophic sets in the generalized weighted distance between neutrosophic sets (NS). Hanafy and co. [7,8] presented the neutrosophic sets' correlation measure. Neutrosophic refined sets were proposed by Deli et al.[2] as an extension of intuitionistic fuzzy multisets and fuzzy multisets..This paper is arranged in the following manner. In section 2 the neutrosophic refined sets,quadripartitioned single valued neutrosophic sets and extended hausdorff distance of neutrosophic refined sets are presented.The section 3 deals with the proposed extended hausdorff distance and similarity measure for QSVNR sets. In section 4, we present an application of extended hausdorff distance and similarity measure to medical diagnosis.

$$A = \{ \langle x, (T_A^1(x), T_A^2(x), \dots, T_A^P(x)), (I_A^1(x), I_A^2(x), \dots, I_A^P(x)), (F_A^1(x), F_A^2(x), \dots, F_A^P(x))) \rangle : x \in X \}$$

where, $T_A^1(x), T_A^2(x), \dots, T_A^P(x) : X \rightarrow [0, 1]$, $I_A^1(x), I_A^2(x), \dots, I_A^P(x) : X \rightarrow [0, 1]$ and $F_A^1(x), F_A^2(x), \dots, F_A^P(x) : X \rightarrow [0, 1]$ such that $0 \leq T_A^i(x) + I_A^i(x) + F_A^i(x) \leq 3$ ($i = 1, 2, \dots, P$) and $T_A^1(x) \leq T_A^2(x) \leq \dots \leq T_A^P(x)$ for any $x \in X$. $(T_A^1(x), T_A^2(x), \dots, T_A^P(x)), (I_A^1(x), I_A^2(x), \dots, I_A^P(x))$ and $(F_A^1(x), F_A^2(x), \dots, F_A^P(x))$ are the truth membership sequence, indeterminacy membership sequence and falsity membership sequence of the element x respectively. P is also known as dimension of NRS A . The truth-membership sequence is arranged in decreasing order but the corresponding indeterminacy- membership and falsity- membership sequence may not be arranged in the same way.

Definition 2.3 [2] Let X be a universe. A quadripartitioned single valued neutrosophic refined set (QSVNR) A on X can be defined as follows:

$A = \{ \langle x, (T_A^1(x), T_A^2(x), \dots, T_A^P(x)), (D_A^1(x), D_A^2(x), \dots, D_A^P(x)), (Y_A^1(x), Y_A^2(x), \dots, Y_A^P(x)), (F_A^1(x), F_A^2(x), \dots, F_A^P(x))) \rangle : x \in X \}$ where, $T_A^1(x), T_A^2(x), \dots, T_A^P(x) : X \rightarrow [0, 1]$, $D_A^1(x), D_A^2(x), \dots, D_A^P(x) : X \rightarrow [0, 1]$, $Y_A^1(x), Y_A^2(x), \dots, Y_A^P(x) : X \rightarrow [0, 1]$, and $F_A^1(x), F_A^2(x), \dots, F_A^P(x) : X \rightarrow [0, 1]$ such that $0 \leq T_A^i(x) + D_A^i(x) + Y_A^i(x) + F_A^i(x) \leq 4$ ($i = 1, 2, \dots, P$) and $(T_A^1(x), T_A^2(x), \dots, T_A^P(x)), (D_A^1(x), D_A^2(x), \dots, D_A^P(x)), (Y_A^1(x), Y_A^2(x), \dots, Y_A^P(x))$ and $(F_A^1(x), F_A^2(x), \dots, F_A^P(x))$ are the truth membership sequence, a contradiction membership sequence, an unknown membership sequence and a falsity membership sequence of the element respectively. Also, P is called the dimension of QSVNR(A).

If $T_A^i(x) \leq T_B^i(x)$, $D_A^i(x) \leq D_B^i(x)$, $Y_A^i(x) \geq Y_B^i(x)$ and $F_A^i(x) \geq F_B^i(x) \forall x \in X$ then A is contained in B , denoted by $A \subseteq B$

Definition 2.4 [9] Hausdorff distance

$H(A, B) = \max\{|a_1 - b_1|, |a_2 - b_2|\}$ For the two intervals $A = [a_1, a_2]$ and $B = [b_1, b_2]$ in a real space R , the hausdorff distance was defined by Nadler in 1978

Definition 2.5 [5] Extended Hausdorff distance Measures for Neutrosophic Refined Sets

Let $A = \{ \langle x_i, T_A^j(x_i), I_A^j(x_i), F_A^j(x_i) \rangle : x_i \in X, j = 1, 2, \dots, m \}$ and $B = \{ \langle x_i, T_B^j(x_i), I_B^j(x_i), F_B^j(x_i) \rangle : x_i \in X, j = 1, 2, \dots, m \}$ be any two NR set in $X = \{x_1, x_2, \dots, x_n\}$ then the extended hausdorff distance of NR set is defined as

$$d_{HNRS}(A, B) = \frac{1}{m} \sum_{j=1}^m \left\{ \frac{1}{n} \sum_{i=1}^n \max\{ |T_A^j(x_i) - T_B^j(x_i)|, |I_A^j(x_i) - I_B^j(x_i)|, |F_A^j(x_i) - F_B^j(x_i)| \} \right\}$$





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Extended Hausdorff Distance and Similarity Measures for Quadripartitioned SingleValued Neutrosophic Refined Sets

Definition 3.1 Let $A = \{ \langle x_j, T_A^i(x_j), D_A^i(x_j), Y_A^i(x_j), F_A^i(x_j) \rangle : x_j \in X, i = 1, 2, \dots, P \}$ and $B = \{ \langle x_j, T_B^i(x_j), D_B^i(x_j), Y_B^i(x_j), F_B^i(x_j) \rangle : x_j \in X, i = 1, 2, \dots, P \}$ be any two QSVNR set in $X = \{x_1, x_2, \dots, x_n\}$ then the extended hausdorff distance of QSVNR set is defined as

$$d_H(A, B) = \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{ |T_A^i(x_j) - T_B^i(x_j)|, |D_A^i(x_j) - D_B^i(x_j)|, |Y_A^i(x_j) - Y_B^i(x_j)|, |F_A^i(x_j) - F_B^i(x_j)| \} \right\}$$

where $d_H(A, B) = H(A, B)$ denote the extended Hausdorff distance between two QSVNR sets A and B.

Let A, B and C be three QSVNR sets for all $x_j \in X$, we have

$$d_H(A, B) = H(A, B) = \max\{ |T_A^i(x_j) - T_B^i(x_j)|, |D_A^i(x_j) - D_B^i(x_j)|, |Y_A^i(x_j) - Y_B^i(x_j)|, |F_A^i(x_j) - F_B^i(x_j)| \}$$

The same between A and C are written as:

for all $x_j \in X$

$$H(A, C) = \max\{ |T_A^i(x_j) - T_C^i(x_j)|, |D_A^i(x_j) - D_C^i(x_j)|, |Y_A^i(x_j) - Y_C^i(x_j)|, |F_A^i(x_j) - F_C^i(x_j)| \}$$

and between B and C is written as:

for all $x_j \in X$

ss

Proposition 3.2 The defined distance $d_H(A, B)$ between QSVNR set A and B satisfies the following properties

E1. $0 \leq d_H(A, B) \leq 1$.

E2. $d_H(A, B) = 0$ if and only if $A = B$.

E3. $d_H(A, B) = d_H(B, A)$.

E4. If $A \supseteq B \supseteq C$ for A, B, C \in QSVNR set, then $d_H(A, C) \geq d_H(A, B)$ and $d_H(A, C) \geq$

$d_H(B, C)$

Proof:

E1. $0 \leq d_H(A, B) \leq 1$.

As truth membership, contradiction, unknown and falsity membership functions of the QSVNR lies between 0 and 1, the distance measure based on these function also lies between 0 and 1.

E2. $d_H(A, B) = 0$ if and only if $A = B$.

(i) Let the two QSVNR A and B be equal (i.e.) $A = B$

This implies for any $T_A^i(x_j) = T_B^i(x_j), D_A^i(x_j) = D_B^i(x_j), Y_A^i(x_j) = Y_B^i(x_j)$ and $F_A^i(x_j) = F_B^i(x_j)$ which states that $|T_A^i(x_j) - T_B^i(x_j)|, |D_A^i(x_j) - D_B^i(x_j)|, |Y_A^i(x_j) - Y_B^i(x_j)|$ and $|F_A^i(x_j) - F_B^i(x_j)| = 0$.

Hence $d_H(A, B) = 0$.

(ii) Let the $d_H(A, B) = 0$.

The zero-distance measure is possible only if both





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$|T_A^i(x_j) - T_B^i(x_j)|, |D_A^i(x_j) - D_B^i(x_j)|, |Y_A^i(x_j) - Y_B^i(x_j)|$ and $|F_A^i(x_j) - F_B^i(x_j)| = 0$, s the hausdorff distance measure concerns with maximum truth membership, contradiction, unknown and falsity membership differences. This refers that

$T_A^i(x_j) = T_B^i(x_j), D_A^i(x_j) = D_B^i(x_j), Y_A^i(x_j) = Y_B^i(x_j)$ and $F_A^i(x_j) = F_B^i(x_j)$ for all i,j values. Hence $A=B$.

E3. $d_H(A, B) = d_H(B, A)$

It is obvious that

$$\begin{aligned} &T_A^i(x_j) - T_B^i(x_j) \neq T_B^i(x_j) - T_A^i(x_j), D_A^i(x_j) - D_B^i(x_j) \neq D_B^i(x_j) - D_A^i(x_j), \\ &Y_A^i(x_j) - Y_B^i(x_j) \neq Y_B^i(x_j) - Y_A^i(x_j) \text{ and } F_A^i(x_j) - F_B^i(x_j) \neq F_B^i(x_j) - F_A^i(x_j) \\ \text{But } &|T_A^i(x_j) - T_B^i(x_j)| = |T_B^i(x_j) - T_A^i(x_j)|, |D_A^i(x_j) - D_B^i(x_j)| = |D_B^i(x_j) - D_A^i(x_j)|, |Y_A^i(x_j) - \\ &Y_B^i(x_j)| = |Y_B^i(x_j) - Y_A^i(x_j)| \text{ and } |F_A^i(x_j) - F_B^i(x_j)| = |F_B^i(x_j) - F_A^i(x_j)| \end{aligned}$$

Hence

$$\begin{aligned} d_H(A, B) &= \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_B^i(x_j)|, |D_A^i(x_j) - D_B^i(x_j)|, |Y_A^i(x_j) - Y_B^i(x_j)|, |F_A^i(x_j) - F_B^i(x_j)|\} \right\} \\ &= \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_B^i(x_j) - T_A^i(x_j)|, |D_B^i(x_j) - D_A^i(x_j)|, |Y_B^i(x_j) - Y_A^i(x_j)|, |F_B^i(x_j) - F_A^i(x_j)|\} \right\} \\ &= d_H(B, A). \end{aligned}$$

E4. If $A \supseteq B \supseteq C$ for $A, B, C \in$ QSVNR set, then $d_H(A, C) \geq d_H(A, B)$ and $d_H(A, C) \geq d_H(B, C)$

Since $A \supseteq B \supseteq C$ implies,

$T_A^i(x_j) \leq T_B^i(x_j) \leq T_C^i(x_j), D_A^i(x_j) \geq D_B^i(x_j) \geq D_C^i(x_j), Y_A^i(x_j) \geq Y_B^i(x_j) \geq Y_C^i(x_j)$ and $F_A^i(x_j) \geq F_B^i(x_j) \geq F_C^i(x_j)$ for every $x_j \in X$

We prove that $d_H(A, B) \leq d_H(A, C)$

μ - If $|T_A^i(x_j) - T_C^i(x_j)| \geq |D_A^i(x_j) - D_C^i(x_j)| \geq |Y_A^i(x_j) - Y_C^i(x_j)| \geq |F_A^i(x_j) - F_C^i(x_j)|$ then

$H(A, C) = |T_A^i(x_j) - T_C^i(x_j)|$ but we have

- a) $|D_A^i(x_j) - D_B^i(x_j)| \leq |D_A^i(x_j) - D_C^i(x_j)|$ for all $x_j \in X$.
 $|Y_A^i(x_j) - Y_B^i(x_j)| \leq |Y_A^i(x_j) - Y_C^i(x_j)|$ for all $x_j \in X$.
 $|F_A^i(x_j) - F_B^i(x_j)| \leq |F_A^i(x_j) - F_C^i(x_j)|$ for all $x_j \in X$.
- b) $|D_B^i(x_j) - D_C^i(x_j)| \leq |D_A^i(x_j) - D_C^i(x_j)|$ for all $x_j \in X$.
 $|Y_B^i(x_j) - Y_C^i(x_j)| \leq |Y_A^i(x_j) - Y_C^i(x_j)|$ for all $x_j \in X$.
 $|F_B^i(x_j) - F_C^i(x_j)| \leq |F_A^i(x_j) - F_C^i(x_j)|$ for all $x_j \in X$.

$$\leq |T_A^i(x_j) - T_C^i(x_j)|$$

On the other hand, we have for all $x_j \in X$

c) $|T_A^i(x_j) - T_B^i(x_j)| \leq |T_A^i(x_j) - T_C^i(x_j)|$ and $|T_B^i(x_j) - T_C^i(x_j)| \leq |T_A^i(x_j) - T_C^i(x_j)|$

Combining a), b) and c) we obtain therefore for all $x_j \in X$

$$\begin{aligned} &\frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_B^i(x_j)|, |D_A^i(x_j) - D_B^i(x_j)|, |Y_A^i(x_j) - Y_B^i(x_j)|, |F_A^i(x_j) - F_B^i(x_j)|\} \right\} \\ &\leq \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_C^i(x_j)|, |D_A^i(x_j) - D_C^i(x_j)|, |Y_A^i(x_j) - Y_C^i(x_j)|, |F_A^i(x_j) - F_C^i(x_j)|\} \right\} \\ &\frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_B^i(x_j) - T_C^i(x_j)|, |D_B^i(x_j) - D_C^i(x_j)|, |Y_B^i(x_j) - Y_C^i(x_j)|, |F_B^i(x_j) - F_C^i(x_j)|\} \right\} \\ &\leq \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_C^i(x_j)|, |D_A^i(x_j) - D_C^i(x_j)|, |Y_A^i(x_j) - Y_C^i(x_j)|, |F_A^i(x_j) - F_C^i(x_j)|\} \right\} \end{aligned}$$

That is





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$d_H(A, B) \leq d_H(A, C)$ and $d_H(B, C) \leq d_H(A, C)$
 • If $|D_A^i(x_j) - D_B^i(x_j)| \geq |T_A^i(x_j) - T_C^i(x_j)| \geq |Y_A^i(x_j) - Y_C^i(x_j)| \geq |F_A^i(x_j) - F_C^i(x_j)|$ then $H(A, C) = |D_A^i(x_j) - D_C^i(x_j)|$ but we have

a) $|T_A^i(x_j) - T_B^i(x_j)| \leq |T_A^i(x_j) - T_C^i(x_j)|$ for all $x_j \in X$.

$\leq |D_A^i(x_j) - D_C^i(x_j)|$

$|Y_A^i(x_j) - Y_B^i(x_j)| \leq |Y_A^i(x_j) - Y_C^i(x_j)|$ for all $x_j \in X$.

$\leq |D_A^i(x_j) - D_C^i(x_j)|$

$|F_A^i(x_j) - F_B^i(x_j)| \leq |F_A^i(x_j) - F_C^i(x_j)|$ for all $x_j \in X$.

$\leq |D_A^i(x_j) - D_C^i(x_j)|$

b) $|T_B^i(x_j) - T_C^i(x_j)| \leq |T_A^i(x_j) - T_C^i(x_j)|$ for all $x_j \in X$.

$\leq |D_A^i(x_j) - D_C^i(x_j)|$

$|Y_B^i(x_j) - Y_C^i(x_j)| \leq |Y_A^i(x_j) - Y_C^i(x_j)|$ for all $x_j \in X$.

$\leq |D_A^i(x_j) - D_C^i(x_j)|$

$|F_B^i(x_j) - F_C^i(x_j)| \leq |F_A^i(x_j) - F_C^i(x_j)|$ for all $x_j \in X$.

$\leq |D_A^i(x_j) - D_C^i(x_j)|$

On the other hand, we have for all $x_j \in X$

c) $|D_A^i(x_j) - D_B^i(x_j)| \leq |D_A^i(x_j) - D_C^i(x_j)|$ and $|D_B^i(x_j) - D_C^i(x_j)| \leq |D_A^i(x_j) - D_C^i(x_j)|$

Combining a), b) and c) we obtain therefore for all $x_j \in X$

$$\left. \begin{aligned} & \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_B^i(x_j)|, |D_A^i(x_j) - D_B^i(x_j)|, |Y_A^i(x_j) - Y_B^i(x_j)|, |F_A^i(x_j) - F_B^i(x_j)|\} \right\} \\ & \leq \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_C^i(x_j)|, |D_A^i(x_j) - D_C^i(x_j)|, |Y_A^i(x_j) - Y_C^i(x_j)|, |F_A^i(x_j) - F_C^i(x_j)|\} \right\} \\ & \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_B^i(x_j) - T_C^i(x_j)|, |D_B^i(x_j) - D_C^i(x_j)|, |Y_B^i(x_j) - Y_C^i(x_j)|, |F_B^i(x_j) - F_C^i(x_j)|\} \right\} \end{aligned} \right\}$$

$$\leq \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_C^i(x_j)|, |D_A^i(x_j) - D_C^i(x_j)|, |Y_A^i(x_j) - Y_C^i(x_j)|, |F_A^i(x_j) - F_C^i(x_j)|\} \right\}$$

That is

$d_H(A, B) \leq d_H(A, C)$ and $d_H(B, C) \leq d_H(A, C)$

• If $|T_A^i(x_j) - T_C^i(x_j)| \leq |D_A^i(x_j) - D_C^i(x_j)| \leq |F_A^i(x_j) - F_C^i(x_j)| \leq |Y_A^i(x_j) - Y_C^i(x_j)|$ then $H(A, C) = |Y_A^i(x_j) - Y_C^i(x_j)|$ but we have

a) $|T_A^i(x_j) - T_B^i(x_j)| \leq |T_A^i(x_j) - T_C^i(x_j)|$ for all $x_j \in X$.

$\leq |Y_A^i(x_j) - Y_C^i(x_j)|$

$|D_A^i(x_j) - D_B^i(x_j)| \leq |D_A^i(x_j) - D_C^i(x_j)|$ for all $x_j \in X$.

$\leq |Y_A^i(x_j) - Y_C^i(x_j)|$

$|F_A^i(x_j) - F_B^i(x_j)| \leq |F_A^i(x_j) - F_C^i(x_j)|$ for all $x_j \in X$.

$\leq |Y_A^i(x_j) - Y_C^i(x_j)|$

b) $|T_B^i(x_j) - T_C^i(x_j)| \leq |T_A^i(x_j) - T_C^i(x_j)|$ for all $x_j \in X$.

$\leq |Y_A^i(x_j) - Y_C^i(x_j)|$

$|D_B^i(x_j) - D_C^i(x_j)| \leq |D_A^i(x_j) - D_C^i(x_j)|$ for all $x_j \in X$.

$\leq |Y_A^i(x_j) - Y_C^i(x_j)|$

$|Y_B^i(x_j) - Y_C^i(x_j)| \leq |Y_A^i(x_j) - Y_C^i(x_j)|$ for all $x_j \in X$.

$\leq |Y_A^i(x_j) - Y_C^i(x_j)|$

On the other hand, we have for all $x_j \in X$

c) $|Y_A^i(x_j) - Y_B^i(x_j)| \leq |Y_A^i(x_j) - Y_C^i(x_j)|$ and $|Y_B^i(x_j) - Y_C^i(x_j)| \leq |Y_A^i(x_j) - Y_C^i(x_j)|$

Combining a), b) and c) we obtain therefore for all $x_j \in X$

$$\left. \begin{aligned} & \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_B^i(x_j)|, |D_A^i(x_j) - D_B^i(x_j)|, |Y_A^i(x_j) - Y_B^i(x_j)|, |F_A^i(x_j) - F_B^i(x_j)|\} \right\} \\ & \leq \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_C^i(x_j)|, |D_A^i(x_j) - D_C^i(x_j)|, |Y_A^i(x_j) - Y_C^i(x_j)|, |F_A^i(x_j) - F_C^i(x_j)|\} \right\} \\ & \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_B^i(x_j) - T_C^i(x_j)|, |D_B^i(x_j) - D_C^i(x_j)|, |Y_B^i(x_j) - Y_C^i(x_j)|, |F_B^i(x_j) - F_C^i(x_j)|\} \right\} \end{aligned} \right\}$$

$$\leq \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_C^i(x_j)|, |D_A^i(x_j) - D_C^i(x_j)|, |Y_A^i(x_j) - Y_C^i(x_j)|, |F_A^i(x_j) - F_C^i(x_j)|\} \right\}$$

That is

$d_H(A, B) \leq d_H(A, C)$ and $d_H(B, C) \leq d_H(A, C)$





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δ - If $|T_A^i(x_j) - T_C^i(x_j)| \leq |D_A^i(x_j) - D_C^i(x_j)| \leq |Y_A^i(x_j) - Y_C^i(x_j)| \leq |F_A^i(x_j) - F_C^i(x_j)|$ then

$H(A, C) = |F_A^i(x_j) - F_C^i(x_j)|$ but we have

a) $|T_A^i(x_j) - T_B^i(x_j)| \leq |T_A^i(x_j) - T_C^i(x_j)|$ for all $x_j \in X$.

$$\leq |F_A^i(x_j) - F_C^i(x_j)|$$

$|D_A^i(x_j) - D_B^i(x_j)| \leq |D_A^i(x_j) - D_C^i(x_j)|$ for all $x_j \in X$.

$$\leq |F_A^i(x_j) - F_C^i(x_j)|$$

$|Y_A^i(x_j) - Y_B^i(x_j)| \leq |Y_A^i(x_j) - Y_C^i(x_j)|$ for all $x_j \in X$.

b) $|T_B^i(x_j) - T_C^i(x_j)| \leq |T_A^i(x_j) - T_C^i(x_j)|$ for all $x_j \in X$.

$$\leq |F_A^i(x_j) - F_C^i(x_j)|$$

$|D_B^i(x_j) - D_C^i(x_j)| \leq |D_A^i(x_j) - D_C^i(x_j)|$ for all $x_j \in X$.

$$\leq |F_A^i(x_j) - F_C^i(x_j)|$$

$|Y_B^i(x_j) - Y_C^i(x_j)| \leq |Y_A^i(x_j) - Y_C^i(x_j)|$ for all $x_j \in X$.

$\leq |F_A^i(x_j) - F_C^i(x_j)|$

On the other hand, we have for all $x_j \in X$

c) $|F_A^i(x_j) - F_B^i(x_j)| \leq |F_A^i(x_j) - F_C^i(x_j)|$ and $|F_B^i(x_j) - F_C^i(x_j)| \leq |F_A^i(x_j) - F_C^i(x_j)|$

Combining a), b) and c) we obtain therefore for all $x_j \in X$

$$\frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_B^i(x_j)|, |D_A^i(x_j) - D_B^i(x_j)|, |Y_A^i(x_j) - Y_B^i(x_j)|, |F_A^i(x_j) - F_B^i(x_j)|\} \right\}$$

$$\leq \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_C^i(x_j)|, |D_A^i(x_j) - D_C^i(x_j)|, |Y_A^i(x_j) - Y_C^i(x_j)|, |F_A^i(x_j) - F_C^i(x_j)|\} \right\}$$

$$\frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_B^i(x_j) - T_C^i(x_j)|, |D_B^i(x_j) - D_C^i(x_j)|, |Y_B^i(x_j) - Y_C^i(x_j)|, |F_B^i(x_j) - F_C^i(x_j)|\} \right\}$$

$$\leq \frac{1}{\eta} \sum_{i=1}^p \left\{ \frac{1}{n} \sum_{j=1}^n \max\{|T_A^i(x_j) - T_C^i(x_j)|, |D_A^i(x_j) - D_C^i(x_j)|, |Y_A^i(x_j) - Y_C^i(x_j)|, |F_A^i(x_j) - F_C^i(x_j)|\} \right\}$$

That is

$d_H(A, B) \leq d_H(A, C)$ and $d_H(B, C) \leq d_H(A, C)$

From μ, ϑ, ω and δ we can obtain the property E4.

Definition 3.3 The similarity measure based on the extended hausdorff distance is

$S_H^1(A, B) = 1 - d_H(A, B)$

$S_H^2(A, B) = (e^{-d_H(A,B)} - e^{-1}) / (1 - e^{-1})$

$S_H^3(A, B) = (1 - d_H(A, B)) / (1 + d_H(A, B))$

$S(A, B)$ is said to be similarity measure between A and B, where $A, B \in QSVNR$, as $S(A, B)$

satisfies the following properties

W1) $S(A, B) = S(B, A)$

W2) $S(A, B) = 1$ if $A = B$ for all $A, B \in QSVNR$ set.

W3) $S(A, B) \in [0, 1]$

W4) If $A \supseteq B \supseteq C$ for $A, B, C \in QSVNR$ set, then $S(A, B) \geq S(A, C)$ and $S(B, C) \geq$

$S(A, C)$

Medical Diagnosis using QSVNRS - Extended Hausdorff distance and Similarity Measure

The process of classifying various sets of symptoms under a single disease name becomes difficult because of the uncertainties inherent in medical diagnosis and the increased volume of information made available to physicians by cutting-edge medical technologies. In some practical situations, symptoms are characterized by four components namely, truth membership, a contradiction, an unknown and falsity membership functions. The proper medical diagnosis is provided by the proposed extended hausdorff and similarity measure between patients Vs symptoms





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and diseases Vs symptoms. The fact that this proposed method takes into account multi-truth membership, a contradiction, an unknown, and falsity membership is a novel feature. The diagnosis may be incorrect if only one inspection is performed. This multi-time inspection, in which samples are taken from the same patient at various times, provides the best diagnosis. Let $P = \{P_1, P_2, P_3\}$ be a set of patients, $D = \{\text{Viral Fever, Dengue, Typhoid, Malaria}\}$ be a set of diseases and $S = \{\text{Temperature, Cough, Stomach pain, Headache, Joint pain}\}$ be a set of symptoms. In the medical diagnosis problem, if we have to take three different samples in three different times in a day (e.g., morning, noon and night) which in turn give rise to different truth membership, contradiction, unknown and falsity membership function for each patient. The highest similarity measure from the table 4,5 gives the proper medical diagnosis. Therefore Patient P1 suffers from Dengue, Patient P2 and P3 suffers from Typhoid.

CONCLUSION

In this paper, we presented an extended Hausdorff distance of quadripartitioned single valued neutrosophic refined sets and proved some of their basic properties. We used this distance measure in an application of medical diagnosis.

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Table 1: M (the relation between Patient and Symptoms)

M	Temperature	Cough	Stomach pain	Headache	Joint pain
P ₁	(0.3,0.2,0.5,0.1)	(0.4,0.3,0.3,0.2)	(0.2,0.4,0.3,0.1)	(0.4,0.2,0.3,0.1)	(0.4,0.1,0.3,0.2)
	(0.1,0.4,0.3,0.2)	(0.3,0.2,0.4,0.1)	(0.1,0.5,0.3,0.4)	(0.4,0.3,0.6,0.2)	(0.1,0.2,0.4,0.3)
	(0.2,0.3,0.5,0.1)	(0.2,0.3,0.1,0.4)	(0.2,0.4,0.5,0.2)	(0.2,0.1,0.5,0.4)	(0.2,0.3,0.2,0.1)
P ₂	(0.5,0.2,0.4,0.2)	(0.5,0.2,0.6,0.3)	(0.5,0.2,0.1,0.3)	(0.5,0.2,0.1,0.2)	(0.3,0.4,0.5,0.2)
	(0.4,0.3,0.2,0.1)	(0.3,0.1,0.5,0.2)	(0.2,0.4,0.3,0.2)	(0.3,0.4,0.2,0.7)	(0.2,0.1,0.6,0.5)
	(0.3,0.2,0.4,0.1)	(0.1,0.3,0.4,0.2)	(0.2,0.3,0.4,0.1)	(0.1,0.3,0.2,0.4)	(0.2,0.4,0.3,0.1)
P ₃	(0.7,0.2,0.4,0.3)	(0.4,0.2,0.6,0.1)	(0.2,0.4,0.5,0.1)	(0.5,0.1,0.4,0.3)	(0.5,0.3,0.4,0.2)
	(0.6,0.4,0.3,0.2)	(0.2,0.1,0.3,0.3)	(0.1,0.4,0.6,0.2)	(0.4,0.2,0.5,0.1)	(0.2,0.3,0.1,0.3)
	(0.5,0.3,0.5,0.3)	(0.4,0.3,0.4,0.1)	(0.2,0.3,0.4,0.3)	(0.1,0.5,0.2,0.3)	(0.1,0.5,0.2,0.1)

Table 2: N (the relation between Symptoms and Diseases)

N	Viral Fever	Dengue	Typhoid	Malaria
Temperature	(0.1,0.4,0.2,0.3)	(0.3,0.5,0.4,0.2)	(0.3,0.2,0.4,0.1)	(0.2,0.6,0.7,0.2)
Cough	(0.5,0.3,0.1,0.4)	(0.7,0.1,0.2,0.3)	(0.2,0.1,0.5,0.3)	(0.1,0.3,0.2,0.4)
Stomach pain	(0.1,0.5,0.2,0.3)	(0.3,0.4,0.2,0.1)	(0.3,0.4,0.1,0.4)	(0.1,0.5,0.1,0.3)
Headache	(0.5,0.7,0.1,0.2)	(0.4,0.2,0.5,0.3)	(0.2,0.5,0.2,0.3)	(0.1,0.4,0.3,0.3)
Joint pain	(0.6,0.4,0.3,0.1)	(0.1,0.2,0.3,0.4)	(0.1,0.2,0.3,0.4)	(0.1,0.1,0.2,0.3)

Table 3: The Hausdorff distance between QSVNRS M and N

	Viral Fever	Dengue	Typhoid	Malaria
P ₁	0.24	0.19	0.195	0.21
P ₂	0.27	0.23	0.17	0.245
P ₃	0.3	0.225	0.22	0.255

Table 4: Similarity Measure $S_H^1(A, B)$ using Hausdorff distance between QSVNRS M and N

	Viral Fever	Dengue	Typhoid	Malaria
P ₁	0.76	0.81	0.805	0.79
P ₂	0.73	0.77	0.83	0.755
P ₃	0.7	0.775	0.78	0.745

Table 5: Similarity Measure $S_H^3(A, B)$ using Hausdorff distance between QSVNRS M and N

	Viral Fever	Dengue	Typhoid	Malaria
P ₁	0.6129	0.6807	0.6736	0.6529
P ₂	0.5748	0.6260	0.7094	0.6064
P ₃	0.5384	0.6326	0.6393	0.5936





Geodetic Domination Index for Graphs

Sandhya P.S^{1*} and U. Mary²

¹Research Scholar, Nirmala College for Women, Red Fields, Coimbatore, Tamil Nadu, India-641018,

²Associate Professor, Nirmala College for Women, Red Fields, Coimbatore, Tamil Nadu, India-641018,

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*Address for Correspondence

Sandhya P.S

Research Scholar,

Nirmala College for Women,

Red Fields, Coimbatore,

Tamil Nadu, India-641018,

E.Mail: sandhyabinoy2004@gmail.com



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ABSTRACT

In this study, we introduce the geodetic domination index, a new topological index for graphs that makes use of the geodetic domination set. Additionally, we create various inequalities and calculate the geodetic domination index for a few common graphs.

Keywords: Geodetic sets, Dominating sets, geodetic domination index

Mathematics Subject Classification 2010:05C69, 05C35, 05C90

INTRODUCTION

For standard terminology and notion in graph theory, we follow the text book of Harary [6]. The non-standard will be given in this paper as and when required. Topological indices on graphs are numerical parameters that are identical for isomorphic graphs. Some of the significant types of topological indices are distance based topological indices, degree based topological indices and spectrum based topological indices, among which most investigated categories are degree based topological indices and are widely used in chemical graph theory. A new topological index is introduced by motivation from different researchers study ([4],[7],[9],[10],[11]). Harary[8] introduced the concept of geodetic number of a graph. In this paper, we consider a simple connected graph $G = (V, E)$. The shortest path between two vertices u and v is a u - v geodesic. The closed interval $I[u, v]$ consists of u, v and all vertices lying in some u - v geodesic in G for any two vertices u and v in G . Let $I[S] = \cup_{u,v \in S} I[u, v]$ for any $S \subseteq V(G)$, and S is a geodetic set of G if $I[S] = V(G)$. The minimum cardinality of a geodetic set is the geodetic number $g(G)$. A subset $D \subseteq V(G)$ is said to be a dominating set of G if for every $u \in V - D$ there exists a vertex $v \in D$ such that u and v are adjacent. For a survey of domination in graphs, refer to ([2],[12],[13]). The minimal dominating set is a dominating set such that no proper subset of it is a dominating set. The minimum cardinality of a minimal dominating set is the domination





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number of the graph, $\gamma(G)$ If a subset S of $V(G)$ is both a geodetic set and a dominating set then S is a geodetic dominating set. The minimum cardinality of a minimal geodetic dominating set is the geodetic domination number [1], $\gamma_g(G)$. The maximum cardinality of a minimal geodetic dominating set is the upper geodetic domination number [3], $\gamma^+(G)$.

Geodetic domination Indices of a graph

In this section we discuss the geodetic domination degree and further analyze the properties of geodetic domination indices of a graph.

Definition 2.1 The geodetic domination degree of a vertex $v \in V(G)$ is defined as the number of minimal geodetic dominating set of G which contains v . The geodetic domination degree of a vertex v is denoted by $d_\sigma(v)$. The minimum geodetic domination degree of G is denoted by $\delta_\sigma(G)$ and the maximum geodetic domination degree of G is denoted by $\Delta_\sigma(G)$, and $T_\sigma(G)$ denote the total number of minimal geodetic dominating set of G .

Remark 2.2 For any graph G , $0 \leq d_\sigma(v) \leq T_\sigma(G)$.

Remark 2.3 Let $G \cong K_n$ and \bar{G} be the complement of G , then $d_{\sigma(G)}(v) = d_{\sigma(\bar{G})}(v)$ and

$$T_\sigma(G) = T_\sigma(\bar{G}) = 1$$

Proposition 2.4 Let G is the complete bipartite graph then $d_{\sigma(G)}(v) = d_{\sigma(\bar{G})}(v)$.

Proof: Let G be a complete bipartite graph with bipartition A and B of cardinality m and n respectively. Clearly the sets A and B are geodetic sets and dominating sets. Each vertex belongs to only one geodetic dominating set, since if $v \in A$ then $v \notin B$. Thus $d_{\sigma(G)}(v) = 1$ for every $v \in V(G)$. Also \bar{G} is the union of two complete graphs and there is only one geodetic

dominating set for \bar{G} . Therefore, $d_{\sigma(\bar{G})}(v) = 1$ for every $v \in V(\bar{G})$. Hence $d_{\sigma(G)}(v) = d_{\sigma(\bar{G})}(v)$

=1.

Definition 2.5 A graph G is called k -geodetic domination regular if $d_{\sigma(G)}(v) = k$, for all $v \in V(G)$.

Remark 2.6 For minimal geodetic dominating sets S_1, S_2, \dots, S_k of a graph G ,

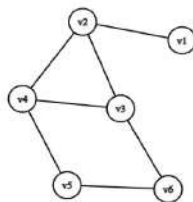
$$k\gamma_g(G) \leq \sum_{v \in V(G)} d_\sigma(v) \leq k\gamma^+(G).$$

Definition 2.7 Consider a simple connected graph G , the first geodetic domination index is

$$\sigma M_1(G) = \sum_{v \in V(G)} d_\sigma^2(v).$$

$$= \sum_{uv \in E(G)} (d_\sigma(u) + d_\sigma(v)).$$

Example 2.8 Consider the following graph G ,





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The minimal geodetic dominating sets are $S_1 = \{v_1, v_3, v_5\}$, $S_2 = \{v_1, v_4, v_6\}$, $S_3 = \{v_1, v_5, v_6\}$. Then $d_\sigma(v_1) = 3$, $d_\sigma(v_2) = 0$, $d_\sigma(v_3) = 1$, $d_\sigma(v_4) = 1$, $d_\sigma(v_5) = 2$, $d_\sigma(v_6) = 2$. Therefore, the first geodetic domination index is $\sigma M_1(G) = 19$ and the second geodetic domination index is $\sigma M_2(G) = 9$.

Proposition 2.9

- (i) If G is the star graph with $n+1$ vertices, then $\sigma M_1(G) = n$, and $\sigma M_2(G) = 0$.
- (ii) For complete graph $G = K_n$, $\sigma M_1(G) = n$, $\sigma M_2(G) = \frac{n(n-1)}{2}$
- (iii) For complete bipartite graph $G = K_{m,n}$, $\sigma M_1(G) = m+n$, $\sigma M_2(G) = mn$
- (iv) If G is a k -geodetic domination graph with n vertices and m edges then,
 $\sigma M_1(G) = nk^2$, $\sigma M_2(G) = mk^2$

Theorem 2.10 Consider a graph G with n vertices. Then $\frac{1}{n} \sum_{v \in V(G)} d_\sigma(v)^2 \leq \sigma M_1(G)$

Proof: We have, $\sigma M_1(G) = \sum_{v \in V(G)} d_\sigma^2(v) = d_\sigma^2(v_1) + d_\sigma^2(v_2) + \dots + d_\sigma^2(v_n)$
 $= \frac{1}{n} [d_\sigma^2(v_1) + d_\sigma^2(v_2) + \dots + d_\sigma^2(v_n)] [1^2 + 1^2 + \dots + 1^2]$

Using Cauchy-Schwartz inequality,

Remark 2.11 If G is 1-geodetic domination regular graph, then $\sigma M_1(G) = \frac{1}{n} [\sum_{i=1}^n d_\sigma(i)]^2$

Theorem 2.12 Consider a graph G of order n , then $2 \leq \sigma M_1(G) \leq n(T_\sigma(G))^2$

Proof: Since $\gamma(G) \geq 2$, $\sigma M_1(G) \geq 2$. By Remark 2.2, $d_\sigma(v) \leq T_\sigma(G)$, then

$$\sum_{v \in V} d_\sigma(v)^2 \leq \sum_{v \in V} T_\sigma(G)^2$$

This implies $\sigma M_1(G) \leq n T_\sigma(G)^2$

Theorem 2.13

Let G be a graph with n vertices and m edges. Then $0 \leq \sigma M_2(G) \leq m (T_\sigma(G))^2$

Proof: Since $d_\sigma(v) \geq 0$, $\sigma M_2(G) \geq 0$. By remark 2.2, $d_\sigma(v) \leq T_\sigma(G)$ and $d_\sigma(u) \leq T_\sigma(G)$ for some $u, v \in V(G)$
 Then $\sigma M_2(G) \leq m (T_\sigma(G))^2$



**Sandhya and Mary****CONCLUSION**

A large number of topological indices based on vertex degrees are studied by many authors. We have introduced geodetic domination degree and a new topological index based on geodetic domination degree and studied some of the properties relevant to further research work.

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Groundwater Suitability for Irrigation in Vythiri Taluk, Wayanad, Kerala, India using Watch it

Insaf M^{1*} and D Nagaraju²

¹Research Scholar, DoS in Earth Science, University of Mysore, Mysuru, Karnataka, India

²Professor, DoS in Earth Science, University of Mysore, Mysuru, Karnataka, India

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*Address for Correspondence

Insaf M

Research Scholar,
DoS in Earth Science,
University of Mysore,
Mysuru, Karnataka, India
E.Mail: Mayanagaraju1966@gmail.com



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ABSTRACT

Groundwater has strategically remained as a valuable resource as the major and preferred source of drinking water in several parts of the world. Water scarcity resulting from increasing demand for water over the years in different parts of the world has also been aggravated by the problems of water pollution or contamination. Quality deterioration is a major concern of groundwater resources. Hydro-geochemical facies is an important diagnostic. Properties of groundwater occurring in various hydrologic systems. Hydro-geochemical facies play an important role in the usage of water. In Vythiri taluk openwells are mostly used by people for drinking water, borewells are major source of irrigation. A multitude of factors, including soil composition, soil texture, the geology of the area and agricultural activity, impacts the water's suitability. The Permeability Index, Salinity and Sodium hazard classification, Sodium Adsorption Ratio, Residual Sodium Carbonate, Sodium Ratio, Adjusted Sodium Adsorption Ratio, United States Salinity Laboratory (salinity USSL), Salinity Hazard, Sodium- Hazard USS, Kelly's Ratio and Corrosivity Ratio are some of the characteristics that determine the quality groundwater used for the irrigation. The present study focuses on to gain the better understanding of the groundwater quality and its suitability for irrigation in the Wayanad district of the Kerala state, India. The present work revealed that more than half of the collected samples are confirmed to be appropriate for irrigation purpose.

Keywords: Water Quality, Irrigation Suitability, Pollution, Groundwater, wells, Vythiri, Kerala





INTRODUCTION

Now a days, fresh water resources are becoming more and more limited with increasing demand in the world. Thus, understanding the hydrochemical characteristics and water quality is becoming critical for groundwater planning and management, to ensure sustainable safe use of the resources for drinking, agricultural and industrial purpose. Groundwater plays a significant role in the global movement toward the progressive realization of the right to water. The development of groundwater is viewed as a major option for resolving service delivery gaps and for constructing resilience to the consequences of climate change in developing country contexts, where 2.1 billion people still lack access to safely managed water and 844 million need even basic water (WHO/UNICEF 2018). 97% of the freshwater that is easily available on Earth is found underground, and 2 billion people depend on it for their irrigation, urban, industrial, and rural water needs (Garduño, H., *et al.*, 2011). The groundwater chemistry could have important information on the suitability of the groundwater for domestic, industrial and agricultural purposes, and its contamination has been recognized as one of the most serious problems in the world (Adams *et al.* 2001; Jalali 2007, 2009, Djabri *et al.* 2007; Wen *et al.* 2008; Giridharan *et al.* 2008; Khazaei *et al.* 2006; Tayfur *et al.* 2008; Anku *et al.* 2009; Trabelsi *et al.* 2009, 2011; Rouabhia *et al.* 2009; Fehdi *et al.* 2009). Groundwater chemistry depends on a number of factors such as general geology, degree of chemical weathering of the various rock types, quality of recharge water, and inputs from sources other than water– rock interaction. Such factors and their interactions result in a complex groundwater quality (Domenico and Schwartz 1990; Edmunds *et al.* 2003; Risacher *et al.* 2003; Guler and Thyne 2004; Vengosh *et al.* 2005; Boughriba *et al.* 2006; Ayenew *et al.* 2008; Giridharan *et al.* 2008; Han *et al.* 2009; Trabelsi *et al.* 2009, 2011). The anthropogenic disturbances through industrial and agricultural pollution, increasing consumption and urbanization degrade the groundwater and impair their use for drinking, agricultural, industrial and domestic uses (Carpenter *et al.* 1998; Jarvie *et al.* 1998; Simeonov *et al.* 2003).

STUDY AREA

Administratively, Vythiri taluk is located within Kalpetta, the district headquarters of Wayanad district, within the state of Kerala, India. The area of the Vythiri taluk covers 637 square kilometers. This area is covered in the Survey of India topographic sheet (no. 49 M/14, 58A/21, 58A/31, and 58A/61) with geographic co-ordinates N 11° 33' 5.97384" and E 76° 2' 24.94356". Vythiri taluk is a famous tourist destination in the Wayanad district. The study area is well connected by road. National Highway 212, connecting Kozhikode (Calicut) with Mysore and the Calicut–Vythiri–Gudallur (CVG) road passes close to the study area. (Fig.1) Geologically, the Wayanad area is an extension of Dharwar Craton which is perhaps one of the important crustal blocks among the collage of terrains in the Southern Granulite Terrain (SGT) and is occupied by the rocks of the Wayanad Group, Charnockite Group, Peninsular Gneissic Complex (PGC) and Migmatitic Complex. Wayanad Group of rocks are supracrustal and include garnet, sillimanite, biotite gneiss, graphite, kyanite, fuchsite, muscovite, quartz, schist, hornblende, biotite schist and gneiss garnet, amphibolites, quartz sericite schist or quartz mica schist, banded magnetite quartzites (BMQ) and meta ultramafic.

These rocks are found as linear bodies within the PGC. The PGC, represented by hornblende-biotite gneiss and pink granite gneiss, occupies a major part. The Charnockite Group comprises the hilly terrain made up of charnockites. Pyroxene granulite and banded magnetite quartzites occur as narrow bands within the charnockite. Migmatite Complex is represented by biotite hornblende gneiss.

METHODOLOGY

A total of 30 samples have been collected randomly from Vythiri taluk (Figure 1), (Table 1). Pre-monsoon & Post-monsoon seasons from the various bore wells in the study region. Samples were taken from the bore wells of different sampling sites at a depth of 160-380 ft height from the ground level. The different sampling location has been assigned as sample points. Water is pumped out for a fair amount of time prior to the collection. Two Liters of



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the sample were collected in clean sterile polyethylene bottles and stored properly at (4°C) for further analysis. The collection, preservation, and analysis of various parameters of water samples from different sampling locations were carried out, by following the standard procedures given in the standard methods for the examination of water and wastewater (APHA 1998).

Volumetric titration techniques were used in the laboratory to measure the concentrations of calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), chloride (Cl), and sulfate (SO₄), whilst chloride concentrations were measured using an auto titrate (Metrohm Titranti, 2020). A spectrophotometer (Model No. 119) was used to evaluate sulfate content, while a flame-photometer (Model No. 128) was used to evaluate sodium and potassium concentrations. Blanks and standards were frequently run to verify the accuracy of the analyses. The ion balance error was also calculated to ensure that the results were accurate to within 5%. After the analysis was complete, WATCHIT software was used to analyze the data, and ARC GIS version (10.8) was used to create the varying thematic maps.

RESULT AND DISCUSSION**GROUNDWATER CHEMISTRY****Physical Parameters**

The findings of a statistical analysis of the physicochemical properties of samples of groundwater are displayed in Table.1. The pH of the research area's groundwater ranges between 8.15 and 5.9, with an average of 6.95, indicating that it is acidic, this low value of pH is to some extent the influences of fertilizers agriculture, certain rock interaction and plant decomposition (WHO, 1997; BIS, 2003). Groundwater's electrical conductivity ranges from 62.5 to 870.31 μS/cm. The TDS ranges from 40 to 557 mg/l. The major source for TDS is due to livestock waste, landfills and dissolved minerals, and iron and manganese.

Cation Hydrogeochemistry

Amongst the cations, Ca²⁺ is the dominant constituent and Ca²⁺>Mg²⁺>Na⁺>K⁺ is the dominance sequence of cations. Ca²⁺, Mg²⁺ vary between 0.82 to 159 mg/l, and 0.01 to 36.75 mg/l respectively and well within the safe limit (WHO, 1997; BIS, 2003). The Na⁺ in the study area that grades from 0.21 to 20 mg/l with an average of 6.82 mg/l; points out that Na⁺ content is within the permissible limit as prescribed by WHO (1997) and BIS (2003). The concentration of K⁺ in the study area ranges from 0.01 mg/l to 8 mg/l with an average of 2.15 mg/l.

Anion Hydrogeochemistry

In the groundwater samples HCO₃⁻ and SO₄²⁻ are prevailing dominant anions while Cl⁻ and NO₃⁻ are the other minor contributing anions with the dominance sequence HCO₃⁻>SO₄²⁻>NO₃⁻>Cl⁻. The HCO₃⁻ ranges from 0.01 to 70 mg/l, with an average of 7.07 mg/l. The occurrence of SO₄²⁻ in groundwater divulges anthropogenic contamination. In the present study the concentration of SO₄²⁻ has been found in the grade between 0.11 to 23 mg/l. The NO₃⁻ concentration shows its variation from 0 to 5 mg/l. The desired limit for Cl⁻ in potable groundwater is 200 mg/l (WHO, 1997), which can further be relaxed up to 1000 mg/l (permissible limit) for Indian conditions (BIS, 1991). The Cl⁻ content from the groundwater samples ranges from 0.01 mg/l to 108.4 mg/l. The groundwater samples are comes within desirable value of Cl⁻ as prescribed by WHO (1997).

Soluble sodium percentage (SSP)

The Soluble Sodium Percentage (SSP) is a key factor in determining sodium hazard. It is used to categorize irrigation water into two groups: soft and hard, with a high value denoting soft water and a low value denoting hard water. The higher soluble percentage has undeserved consequences in irrigation water due to the process of Base Exchange, which replaces the calcium cation primarily by the sodium cation in the soil, which in turns lowers the soil permeability (Y.A. Murkute 2023). The equation shown below is used to calculate the Soluble Sodium Percentage (S.S.P.) The rest of the analyzed samples in the study area were suitable for agricultural use; however, 1 of the





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samples are in the inappropriate group and cannot be irrigated. Therefore, the spatial distribution of the sodium ratio is slightly variable. Fig.2

$$\text{Na}\% = \frac{(\text{Na}^+ + \text{K}^+)}{(\text{Ca}^{2+} + \text{Mg}^{2+} + \text{Na}^+ + \text{K}^+)}$$

Thirty different groundwater samples from the study area have all been deemed acceptable and suitable for irrigation—Table 3. Greater concentrations of soluble sodium are visible on the spatial distribution map in the area of vythiri taluk.

Sodium adsorption ratio (SAR)

The suitability of irrigation quality of groundwater samples was evaluated by determining the Sodium adsorption ratio (SAR). It can be used to find out the degree to which irrigation water tends to enter into cation exchange reactions, undergo within the soil. If high amount of sodium present in the groundwater can have the tendency to replace the adsorbed calcium or magnesium in the aquifer, causes damage to soil structure and the soil becomes compact and impermeable (Todd 1980; Domenico and Schwartz 1990). The calculated SAR Values range from 0.01 to 1.94. Richard L. A. (1954), has classified ground water based on SAR and the classification criteria are presented in Table 4. Compared to the table value it's clear that all the water samples studied in all season's falls the low sodium class. Figure 3 shows that all the water samples studied in the study area fall under the excellent category for irrigation quality.

$$\text{SAR} = \text{Na} / \sqrt{((\text{Ca} + \text{Mg})/2)}$$

Corrosivity Ratio (CR)

The CR is the crucial parameter, which involves the anthropologically generated anions (Cl and SO_4^{2-}). Corrosion is a type of electrolysis in which metal surfaces are attacked and corroded away. Corrosion rates are affected by a number of chemical equilibrium reactions as well as physical factors such as temperature and flow velocity (Malpe, 2021). Groundwater with a corrosivity ratio of less than one is safe to transport in any type of pipe, while groundwater with a corrosivity ratio more than one is corrosive and should not be transported in metal pipes. The CR was calculated using the equation below.

$$\text{CR} = \frac{\left(\frac{\text{Cl}^-}{35} + \frac{\text{SO}_4^{2-}}{96}\right)}{\frac{\text{CO}_3^{2-} + \text{HCO}_3^-}{100}}$$

The study area groundwater samples showing 73.3% of the samples are low corrosivity ratio and that water can pass through metallic pipes without corroding them, but 26.6% of the water samples are showing greater corrosivity ratio, and water cannot be transported through copper pipes.

Magnesium Adsorption Ratio (MAR)

In water the concentration of magnesium exceeds over calcium, creates adverse effects on crop yield. Excess magnesium enhances the soil pH and affects its quality. Magnesium Adsorption Ratio (MAR) < 50 means water is suitable for irrigation and the MAR > 50, water is unsuitable for irrigation Paliwal, K. V. (1972). Seasonal variations of the MAR values of different locations are shown in the Table 6. The results reveals that 29 water samples are suitable for irrigation, MAR is in the range of 0.02meq/l to 47.29meq/l that means water is suitable for irrigation purpose, and Nedumbala area sample shows 53.08meq/l this is unsuitable for irrigation.

$$\text{MAR} = \text{Mg} \times 100 / (\text{Ca} + \text{Mg})$$

Permeability Index (PI)

The soil permeability is affected by long term use of irrigation water. Permeability Index (PI) is also used to determine the suitability of water for irrigation purpose. Table 6 shows the classification of Irrigation water based on permeability index (PI). Permeability is often measured in a saturated state. Permeability refers to the ability of a soil to transfer water. Long-term soil permeability will be affected by greater levels of ions such as sodium, calcium, and magnesium (Prמוד G et al., 2022). According to PI water is classified as three classes, class I hold 75 % or more of maximum permeability, class II is greater than 25% permeability and these two categories suitable for irrigation.





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Class III is less than 25% permeability and it considered as unsuitable for irrigation. Figure 7 illustrates that all the water samples tested in all seasons show class I category and PI is greater than 75% and is good for irrigation purpose.

$$PI = \frac{(Na + \sqrt{HCO_3})}{Ca + Mg + Na} \times 100$$

Kelly's ratio

Kelly's ratio was measured by sodium against calcium and magnesium (Pophare and Sadawarti, 2019). If the Kelly's index is larger than one, the salt content of the water is too high. When the Kelly's ratio is more than one, the water contains too much sodium (Promoda G et al 2022). The Kelly's ratio is less than one indicates water is suitable for irrigation and more than one indicates an excess level of sodium in water and that is unsuitable. From the Figure 6 it is clear that except one that is Veduvanchal area all the 29 groundwater sources are suitable for irrigation purposes, being $KR < 1$.

$$KR = \frac{Na^+}{Ca^{2+} + Mg^{2+}}$$

Residual Sodium Carbonate (RSC)

Residual Sodium Carbonate (RSC). The excess sum of carbonate and bicarbonate in groundwater over the sum of calcium and magnesium also influences the suitability of water for irrigation because in waters having high concentration of bicarbonate, there is tendency for calcium and magnesium to precipitate as the water in the soil becomes more concentrated. An excess quantity of sodium bicarbonate and carbonate is considered to be detrimental to the physical properties of soils, as it causes dissolution of organic matter in the soil, which in turn leaves a black stain on the soil surface on drying. Residual sodium carbonate (RSC) is the excess sum of $HCO_3^{3-} + CO_3^{3-}$ in water over the sum of $Ca^{2+} + Mg^{2+}$ (Eaton 1950) and is calculated using the equation.

$$RSC = (HCO_3^{-3} + CO_3^{-3}) - (Ca^{2+} + Mg^{2+})$$

Concentration is expressed in meq/L. Water containing excess of carbonate and bicarbonate tends to precipitate calcium and magnesium present in the soil as their carbonates. As a consequence, the relative proportion of sodium increases and gets fixed in the soil, thereby decreasing the soil permeability. A negative RSC indicates that sodium build-up is unlikely since sufficient calcium and magnesium are in excess of what can be precipitated as carbonates. Positive RSC indicates that sodium build-up in the soil is possible. If the RSC exceeds 2.5 meq/L, the water is unsuitable for irrigation, if RSC is between 1.25 and 2.5 meq/L, then the water is of marginal quality, and if $RSC < 1.25$, then the water is suitable for irrigation (Llyond and Heathcoat 1985). The RSC of the collected samples of Vythiri taluk is resulting 24 water samples are good for irrigation, 4 groundwater samples are medium (1.25-2.50 meq/l) water is marginally suitable for irrigation and can be used with certain water treatments and Mandad Panjayath and Nedumbala regions groundwater samples showing >2.50 meq/l RSC range which are unsuitable for irrigation. Fig.7.

Residual Sodium Bicarbonate (RSBC)

The RSBC of both of ground water was high due to the high content of HCO_3^{3-} of the sources. All the samples both of ground and surface water are very high alkaline water (> 10 meq l^{-1}) and plants suffer with alkaline hazard by using as irrigation (Gupta and Gupta, 1987). According to the RSBC values, all groundwater samples collected were found to be satisfactory (<5 meq/l) according to the criteria set by Gupta and Gupta (1987). The RSBC values are ≤ 5 meq/l and are therefore considered safe for irrigation purposes. Fig.8

CONCLUSION

The suitability of groundwater for irrigation was evaluated based on the irrigation quality parameters like SAR, %Na, RSC, RSBC, and permeability index. Among these parameters, SAR imply that the water samples fall in





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excellent to permissible, excellent to doubtful, excellent to good for irrigation purpose. RSC and RSBC values specify that water samples belong to good classes. The high EC value and percentage of Na in most of the groundwater indicate its unsuitability for irrigation. However, permeability index recommends that the water samples from longing to class 2, are suitable for irrigation.

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Table 1: Statistical analysis of Physio-Chemical Parameters of Pre-monsoon groundwater

Parameter	Unit	Max	Min	Mean	WHO (1997)				BIS (2003) IS:10500			
					Desirable limit (DL)	Permissible limit (PL)	% of samples > DL	% of samples > PL	Desirable (DL)	Permissible limit (PL)	% of samples > DL	% of samples > PL
pH	-	8.15	5.9	6.95	7.0-8.5	6.5-9.2	0.0	0.0	6.5-8.5	8.5-9.2	0.0	0.0
TDS	mg/l	557	40	208.77	500	1500	3.33	0.0	500	2000	3.33	0.0
EC	µs/cm	870.31	62.5	326.20	750	1500	3.33	0.0	-	-	-	-
Ca ⁺⁺	mg/l	159	0.82	48.065	75	200	26.66	0.0	75	200	26.66	0.0
Mg ⁺⁺	mg/l	36.75	0.01	11.55	30	150	3.33	0.0	30	100	10	0.0
Na ⁺	mg/l	20	0.21	6.82	50	200	0.0	0.0	-	-	-	-
K ⁺	mg/l	8	0.01	2.158	100	200	0.0	0.0	-	-	-	-
HCO ₃ ⁻	mg/l	70	0.01	7.070	200	600	0.0	0.0	200	600	0.0	0.0
Cl ⁻	mg/l	108.4	0.01	17.056	250	600	0.0	0.0	250	1000	0.0	0.0
SO ₄ ⁻	mg/l	23	0.11	3.46	200	600	0.0	0.0	200	400	0.0	0.0
NO ₃ ⁻	mg/l	5	0	1.1	-	50	-	0.0	45	100	0.0	0.0

Table2. Salinity Hazard (After Davis and De Weiest, 1966; Wilcox, 1955)

Salinity Hazard Classification	Remarks on quality	Number. of Samples	Percentage
C1	Excellent	20	6.66
C2	Good	10	3.33
C3	Doubtful	00	00
C4	Unsuitable	00	00





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Table 3. Soluble Sodium Percentage (SSP) classification (After Wilcox, 1955).

Water type	S.S.P. Range (%)	No. of samples	%
Excellent	<20	20	66.60
Good	20 – 40	8	26.60
Permissible	40 – 60	1	3.30
Doubtful	60 – 80	1	3.30
Unsafe	>80	0	00

Table 4. Sodium adsorption ratio (SAR)(After Abou-EI-Defan *et al.*, 2016)

Water type	Description	SAR range meq/l	No. of Samples	%
Excellent	Low sodium water	< 10	30	100
Good	Medium sodium water	10-18	0	0
Doubtful	High sodium water	18-26	0	0
Unsuitable	Very high sodium water	>26	0	0

Table 4. Corrosivity Ratio of the groundwater samples in the study area (after Balasubramanian and Nagaraju, 2019)

SI. No	Values meq/l	Remarks on quality	No. of samples	%
1	<1	Water transport in any type of pipe is entirely safe.	22	73.33
2	>1	Corrosive and should not be transported in metal pipes	8	26.66

Table 5. MAR Classification of the groundwater samples in the study area (after Gupta and Gupta, 1987)

MAR (%)	Water Quality	No. of samples	%
<50	Suitable for agriculture	29	96.66
>50	Unsuitable for agriculture	1	3.33

Table 6. Permeability Index (PI)(Doneen, 1964)

Class	Water type	No. of Samples	%
>75% (Class I)	Very Good for irrigation (G)	0	0
25-75% (Class II)	Good for irrigation(G)	7	23.33
<25% (Class III)	Unsuitable for irrigation (US)	23	76.66

Table 8. Kelly's Ratio (Kelly, 1940) of the groundwater samples in the study area

SI No	Values meq/l	Remarks on quality	Numbers of Samples	%
1	<1	Suitable for agriculture	29	96.66
2	>1	Unsuitable for agriculture	1	3.33





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Table 9. Residual Sodium Carbonate of the groundwater samples in the study area (after Abou-El-Defan et al., 2016)

Category	R.S.C. range (meq/l)	Water Quality	No. of samples
Good	< 1.25	Water probably safe for irrigation	24
Medium	1.25-2.50	Water is marginally suitable for irrigation and can be used with certain conducts.	4
Bad	>2.50	Water is unsuitable for irrigation purposes.	2

Table 10: RSBC Classification of the groundwater samples in the study area (after Abou –El- Defan et al., 2016)

SI.No	Category	R.S.B.C. range (meq/l)	No. of samples
1	Non-alkaline water	-value	30
2	Normal water	0-1	0
3	Low alkalinity water	1-2.5	0
4	Medium alkalinity water	2.5-5.0	0
5	High alkalinity water	5.0-10.0	0
6	Very high alkalinity water	>10.0	0

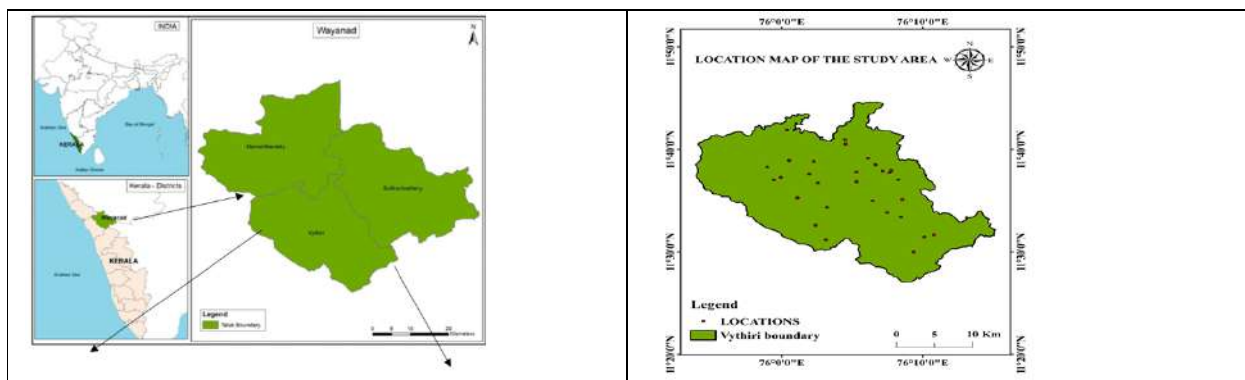


Fig.1 Location map of the study area

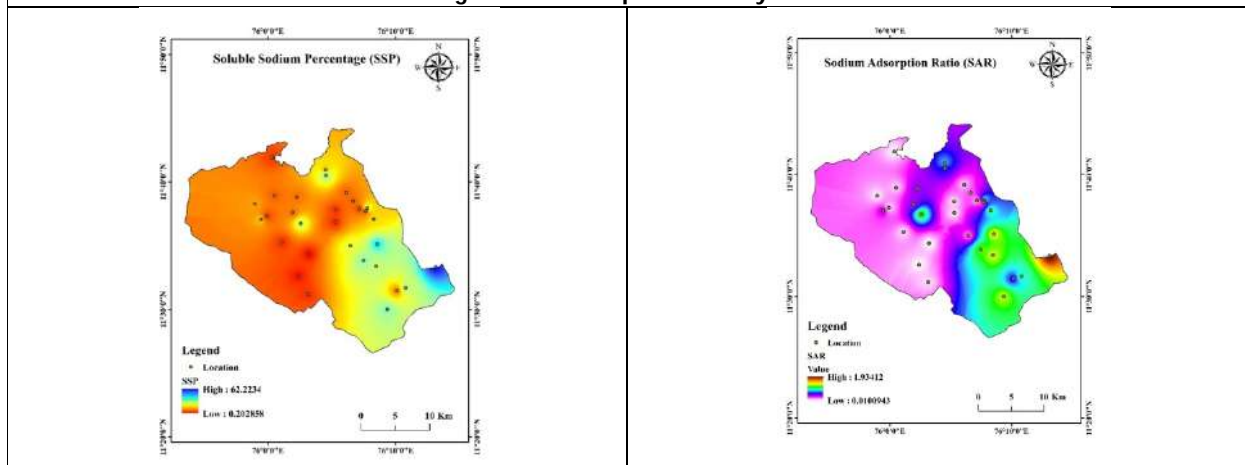


Fig. 2. Spatial distribution of Soluble Sodium Percentage (SSP)

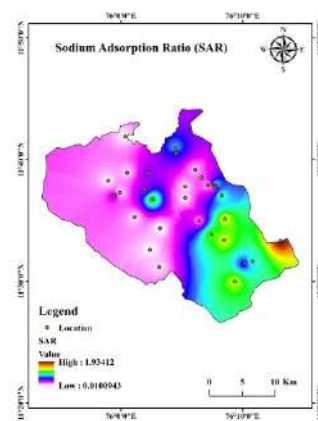


Fig. 3 Spatial distribution of SAR





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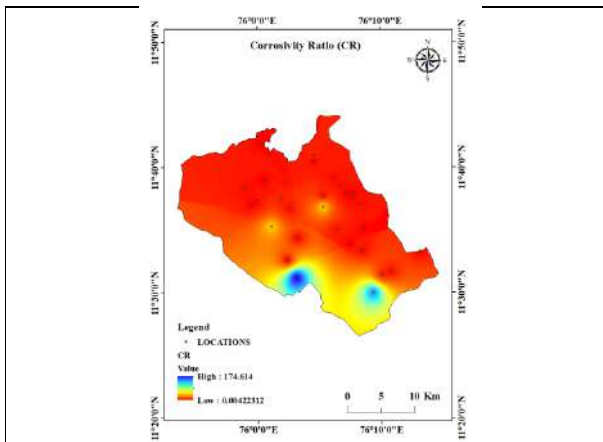


Fig 4. Spatial distribution of Corrosivity ratio (CR)

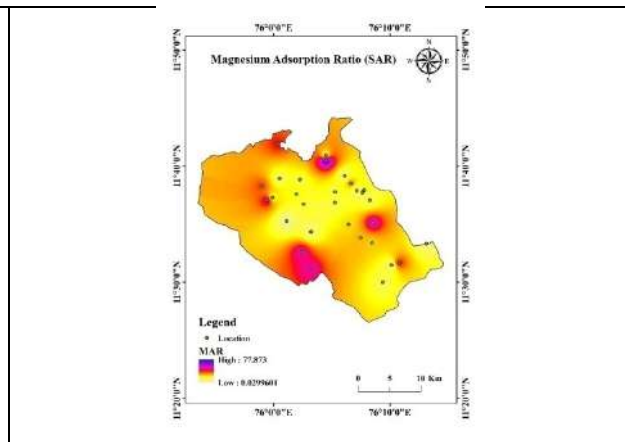


Fig 5. Spatial distribution of MAR

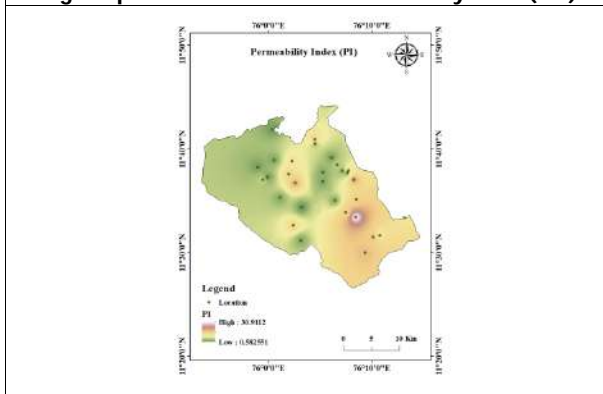


Fig 6. Spatial distribution of Permeability Index (PI)

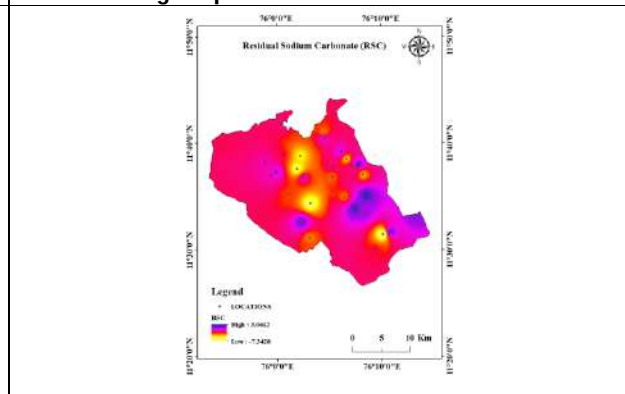


Fig 7. Spatial distribution of Residual Sodium Carbonate (RSC)

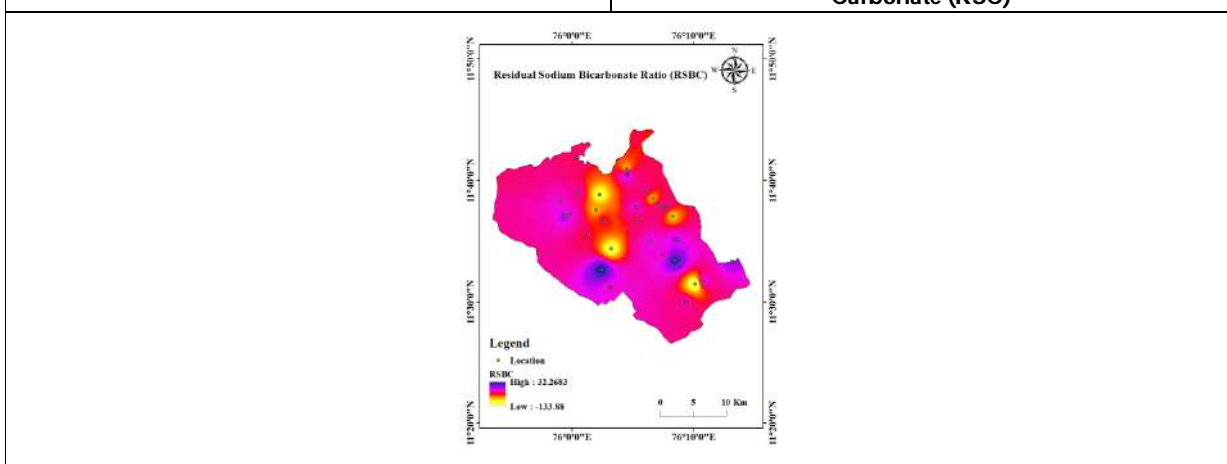


Fig 8. Spatial distribution of Residual Sodium Bicarbonate (RSBC)





A Critical Study on Neutrosophic Fuzzy Soft Matrix

Agnes Jenifa.A^{1*} and A. Sahaya Sudha²

¹Research Scholar, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Assistant Professor, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India

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*Address for Correspondence

Agnes Jenifa.A

Research Scholar,

Department of Mathematics,

Nirmala College for Women,

Coimbatore, Tamil Nadu, India

E.Mail: agnesasir@gmail.com



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ABSTRACT

This paper defines the different view on Neutrosophic soft set in Parikh field. Parikh set works as the transformation of words to numbers. Whereas the Neutrosophic set consists of truth membership, indeterminacy membership and false membership functions. Neutrosophic soft set has a parameter P in the Universal set along with the membership functions. In combining Parikh set and Neutrosophic soft set, a new set called Parikh Neutrosophic soft set emerges. New operations dealing with Parikh Neutrosophic soft set is defined. Specifically, a couple of product operations are developed. This Parikh Neutrosophic soft set is developed in the Parikh field. Some counter examples for its respective definitions and operations are illustrated.

Keywords: Soft set, Neutrosophic soft set, Neutrosophic soft matrix, Parikh matrix, Parikh Neutrosophic soft set.

INTRODUCTION

Periodically, researches face problems with uncertain and imprecise situations which cannot be solved using regular conditions. These uncertain cases are often considered with the support of fuzzy sets, intuitionistic fuzzy sets, Neutrosophic sets, etc., Fuzzy sets were introduced by Zadeh [15] to make solution for imprecise and uncertain cases in the year 1965. Fuzzy set is characterized by a membership function which assigns grades between zero and one. Atanassov [2] in the year 1986 gave the new concept of Intuitionistic fuzzy set which deals with truth and false membership functions. A soft set is a family of sets with parameters dealing with Universal set X. Maji, Biswas and





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Roy [8] defined the Soft set in the year 2001. Molotov [12] gave the concept of Soft set theory and its first result in the year 1999. Again, a parameterized family of sets with uncertain cases is studied in Fuzzy soft set which was developed by Maji, Biswas and Roy in the year 2001 [9]. The satisfactory evaluation of membership values is not always possible because of the insufficiency in the available information situation. Maji, Biswas and Roy introduced the Intuitionistic fuzzy soft set to make the set in the truth and false membership function basis in the year [10].

Matrices play a major role in the field of science and engineering. Sometimes, the Classical matrix theory may go wrong to solve the problems which have uncertainties. Therefore, numerous authors developed the matrix representation of soft set, fuzzy soft set, and intuitionistic soft set. Soft matrix theory and its decision-making problems are studied by Cagman and Enginoglu [5] in the year 2010. Even though, the evaluation of non-membership values sustains. To overcome this, Neutrosophic set was introduced by Smarandache which is a generalization of classical sets, fuzzy sets and intuitionistic fuzzy sets. Using this, Neutrosophic soft set arises solving indeterminate cases with parameters. Deli and Broumi [7] discussed the Neutrosophic soft relations and some of their properties during the year 2015. In the year 2016, Bera and Mahapatra [3] introduced the abstraction of Neutrosophic soft groups. And in the same year, Bera and Mahapatra [4] gave the Neutrosophic normal soft groups. Bera and Mahapatra [14] in the year 2017 studied Neutrosophic soft Matrix and its application to Decision making problems. In advance to these, Neutrosophic soft Matrices and its NSM- decision making problems are defined by Deli and Broumi [6].

A compulsive tool emerges named ad Parikh matrix which was given by Mateescu et al in the year 2000. The Parikh Mapping also called as Parikh vector is an important presentation in the theory of formal languages which had led to some interesting outcomes. An extension of Parikh matrix from Parikh mapping was based on some types of matrices. Subramanian, Huey and A.K. Nagar [13] defined the Parikh Matrices during the year 2009. The attractive feature of the Parikh matrices is that it contains Classical Parikh vector as the following diagonal. On the injectivity of the Parikh matrix mapping was given by Atanasiu and Martin-Vide [1] in the year 2001. Although, the Parikh matrix mapping is still not injective, two words with same Parikh vector have in many cases different Parikh matrices and thus the Parikh matrices gives more information about a word than a Parikh Vector does. In the year 2001, Mateescu, Salomaa and Yu [11] gave an article called A Sharpening of the Parikh Mapping.

Here the combination of Parikh set and Neutrosophic soft set resulting Parikh Neutrosophic soft set is defined. And the respective operations defining couple of product operations are studied. This Parikh Neutrosophic soft set is developed in the Parikh field. Numerical illustrations are provided for its respective definitions and operations

Preliminaries

2.1. Soft set:[12]

Let S be an initial universe set and P be a set of parameters. Let $P(S)$ denote the power set of S . Then for $A \subseteq P$, a pair (X, A) is called a soft set over S , where $X: A \rightarrow P(S)$ is a mapping.

2.2. Neutrosophic Fuzzy set:[7]

Let σ represents a universe set and a Neutrosophic fuzzy set N over the σ . Then, the Neurosophic set N can be described as follows.

$$N = \{ \langle p, (\alpha(p), \beta(p), \gamma(p)) \rangle : p \in \sigma \}$$

Where $\alpha(p)$, $\beta(p)$ and $\gamma(p)$ are represented three membership functions: truth, indeterminacy and false of element p respectively. Those membership functions are respectively described by

$$\alpha: \sigma \rightarrow]-0, 1+[, \beta: \sigma \rightarrow]-0, 1+[, \gamma: \sigma \rightarrow]-0, 1+[$$

such that $0 - \leq \alpha(p) + \beta(p) + \gamma(p) \leq 3$.





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Neutrosophic soft set: [7]

Let σ represents a universe set and a Neutrosophic fuzzy set N over the σ . Then, the Neurosophic set N can be described as follows.

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$$\alpha : \sigma \rightarrow]-0, 1 +[, \beta : \sigma \rightarrow]-0, 1 +[, \gamma : \sigma \rightarrow]-0, 1 +[$$

such that $0 - \leq \alpha (p) + \beta (p) + \gamma (p) \leq 3$.

Neutrosophic soft set: [7]

Let σ be an initial universe set and P be a set of parameters. Let $NS(U)$ denote the set of all Neutrosophic soft sets of σ . Then for $A \subseteq P$, a pair (X, A) is called an Neutrosophic Soft Set over N , where $X: A \rightarrow NS(U)$ is a mapping.

Neutrosophic soft matrix:[6]

Let σ be a neutrosophic soft set over $NS(U)$. Then a subset of $NS(U) \times P$ is uniquely defined by:

$$GN = \{(fN(x), x) : x \in P, fN(x) \in NS(\sigma)\},$$
 which is called a relation form.

The characteristic function of GN is written as:

$$\theta GN : NS(U) \times P \rightarrow [0, 1] \times [0, 1] \times [0, 1]$$
 by

$$\theta GN(\sigma, x) = (TfN(x)(\sigma), FfN(x)(\sigma), IfN(x)(\sigma)),$$

where $TfN(x)(\sigma)$, $FfN(x)(\sigma)$, $IfN(x)(\sigma)$ are truth-membership, indeterminacy-membership and falsity-membership of $\sigma \in \sigma$, respectively.

If $a_{ij} = \theta GN(\sigma_m, x_m)$, we can define matrix,

$$[a_{ij}]_{m \times n} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nm} \end{bmatrix}$$

which is called an $m \times n$ neutrosophic soft matrix of the soft set (F, P) over

universal set.

Parikh matrix: [13]

Let $\Sigma = \{a_1 < a_2 < \dots < a_k\}$ be an ordered alphabet. The parikh matrix mapping is the morphism

$$\Psi_k : \Sigma^+ \rightarrow M_{k+1},$$
 defined by the condition $\Psi_k(\lambda) = I_{k+1}$

and if $\Psi_k(a_q) = (m_{ij})_{i,j < 1, j < (k+1)}$, then for each

$$1 \leq i \leq (k + 1) = \begin{cases} m_{i,j} = 1 \\ m_{q,q+1} = 1 \end{cases},$$
 all other elements of the matrix $\Psi_k(a_q)$ are 0.

For a word $w = a_{i1}, a_{i2}, \dots, a_{im}, a_{ij} \in \Sigma$ for $1 \leq j \leq m$, we have $\Psi_k(w) = \Psi_k(a_{i1}) \Psi_k(a_{i2}) \dots$

$$\Psi_k(a_{im}).$$

In other words, $\Psi_k(w)$ is computed by multiplication of matrices and the triangle matrix

$\Psi_k(w)$ is called the Parikh matrix of w .





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Parikh Neutrosophic Fuzzy Soft Set

Definition:

Let (FA, P) be a Parikh soft set over σ . Then a subsets of $\sigma \times P$ is uniquely defined by $GN = \{(\sigma, e): e \in A, u \in FA(e)\}$

$GN1 = \{(\sigma m, xm): e \in A, u \in FA(e) \ \& \ m: 1 - n\}$, which is called a relation form of (FA, E) . The characteristic function of RA is written by,

$$\theta GN : \sigma \times P \rightarrow \{0,1\}.$$

If $a_{ij} = \theta GN(\sigma m, xm)$: we can define a matrix,

$$[a_{ij}]_{m \times n} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nm} \end{bmatrix} \text{ also } a_{ij} = \theta,$$

Whenever $i > j$, which is called an $m \times n$ Parikh soft matrix of the soft set (FA, P) over Universal set.

Example:

Assume alphabets be the universal set $A = \{A1, A2, A3, \dots\}$. Let the parameters be the letters of the word. Here we have the word "CAT"

The corresponding Parikh Neutrosophic soft matrix is, Arrange the word CAT in alphabetical order, i.e.

A<C<T

$$C \times A \times T = \begin{bmatrix} (1,0,0) & (0) & 0 & 0 \\ 0 & (1,0,0) & (1,0,0) & 0 \\ 0 & 0 & (1,0,0) & (1,0,0) \\ 0 & 0 & 0 & (1,0,0) \end{bmatrix} \times \begin{bmatrix} (1,0,0) & (1,0,0) & 0 & 0 \\ 0 & (1,0,0) & 0 & 0 \\ 0 & 0 & (1,0,0) & (1,0,0) \\ 0 & 0 & 0 & (1,0,0) \end{bmatrix} \times \begin{bmatrix} (1,0,0) & 0 & 0 & 0 \\ 0 & (1,0,0) & 0 & 0 \\ 0 & 0 & (1,0,0) & (1,0,0) \\ 0 & 0 & 0 & (1,0,0) \end{bmatrix}$$

$$= \begin{bmatrix} (1,0,0) & 0 & (1,0,0) & (1,0,0) \\ 0 & (1,0,0) & 0 & (1,0,0) \\ 0 & 0 & (1,0,0) & (1,0,0) \\ 0 & 0 & 0 & (1,0,0) \end{bmatrix} \times \begin{bmatrix} (1,0,0) & 0 & 0 & 0 \\ 0 & (1,0,0) & 0 & 0 \\ 0 & 0 & (1,0,0) & (1,0,0) \\ 0 & 0 & 0 & (1,0,0) \end{bmatrix}$$

$$CAT = \begin{bmatrix} (1,0,0) & (1,0,0) & 0 & 0 \\ 0 & (1,0,0) & (1,0,0) & 0 \\ 0 & 0 & (1,0,0) & (1,0,0) \\ 0 & 0 & 0 & (1,0,0) \end{bmatrix}$$





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Properties of Parikh Neutrosophic Soft Matrix

Let $[a_{ij}] \in \text{PNSM}_{m \times n}$. (PSNM denotes Parikh Neutrosophic Soft Matrix). Then $[a_{ij}]$ is called,

- i. A zero Parikh Neutrosophic soft matrix, which is denoted by $[0]$, but $a_{ij} = 1$ when $i = j$, for all i and j .
- ii. A universal Parikh Neutrosophic soft matrix, denoted by $[a_{ij}]$, if $a_{ij} = 1$ for all $j \in I_A = \{j: e_j \in A\}$ and i .
- iii. A universal Parikh Neutrosophic soft matrix, denoted by $[1]$, if $a_{ij} = 1$ for all i and j .

Operators of Parikh Neutrosophic Soft Matrix

Let $[a_{ij}], [b_{ij}] \in \text{PNSM}_{m \times n}$. Then the Parikh soft matrix $[c_{ij}]$ is called,

1. Union:

Union of $[a_{ij}]$ and $[b_{ij}]$, denoted $[a_{ij}] \cup [b_{ij}] = [c_{ij}]$ if $[c_{ij}] = \max [a_{ij}, b_{ij}]$ for all i and j .

2. Intersection

Intersection of $[a_{ij}]$ and $[b_{ij}]$, denoted $[a_{ij}] \cap [b_{ij}] = [c_{ij}]$ if $[c_{ij}] = \min [a_{ij}, b_{ij}]$ for all i and j .

3. Complement

Complement of $[a_{ij}]$, denoted by $[a_{ij}]^c = [c_{ij}]$, if $c_{ij} = 1 - [a_{ij}]$ for all i and j .

4. Permutation:

While any $S \in \text{PNSM}_{5 \times 5}$ Neutrosophic parikh soft matrix is arranged according to any $\pi \in S_5$ permutation group, the elements in each row of the soft matrix are displaced according to the given π . Obtained matrix will be shown with S_π .

Example:

$$\text{Let } S = \begin{bmatrix} (1,0,0) & 0 & 0 & (1,0,0) & 0 \\ 0 & (1,0,0) & (1,0,0) & 0 & 0 \\ 0 & 0 & (1,0,0) & (1,0,0) & 0 \\ 0 & 0 & 0 & (1,0,0) & 0 \\ 0 & 0 & 0 & 0 & (1,0,0) \end{bmatrix}$$

and $\pi = (13542)$.

The elements of each row of soft matrix are displaced according to $1 \rightarrow 3 \rightarrow 5 \rightarrow 4 \rightarrow 2 \rightarrow 1$ to arrange soft matrix according to π permutation. The first row arranged is 01000. If the same operation applied to each row

$$S_\pi = \begin{bmatrix} 0 & (1,0,0) & 0 & 0 & 0 \\ 0 & 0 & 0 & (1,0,0) & 0 \\ (1,0,0) & 0 & 0 & (1,0,0) & 0 \\ (1,0,0) & (1,0,0) & 0 & 0 & (1,0,0) \\ 0 & 0 & (1,0,0) & 0 & 0 \end{bmatrix} \text{ matrix is obtained.}$$

Product

Here we give two types of Products for parikh Neutrosophic Soft matrix namely Parikh Neutrosophic soft difference product and parikh Neutrosophic Soft restricted difference product.





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4.1. Parikh Neutrosophic soft difference product:

Let FA and GA be the two parikh Neutrosophic soft set over the universal set. Then the difference product is denoted by $FA \setminus GA = HB$. Where HB is a PNSM. It is defined as

$$H(x) = F(x) \setminus G(x).$$

4.2. Parikh Neutrosophic Soft restricted difference product:

Let $FA [a_{ij}], GA [b_{ij}] \in \text{PNSM}^{m \times n}$. Then the restricted difference product $IB = \{j: e_j \in\}$ of FA and GA is denoted by $FA \setminus_r GA = c_{ij} \in \text{PNSM}^{m \times n}$.

$$\text{It is defined as } [c_{ij}] = \begin{cases} \min\{a_{ij}, 1 - b_{ij}\} & \text{if } j \in I_B \\ 0 & \text{if } j \notin I_B \end{cases}$$

CONCLUSION

In this article, Parikh Neutrosophic soft set is introduced and developed. Their definitions and its significant operations are included. Operations consists a pair of product operators. Numerical illustrations for these respective definitions and operations are defined. This can be extended to Cryptosystem field. All our social media platforms are recently losing in secure system. So, we secure our words using this different way.

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Applying AHP in Analysis of Power Generation of Windmills in Different Seasons

M C Rahinipriya^{1*} and A.Sahaya Sudha²

¹Research Scholar, Nirmala College for Women, Coimbatore, Tamil Nadu, India

²Assistant Professor, Nirmala College for Women Coimbatore, Tamil Nadu, India

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*Address for Correspondence

M C Rahinipriya

Research Scholar,

Nirmala College for Women,

Coimbatore, Tamil Nadu, India,

E.Mail: rahinipriya5071@gmail.com



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ABSTRACT

MCDM has been widely applied in various decision-making process, In this paper a case study of seasonal weather effects on wind turbine power generation in a season is taken. Four-season power generation data has been collected in order to better understanding the seasonal power generation. An analysis of four seasons is presented in this paper. The wind production during the winter being considerably higher than other seasons.

Keywords: AHP, MCDM, Ranking, pairwise comparison, Normalized matrix, Eigen value

INTRODUCTION

Multi-Criteria Decision Making (MCDM) is a general class of operations research models, which considers problems in decision making in the presences of many decision criteria. There are two types of the MCDM; MODM (Multi-Objective Decision Making) and MADM. (Multi-Attribute Decision Making) MODM usually involves maximization of mathematical problems involving function that is more objective. MADM is an approach developed for selecting the best criteria or alternative(s) This is used in decision-making problems involving a number of options for making decisions. This model is based on the list of criteria that has been selected, its parameters, and the variables that one wishes to track during the decision-making process. A minimum number of choices have been chosen using the MCDM category. There are numerous additional techniques that are employed in MADM, including Analytical Hierarchy Process (AHP), Simple Additive Weighting (SAW), Ordered Weighted Averages (OWA), Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS), Elimination by Choice Translating Reality (ELECTRE), Decision Trial and Evaluation Laboratory (DEMATEL), Simple Multi Attribute Rating Technique (SMART).





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LITERATURE REVIEW

This paper is aimed to suggest a fresh approach for decision support enabling effective supplier selection processes in electronic marketplaces by A.M. Cox, J. Alwang and T.G. Johnson [1]. In this paper we argue that there should be no conflict between the objective of a multicriteria analysis and that of maximizing the wealth of the firm. They introduce a framework of analysis in which a decision maker's judgments concerning the intangible and difficult-to-quantify criteria are given economic value developed by Boucher T. O, and Mc. Stravic E.L.[2], This paper is to demonstrate how critics can mislead themselves and others in pursuing examples and ideas that draw false conclusions was introduced Chamodrakas, I,Batis,D,and Martakos, D [5] Remarks on the Analytic Hierarchy Process by Dyer J.S [4] represents an accurate approach to quantifying the weights of decision criteria. Individual experts' experiences are utilized to estimate the relative magnitudes of factors through pair-wise comparisons Dagdeviren and Yuksel[6].In the present paper an empirical study was conducted to find out the relative importance of the factors affecting the quality of service in the hotel industry of NCR in India by Deng. H [7]. Propose a methodology for risk and opportunity assessment of international projects. The proposed model uses an analytic hierarchy process for calculation of risk and opportunity ratings was Dikmen I., TalatBirgonul M. (2006)[8]. Remarks on the Analytic Hierarchy Process developed by Dyer J.S[9]. A critique of the Analytic Hierarchy Process", International Journal of Industrial Engineering, Working paper introduced by Dyer J.S[10]. Multi-criteria analysis with pair-wise comparison is found and weights are introduced" by Deng. H[12]. The Analytic Hierarchy Process for decision making in engineering applications some challenges"given by Evangelos Triantaphyllou, Mann. H.[13]. A decision support system for selecting convenience store location through integration of fuzzy AHP and artificial neural network introduced by R.J. Kuo, S.C. Chi and S.S. Kao[14].Application of Analytical Hierarchy Process in Industries developed by hashikant Tamrakar, Dr. Ajay Tiwari, Praveen Tandon[17]. Multiple criteria decision making developed by ZelenyM [19].

AHP METHOD

The analytic hierarchy process (AHP), is a structured method for gathering and analysing difficult decisions that is based on both mathematics and psychology. AHP was created in the Year 1970s by Thomas L. Saaty; in 1983,[15][16] he collaborated with Ernest Forman to create the software Expert Choice, and since then, it has undergone substantial research and development. It represents a precise method for determining the relative importance of the various decision-making factors.[19] The relative magnitudes of factors are estimated using pair-wise comparisons based on the experiences of individual experts. Using a unique questionnaire, each respondent compares the relative weight of each pair of items [12].

PRELIMINARIES

CONSISTENCY INDEX[15]

The consistency ratio is calculated by AHP by comparing the matrix's consistency index to a random matrix.. As a result, it is anticipated to be very erratic.

$$CI = \frac{\lambda_{max} - n}{n-1}$$

CONSISTENCY RATIO [15]

The consistency ratio (CR) or the size of the matrix used to calculate the deviation from pure inconsistency quantifies this distance. According to Saaty, it is the ratio of an individual consistency index to the mean consistency index across a sizable sample of randomly produced matrices.

$$CR = \frac{CI}{RI}$$

RANKING [16]

These detected CSFs(Critical success factors) were compared and ranked using the analytical hierarchy process (AHP), one of the most popular methodologies for decision making in the face of many criteria. According to the study's findings, resistance hurdles are more significant than planning and technological ones.





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PAIRWISE COMPARISON[7]

A process for ranking or choosing from a group of alternatives by comparing them against each other in pairs[12]

$$\lambda_{max} = \frac{1}{m} \sum_{j=1}^m \frac{(AW)_j}{W_j}$$

Where j=1,2,...n

NORMALIZED MATRIX [13]

The process of establishing relationships between criteria will make use of the normalising matrix. Using the analytical hierarchy process (AHP) method, relationships between criteria will be created. On the basis of comparing criteria pair values, AHP is used to determine the ratio scale.

$$N.M = b_{jk} = \frac{a_{jk}}{\sum_{i=1}^m a_{ik}}$$

Where i,j,k=1,2,3...n

ALGORITHM FOR PROPOSED METHOD

To make a decision in an organised way to generate priorities we need to decompose the decision into the following steps.

Step 1: Define the Decision problem

Step 2: A series of pair-wise comparisons are carried out among the elements at the same level in the next higher level using Saaty’s nine-point scale which is listed below, and judgment matrices are formulated for all evaluation criteria. The pair-wise comparisons of various criteria generated say matrix A.

Step 3: The next step involves the comparison matrix A and transforming it into matrix B, for calculating average

$$b_{jk} = \frac{a_{jk}}{\sum_{i=1}^m a_{ik}}$$

Where i,j,k=1,2,3,...n

Step 4: Then calculate eigenvector w=w_j, which is known as the criteria weight vector w

$$W_j = \frac{\sum_{i=1}^m b_{i1}}{m}$$

Where i,j=1,2,3,...n

Step 5: The pair wise comparisons of various criteria generated at step 4, Based on the calculated Value the maximum eigen values are calculates using the below equation

$$\lambda_{max} = \frac{1}{m} \sum_{j=1}^m \frac{(AW)_j}{W_j}$$

Where j=1,2,3,...n

Step 6: The consistency of the matrix of order m is evaluated. The AHP incorporates an effective technique for checking the consistency of the evaluations when building each of the pair wise comparison matrices involved in the process. For checking the consistency of matrix, calculate the Consistency Index (CI) as

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

Step 7: Consistency ratio (CR), which can be calculated as the ratio of the consistency index (CI) of the matrix to the consistency index of a random index (RI). The value of RI takes from the Consistency indices for a randomly generated matrix.

$$CR = \frac{CI}{RI}$$





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Linguistic Variables

Verbal preference assessment	Numerical Rating	Range
Low power Generation	1	1000-1500
Medium power Generation	3	1501-2500
Moderate power Generation	5	2501-3500
High power generation	7	3501-4500
Very high-power generation	9	4501-5500
Intermediate values	2,4,6,8	

Step 1: Table1.Decision problem

Step 2: The above linguistic variables is converted into pairwise comparison matrix for making pairwise comparison for each criterion comparing with seasons and selecting best one is given below(Table 2)

Step 3: Sum value in each column of pair wise comparison matrix is divided by its column total to compute Average is given below (Table3)

Step 4: Divide each sum vector elements by associated priority column value to compute weight sum is given below (Table 4),

Step 5: Dividing weight sum element by associated priority value to find λ_{max} is given below

Calculation:

$$SPRING = (1.000 \times 0.059246) + (0.143 \times 0.482801) + (0.200 \times 0.313849) + (0.333 \times 0.144104)$$

$$= \frac{0.239022}{0.059246}$$

$$= 4.034403$$

Similarly,

$$\lambda_{max}(SUMMER) = 4.054533$$

$$\lambda_{max}(AUTUMN) = 4.090469$$

$$\lambda_{max}(WINTER) = 4.076170$$

$$\lambda_{max} = (4.034403 + 4.054533 + 4.090469 + 4.076170) = 4.063894$$

Step6: consistency index

$$CI = \frac{(\lambda_{max} - n)}{(n-1)}, \text{ Where } n=4$$

$$CI = \frac{(4.063894 - 4)}{(4-1)}$$

$$= 0.021298$$

Step7: consistency Ratio

$$CR = \frac{CI}{RI}$$

$$= \frac{0.021298}{0.89} \text{ (Since } n=4, RI=0.89)$$

$$= 0.0239303$$

Since $CR < 0.1$, the Consistency is Acceptable.

Step 8: For developing overall priority Ranking we need to find Normalized pairwise comparison matrix is given below





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Step 9: For considering overall Ranking, we should multiply each row in Normalized pair wise comparison matrix with respected weights are $W_1 = 0.059246$, $W_2 = 0.482801$, $W_3 = 0.313849$, $W_4 = 0.144104$

Calculation:

Spring $= (1 \times 0.059246) + (1.178089 \times 0.482801) + (1.086957 \times 0.313849) + (1.086957 \times 0.144104) = 1.113273$

Summer $= (1.621476 \times 0.059246) + (1 \times 0.482801) + (1.02913 \times 0.313849) + (1.657258 \times 0.144104) = 1.140676$

Autumn $= (2.382124 \times 0.059246) + (1.744372 \times 0.482801) + (1.738261 \times 0.313849) + (1.742832 \times 0.144104) = 1.780016$

Winter $= (3.258548 \times 0.059246) + (2.768884 \times 0.482801) + (1 \times 0.313849) + (1.72043 \times 0.144104) = 2.091646$

From above table we conclude that WINTER season Generates more power. then the other Seasons.

CONCLUSION

In this paper a short review of Multi-criteria Decision Making (MCDM), and Analytic Hierarchy Process (AHP) is discussed. It was observed that, Analytic Hierarchy Process (AHP) method is suitable for ranking and analysing complex decision-making problems. AHP is also regarded as one of perfect and easiest method under MCDM because it is easy to use and makes room for checking and reducing inconsistencies in opinion(s), In this study it has been found that maximum power generations during winter season in the wind mills we found that the best season in production of power in windmills.

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Table 1. Decision problem

SEASONS	SPRING	SUMMER	AUTUMN	WINTER
SPRING	1667	2355	2500	2232
SUMMER	2703	1999	2367	3699
AUTUMN	3971	3487	3998	3890
WINTER	5432	5535	2300	3840

Table 2. Pairwise comparison matrix

SEASON S	SPRING	SUMMER	AUTUMN	WINTER
SPRING	1.000	0.143	0.200	0.333
SUMMER	7.000	1.000	2.000	3.000
AUTUMN	5.000	0.500	1.000	3.000
WINTER	3.000	0.333	0.333	1.000

Table 3 Calculation of Average

SEASONS	SPRING	SUMMER	AUTUMN	WINTER	AVERAGE
SPRING	1.000	0.143	0.200	0.333	0.312394
SUMMER	7.000	1.000	2.000	3.000	2.54573
AUTUMN	5.000	0.500	1.000	3.000	1.654875
WINTER	3.000	0.333	0.333	1.000	0.759836
SUM					5.272835

Table 4 Calculation of weights

SEASON S	SPRING	SUMMER	AUTUMN	WINTER	AVERAGE	WEIGHTS
SPRING	1.000	0.143	0.200	0.333	0.312394	0.05924593
SUMMER	7.000	1.000	2.000	3.000	2.54573	0.48280097
AUTUMN	5.000	0.500	1.000	3.000	1.654875	0.31384928
WINTER	3.000	0.333	0.333	1.000	0.759836	0.14410382
sum					5.272835	$\sum W = 1$





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Table 5 Calculation of λ_{max}

SEASON S	SPRING	SUMMER	AUTUMN	WINTER	WEIGHTS	
SPRING	1.000	0.143	0.200	0.333	0.059246	4.034403
SUMMER	7.000	1.000	2.000	3.000	0.482801	4.054533
AUTUMN	5.000	0.500	1.000	3.000	0.313849	4.090469
WINTER	3.000	0.333	0.333	1.000	0.144104	4.076170

$\lambda_{max} = 4.063894$

Table 6 Normalized pairwise comparison matrix

SPRING	1	1.178089	1.086957	1
SUMMER	1.621476	1	1.029138	1.657258
AUTUMN	2.382124	1.744372	1.738261	1.742832
WINTER	3.258548	2.768884	1	1.72043

Table 7 Rating of the seasons

SPRING	1.113273	4
SUMMER	1.140676	3
AUTUMN	1.780016	2
WINTER	2.091646	1





Interval Valued Pythagorean Fuzzy Prime Ideals of BCK-Algebras

M.Dhanapackiam^{1*} and M.Trinita Pricilla²

¹Research Scholar, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

M.Dhanapackiam

Research Scholar,

Department of Mathematics,

Nirmala College for Women,

Coimbatore, Tamil Nadu, India.

E.Mail: dhanapackiam2126@gmail.com



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ABSTRACT

In this paper, Defines the notion of Interval valued Pythagorean fuzzy prime ideals in BCK-algebras and investigated some of their properties.

Keywords: BCK-Algebra, IVPF Ideal, IVPF Prime Ideal.

INTRODUCTION

Zadeh[15] Introduced the concept of fuzzy set. Atanassov [1] proposed the concept of Intuitionistic fuzzy set. Yager. R.R[13,14] developed the concept of Pythagorean Fuzzy set which is a generalisation of IFS. In 1996, Imai and Iseki introduced two classes of abstract algebras, BCK-algebras and BCI algebras [4,5]. BCI algebras are generalizations of BCK-algebra[4,5]. In 1999, Jeong [9,10,11,12] applied the Biswas concept to BCK-algebras so he defined the notion of Anti fuzzy prime ideal of BCK-algebras and in this paper we introduced Interval Valued Pythagorean Fuzzy Prime Ideals and investigate some related properties.

PRELIMINARIES

Definition 2.1:[8] By a BCK-algebra a non empty set X with a binary operation $*$ and a constant 0 satisfying the following conditions





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- (i) $((x * y) * (x * z)) * (z * y) = 0,$
- (ii) $(x * (x * y)) * y = 0,$
- (iii) $x * x = 0$
- (iv) $0 * x = 0$
- (v) $x * y = 0$ and $y * x = 0$ imply that $x = y$, for all $x, y, z \in X$.

A partial ordering " \leq " on X can be defined by $x \leq y$ if and only if $x * y = 0$.

Definition 2.2: [8] A subset I of a BCK-algebra $(X, *, 0)$ is called an ideal of X , if for any $x, y \in X$

- (i) $0 \in I$
- (ii) $x * y$ and $y \in I \Rightarrow x \in I$

Definition 2.3: [3,4] An Ideal I of BCK-algebra $(X, *, 0)$ is called closed ideal, if $0 * x \in I$ and $x \in I$.

Definition 2.4: [7] An Ideal of commutative BCK-algebras X is said to be prime if $x \wedge y \in I$ implies $x \in I$ and $y \in I$.

Definition 2.5: [8] A fuzzy Ideal $[\zeta_A^L, \zeta_A^U]$ of commutative algebra X is called anti fuzzy Prime Ideal of X if

$$\zeta_A^L(x \wedge y) \geq \min\{\zeta_A^L(x), \zeta_A^L(y)\}$$

$$\zeta_A^U(x \wedge y) \geq \min\{\zeta_A^L(x), \zeta_A^L(y)\}$$

for all $x, y \in X$

Definition 2.6: [9,10] If X is a fixed set, then a PFs can be defined as

$A = \{ \langle x, \zeta_A(x), \eta_A(x) \rangle / x \in X \}$ where $\zeta_A(x)$ and $\eta_A(x)$ are mappings from

$\zeta_A(x) : X \rightarrow [0,1]$ and $\eta_A(x) : X \rightarrow [0,1]$ such that $0 \leq \zeta_A(x) \leq 1$ and $0 \leq \eta_A(x) \leq 1$ and

$0 \leq ((\zeta_A(x))^2 + (\eta_A(x))^2) \leq 1$ and for all $x \in X$ and represent the degree of membership and

degree of non-membership element $x \in X$ to set A . Let $\pi_A(x) = \sqrt{1 - (\zeta_A(x))^2 + (\eta_A(x))^2}$ then

it is said to be Pythagorean fuzzy set index element $x \in X$ to set A , represent the degree of

indeterminacy of x to A . also, $0 \leq \pi_A(x) \leq 1$ for every $x \in X$.

Definition 2.7: [2] Let X be a BCK-algebra. An Interval valued Pythagorean fuzzy set

$A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ of BCK-algebra X is called an IVPF Sub-algebra of X if it

satisfies,

$$\zeta_A^L(x * y) \geq \min(\zeta_A^L(x), \zeta_A^L(y))$$

$$\zeta_A^U(x * y) \geq \min(\zeta_A^U(x), \zeta_A^U(y))$$

$$\eta_A^L(x * y) \leq \max(\eta_A^L(x), \eta_A^L(y))$$

$$\eta_A^U(x * y) \leq \max(\eta_A^U(x), \eta_A^U(y))$$

for all $x, y \in X$.

Definition 2.8: [2] An Interval Valued Pythagorean Fuzzy set $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ in

X is called Interval Valued Pythagorean Fuzzy Ideal of X , if it satisfies the following axioms

$$\left. \begin{aligned} \zeta_A^L(0) \geq \zeta_A^L(x) \text{ and } \eta_A^L(0) \leq \eta_A^L(x) \\ \zeta_A^U(0) \geq \zeta_A^U(x) \text{ and } \eta_A^U(0) \leq \eta_A^U(x) \end{aligned} \right\} (IVPF(i))$$

$$\left. \begin{aligned} \zeta_A^L(x * y) \geq \min(\zeta_A^L(x), \zeta_A^L(y)) \\ \zeta_A^U(x * y) \geq \min(\zeta_A^U(x), \zeta_A^U(y)) \end{aligned} \right\} (IVPF(ii))$$

$$\left. \begin{aligned} \eta_A^L(x * y) \leq \max(\eta_A^L(x), \eta_A^L(y)) \\ \eta_A^U(x * y) \leq \max(\eta_A^U(x), \eta_A^U(y)) \end{aligned} \right\} (IVPF(iii))$$

for all $x, y \in X$.





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Definition 2.9: [2] An Interval Valued Pythagorean Fuzzy Ideal $A = ([\zeta_A^L, \zeta_A^U][\eta_A^L, \eta_A^U])$ of BCK-algebra X is called Interval Valued Pythagorean Fuzzy closed ideal X, if the following axiom satisfies

$$\left. \begin{aligned} \zeta_A^L(0 * x) &\geq \zeta_A^L(x) \\ \zeta_A^U(0 * x) &\geq \zeta_A^U(x) \\ \eta_A^L(0 * x) &\leq \eta_A^L(x) \\ \eta_A^U(0 * x) &\leq \eta_A^U(x) \end{aligned} \right\} (IVPF(IV))$$

for all $x \in X$.

Theorem 2.10: [2] Every Interval Valued Pythagorean Fuzzy Ideal of BCK-algebra X is Interval Valued Pythagorean fuzzy sub-algebra of BCK-algebra X.

Proposition 2.11: Every Prime Ideal of commutative BCK-algebra X is an Ideal of X.

INTERVAL VALUED PYTHAGOREAN FUZZY PRIME IDEALS OF BCK-ALGEBRAS

Definition 3.1: An Interval Valued Pythagorean Fuzzy Ideal $A = ([\zeta_A^L, \zeta_A^U][\eta_A^L, \eta_A^U])$ of BCK-algebra X is called Interval Valued Pythagorean Fuzzy Prime Ideal of X if

$$\begin{aligned} A &= ([\zeta_A^L, \zeta_A^U][\eta_A^L, \eta_A^U]) \\ \zeta_A^L(x \wedge y) &\leq \max\{\zeta_A^L(x), \zeta_A^L(y)\} \\ \zeta_A^U(x \wedge y) &\leq \max\{\zeta_A^U(x), \zeta_A^U(y)\} \\ \eta_A^L(x \wedge y) &\geq \min\{\eta_A^L(x), \eta_A^L(y)\} \\ \eta_A^U(x \wedge y) &\geq \min\{\eta_A^U(x), \eta_A^U(y)\} \end{aligned}$$

for all $x, y \in X$.

Example: 3.2

Consider a BCK Algebra $X = \{0, a, b, c\}$ with the following cayley table

*	0	A	b	C
0	0	0	0	0
A	a	0	0	0
B	b	A	0	0
C	c	B	a	0





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Let $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an IVPF topology in X is defined by

$$\zeta_A^L(0) = 0, \zeta_A^L(a) = 0.8, \zeta_A^L(b) = 0.4 \text{ and } \zeta_A^L(c) = 0.$$

$$\zeta_A^U(0) = 0, \zeta_A^U(a) = 0.7, \zeta_A^U(b) = 0.3 \text{ and } \zeta_A^U(c) = 0.$$

$$\eta_A^L(0) = 1, \eta_A^L(a) = 0.1, \eta_A^L(b) = 0.4 \text{ and } \eta_A^L(c) = 1$$

$$\eta_A^U(0) = 1, \eta_A^U(a) = 0.2, \eta_A^U(b) = 0.5 \text{ and } \eta_A^U(c) = 1.$$

Then $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an IVPF prime ideal of x.

Theorem 3.3: If $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy prime Ideal of a commutative BCK-algebra X, then the sets $J = \{x \in X / [\zeta_A^L(x), \zeta_A^U(x)] = [\zeta_A^L(0), \zeta_A^U(0)]\}$ and

$K = \{x \in X / [\eta_A^L(x), \eta_A^U(x)] = [\eta_A^L(0), \eta_A^U(0)]\}$ are prime Ideals of X.

Corollary 3.4: If $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy prime Ideal of a commutative BCK-algebra X, then the sets $P_1 = \{x \in X / [\zeta_A^L(x), \zeta_A^U(x)] = 0\}$ and $P_2 = \{x \in X / [\eta_A^L(x), \eta_A^U(x)] = 0\}$ are either empty or prime ideals of X.

Proposition 3.5: If $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy prime ideal of a commutative BCK-algebra X, then the sets $P_1 = \{x \in X / [\zeta_A^L(x), \zeta_A^U(x)] = 1\}$ and $I = \{x \in X / [\eta_A^L(x), \eta_A^U(x)] = 1\}$ are either empty or prime ideals of X.

Proposition 3.6: Every Interval Valued Pythagorean Fuzzy Prime Ideal of a commutative BCK-algebra X is Interval Valued Pythagorean Fuzzy Ideal of commutative BCK –algebra X

Remark 3.7: An Interval Valued Pythagorean Fuzzy Ideal of commutative BCK-algebra X need not be an Interval Valued Pythagorean Fuzzy prime Ideal of X . Shown in the following example.

Example 3.8:

Consider a BCK Algebra $X = \{0, A, B, C\}$ with the following Cayley table

*	0	A	B	C
0	0	0	0	0
A	A	0	0	A
B	B	A	0	B
C	C	C	C	0

Then the BCK-algebra X is commutative. Define an IVPF s $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U]) : X \rightarrow [0,1]$ be an IVPF topology in X is defined by

$$\zeta_A^L(0) = 0, \zeta_A^L(a) = \zeta_A^L(b) = 0.4 \text{ and } \zeta_A^L(c) = 0.$$

$$\zeta_A^U(0) = 1, \zeta_A^U(a) = \zeta_A^U(b) = 0.5 \text{ and } \zeta_A^U(c) = 0.2.$$

$$\eta_A^L(0) = 0, \eta_A^L(a) = \eta_A^L(b) = 0.4 \text{ and } \eta_A^L(c) = 1$$

$$\eta_A^U(0) = 0, \eta_A^U(a) = \eta_A^U(b) = 0.3 \text{ and } \eta_A^U(c) = 1.$$

Then $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an IVPF fuzzy ideal of X but not Interval Valued Pythagorean Fuzzy Prime Ideal of X.





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Proposition 3.9: Let $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an Interval Valued Pythagorean Fuzzy set of a commutative BCK-algebra X, then $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy prime ideal of X, if and only if $[\zeta_A^L, \zeta_A^U]$ and $[\eta_A^L, \eta_A^U]^c$ are fuzzy prime Ideals of X, where $[\eta_A^L, \eta_A^U]^c = 1 - [\eta_A^L, \eta_A^U]$.

Proof: Let $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an Interval Valued Pythagorean Fuzzy set of a commutative BCK-algebra X. Since by proposition 3.6, $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy Ideal, so by (An IVPFS $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy Ideal of X if and only if the fuzzy sets $[\zeta_A^L, \zeta_A^U]$ and $[\bar{\eta}_A^L, \bar{\eta}_A^U]$ are fuzzy ideals of X.) $[\zeta_A^L, \zeta_A^U]$ and $[\bar{\eta}_A^L, \bar{\eta}_A^U]$ are fuzzy Ideals of X. Let for any $x, y \in X$. Then,

$$\begin{aligned} \zeta_A^L(x \wedge y) &\leq \max\{\zeta_A^L(x), \zeta_A^L(y)\} \\ \zeta_A^U(x \wedge y) &\leq \max\{\zeta_A^U(x), \zeta_A^U(y)\} \\ \eta_A^L(x \wedge y) &\geq \min\{\eta_A^L(x), \eta_A^L(y)\} \\ \eta_A^U(x \wedge y) &\geq \min\{\eta_A^U(x), \eta_A^U(y)\} \end{aligned}$$

Now,

$$\begin{aligned} 1 - \eta_A^L(x \wedge y) &\leq 1 - \min\{\eta_A^L(x), \eta_A^L(y)\}. \\ [\bar{\eta}_A^L(x \wedge y)] &\leq \max\{1 - \eta_A^L(x), 1 - \eta_A^L(y)\}. \\ [\bar{\eta}_A^L(x \wedge y)] &\leq \max\{\bar{\eta}_A^L(x), \bar{\eta}_A^L(y)\}. \end{aligned}$$

Hence $[\zeta_A^L, \zeta_A^U]$ and $[\bar{\eta}_A^L, \bar{\eta}_A^U]$ are fuzzy prime ideal of X. The proof is similar for the upper limit values.

Proposition 3.10: Let $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an Interval Valued Pythagorean Fuzzy ideal of a commutative BCK-algebra X, then $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an interval valued Pythagorean fuzzy prime ideal of X, if and only if $[\zeta_A^L, \zeta_A^U]$ and $[\eta_A^L, \eta_A^U]^c$ are anti fuzzy prime ideals of X, where $[\zeta_A^L, \zeta_A^U]^c = 1 - [\zeta_A^L, \zeta_A^U]$.

Proposition 3.11: Let $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an interval valued Pythagorean Fuzzy prime Ideal of a commutative BCK-algebra X. Then $\square A = ([\zeta_A^L, \zeta_A^U], [\bar{\zeta}_A^L, \bar{\zeta}_A^U])$ is an Interval Valued Pythagorean Fuzzy Prime Ideal of X, where $[\zeta_A^L, \zeta_A^U]^c = 1 - [\zeta_A^L, \zeta_A^U]$.

Proof: Let $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an interval valued Pythagorean fuzzy prime ideal of a commutative BCK-algebra X. Then by proposition 3.6, $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an IVPF ideal of X, so by [let $A = ([\zeta_A^L, \zeta_A^U], [\bar{\zeta}_A^L, \bar{\zeta}_A^U])$ be an IVPFS in X, if and only if $\square A = ([\zeta_A^L, \zeta_A^U], [\bar{\zeta}_A^L, \bar{\zeta}_A^U])$ and $\triangle A = ([\bar{\eta}_A^L, \bar{\eta}_A^U], [\eta_A^L, \eta_A^U])$ are IVPF ideal of X]. $\square A = ([\zeta_A^L, \zeta_A^U], [\bar{\zeta}_A^L, \bar{\zeta}_A^U])$ is an interval valued Pythagorean fuzzy ideal of X. For any $x, y \in X$, then $\zeta_A^L(x \wedge y) \leq \max\{\zeta_A^L(x), \zeta_A^L(y)\}$. Now

$$\begin{aligned} 1 - \zeta_A^L(x \wedge y) &\geq 1 - \max\{\zeta_A^L(x), \zeta_A^L(y)\}. \\ \bar{\zeta}_A^L(x \wedge y) &\geq \min\{1 - \zeta_A^L(x), 1 - \zeta_A^L(y)\} \\ \bar{\zeta}_A^L(x \wedge y) &\geq \min\{\bar{\zeta}_A^L(x), \bar{\zeta}_A^L(y)\}. \end{aligned}$$

Hence $\square A = ([\zeta_A^L, \zeta_A^U], [\bar{\zeta}_A^L, \bar{\zeta}_A^U])$ is an interval valued Pythagorean fuzzy prime ideal of a commutative BCK-algebra X.





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Proposition 3.12: Let $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an Interval Valued Pythagorean Fuzzy Prime Ideal of a commutative BCK-algebra X. Then $\Delta A = ([\bar{\eta}_A^L, \bar{\eta}_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy Prime Ideal of X, where $[\eta_A^L, \eta_A^U]^c = 1 - [\eta_A^L, \eta_A^U]$.

Proof: Let $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an interval valued Pythagorean fuzzy Prime Ideal of a commutative BCK-algebra X. so by proposition 3.12(Let $A = (\zeta_A^L, \zeta_A^U), (\eta_A^L, \eta_A^U)$ be an IVPF of X. Then $A = (\zeta_A^L, \zeta_A^U), (\eta_A^L, \eta_A^U)$ is an IVPF Ideal of X if and only if

$$\square A = (\zeta_A^L, \zeta_A^U), (\eta_A^L, \eta_A^U) \text{ and } \Delta A = (\eta_A^L, \eta_A^U), (\eta_A^U, \eta_A^L) \text{ are IVPF Ideals of X.}$$

$\Delta A = (\eta_A^L, \eta_A^U), (\eta_A^U, \eta_A^L)$ is an Interval Valued Pythagorean Fuzzy Ideal X. Let for any $x, y \in X$. Then

$$\zeta_A^L(x \wedge y) \leq \max\{\zeta_A^L(x), \zeta_A^L(y)\}$$

$$\zeta_A^U(x \wedge y) \leq \max\{\zeta_A^U(x), \zeta_A^U(y)\}$$

$$\eta_A^L(x \wedge y) \geq \min\{\eta_A^L(x), \eta_A^L(y)\}$$

$$\eta_A^U(x \wedge y) \geq \min\{\eta_A^U(x), \eta_A^U(y)\}$$

$$\text{Now } 1 - \eta_A^L(x \wedge y) \leq 1 - \min\{\eta_A^L(x), \eta_A^L(y)\}$$

$$\bar{\eta}_A^L(x \wedge y) \leq \max\{1 - \eta_A^L(x), 1 - \eta_A^L(y)\}$$

$$\bar{\eta}_A^U(x \wedge y) \leq \max\{\bar{\eta}_A^U(x), \bar{\eta}_A^U(y)\}$$

$$\bar{\eta}_A^L(x \wedge y) \leq \max\{1 - \eta_A^L(x), 1 - \eta_A^L(y)\}$$

$$\bar{\eta}_A^U(x \wedge y) \leq \max\{\bar{\eta}_A^U(x), \bar{\eta}_A^U(y)\}$$

Hence $\Delta A = (\eta_A^L, \eta_A^U), (\eta_A^U, \eta_A^L)$ is an Interval Valued Pythagorean Fuzzy Prime Ideal of commutative BCK-algebra X.

Theorem 3.13: Let $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an Interval Valued Pythagorean Fuzzy commutative BCK-algebra X. Then $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy Prime Ideal of commutative BCK-algebra X if and only if $\square A = (\zeta_A^L, \zeta_A^U), (\eta_A^L, \eta_A^U)$ and $\Delta A = ([\bar{\eta}_A^L, \bar{\eta}_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy Prime Ideal of X.

Definition 3.14: Let $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ be an Interval Valued Pythagorean Fuzzy set of BCK-algebra X. Then for $s, t \in [0, 1]$, the set $U([\zeta_A^L, \zeta_A^U]; t) = \{x \in X / [\zeta_A^L, \zeta_A^U] \geq t\}$ is called upper t-level cut of $[\zeta_A^L, \zeta_A^U]$ and the set $L([\eta_A^L, \eta_A^U]; s) = \{x \in X / [\eta_A^L, \eta_A^U] \leq s\}$ is called lower s-level cut of $[\eta_A^L, \eta_A^U]$.

Theorem 3.15: An Interval Valued Pythagorean Fuzzy set $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy prime Ideal of a commutative BCK-algebra X if and only if for all $s, t \in [0, 1]$, the sets $U([\zeta_A^L, \zeta_A^U]; t)$ and $L([\eta_A^L, \eta_A^U]; s)$ are prime Ideal of X.

Proof: Suppose $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy Prime Ideal of a commutative BCK-algebra X. Then since by proposition 3.6 $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy prime Ideal of a commutative BCK-algebra X. so by Theorem 3.13(An IVPF $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy Ideal of X if and only if for all $s, t \in [0, 1]$, the sets





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$U([\zeta_A^L, \zeta_A^U]; t)$ and $L([\eta_A^L, \eta_A^U]; s)$ are either empty or ideals of X . $U([\zeta_A^L, \zeta_A^U]; t)$ and $L([\eta_A^L, \eta_A^U]; s)$ are ideals of X . Let $x \wedge y \in U([\zeta_A^L, \zeta_A^U]; t)$ This implies $[\zeta_A^L, \zeta_A^U](x \wedge y) \geq t$ and $\zeta_A^L(x \wedge y) \leq \max\{\zeta_A^L(x), \zeta_A^L(y)\}$; this implies $\max\{\zeta_A^L(x), \zeta_A^L(y)\} \geq \zeta_A^L(x \wedge y) \geq t$ implies that $\max\{\zeta_A^L(x), \zeta_A^L(y)\} \geq t$ this implies $\zeta_A^L(x) \geq t$ and $\zeta_A^L(y) \geq t$. This condition is similar for the upper limit values so that $x \in U([\zeta_A^L, \zeta_A^U]; t)$ and $y \in U([\zeta_A^L, \zeta_A^U]; t)$. Hence $U([\zeta_A^L, \zeta_A^U]; t)$ is a prime ideal of X . Similarly $L([\eta_A^L, \eta_A^U]; s)$ is a prime of X .

Conversely, Let $U([\zeta_A^L, \zeta_A^U]; t)$ and $L([\eta_A^L, \eta_A^U]; s)$ is a prime ideal of X . Then by [7] $U([\zeta_A^L, \zeta_A^U]; t)$ and $L([\eta_A^L, \eta_A^U]; s)$ are ideal of X . Since $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy Ideal of X . On contrary $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is not an Interval Valued Pythagorean Fuzzy Prime Ideal of X . Then there exist, $x, y \in X$ such that $\zeta_A^L(x \wedge y) > \max\{\zeta_A^L(x), \zeta_A^L(y)\}$. Let $t = \frac{1}{2} \{\zeta_A^L(x \wedge y) + \max\{\zeta_A^L(x), \zeta_A^L(y)\}\}$. This implies $\zeta_A^L(x \wedge y) > t > \max\{\zeta_A^L(x), \zeta_A^L(y)\}$. This implies $(x \wedge y) \in U([\zeta_A^L(x), \zeta_A^L(y)]; t)$ but $x \notin U([\zeta_A^L(x), \zeta_A^L(y)]; t)$ and $y \notin U([\zeta_A^L(x), \zeta_A^L(y)]; t)$ which is a contradiction. Hence $A = ([\zeta_A^L, \zeta_A^U], [\eta_A^L, \eta_A^U])$ is an Interval Valued Pythagorean Fuzzy prime Ideal of a commutative BCK-algebra X .

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Use of E-Resources by the Faculty Members in Nehru Institute of Technology in Coimbatore (NIT): A Study

Arockia Saranya.A^{1*} and M.Jaculine Mary²

¹Research Scholar, PG and Research, Department of Library and Information Science, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Research Supervisor, PG and Research, Department of Library and Information Science, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

Arockia Saranya.A

Research Scholar,
PG and Research Department of Library and Information Science,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.



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ABSTRACT

In this study, an attempt was made to highlight the accessibility to web-based Information resources by the faculty at *Nehru Institute of Technology* Library in Coimbatore. A study was conducted to collect primary data from respondents through a structured questionnaire. The questionnaire was personally distributed to the faculty. The findings show that users were using various resources; the awareness about e-resources encourages users to use such resources to the maximum; The impact of e-resources was visible from the decrease in the number of printed documents in comparison to the increase in the number of electronic resources. The use of e-resources has increased manifold.

Keywords: web-based information sources, Usage of e-resources, web-based information services, and electronic resources.

INTRODUCTION

The speedy growth of information and communication technology has brought a revolutionary change in libraries and information services. The Information has value only if it is received on time and is put into utility. It introduces several options to access various information sources conveniently and effortlessly, as a result of which e-resources have become the most desirable modern library reserves in satisfying the diverse needs of users with minimum risk and time consumption. Electronic information resources have acquired a major part of library collections. Information technology has transformed the world and becomes an important tool for retrieving electronic information. Therefore, there is a need to make a study on different aspects of e-resources and the issues relating to



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the use of resources by users, more particularly by the faculty members of academic institutions. The present study has been taken as an attempt to analyze the use of e-resources by the faculty members of *Nehru Institute of Technology* College Library in Coimbatore and to find out the difficulties and limitations faced by users during accessing e-resources with some purposeful suggestions for its improvement in the services provided by the library.

REVIEW OF LITERATURE

Rekhraj Sahu, and Brajesh Tiwari (2022) explored different aspects of electronic resources of UG Students in terms of awareness and uses, frequency of use, how you are aware regarding electronic resources, types of e-resources used by the students, the problem faced while using electronic resources and discuss suggest ways to improve electronic resources by the students.

Saklani Kumar (2021), described modernizing libraries. Digital data sources are created by making digital print sources digital. Computers and the Internet played a vital role in the development of the library. Users are subscribed to e-resources by a tertiary institution to provide current information within a set period. The use of electronic resources in subject libraries is constantly increasing due to readability, accessibility, and accessibility.

Alugumi Samuel Ndouand Wanyenda Leonard Chilimo (2021) recommended that the university library should train academics on plagiarism detection. In addition, the library should adopt innovative ways of improving e-resource services, such as providing an Online Public Access Catalogue (OPAC) with advanced and federated search capabilities

Olabisilyabode Moruwawon (2020) showed that the application of e-resources is very paramount to library services and as such, every impediment to its effective use should be taken into consideration.

OBJECTIVES OF THE STUDY

The following are the specific objectives of the study.

- To find out the frequency of usage of the library e-resources by the faculty members.
- To explore the search Methods used by the faculty members to retrieve documents.
- To identify the use of the Websites/Databases by the faculty members.
- To know the most preferred Search Engines by the faculty members.

METHODOLOGY

This study is based on a questionnaire method. A structured questionnaire was designed to collect data from the faculty members of the *Nehru Institute of Technology*. The data were randomly selected and personally collected from the various department faculty members. The study is based on a quantitative method of data collection to assess the problems relating to the use of e-resources by the faculty members and provide an appropriate solution to the same.

SAMPLE SIZE

The structured questionnaire in printed form has been distributed in person to the respondents. Total of 75 questionnaires has been distributed out of which, 50 were filled in and received and therefore responder rate is 66.66% percent. About Nehru Institute of Technology (NIT) Nehru Institute of Technology is established by Founder Chairman, Late Shri. P. K. Das in the year 2008. It is a private self-financing technical institution recognized by AICTE, New Delhi, and affiliated to Anna University, Chennai, accredited by NAAC with an A+ grade, Recognized by UGC Under Section 2(f). The main focus of the Institution is to empower students with sound Knowledge, Wisdom, Experience, and Training both at the Academic level of Engineering and in the highly Competitive Global Industrial market. NIT central library is automated with the KOHA software package which is





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an integrated multi-user Library Management Software that supports all in-house operations in the library. Library operations are mostly computerized especially in textbook circulation and OPAC. NIT central Library aims to incorporate the latest technology and adopt a user-friendly approach toward students and faculty. The library intends to offer comprehensive services related to the dissemination of knowledge. The library serves as a resource center and aims to develop a comprehensive collection of documents useful for faculty and students of the institute and provides an efficient dissemination of knowledge.

NIT Library Resources

Open Access E-Books

S.N	E-BOOKS – Links
1	http://www.freebookcentre.net/
2	http://www.ebooklobby.com/
3	http://www.doabooks.org/
4	http://www.freetechbooks.com/
5	http://www.ibiblio.org/
6	http://www.springeropen.com/books/
7	http://www.getfreebooks.com
8	http://4ebooks.org
9	http://www.e-booksdirectory.com/
10	http://pdfsb.net/

Valuable web Sites

S.N	Particulars	Links
1	Inflibnet	http://www.inflibnet.ac.in/
2	Education	https://www.education.gov.in/hi
3	Parliament	https://parliamentofindia.nic.in/
4	Planning commission	http://www.planningcommission.nic.in/
5	Rajbhavan	http://www.tnrajbhavan.gov.in
6	Election Commission	http://www.eci.nic.in/eci_main1/index.aspx
7	Supremecourt	http://www.supremecourtsofindia.nic.in/
8.	Vidwan	https://vidwan.inflibnet.ac.in
9	Directorate of Technical Education	http://www.tndte.gov.in/site/
10	CEC UGC you Tube Channel	https://m.youtube.com/user/cecedusat

Theses

S. N.	E- THESES Links
1	http://shodhganga.inflibnet.ac.in/
2	http://pqdtopen.proquest.com/
3	http://www.mgutheses.in/





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Digital Libraries

S. No	Digital Library
1	http://nsdl.org/
2	http://nopr.niscair.res.in/
3	http://www.vlib.org/
4	http://www.opendoar.org/find.php
5	http://www.wdl.org
6	http://www.loc.gov

Library E-Resources

S. N.	E-Journals	E-Books
1	K-HUB =860	K-HUB – Core Engineering E-books = 4812
2	DELNET = 10083	DELNET E- Books = 15577

For all disciplines Links to E-Resources

S. N	E-Journal	Database E-Resources URL Address
1	DELNET: E-Books and E-Journal	http://delnet.nic.in/publications.htm
2	K-HUB: E-Books and E-Journal	www.k.hub.in
3.	NPTEL:	https://nptel.ac.in/
4.	SHOUTHSINDHU:	https://ess.inflibnet.ac.in
5.	icampuz.	http://www.icampuz.in
6.	OPAC	http://192.168.1.71/opac/index.asp

Data Analysis and Interpretation

Total of 75 structured questionnaires have been distributed among the respondents of which 50 responses were received which included the faculty members of NIT. The total number of 50 respondents includes 35 Males and 15 Females. Comprised 70% and 30% of the total population for data collection. The graphical representation is below. Out of the total 50 respondents age group of the respondents for data collection are 16 (32%) in the 25-30 age group, 12 (24%) in the 31-35 age group, 5 (10%) in the 36-40 age group, 7 (14%) in 41-45 age group, 6 (12%) in 46-50 age group and only 4 (8%) in 50 and above age group. The graphical representation is below. Out of the total 50 respondents Educational Qualification of the respondents are 21 (42%) in B. Tech, 14 (28%) in M. Tech, 9 (18%) have done M.Sc., and only 6 (12%) Ph.D. The graphical representation is below. Out of the total 50 respondents, the designation details of the respondents are 21 (42%) are Professors, 15 (30%) are Associate Professors, 6 (12%) are Assistant Professors and 8 (6%) are Guest faculty. The graphical representation for the above data is below. Out of the total 50 respondents, the Teaching experience of the respondents are 18 (36%) have Below 5 years, 13 (26%) 6-10 years, 10 (20%) 15-25 years, and only 9 (18%) are above 25 years teaching experience. The graphical representation for the above data is below.

Out of the total 50 respondents, the frequency of use of the library is 25 (50%) every day, 10 (20%) weekly, 7 (14%) twice a week, 5 (10%) once in a month, and only 3 (6%) twice in a month. The graphical representation for the above data is below. Out of the total 50 respondents the purpose of visiting the library are 3 (6%) for reading newspapers, 3 (6%) to borrow books, 4 (8%) to refer to documents, 12 (24%) to refer to journals & articles, 10 (20%) to access e-resources, 18 (36%) to collect other information. The graphical representation for the above data is below. Out of the total 50 respondents, the preferred academic search engines used for searching information are 11 (22%) using Bing, 6 (12%) using Google, 16 (32%) using Google Scholar, 7 (14%) using Rediff, 8 (16%) using Yahoo and only 2 (4%) are using other Search Engines. The graphical representation for the above data is below.



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Out of the total 50 respondents, the responses received for searching methods or techniques used by the respondents for retrieving the desired document are only 2 (04%) abstract searching, 5 (10%) using author/ editor searching, 11(22%) uses Boolean operators, 2 (4%) through Date/Year, 7 (14%) through field Searching, 12 (24%) uses keywords to search, 5 (10%) search through the subject, and 6 (12%) search by the title of Articles. The graphical representation for the above data is below. Out of the total 50 respondents the responses received for the preferred website/database used maximum by the respondents for retrieving the desired information are 10 (20%) using IEEE Xplore, 5 (10%) use JSTOR, 3(6%) Materials Science, 4 (8%) MathSciNet, only 2 (4%) Oxford University Press, 16 (32%) Science Direct, only 2 (4%) Springer and 8 (6%) use Web of Science. The graphical representation for the above data is below. Out of the total 50 respondents, the responses received for barriers or challenges faced during downloading or retrieving the desired e-content from the various databases or journal publisher websites are 14 (28%) face copyright issues, 5 (10%) find difficulty reading from the computer, 8 (16%) finds difficulty in accessing full-text, 9 (18%) finds insufficient time & training responsible barrier to information communication, 7 (14%) regards lack of poor system speed as a barrier to information retrieval, 3 (6%) regards poorly designed websites as a challenge in the retrieval of the needed information, and 4 (8 %) finds some retrieval problems (including loading) as the reason for poor downloading from the databases. The graphical representation for the above data is below.

CONCLUSION

The study undertaken on the use of e-Resources by the Faculty Members in Nehru Institute of Technology in Coimbatore is worth to find out the difficulties or problems faced during the searching and retrieval of various databases and Journal publishers' websites subscribed by the library in Nehru Institute of Technology, to improve the present services offered by the library for the faculty members in particular and the research community in general. The survey results reveal that majority of the faculty members and researchers are aware about the e-resources. It is observed that most of the faculty members and researchers are satisfied with library services. Out of the total 50 respondents the frequency in use of library is 25 (50%) every day, 10 (20%) weekly, 7 (14%) twice in a week, 5 (10%) once in a month and only 3 (6%) twice in a month. Out of the total 50 respondents the responses received for searching methods or techniques used by the respondents for retrieving the desired document are only 2 (04%) abstracts searching, 5 (10%) uses author/ editor searching, 11(22%) uses Boolean operators, 2 (4%) through Date/Year, 7 (14%) through field Searching, 12 (24%) uses keywords to search, 5 (10%) searches through the subject, and 6 (12%) search by the title of Articles. Out of the total 50 respondents the responses received for preferred website/database used maximum by the respondents for retrieving the desired information are 10 (20%) uses IEEE Xplore, 5 (10%) use JSTOR, 3(6%) Materials Science, 4 (8%) MathSciNet, only 2 (4%) Oxford University Press, 16 (32%) Science Direct, only 2 (4%) Springer and 8 (6%) use Web of Science. Out of the total 50 respondents the preferred academic search engines used for searching information are 11 (22%) using Bing, 6 (12%) using Google, 16 (32%) using Google Scholar, 7 (14%) using Rediff, 8 (16%) using Yahoo and only 2 (4%) are using other Search Engines. The above data collected and analysed paves the way for library management in Nehru Institute of Technology to improve their services for their research community.

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Table:1 Gender Details

S. N	Gender	Total Numbers	Percentage
1	Male	35	70%
2	Female	15	30%

Table: 2. Age Group

S. No	Age Group	Total	Percentage
1	25-30	16	32%
2	31-35	12	24%
3	36-40	5	10%
4	41-45	7	14%
5	46-50	6	12%
6	50 & above	4	08%

Table: 3 Educational Qualifications

S.NO	Educational Qualification	Total	Percentage
1	B. Tech	21	42%
2	M. Tech	14	28%
3	M.Sc	9	18%
4	Ph.D	6	12%





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Table: 4 Designation Details

S.NO	Designation	Total	Percentage
1	Professor	21	42%
2	Associate Professor	15	30%
3	Assistant Professor	6	12%
4	Guest Faculty	8	16%

Table: 5 Teaching experience

S.NO	Teaching experience	In years	In Percentage
1	Below 5 years	18	36%
2	6-10 years	13	26%
3	15-25 years	10	20%
4	Above 25 years	9	18%

Table: 6 Frequent uses of library

S.NO	Frequent use of the library	Total	Percentage
1	Every day	25	50%
2	Weekly	10	20%
3	Weekly Twice	7	14%
4	Monthly Once	5	10%
5	Monthly Twice	3	06%

Table: 7 Purpose of visiting the Library

S. No	Purpose of visiting the Library	Total	Percentage
1	For reading newspapers	3	6%
2	To borrow books	3	6%
3	Refer to documents	4	8%
4	Refer to journal & Articles	12	24%
5	To access e-resources	10	20%
6	To collect other information	18	36%

Table: 8 Preferred Academic Search Engines

S. No	Preferred Academic Search Engines	Total	Percentage
1	Bing	11	22%
2	Google	6	12%
3	Google Scholar	16	32%
4	Rediff	7	14%
5	Yahoo	8	16%
6	Others	2	04%

Table: 9 Searching Methods

S. No	Searching Methods	Total	Percentage
1	Abstract	2	04%
2	Author/ Editor	5	10%
3	Boolean Operators	11	22%
4	Date/Year	2	04%
5	Field Searching	7	14%
6	Keywords	12	24%





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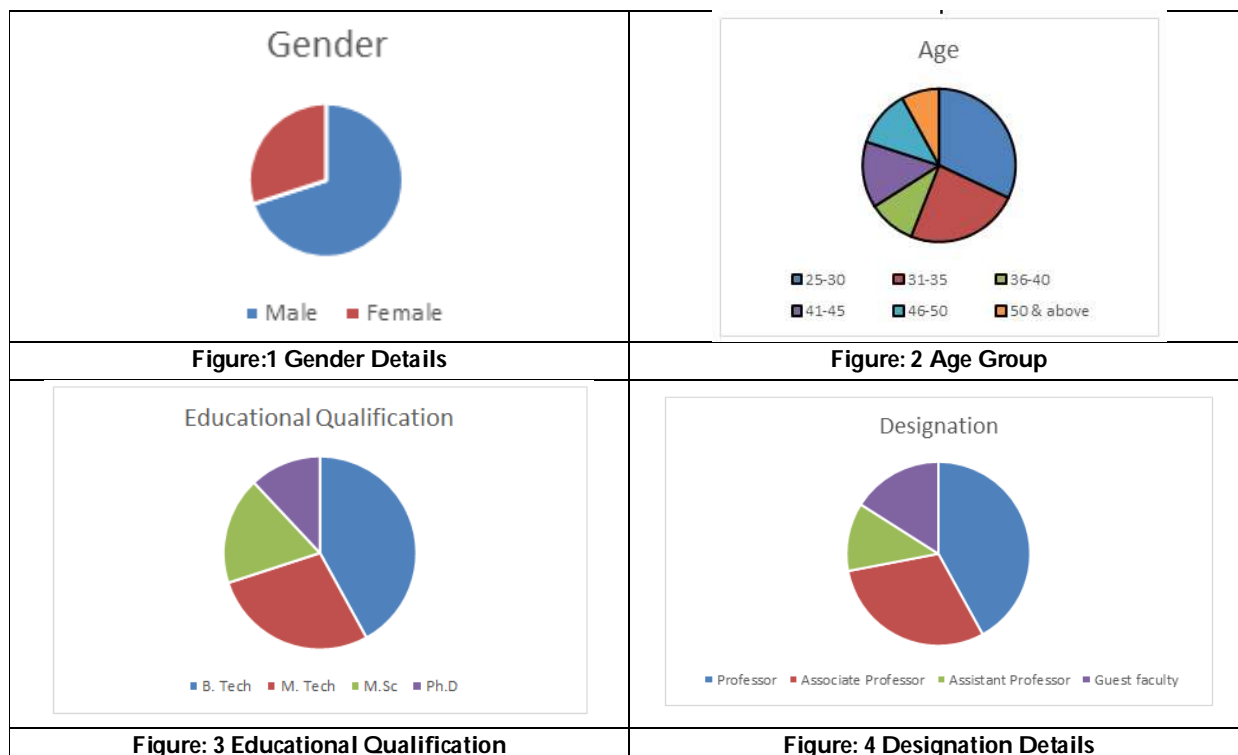
7	Subject	5	10%
8	Title of Articles	6	12%

Table 10: Preferred Website/Database

S. No	Website/Database	Total	Percentage
1	IEEE Xplore	10	20%
2	JSTOR	5	10%
3	Materials Science	3	06%
4	MathSciNet	4	08%
5	Oxford University Press	2	04%
6	Science Direct	16	32%
7	Springer	2	04%
8	Web of Science	8	16%


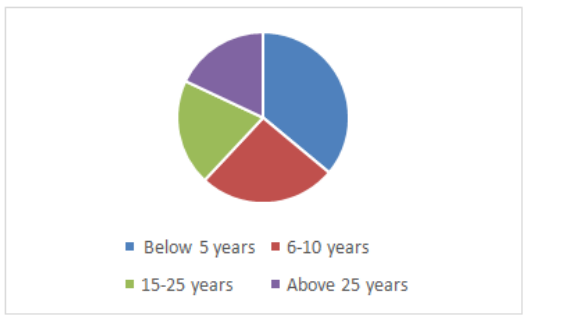
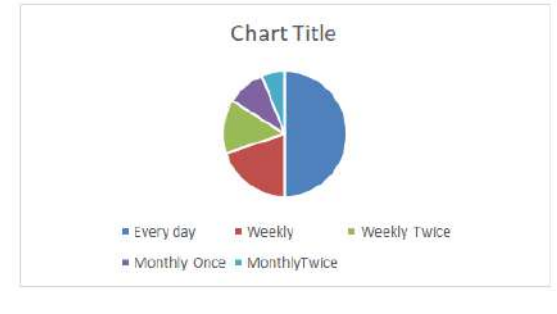
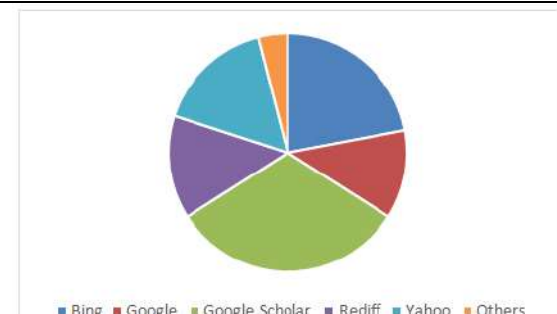

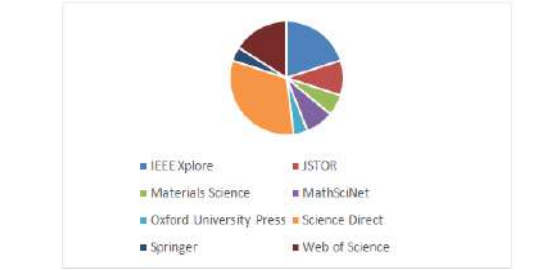
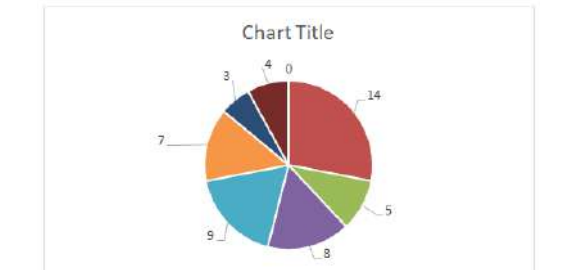
Table: 11 Barriers

S. No	Barriers	Total	Percentage
1	Copyright issues	14	28%
2	Difficult to read from the computer	5	10%
3	Difficulty in accessing full-text	8	16%
4	Insufficient time & training	9	18%
5	Lack of system speed	7	14%
6	Poorly designed websites	3	06%
7	Retrieval Problems (including loading)	4	08%





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 <p>Figure: 5 Teaching experience</p>	 <p>Table: 6 Frequent uses of library</p>
 <p>Table: 7 Purpose of visiting the Library</p>	 <p>Table: 8 Preferred Academic Search Engines</p>
 <p>Table: 9 Searching Methods</p>	 <p>Table 10: Preferred Website/Database</p>
 <p>Table: 11 Barriers</p>	 <p>Table: 11 Barriers</p>





Interval Valued Neutrosophic Pythagorean Point Operators

Stephy Stephen^{1*} and M.Helen²

¹Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

Stephy Stephen

Department of Mathematics,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.
E.Mail: stephy.stephen25@gmail.com



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ABSTRACT

In this article, we have discussed about the point operators in the field of neutrosophic Pythagorean sets with interval values. The point operators are defined for each point in the set and for interval-valued neutrosophicpythagorean number with specific values of α and β . Additionally, we have spoken about the aggregate averaging operator in relation to neutrosophic Pythagorean point weighted values with interval values. Some properties related to idempotency and monotonicity are proved in the context of interval-valued neutrosophic Pythagorean point weighted averaging operators.

Keywords: interval-valued neutrosophic Pythagorean, point operators, neutrosophy, averaging operator

INTRODUCTION

There has been continuous development in the field of fuzzy set theory from providing membership values ranging from 0 to 1 for the crisp numbers by Zadeh [15] to allocating non-membership values and membership values to the fuzzy number by Atanassov[1] and Smarandache[5-7] developed the concept of neutrosophy by taking into account the indeterminacy property and thereby put forward an end to the elimination of uncertain conditions and situations. Yager[14] and Abbasov introduced the idea of Pythagorean fuzzy sets in 2013 to address the drawbacks of intuitionistic fuzzy sets. Numerous research publications have been written based on the study of Pythagorean fuzzy sets and their use in a variety of domains, including risk assessments [17], supply chain management [12], health management [2], and environment management [11]. Xu et al [13] investigated geometric aggregation operations using interval-valued intuitionistic fuzzy sets. Interval-valued Pythagorean fuzzy geometric operators were developed by Rahman et al [4]. Peng and Yang [3] proposed some basic characteristics of Pythagorean fuzzy aggregation operators with interval values. Zhu et al [18] worked on point operators and their use in decision making. Stephy and Helan[9] introduced the concept of interval-valued neutrosophic Pythagorean sets and





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developed some properties and results based on aggregation operators[10]. Also, decision making using TOPSIS, TODIM [8] in interval-valued neutrosophic Pythagorean sets were also studied.

PRELIMINARIES

Definition 2.1[9]: An Interval-valued neutrosophic Pythagorean set having truth T and falsity F as dependent interval-valued neutrosophic components and indeterminacy I as independent interval-valued neutrosophic component in a universe S can be defined as

$$M = \{ \langle s, [T_M^L, T_M^U], [I_M^L, I_M^U], [F_M^L, F_M^U] \rangle; s \in S \} \text{ on } S \text{ having the form } \left[\frac{T_M^L + T_M^U}{2} \right]^2 + \left[\frac{I_M^L + I_M^U}{2} \right]^2 + \left[\frac{F_M^L + F_M^U}{2} \right]^2 \leq 2.$$

Here $[T_M^L, T_M^U], [I_M^L, I_M^U], [F_M^L, F_M^U]$ represents the lower and upper bound of the truth, indeterminacy and falsity membership degrees.

Let $\rho_M(s) = \sqrt{1 - \left[\frac{T_M^L + T_M^U}{2} \right]^2 - \left[\frac{I_M^L + I_M^U}{2} \right]^2 - \left[\frac{F_M^L + F_M^U}{2} \right]^2}$ is called a Neutrosophic Pythagorean index of element $s \in S$ to set M. and $\rho_M(s)$ lies in $[0, 1]$ for every $s \in S$.

Definition 2.2 [9]: Let M, M_1, M_2 be three interval-valued neutrosophic Pythagorean sets and $\alpha > 0$, then their operators are defined as follows:

1. $M_1 \cup M_2 = \left\{ \langle s, \left[\max(T_1^L(x), T_2^L(x)), \max(T_1^U(x), T_2^U(x)) \right], \left[\min(I_1^L(x), I_2^L(x)), \min(I_1^U(x), I_2^U(x)) \right], \left[\min(F_1^L(x), F_2^L(x)), \min(F_1^U(x), F_2^U(x)) \right] \right\rangle / s \in S \right\}$
2. $M_1 \cap M_2 = \left\{ \langle s, \left[\min(T_1^L(x), T_2^L(x)), \min(T_1^U(x), T_2^U(x)) \right], \left[\max(I_1^L(x), I_2^L(x)), \max(I_1^U(x), I_2^U(x)) \right], \left[\max(F_1^L(x), F_2^L(x)), \max(F_1^U(x), F_2^U(x)) \right] \right\rangle / s \in S \right\}$
3. $M_1 \oplus M_2 = \left\{ \langle s, \left[\sqrt{(T_1^L(x))^2 + (T_2^L(x))^2 - (T_1^L(x))^2 (T_2^L(x))^2}, \sqrt{(T_1^U(x))^2 + (T_2^U(x))^2 - (T_1^U(x))^2 (T_2^U(x))^2} \right], \left[I_1^L(x) I_2^L(x), I_1^U(x) I_2^U(x) \right], \left[F_1^L(x) F_2^L(x), F_1^U(x) F_2^U(x) \right] \right\rangle / s \in S \right\}$
4. $M_1 \otimes M_2 = \left\{ \langle s, \left[T_1^L(x) T_2^L(x), T_1^U(x) T_2^U(x) \right], \left[\sqrt{(I_1^L(x))^2 + (I_2^L(x))^2 - (I_1^L(x))^2 (I_2^L(x))^2}, \sqrt{(I_1^U(x))^2 + (I_2^U(x))^2 - (I_1^U(x))^2 (I_2^U(x))^2} \right], \left[\sqrt{(F_1^L(x))^2 + (F_2^L(x))^2 - (F_1^L(x))^2 (F_2^L(x))^2}, \sqrt{(F_1^U(x))^2 + (F_2^U(x))^2 - (F_1^U(x))^2 (F_2^U(x))^2} \right] \right\rangle / s \in S \right\}$
5. $\alpha M = \left\{ \langle s, \left[\sqrt{1 - (1 - (T_M^L(x))^2)^\alpha}, \sqrt{1 - (1 - (T_M^U(x))^2)^\alpha} \right], \left[(I_M^L(x))^\alpha, (I_M^U(x))^\alpha \right], \left[(F_M^L(x))^\alpha, (F_M^U(x))^\alpha \right] \right\rangle / s \in S \right\}$





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$$6. \quad M^\alpha = \left\{ \left\langle s, \left[\left(T_M^L(x) \right)^\alpha, \left(T_M^U(x) \right)^\alpha \right], \left[\sqrt{1 - \left(1 - \left(I_M^L(x) \right)^2 \right)^\alpha}, \sqrt{1 - \left(1 - \left(I_M^U(x) \right)^2 \right)^\alpha} \right], \left[\sqrt{1 - \left(1 - \left(F_M^L(x) \right)^2 \right)^\alpha}, \sqrt{1 - \left(1 - \left(F_M^U(x) \right)^2 \right)^\alpha} \right] \right\rangle / s \in S \right\}$$

7. $M_1 \subseteq M_2$ iff

$$\begin{aligned} M_1^L(x) &\leq M_2^L(x), M_1^U(x) \leq M_2^U(x), \\ I_1^L(x) &\geq I_2^L(x), I_1^U(x) \geq I_2^U(x) \\ F_1^L(x) &\geq F_2^L(x), F_1^U(x) \geq F_2^U(x) \text{ for all } s \in S. \end{aligned}$$

INTERVAL VALUED NEUTROSOPHIC PYTHAGOREAN POINT OPERATORS

Definition 3.1: Let $M = \{ \langle s, [T_M^L, T_M^U], [I_M^L, I_M^U], [F_M^L, F_M^U] \rangle ; s \in S \}$, $\alpha, \beta \in [0,1]$ and $\alpha + \beta \leq 1$, then we define some point operators for interval-valued neutrosophic Pythagorean set as follows:

$$1. \quad D_\alpha(M) = \left\{ \left\langle s, \left[\sqrt{(T_M^L)^2 + \alpha(\pi_M^L)^2}, \sqrt{(T_M^U)^2 + \alpha(\pi_M^U)^2} \right], \left[\sqrt{(I_M^L)^2 + (1-\alpha)(\pi_M^L)^2}, \sqrt{(I_M^U)^2 + (1-\alpha)(\pi_M^U)^2} \right], \left[\sqrt{(F_M^L)^2 + (1-\alpha)(\pi_M^L)^2}, \sqrt{(F_M^U)^2 + (1-\alpha)(\pi_M^U)^2} \right] \right\rangle / s \in S \right\}$$

$$2. \quad F_{\alpha,\beta}(M) = \left\{ \left\langle s, \left[\sqrt{(T_M^L)^2 + \alpha(\pi_M^L)^2}, \sqrt{(T_M^U)^2 + \alpha(\pi_M^U)^2} \right], \left[\sqrt{(I_M^L)^2 + \beta(\pi_M^L)^2}, \sqrt{(I_M^U)^2 + \beta(\pi_M^U)^2} \right], \left[\sqrt{(F_M^L)^2 + \beta(\pi_M^L)^2}, \sqrt{(F_M^U)^2 + \beta(\pi_M^U)^2} \right] \right\rangle / s \in S \right\}$$

$$3. \quad G_{\alpha,\beta}(M) = \left\{ \left\langle s, \left[\sqrt{\alpha} T_M^L, \sqrt{\alpha} T_M^U \right], \left[\sqrt{\beta} I_M^L, \sqrt{\beta} I_M^U \right], \left[\sqrt{\beta} F_M^L, \sqrt{\beta} F_M^U \right] \right\rangle / s \in S \right\}$$

$$4. \quad H_{\alpha,\beta}(M) = \left\{ \left\langle s, \left[\sqrt{\alpha} T_M^L, \sqrt{\alpha} T_M^U \right], \left[\sqrt{(I_M^L)^2 + \beta(\pi_M^L)^2}, \sqrt{(I_M^U)^2 + \beta(\pi_M^U)^2} \right], \left[\sqrt{(F_M^L)^2 + \beta(\pi_M^L)^2}, \sqrt{(F_M^U)^2 + \beta(\pi_M^U)^2} \right] \right\rangle / s \in S \right\}$$

$$5. \quad H^*_{\alpha,\beta}(M) = \left\{ \left\langle s, \left[\sqrt{\alpha} T_M^L, \sqrt{\alpha} T_M^U \right], \left[\sqrt{(I_M^L)^2 + \beta(1 - \alpha(T_M^L)^2 - (\pi_M^L)^2)}, \sqrt{(I_M^U)^2 + \beta(1 - \alpha(T_M^U)^2 - (\pi_M^U)^2)} \right], \left[\sqrt{(F_M^L)^2 + \beta(1 - \alpha(T_M^L)^2 - (\pi_M^L)^2)}, \sqrt{(F_M^U)^2 + \beta(1 - \alpha(T_M^U)^2 - (\pi_M^U)^2)} \right] \right\rangle / s \in S \right\}$$

$$6. \quad J_{\alpha,\beta}(M) = \left\{ \left\langle s, \left[\sqrt{(T_M^L)^2 + \alpha(\pi_M^L)^2}, \sqrt{(T_M^U)^2 + \alpha(\pi_M^U)^2} \right], \left[\sqrt{\beta} I_M^L, \sqrt{\beta} I_M^U \right], \left[\sqrt{\beta} F_M^L, \sqrt{\beta} F_M^U \right] \right\rangle / s \in S \right\}$$





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$$\begin{aligned}
 7. \quad J_{\alpha, \beta}^*(M) &= \left\{ \begin{aligned} &< s, \left[\sqrt{(T_M^L)^2 + \alpha(1 - (T_M^L)^2 - \beta(\pi_M^L)^2)}, \sqrt{(T_M^U)^2 + \alpha(1 - (T_M^U)^2 - \beta(\pi_M^U)^2)} \right], \\ &[\sqrt{\beta}I_M^L, \sqrt{\beta}I_M^U], \\ &[\sqrt{\beta}F_M^L, \sqrt{\beta}F_M^U] > / s \in S \end{aligned} \right\} \\
 8. \quad P_{\alpha, \beta}(M) &= \left\{ \begin{aligned} &< s, [\max(\alpha, T_M^L), \max(\alpha, T_M^U)], \\ &[\min(\beta, I_M^L), \min(\beta, I_M^U)], \\ &[\min(\beta, F_M^L), \min(\beta, F_M^U)] > / s \in S \end{aligned} \right\} \\
 9. \quad Q_{\alpha, \beta}(M) &= \left\{ \begin{aligned} &< s, [\min(\alpha, T_M^L), \min(\alpha, T_M^U)], \\ &[\max(\beta, I_M^L), \max(\beta, I_M^U)], \\ &[\max(\beta, F_M^L), \max(\beta, F_M^U)] > / s \in S \end{aligned} \right\}
 \end{aligned}$$

Definition 3.2: Assume $M = \{ < s, [T_M^L, T_M^U], [I_M^L, I_M^U], [F_M^L, F_M^U] > ; s \in S \}$ for each point $s \in S$ taking $\alpha_s, \beta_s \in [0,1]$ and $\alpha_s + \beta_s \leq 1$, then we define the point operators for interval-valued neutrosophic Pythagorean set as follows:

$$\begin{aligned}
 1. \quad D_{\alpha_s}(M) &= \left\{ \begin{aligned} &< s, \left[\sqrt{(T_M^L)^2 + \alpha_s(\pi_M^L)^2}, \sqrt{(T_M^U)^2 + \alpha_s(\pi_M^U)^2} \right], \\ &\left[\sqrt{(I_M^L)^2 + (1 - \alpha_s)(\pi_M^L)^2}, \sqrt{(I_M^U)^2 + (1 - \alpha_s)(\pi_M^U)^2} \right], \\ &\left[\sqrt{(F_M^L)^2 + (1 - \alpha_s)(\pi_M^L)^2}, \sqrt{(F_M^U)^2 + (1 - \alpha_s)(\pi_M^U)^2} \right] > / s \in S \end{aligned} \right\} \\
 2. \quad F_{\alpha_s, \beta_s}(M) &= \left\{ \begin{aligned} &< s, \left[\sqrt{(T_M^L)^2 + \alpha_s(\pi_M^L)^2}, \sqrt{(T_M^U)^2 + \alpha_s(\pi_M^U)^2} \right], \\ &\left[\sqrt{(I_M^L)^2 + \beta_s(\pi_M^L)^2}, \sqrt{(I_M^U)^2 + \beta_s(\pi_M^U)^2} \right], \\ &\left[\sqrt{(F_M^L)^2 + \beta_s(\pi_M^L)^2}, \sqrt{(F_M^U)^2 + \beta_s(\pi_M^U)^2} \right] > / s \in S \end{aligned} \right\} \\
 3. \quad G_{\alpha_s, \beta_s}(M) &= \left\{ \begin{aligned} &< s, [\sqrt{\alpha_s}T_M^L, \sqrt{\alpha_s}T_M^U], \\ &[\sqrt{\beta_s}I_M^L, \sqrt{\beta_s}I_M^U], \\ &[\sqrt{\beta_s}F_M^L, \sqrt{\beta_s}F_M^U] > / s \in S \end{aligned} \right\} \\
 4. \quad H_{\alpha_s, \beta_s}(M) &= \left\{ \begin{aligned} &< s, [\sqrt{\alpha_s}T_M^L, \sqrt{\alpha_s}T_M^U], \\ &\left[\sqrt{(I_M^L)^2 + \beta_s(\pi_M^L)^2}, \sqrt{(I_M^U)^2 + \beta_s(\pi_M^U)^2} \right], \\ &\left[\sqrt{(F_M^L)^2 + \beta_s(\pi_M^L)^2}, \sqrt{(F_M^U)^2 + \beta_s(\pi_M^U)^2} \right] > / s \in S \end{aligned} \right\} \\
 5. \quad H_{\alpha_s, \beta_s}^*(M) &= \left\{ \begin{aligned} &< s, [\sqrt{\alpha_s}T_M^L, \sqrt{\alpha_s}T_M^U], \\ &\left[\sqrt{(I_M^L)^2 + \beta_s(1 - \alpha_s(T_M^L)^2 - (\pi_M^L)^2)}, \sqrt{(I_M^U)^2 + \beta_s(1 - \alpha_s(T_M^U)^2 - (\pi_M^U)^2)} \right], \\ &\left[\sqrt{(F_M^L)^2 + \beta_s(1 - \alpha_s(T_M^L)^2 - (\pi_M^L)^2)}, \sqrt{(F_M^U)^2 + \beta_s(1 - \alpha_s(T_M^U)^2 - (\pi_M^U)^2)} \right] > / s \in S \end{aligned} \right\} \\
 6. \quad J_{\alpha_s, \beta_s}(M) &= \left\{ \begin{aligned} &< s, \left[\sqrt{(T_M^L)^2 + \alpha_s(\pi_M^L)^2}, \sqrt{(T_M^U)^2 + \alpha_s(\pi_M^U)^2} \right], \\ &[\sqrt{\beta_s}I_M^L, \sqrt{\beta_s}I_M^U], \\ &[\sqrt{\beta_s}F_M^L, \sqrt{\beta_s}F_M^U] > / s \in S \end{aligned} \right\} \\
 7. \quad J_{\alpha_s, \beta_s}^*(M) &= \left\{ \begin{aligned} &< s, \left[\sqrt{(T_M^L)^2 + \alpha_s(1 - (T_M^L)^2 - \beta_s(\pi_M^L)^2)}, \sqrt{(T_M^U)^2 + \alpha_s(1 - (T_M^U)^2 - \beta_s(\pi_M^U)^2)} \right], \\ &[\sqrt{\beta_s}I_M^L, \sqrt{\beta_s}I_M^U], \\ &[\sqrt{\beta_s}F_M^L, \sqrt{\beta_s}F_M^U] > / s \in S \end{aligned} \right\}
 \end{aligned}$$





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$$\begin{aligned}
 8. \quad P_{\alpha_s, \beta_s}(M) &= \left\{ \begin{array}{l} < s, [\max(\alpha_s, T_M^L), \max(\alpha_s, T_M^U)], \\ [\min(\beta_s, I_M^L), \min(\beta_s, I_M^U)], \\ [\min(\beta_s, F_M^L), \min(\beta_s, F_M^U)] > / s \in S \end{array} \right\} \\
 9. \quad Q_{\alpha_s, \beta_s}(M) &= \left\{ \begin{array}{l} < s, [\min(\alpha_s, T_M^L), \min(\alpha_s, T_M^U)], \\ [\max(\beta_s, I_M^L), \max(\beta_s, I_M^U)], \\ [\max(\beta_s, F_M^L), \max(\beta_s, F_M^U)] > / s \in S \end{array} \right\}
 \end{aligned}$$

Definition 3.3: Let us consider $\tilde{M} = \{ < s, [T_M^L, T_M^U], [I_M^L, I_M^U], [F_M^L, F_M^U] >; s \in S \}$ to be an interval-valued neutrosophic Pythagorean number, with $\alpha_{\tilde{M}}, \beta_{\tilde{M}} \in [0,1]$ and $\alpha_{\tilde{M}} + \beta_{\tilde{M}} \leq 1$, then we define some point operators for interval-valued neutrosophic Pythagorean number as follows:

$$\begin{aligned}
 1. \quad D_{\alpha_{\tilde{M}}}(\tilde{M}) &= \left\{ \begin{array}{l} < s, \left[\sqrt{(T_M^L)^2 + \alpha_{\tilde{M}}(\pi_M^L)^2}, \sqrt{(T_M^U)^2 + \alpha_{\tilde{M}}(\pi_M^U)^2} \right], \\ \left[\sqrt{(I_M^L)^2 + (1 - \alpha_{\tilde{M}})(\pi_M^L)^2}, \sqrt{(I_M^U)^2 + (1 - \alpha_{\tilde{M}})(\pi_M^U)^2} \right], \\ \left[\sqrt{(F_M^L)^2 + (1 - \alpha_{\tilde{M}})(\pi_M^L)^2}, \sqrt{(F_M^U)^2 + (1 - \alpha_{\tilde{M}})(\pi_M^U)^2} \right] > / s \in S \end{array} \right\} \\
 2. \quad F_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) &= \left\{ \begin{array}{l} < s, \left[\sqrt{(T_M^L)^2 + \alpha_{\tilde{M}}(\pi_M^L)^2}, \sqrt{(T_M^U)^2 + \alpha_{\tilde{M}}(\pi_M^U)^2} \right], \\ \left[\sqrt{(I_M^L)^2 + \beta_{\tilde{M}}(\pi_M^L)^2}, \sqrt{(I_M^U)^2 + \beta_{\tilde{M}}(\pi_M^U)^2} \right], \\ \left[\sqrt{(F_M^L)^2 + \beta_{\tilde{M}}(\pi_M^L)^2}, \sqrt{(F_M^U)^2 + \beta_{\tilde{M}}(\pi_M^U)^2} \right] > / s \in S \end{array} \right\} \\
 3. \quad G_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) &= \left\{ \begin{array}{l} < s, [\sqrt{\alpha_{\tilde{M}}} T_M^L, \sqrt{\alpha_{\tilde{M}}} T_M^U], \\ [\sqrt{\beta_{\tilde{M}}} I_M^L, \sqrt{\beta_{\tilde{M}}} I_M^U], \\ [\sqrt{\beta_{\tilde{M}}} F_M^L, \sqrt{\beta_{\tilde{M}}} F_M^U] > / s \in S \end{array} \right\} \\
 4. \quad H_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) &= \left\{ \begin{array}{l} < s, [\sqrt{\alpha_{\tilde{M}}} T_M^L, \sqrt{\alpha_{\tilde{M}}} T_M^U], \\ \left[\sqrt{(I_M^L)^2 + \beta_{\tilde{M}}(\pi_M^L)^2}, \sqrt{(I_M^U)^2 + \beta_{\tilde{M}}(\pi_M^U)^2} \right], \\ \left[\sqrt{(F_M^L)^2 + \beta_{\tilde{M}}(\pi_M^L)^2}, \sqrt{(F_M^U)^2 + \beta_{\tilde{M}}(\pi_M^U)^2} \right] > / s \in S \end{array} \right\} \\
 5. \quad H^*_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) &= \left\{ \begin{array}{l} < s, [\sqrt{\alpha_{\tilde{M}}} T_M^L, \sqrt{\alpha_{\tilde{M}}} T_M^U], \\ \left[\sqrt{(I_M^L)^2 + \beta_{\tilde{M}}(1 - \alpha_{\tilde{M}}(T_M^L)^2 - (\pi_M^L)^2)}, \sqrt{(I_M^U)^2 + \beta_{\tilde{M}}(1 - \alpha_{\tilde{M}}(T_M^U)^2 - (\pi_M^U)^2)} \right], \\ \left[\sqrt{(F_M^L)^2 + \beta_{\tilde{M}}(1 - \alpha_{\tilde{M}}(T_M^L)^2 - (\pi_M^L)^2)}, \sqrt{(F_M^U)^2 + \beta_{\tilde{M}}(1 - \alpha_{\tilde{M}}(T_M^U)^2 - (\pi_M^U)^2)} \right] > / s \in S \end{array} \right\} \\
 6. \quad J_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) &= \left\{ \begin{array}{l} < s, \left[\sqrt{(T_M^L)^2 + \alpha_{\tilde{M}}(\pi_M^L)^2}, \sqrt{(T_M^U)^2 + \alpha_{\tilde{M}}(\pi_M^U)^2} \right], \\ [\sqrt{\beta_{\tilde{M}}} I_M^L, \sqrt{\beta_{\tilde{M}}} I_M^U], \\ [\sqrt{\beta_{\tilde{M}}} F_M^L, \sqrt{\beta_{\tilde{M}}} F_M^U] > / s \in S \end{array} \right\} \\
 7. \quad J^*_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) &= \left\{ \begin{array}{l} < s, \left[\sqrt{(T_M^L)^2 + \alpha_{\tilde{M}}(1 - (T_M^L)^2 - \beta_{\tilde{M}}(\pi_M^L)^2)}, \sqrt{(T_M^U)^2 + \alpha_{\tilde{M}}(1 - (T_M^U)^2 - \beta_{\tilde{M}}(\pi_M^U)^2)} \right], \\ [\sqrt{\beta_{\tilde{M}}} I_M^L, \sqrt{\beta_{\tilde{M}}} I_M^U], \\ [\sqrt{\beta_{\tilde{M}}} F_M^L, \sqrt{\beta_{\tilde{M}}} F_M^U] > / s \in S \end{array} \right\} \\
 8. \quad P_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) &= \left\{ \begin{array}{l} < s, [\max(\alpha_{\tilde{M}}, T_M^L), \max(\alpha_{\tilde{M}}, T_M^U)], \\ [\min(\beta_{\tilde{M}}, I_M^L), \min(\beta_{\tilde{M}}, I_M^U)], \\ [\min(\beta_{\tilde{M}}, F_M^L), \min(\beta_{\tilde{M}}, F_M^U)] > / s \in S \end{array} \right\}
 \end{aligned}$$





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$$9. \quad Q_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) = \left\{ \begin{array}{l} < s, [\min(\alpha_{\tilde{M}}, T_{\tilde{M}}^L), \min(\alpha_{\tilde{M}}, T_{\tilde{M}}^U)], \\ [\max(\beta_{\tilde{M}}, I_{\tilde{M}}^L), \max(\beta_{\tilde{M}}, I_{\tilde{M}}^U)], \\ [\max(\beta_{\tilde{M}}, F_{\tilde{M}}^L), \max(\beta_{\tilde{M}}, F_{\tilde{M}}^U)] > / s \in S \end{array} \right\}$$

Definition 3.4: For any interval-valued neutrosophic Pythagorean number $\tilde{M} = \{ < s, [T_{\tilde{M}}^L, T_{\tilde{M}}^U], [I_{\tilde{M}}^L, I_{\tilde{M}}^U], [F_{\tilde{M}}^L, F_{\tilde{M}}^U] >; s \in S \}$ with $\alpha_{\tilde{M}}, \beta_{\tilde{M}} \in [0, 1]$ and $\alpha_{\tilde{M}} + \beta_{\tilde{M}} \leq 1$ and if in the previous definition, we have $D^0_{\alpha_{\tilde{M}}}(\tilde{M}) =$

$F^0_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) = G^0_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) = H^0_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) = H^{*,0}_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) = J^0_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) = J^{*,0}_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) = P^0_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) = Q^0_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) = \tilde{M}$, then we have the following definition

$$1. \quad D^n_{\alpha_{\tilde{M}}}(\tilde{M}) = \left\{ \begin{array}{l} \left[\sqrt{(T_{\tilde{M}}^L)^2 + \alpha_{\tilde{M}}(\pi_{\tilde{M}}^L)^2}, \sqrt{(T_{\tilde{M}}^U)^2 + \alpha_{\tilde{M}}(\pi_{\tilde{M}}^U)^2} \right], \\ \left[\sqrt{(I_{\tilde{M}}^L)^2 + (1 - \alpha_{\tilde{M}})(\pi_{\tilde{M}}^L)^2}, \sqrt{(I_{\tilde{M}}^U)^2 + (1 - \alpha_{\tilde{M}})(\pi_{\tilde{M}}^U)^2} \right], \\ \left[\sqrt{(F_{\tilde{M}}^L)^2 + (1 - \alpha_{\tilde{M}})(\pi_{\tilde{M}}^L)^2}, \sqrt{(F_{\tilde{M}}^U)^2 + (1 - \alpha_{\tilde{M}})(\pi_{\tilde{M}}^U)^2} \right] \end{array} \right\}$$

$$2. \quad F^n_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) = \left\{ \begin{array}{l} \left[\sqrt{(T_{\tilde{M}}^L)^2 + \alpha_{\tilde{M}}(\pi_{\tilde{M}}^L)^2 \frac{1 - (1 - \alpha_{\tilde{M}} - \beta_{\tilde{M}})^n}{\alpha_{\tilde{M}} + \beta_{\tilde{M}}}}, \sqrt{(T_{\tilde{M}}^U)^2 + \alpha_{\tilde{M}}(\pi_{\tilde{M}}^U)^2 \frac{1 - (1 - \alpha_{\tilde{M}} - \beta_{\tilde{M}})^n}{\alpha_{\tilde{M}} + \beta_{\tilde{M}}}} \right], \\ \left[\sqrt{(I_{\tilde{M}}^L)^2 + (1 - \alpha_{\tilde{M}})(\pi_{\tilde{M}}^L)^2 \frac{1 - (1 - \alpha_{\tilde{M}} - \beta_{\tilde{M}})^n}{\alpha_{\tilde{M}} + \beta_{\tilde{M}}}}, \sqrt{(I_{\tilde{M}}^U)^2 + (1 - \alpha_{\tilde{M}})(\pi_{\tilde{M}}^U)^2 \frac{1 - (1 - \alpha_{\tilde{M}} - \beta_{\tilde{M}})^n}{\alpha_{\tilde{M}} + \beta_{\tilde{M}}}} \right], \\ \left[\sqrt{(F_{\tilde{M}}^L)^2 + (1 - \alpha_{\tilde{M}})(\pi_{\tilde{M}}^L)^2 \frac{1 - (1 - \alpha_{\tilde{M}} - \beta_{\tilde{M}})^n}{\alpha_{\tilde{M}} + \beta_{\tilde{M}}}}, \sqrt{(F_{\tilde{M}}^U)^2 + (1 - \alpha_{\tilde{M}})(\pi_{\tilde{M}}^U)^2 \frac{1 - (1 - \alpha_{\tilde{M}} - \beta_{\tilde{M}})^n}{\alpha_{\tilde{M}} + \beta_{\tilde{M}}}} \right] \end{array} \right\}$$

$$3. \quad G^n_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) = \left\{ \begin{array}{l} \left[\sqrt{\alpha_{\tilde{M}}^n T_{\tilde{M}}^L}, \sqrt{\alpha_{\tilde{M}}^n T_{\tilde{M}}^U} \right], \\ \left[\sqrt{\beta_{\tilde{M}}^n I_{\tilde{M}}^L}, \sqrt{\beta_{\tilde{M}}^n I_{\tilde{M}}^U} \right], \\ \left[\sqrt{\beta_{\tilde{M}}^n F_{\tilde{M}}^L}, \sqrt{\beta_{\tilde{M}}^n F_{\tilde{M}}^U} \right] \end{array} \right\}$$

$$4. \quad H^n_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}(\tilde{M}) = \left\{ \begin{array}{l} \left[\sqrt{\alpha_{\tilde{M}}^n T_{\tilde{M}}^L}, \sqrt{\alpha_{\tilde{M}}^n T_{\tilde{M}}^U} \right], \\ \left[\sqrt{(I_{\tilde{M}}^L)^2 + (1 - (I_{\tilde{M}}^L)^2)(1 - (1 - \beta_{\tilde{M}})^n) - (T_{\tilde{M}}^L)^2 \beta_{\tilde{M}} (\sum_{t=0}^{n-1} \alpha_{\tilde{M}}^{n-1-t} (1 - \beta_{\tilde{M}})^t)}, \right. \\ \left. \sqrt{(I_{\tilde{M}}^U)^2 + (1 - (I_{\tilde{M}}^U)^2)(1 - (1 - \beta_{\tilde{M}})^n) - (T_{\tilde{M}}^U)^2 \beta_{\tilde{M}} (\sum_{t=0}^{n-1} \alpha_{\tilde{M}}^{n-1-t} (1 - \beta_{\tilde{M}})^t)} \right], \\ \left[\sqrt{(F_{\tilde{M}}^L)^2 + (1 - (F_{\tilde{M}}^L)^2)(1 - (1 - \beta_{\tilde{M}})^n) - (T_{\tilde{M}}^L)^2 \beta_{\tilde{M}} (\sum_{t=0}^{n-1} \alpha_{\tilde{M}}^{n-1-t} (1 - \beta_{\tilde{M}})^t)}, \right. \\ \left. \sqrt{(F_{\tilde{M}}^U)^2 + (1 - (F_{\tilde{M}}^U)^2)(1 - (1 - \beta_{\tilde{M}})^n) - (T_{\tilde{M}}^U)^2 \beta_{\tilde{M}} (\sum_{t=0}^{n-1} \alpha_{\tilde{M}}^{n-1-t} (1 - \beta_{\tilde{M}})^t)} \right] \end{array} \right\}$$





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$$\begin{aligned}
 5. \quad H_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}^{*,n}(\tilde{M}) &= \left\{ \begin{aligned} & \left[\sqrt{\alpha_{\tilde{M}}^n T_{\tilde{M}}^L}, \sqrt{\alpha_{\tilde{M}}^n T_{\tilde{M}}^U} \right], \\ & \left[\sqrt{\frac{(I_{\tilde{M}}^L)^2 + (1 - (I_{\tilde{M}}^L)^2)(1 - (1 - \beta_{\tilde{M}})^n) - (T_{\tilde{M}}^L)^2 \alpha_{\tilde{M}} \beta_{\tilde{M}} (\sum_{t=0}^{n-1} \alpha_{\tilde{M}}^{n-1-t} (1 - \beta_{\tilde{M}})^t)}{(I_{\tilde{M}}^U)^2 + (1 - (I_{\tilde{M}}^U)^2)(1 - (1 - \beta_{\tilde{M}})^n) - (T_{\tilde{M}}^U)^2 \alpha_{\tilde{M}} \beta_{\tilde{M}} (\sum_{t=0}^{n-1} \alpha_{\tilde{M}}^{n-1-t} (1 - \beta_{\tilde{M}})^t)} \right], \\ & \left[\sqrt{\frac{(F_{\tilde{M}}^L)^2 + (1 - (F_{\tilde{M}}^L)^2)(1 - (1 - \beta_{\tilde{M}})^n) - (T_{\tilde{M}}^L)^2 \alpha_{\tilde{M}} \beta_{\tilde{M}} (\sum_{t=0}^{n-1} \alpha_{\tilde{M}}^{n-1-t} (1 - \beta_{\tilde{M}})^t)}{(F_{\tilde{M}}^U)^2 + (1 - (F_{\tilde{M}}^U)^2)(1 - (1 - \beta_{\tilde{M}})^n) - (T_{\tilde{M}}^U)^2 \alpha_{\tilde{M}} \beta_{\tilde{M}} (\sum_{t=0}^{n-1} \alpha_{\tilde{M}}^{n-1-t} (1 - \beta_{\tilde{M}})^t)} \right] \end{aligned} \right\} \\
 6. \quad J_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}^n(\tilde{M}) &= \left\{ \begin{aligned} & \left[\sqrt{\frac{(T_{\tilde{M}}^L)^2 + (1 - (T_{\tilde{M}}^L)^2)(1 - (1 - \alpha_{\tilde{M}})^n) - (I_{\tilde{M}}^L)^2 \alpha_{\tilde{M}} (\sum_{t=0}^{n-1} \beta_{\tilde{M}}^{n-1-t} (1 - \alpha_{\tilde{M}})^t)}{(T_{\tilde{M}}^U)^2 + (1 - (T_{\tilde{M}}^U)^2)(1 - (1 - \alpha_{\tilde{M}})^n) - (I_{\tilde{M}}^U)^2 \alpha_{\tilde{M}} (\sum_{t=0}^{n-1} \beta_{\tilde{M}}^{n-1-t} (1 - \alpha_{\tilde{M}})^t)} \right], \\ & \left[\sqrt{\beta_{\tilde{M}}^n I_{\tilde{M}}^L}, \sqrt{\beta_{\tilde{M}}^n I_{\tilde{M}}^U} \right], \\ & \left[\sqrt{\beta_{\tilde{M}}^n F_{\tilde{M}}^L}, \sqrt{\beta_{\tilde{M}}^n F_{\tilde{M}}^U} \right] \end{aligned} \right\} \\
 7. \quad J_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}^{*,n}(\tilde{M}) &= \left\{ \begin{aligned} & \left[\sqrt{\frac{(T_{\tilde{M}}^L)^2 + (1 - (T_{\tilde{M}}^L)^2)(1 - (1 - \alpha_{\tilde{M}})^n) - (I_{\tilde{M}}^L)^2 \alpha_{\tilde{M}} \beta_{\tilde{M}} (\sum_{t=0}^{n-1} \beta_{\tilde{M}}^{n-1-t} (1 - \alpha_{\tilde{M}})^t)}{(T_{\tilde{M}}^U)^2 + (1 - (T_{\tilde{M}}^U)^2)(1 - (1 - \alpha_{\tilde{M}})^n) - (I_{\tilde{M}}^U)^2 \alpha_{\tilde{M}} \beta_{\tilde{M}} (\sum_{t=0}^{n-1} \beta_{\tilde{M}}^{n-1-t} (1 - \alpha_{\tilde{M}})^t)} \right], \\ & \left[\sqrt{\beta_{\tilde{M}}^n I_{\tilde{M}}^L}, \sqrt{\beta_{\tilde{M}}^n I_{\tilde{M}}^U} \right], \\ & \left[\sqrt{\beta_{\tilde{M}}^n F_{\tilde{M}}^L}, \sqrt{\beta_{\tilde{M}}^n F_{\tilde{M}}^U} \right] \end{aligned} \right\} \\
 8. \quad P_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}^n(\tilde{M}) &= \left\{ \begin{aligned} & [\max(\alpha_{\tilde{M}}, T_{\tilde{M}}^L), \max(\alpha_{\tilde{M}}, T_{\tilde{M}}^U)], \\ & [\min(\beta_{\tilde{M}}, I_{\tilde{M}}^L), \min(\beta_{\tilde{M}}, I_{\tilde{M}}^U)], \\ & [\min(\beta_{\tilde{M}}, F_{\tilde{M}}^L), \min(\beta_{\tilde{M}}, F_{\tilde{M}}^U)] \end{aligned} \right\} \\
 9. \quad Q_{\alpha_{\tilde{M}}, \beta_{\tilde{M}}}^n(\tilde{M}) &= \left\{ \begin{aligned} & [\min(\alpha_{\tilde{M}}, T_{\tilde{M}}^L), \min(\alpha_{\tilde{M}}, T_{\tilde{M}}^U)], \\ & [\max(\beta_{\tilde{M}}, I_{\tilde{M}}^L), \max(\beta_{\tilde{M}}, I_{\tilde{M}}^U)], \\ & [\max(\beta_{\tilde{M}}, F_{\tilde{M}}^L), \max(\beta_{\tilde{M}}, F_{\tilde{M}}^U)] \end{aligned} \right\}
 \end{aligned}$$

INTERVAL-VALUED NEUTROSOPHIC PYTHAGOREAN POINT WEIGHTED AVERAGING OPERATORS

Definition 3.5: Let us consider $M_j = \{ [T_{M_j}^L, T_{M_j}^U], [I_{M_j}^L, I_{M_j}^U], [F_{M_j}^L, F_{M_j}^U] \}$ ($j=1,2,\dots,n$) to be a collection of interval-valued neutrosophic Pythagorean numbers, $\alpha_{M_j}, \beta_{M_j} \in [0,1], \lambda > 0$ and let $w = (w_1, w_2, \dots, w_n)^T$ be the weights associated with the vector M_j , with $w_j \geq 0, \sum_{j=1}^n w_j = 1$, then we define the interval-valued neutrosophic Pythagorean point weighted averaging operator as a mapping IVNPPWA: $M^n \rightarrow M$, where

$$1. \quad IVNPPWA_w^n(M_1, M_2, \dots, M_n) = \left\{ \begin{aligned} & \left[\sum_{j=1}^n w_j \sqrt{(T_{M_j}^L)^2 + \alpha_{M_j} (\pi_{M_j}^L)^2}, \sum_{j=1}^n w_j \sqrt{(T_{M_j}^U)^2 + \alpha_{M_j} (\pi_{M_j}^U)^2} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{(I_{M_j}^L)^2 + (1 - \alpha_{M_j}) (\pi_{M_j}^L)^2}, \sum_{j=1}^n w_j \sqrt{(I_{M_j}^U)^2 + (1 - \alpha_{M_j}) (\pi_{M_j}^U)^2} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{(F_{M_j}^L)^2 + (1 - \alpha_{M_j}) (\pi_{M_j}^L)^2}, \sum_{j=1}^n w_j \sqrt{(F_{M_j}^U)^2 + (1 - \alpha_{M_j}) (\pi_{M_j}^U)^2} \right] \end{aligned} \right\}$$





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2. $IVNPPWAF_w^n(M_1, M_2, \dots, M_n) = \left\{ \begin{aligned} & \left[\sum_{j=1}^n w_j \sqrt{(T_{M_j}^L)^2 + \alpha_{M_j} (\pi_{M_j}^L)^2 \frac{1-(1-\alpha_{M_j}-\beta_{M_j})^n}{\alpha_{M_j}+\beta_{M_j}}}, \sum_{j=1}^n w_j \sqrt{(T_{M_j}^U)^2 + \alpha_{M_j} (\pi_{M_j}^U)^2 \frac{1-(1-\alpha_{M_j}-\beta_{M_j})^n}{\alpha_{M_j}+\beta_{M_j}}} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{(I_{M_j}^L)^2 + (1-\alpha_{M_j}) (\pi_{M_j}^L)^2 \frac{1-(1-\alpha_{M_j}-\beta_{M_j})^n}{\alpha_{M_j}+\beta_{M_j}}}, \sum_{j=1}^n w_j \sqrt{(I_{M_j}^U)^2 + (1-\alpha_{M_j}) (\pi_{M_j}^U)^2 \frac{1-(1-\alpha_{M_j}-\beta_{M_j})^n}{\alpha_{M_j}+\beta_{M_j}}} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{(F_{M_j}^L)^2 + (1-\alpha_{M_j}) (\pi_{M_j}^L)^2 \frac{1-(1-\alpha_{M_j}-\beta_{M_j})^n}{\alpha_{M_j}+\beta_{M_j}}}, \sum_{j=1}^n w_j \sqrt{(F_{M_j}^U)^2 + (1-\alpha_{M_j}) (\pi_{M_j}^U)^2 \frac{1-(1-\alpha_{M_j}-\beta_{M_j})^n}{\alpha_{M_j}+\beta_{M_j}}} \right] \end{aligned} \right\}$
3. $IVNPPWAF_w^n(M_1, M_2, \dots, M_n) = \left\{ \begin{aligned} & \left[\sum_{j=1}^n w_j \sqrt{\alpha_{M_j}^n T_{M_j}^L}, \sum_{j=1}^n w_j \sqrt{\alpha_{M_j}^n T_{M_j}^U} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{\beta_{M_j}^n I_{M_j}^L}, \sum_{j=1}^n w_j \sqrt{\beta_{M_j}^n I_{M_j}^U} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{\beta_{M_j}^n F_{M_j}^L}, \sum_{j=1}^n w_j \sqrt{\beta_{M_j}^n F_{M_j}^U} \right] \end{aligned} \right\}$
4. $IVNPPWAH_w^n(M_1, M_2, \dots, M_n) = \left\{ \begin{aligned} & \left[\sum_{j=1}^n w_j \sqrt{\alpha_{M_j}^n T_{M_j}^L}, \sum_{j=1}^n w_j \sqrt{\alpha_{M_j}^n T_{M_j}^U} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{\frac{(I_{M_j}^L)^2 + (1-(I_{M_j}^L)^2)(1-(1-\beta_{M_j})^n) - (T_{M_j}^L)^2 \beta_{M_j} (\sum_{t=0}^{n-1} \alpha_{M_j}^{n-1-t} (1-\beta_{M_j})^t)}{\alpha_{M_j}+\beta_{M_j}}}}, \right. \\ & \left. \sum_{j=1}^n w_j \sqrt{\frac{(I_{M_j}^U)^2 + (1-(I_{M_j}^U)^2)(1-(1-\beta_{M_j})^n) - (T_{M_j}^U)^2 \beta_{M_j} (\sum_{t=0}^{n-1} \alpha_{M_j}^{n-1-t} (1-\beta_{M_j})^t)}{\alpha_{M_j}+\beta_{M_j}}} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{\frac{(F_{M_j}^L)^2 + (1-(F_{M_j}^L)^2)(1-(1-\beta_{M_j})^n) - (T_{M_j}^L)^2 \beta_{M_j} (\sum_{t=0}^{n-1} \alpha_{M_j}^{n-1-t} (1-\beta_{M_j})^t)}{\alpha_{M_j}+\beta_{M_j}}}}, \right. \\ & \left. \sum_{j=1}^n w_j \sqrt{\frac{(F_{M_j}^U)^2 + (1-(F_{M_j}^U)^2)(1-(1-\beta_{M_j})^n) - (T_{M_j}^U)^2 \beta_{M_j} (\sum_{t=0}^{n-1} \alpha_{M_j}^{n-1-t} (1-\beta_{M_j})^t)}{\alpha_{M_j}+\beta_{M_j}}} \right] \end{aligned} \right\}$
5. $IVNPPWAH_w^{*n}(M_1, M_2, \dots, M_n) = \left\{ \begin{aligned} & \left[\sum_{j=1}^n w_j \sqrt{\alpha_{M_j}^n T_{M_j}^L}, \sum_{j=1}^n w_j \sqrt{\alpha_{M_j}^n T_{M_j}^U} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{\frac{(I_{M_j}^L)^2 + (1-(I_{M_j}^L)^2)(1-(1-\beta_{M_j})^n) - (T_{M_j}^L)^2 \alpha_{M_j} \beta_{M_j} (\sum_{t=0}^{n-1} \alpha_{M_j}^{n-1-t} (1-\beta_{M_j})^t)}{\alpha_{M_j}+\beta_{M_j}}}}, \right. \\ & \left. \sum_{j=1}^n w_j \sqrt{\frac{(I_{M_j}^U)^2 + (1-(I_{M_j}^U)^2)(1-(1-\beta_{M_j})^n) - (T_{M_j}^U)^2 \alpha_{M_j} \beta_{M_j} (\sum_{t=0}^{n-1} \alpha_{M_j}^{n-1-t} (1-\beta_{M_j})^t)}{\alpha_{M_j}+\beta_{M_j}}} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{\frac{(F_{M_j}^L)^2 + (1-(F_{M_j}^L)^2)(1-(1-\beta_{M_j})^n) - (T_{M_j}^L)^2 \alpha_{M_j} \beta_{M_j} (\sum_{t=0}^{n-1} \alpha_{M_j}^{n-1-t} (1-\beta_{M_j})^t)}{\alpha_{M_j}+\beta_{M_j}}}}, \right. \\ & \left. \sum_{j=1}^n w_j \sqrt{\frac{(F_{M_j}^U)^2 + (1-(F_{M_j}^U)^2)(1-(1-\beta_{M_j})^n) - (T_{M_j}^U)^2 \alpha_{M_j} \beta_{M_j} (\sum_{t=0}^{n-1} \alpha_{M_j}^{n-1-t} (1-\beta_{M_j})^t)}{\alpha_{M_j}+\beta_{M_j}}} \right] \end{aligned} \right\}$
6. $IVNPPWAJ_w^n(M_1, M_2, \dots, M_n) = \left\{ \begin{aligned} & \left[\sum_{j=1}^n w_j \sqrt{\frac{(T_{M_j}^L)^2 + (1-(T_{M_j}^L)^2)(1-(1-\alpha_{M_j})^n) - (I_{M_j}^L)^2 \alpha_{M_j} (\sum_{t=0}^{n-1} \beta_{M_j}^{n-1-t} (1-\alpha_{M_j})^t)}{\alpha_{M_j}+\beta_{M_j}}}}, \right. \\ & \left. \sum_{j=1}^n w_j \sqrt{\frac{(T_{M_j}^U)^2 + (1-(T_{M_j}^U)^2)(1-(1-\alpha_{M_j})^n) - (I_{M_j}^U)^2 \alpha_{M_j} (\sum_{t=0}^{n-1} \beta_{M_j}^{n-1-t} (1-\alpha_{M_j})^t)}{\alpha_{M_j}+\beta_{M_j}}} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{\beta_{M_j}^n I_{M_j}^L}, \sum_{j=1}^n w_j \sqrt{\beta_{M_j}^n I_{M_j}^U} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{\beta_{M_j}^n F_{M_j}^L}, \sum_{j=1}^n w_j \sqrt{\beta_{M_j}^n F_{M_j}^U} \right] \end{aligned} \right\}$





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$$\begin{aligned}
 7. \quad & IVNPPWAJ_w^{*,n}(M_1, M_2, \dots, M_n) = \left[\frac{\left[\sum_{j=1}^n w_j \sqrt{(T_{M_j}^L)^2 + (1 - (T_{M_j}^L)^2)} (1 - (1 - \alpha_{M_j})^n) - (I_{M_j}^L)^2 \alpha_{M_j} \beta_{M_j} \left(\sum_{t=0}^{n-1} \beta_{M_j}^{n-1-t} (1 - \alpha_{M_j})^t \right) \right]}{\left[\sum_{j=1}^n w_j \sqrt{(T_{M_j}^U)^2 + (1 - (T_{M_j}^U)^2)} (1 - (1 - \alpha_{M_j})^n) - (I_{M_j}^U)^2 \alpha_{M_j} \beta_{M_j} \left(\sum_{t=0}^{n-1} \beta_{M_j}^{n-1-t} (1 - \alpha_{M_j})^t \right) \right]} \right] \\
 & \left[\begin{aligned} & \left[\sum_{j=1}^n w_j \sqrt{\beta_{M_j}^n I_{M_j}^L}, \sum_{j=1}^n w_j \sqrt{\beta_{M_j}^n I_{M_j}^U} \right], \\ & \left[\sum_{j=1}^n w_j \sqrt{\beta_{M_j}^n F_{M_j}^L}, \sum_{j=1}^n w_j \sqrt{\beta_{M_j}^n F_{M_j}^U} \right] \end{aligned} \right] \\
 8. \quad & IVNPPWAP_w^n(M_1, M_2, \dots, M_n) = \left\{ \begin{aligned} & \left[\sum_{j=1}^n w_j \max(\alpha_{M_j}, T_{M_j}^L), \sum_{j=1}^n w_j \max(\alpha_{M_j}, T_{M_j}^U) \right], \\ & \left[\sum_{j=1}^n w_j \min(\beta_{M_j}, I_{M_j}^L), \sum_{j=1}^n w_j \min(\beta_{M_j}, I_{M_j}^U) \right], \\ & \left[\sum_{j=1}^n w_j \min(\beta_{M_j}, F_{M_j}^L), \sum_{j=1}^n w_j \min(\beta_{M_j}, F_{M_j}^U) \right] \end{aligned} \right\} \\
 9. \quad & IVNPPWAQ_w^n(M_1, M_2, \dots, M_n) = \left\{ \begin{aligned} & \left[\sum_{j=1}^n w_j \min(\alpha_{M_j}, T_{M_j}^L), \sum_{j=1}^n w_j \min(\alpha_{M_j}, T_{M_j}^U) \right], \\ & \left[\sum_{j=1}^n w_j \max(\beta_{M_j}, I_{M_j}^L), \sum_{j=1}^n w_j \max(\beta_{M_j}, I_{M_j}^U) \right], \\ & \left[\sum_{j=1}^n w_j \max(\beta_{M_j}, F_{M_j}^L), \sum_{j=1}^n w_j \max(\beta_{M_j}, F_{M_j}^U) \right] \end{aligned} \right\}
 \end{aligned}$$

Theorem 3.1: (Idempotency)

Let us assume $M_j = \{ [T_{M_j}^L, T_{M_j}^U], [I_{M_j}^L, I_{M_j}^U], [F_{M_j}^L, F_{M_j}^U] \}$ ($j=1,2,\dots,n$) to be a collection of interval-valued neutrosophic Pythagorean numbers, $\alpha_{M_j}, \beta_{M_j} \in [0,1], \lambda > 0$ and should satisfy $\alpha_{M_j} + \beta_{M_j} \leq 1$. Let $w = (w_1, w_2, \dots, w_n)^T$ be the weights associated with the vector M_j , with $w_j \geq 0, \sum_{j=1}^n w_j = 1$. If for all $M_j = M$, then

1. $IVNPPWAD_w^n(M_1, M_2, \dots, M_n) = D_{\alpha_M}^n(M)$
2. $IVNPPWAF_w^n(M_1, M_2, \dots, M_n) = F_{\alpha_M, \beta_M}^n(M)$
3. $IVNPPWAG_w^n(M_1, M_2, \dots, M_n) = G_{\alpha_M, \beta_M}^n(M)$
4. $IVNPPWAH_w^n(M_1, M_2, \dots, M_n) = H_{\alpha_M, \beta_M}^n(M)$
5. $IVNPPWAH_w^{*,n}(M_1, M_2, \dots, M_n) = H_{\alpha_M, \beta_M}^{*,n}(M)$
6. $IVNPPWAJ_w^n(M_1, M_2, \dots, M_n) = J_{\alpha_M, \beta_M}^n(M)$
7. $IVNPPWAJ_w^{*,n}(M_1, M_2, \dots, M_n) = J_{\alpha_M, \beta_M}^{*,n}(M)$
8. $IVNPPWAP_w^n(M_1, M_2, \dots, M_n) = P_{\alpha_M, \beta_M}^n(M)$
9. $IVNPPWAQ_w^n(M_1, M_2, \dots, M_n) = Q_{\alpha_M, \beta_M}^n(M)$

Theorem 3.2 (Monotonicity):

Let us assume $M_j = \{ [T_{M_j}^L, T_{M_j}^U], [I_{M_j}^L, I_{M_j}^U], [F_{M_j}^L, F_{M_j}^U] \}$ and $M_j' = \{ [T_{M_j'}^L, T_{M_j'}^U], [I_{M_j'}^L, I_{M_j'}^U], [F_{M_j'}^L, F_{M_j'}^U] \}$ be two collections of interval-valued neutrosophic Pythagorean numbers. Let $\alpha_{M_j}, \beta_{M_j}, \alpha_{M_j'}, \beta_{M_j'} \in [0,1]$ and $\alpha_{M_j} + \beta_{M_j} \leq 1$ and $\alpha_{M_j'} + \beta_{M_j'} \leq 1, \lambda > 0$. Let w be the weight vector associated with M_j and M_j' with $\sum_{j=1}^n w_j = 1$. If for all $M_j < M_j'$, then

1. $IVNPPWAD_w^n(M_1, M_2, \dots, M_n) \leq IVNPPWAD_w^n(M_1', M_2', \dots, M_n')$
2. $IVNPPWAF_w^n(M_1, M_2, \dots, M_n) \leq IVNPPWAF_w^n(M_1', M_2', \dots, M_n')$
3. $IVNPPWAG_w^n(M_1, M_2, \dots, M_n) \leq IVNPPWAG_w^n(M_1', M_2', \dots, M_n')$
4. $IVNPPWAH_w^n(M_1, M_2, \dots, M_n) \leq IVNPPWAH_w^n(M_1', M_2', \dots, M_n')$
5. $IVNPPWAH_w^{*,n}(M_1, M_2, \dots, M_n) \leq IVNPPWAH_w^{*,n}(M_1', M_2', \dots, M_n')$
6. $IVNPPWAJ_w^n(M_1, M_2, \dots, M_n) \leq IVNPPWAJ_w^n(M_1', M_2', \dots, M_n')$
7. $IVNPPWAJ_w^{*,n}(M_1, M_2, \dots, M_n) \leq IVNPPWAJ_w^{*,n}(M_1', M_2', \dots, M_n')$
8. $IVNPPWAP_w^n(M_1, M_2, \dots, M_n) \leq IVNPPWAP_w^n(M_1', M_2', \dots, M_n')$
9. $IVNPPWAQ_w^n(M_1, M_2, \dots, M_n) \leq IVNPPWAQ_w^n(M_1', M_2', \dots, M_n')$





RESULTS AND DISCUSSION

In this work, we analysed point operators about a point and developed interval-valued neutrosophic point operators. Additionally, we constructed average aggregation operations for interval-valued neutrosophic Pythagorean sets and defined point operators for interval-valued neutrosophic Pythagorean numbers too. This can be used in decision making problems to attain the optimum decision for the real world problem chosen.

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Phytochemical Screening and Molecular Docking studies of the Phytocompounds in *Cassia fistula* Linn. for Anti-Seborrheic Activity

Prathyusha.P^{1*}, D. Shana Evanjalin¹, S. Maanisha¹, A.Jasmin¹ and S. Aswini²

¹Assistant Professor, Department of Botany, Nirmala College for Women, Coimbatore, Tamil Nadu, India

²Department of Botany, Nirmala College for Women, Coimbatore, Tamil Nadu, India

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*Address for Correspondence

Prathyusha.P

Assistant Professor,
Department of Botany,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India
E. Mail: prathyusha.phd1@gmail.com



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ABSTRACT

Medicinal properties of the medicinal plant are high and they are used to get relief from all sorts of diseases and are used widely in traditional medicine practice since prehistoric times, are also widely used in non-industrialized societies, due to availability and cost efficient than synthetic medicine. A potential medicinal plant *Cassia fistula* L. is known as Golden shower or Indian labrum or pudding-pine tree or Amaltas belonging to the Fabaceae leguminous family is traditionally used for the treatment of many diseases and many secondary metabolites are present that has significant role. Each and every part like leaves, stems, root, flower, fruit, pods and bark of *Cassia fistula* has its own medicinal uses. The bark of *Cassia fistula* has more therapeutic values, it is a good anti-dysenteric and is also used for skin complaints, powder or decoction of bark is administered in leprosy, jaundice, syphilis and heart diseases and aqueous extract of the root bark exhibits anti-inflammatory activity. The stem bark is used against amenorrhea, chest pain, swellings etc. For the present study the compounds showing anti-seborrheic activity was chosen from the GC-MC analysis and pharmaceutical activity were predicted using computational methods which was docked against the drug target used to treat Seborrhea

Keywords: *Cassia fistula* L., Anti-Seborrheic Activity, Molecular Docking, GC-MC analysis,

INTRODUCTION

Medicinal plants are found in all places, they play an important role in the field of health, due to the growing needs of the population and the necessity to get rid of the ailments. Now a days herbal medicines has gained attention due



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to their pharmaceutical and therapeutically properties and minimum amount of side-effects or no side-effects when compare to synthetic medicines. The therapeutic properties are mainly due to chemical compounds which are regarded as secondary metabolites because plants uses these metabolites in a lesser quantity, so they are derived from plant and utilized. As they supply raw materials for the field of nutraceuticals, folk medicines, food supplements, pharmaceutical intermediates and chemical entities for synthetic drugs [1]. These chemical constituents, the secondary metabolites may be present in any part of the plant, at stem or leaves, sometimes at the root or bark or at fruits, flowers, seeds or in the whole plant. Some of the phytochemical compounds like Alkaloids, Glycosides, Polyphenols, Terpenes, Saponoids, these have high property of therapeutic uses.

A potential medicinal plant namely *Cassia fistula* Linn. is commonly known as the golden shower or Indian labrum or pudding-pine tree. The whole plant contains many secondary metabolites such as Citronelol, linoleic acid, anthroquinone, alloin wax, phenolic compounds, free sugar, galactoman, free aminoacids, saponin, gum cardiac glycosoids, alkaloids, glycosoids, iron, calcium, phosphate, resins, tannins, steroids, terpenoids, rhein, sennoside A and B Flavan 3-ol derivatives[2]Anthroquinone is used as a laxative, antimicrobial and anti- inflammatory and current therapeutic indication includes cancer, constipation, arthritis and multiple sclerosis. All the other compounds also have significant therapeutic uses such as antioxidant, anti-microbial, anti-inflammatory, anti-tumor, hypoglycemic activity, bronchitis, skin diseases, liver disorder, jaundice, tuberculosis, heart diseases, leprosy, carminatives, anti- fungal, rheumatism, malaria and ulcer etc. [3]

The bark of *Cassia fistula* has many therapeutical uses, here we have selected it to do a wide research on the bark. Computational methods are the most popular methods that are helpful in a variety of ways. Starting from Sequence analysis to Drug Designing, Computational prediction methods of Computational Biology/Bioinformatics is its ability to design small molecules, predict its activity and thus minimizing the time and efforts needed for discovery of a new lead compound for drug discovery. Many softwares, tools and web servers are the backbones of Computational Prediction. Hence this present study about the bark of *Cassia fistula* is further carried out by the evaluation of phytochemicals from the methanolic soxhlet extract of bark of *Cassia fistula* and the sample was subjected to GC-MS analysis for the identification of various components that are responsible for various activities. The main aim is to determine the phytochemical constitutents and to predict the activities of each compounds and to dock each compounds with the target molecule to predict the activities of the drug by Molecular Docking Method.

MATERIALS AND METHODS

STUDY AREA

The study of *Cassia fistula* Linn. was carried out in Nirmala College for Women, Coimbatore, Tamil Nadu. The medium sized deciduous tree of about 10 to 15m tall was found and identified. It has been found that its altitude from the sea level is 1300m. The bark of *Cassia fistula* L. was collected inside the campus.

Vernacular Names

English-Indian Laburnum, Purging Fistula, Cassia, Golden Shower; Hindi-Sonhali, Amultus; Tamil-Shrakkonnai, Konai, Irjviruttam; Marathi-Bahava; Sanskrit –Nripadruma; Arab- Khayarsambhar

COLLECTION OF SAMPLE

The bark of *Cassia fistula* Linn was selected for the current study of qualitative phytochemical analysis and for the GC-MS analysis. Dried barks grinded into fine powder using a pulvarizer. The powdered sample subjected to maceration in methanol using Soxhlet Extractor.





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PHYTOCHEMICAL TEST

The extracts were subjected to phytochemical testing to detect for the presence of different chemical groups of compounds. Air dried, powdered and soxhleted plant sample were investigated for the presence of Proteins, Carbohydrates, Phenols and tannins, Flavonoids, Saponins, glycosides, steroid, terpenoids and alkaloids [4]

GC-MS ANALYSIS

The experiment was performed on a GC-MS equipment. The name of the equipment was CH-GCMSMS-02. The solvent used to run the GC-MS test was Methanol. DB 5-MS Capillary standard non polar column, with a dimension of 30 Mts. With an ID of 0.25mm and Film thickness of 0.25 μ m was used. The flow rate of the mobile phase was set at 1.0 ml/min. In the gas chromatography part, temperature was 40 $^{\circ}$ C raised to 290 C at 5 C/min and injection volume was 1.0 μ l. A scan interval of 0.5 seconds with scan range of 40-600 m/z was set. Total GC running time was 37 minutes and the results were compared by using Wiley Spectral library search programme. From the phytochemicals which has been identified through GC-MS Analysis, anti-seborrheic activities were commonly found in eight of the compounds. So those 8 Compounds were selected for the Docking Studies. To know about their binding affinity with the drug target, molecular docking was performed. The receptor for the docking was retrieved from Protein Data Bank. Drug Target for the Ketoconazole, the drug for treating Seborrhea was found through Drug Bank and the structure was retrieved from protein Data Bank.

Activity Prediction using PASS

The components that have been derived from the GC-MS analysis are used to predict the pharmacological activity of the particular compound. From Canonical Smiles of the Compounds the pharmacological activities of the Compounds can be predicted using PASS server. The PASS (prediction of activity spectra for substance) is a software product of web- based application, which predicts 4000 kinds of biological activity including pharmacological effects and biochemical mechanisms on the basis of the structural formula of a substance, may be efficiently used to find new targets for some ligands and conversely, to reveal new ligands for some biological targets.

Molecular Docking

The docking of the compounds with Anti-seborrheic activity with the drug target 17- alpha-hydroxylose/17,20 lyase was performed using MGL Tools and Autodock by the following procedure:

Preparation of Receptor and Ligand files

Autodock entails both receptor and ligand in PDBQT format for assessing the binding energy 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. First the Macromolecule is loaded as the Drug Target. The water molecules in the receptor file were removed and implicit Hydrogen atoms were added. Then the Ligand Molecule was loaded and the output was saved in PDBQT format and then the Macromolecule was chosen and this was also saved in PDBQT format. Similarly, the ligand files in PDB format was retrieved by Autodock and save in PDBQT format.

Preparation of Grid and Dock Parameter files

AutoDock Tool was used to perform the grid computation. The grids maps with a dimension of 90x90x90 and spacing of 0.375 A° 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.

Docking and Visualization

Docking was performed using Lamarckian Genetic Algorithm with lowest binding energy which is selected from the 10 conformation with an initial population of 150 randomly placed ligand on the receptor binding site. A maximum

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of 2.5×10^5 evaluations on the energy will be carried out from 27×10^3 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.

Validation of the lead compound

The validation of the lead compounds were done by comparing the docking results with the docking results of Ketoconazole, the standard drug for Seborrhea

RESULT AND DISCUSSION

Phytochemical screening

The plant extract were screened for the presence of primary metabolites according to the common phytochemical methods. The test is based on visual observation of the change in colour or formation of precipitate after the addition of specific reagents. The results of phytochemical tests carried out for the bark of methanolic extract of *Cassia fistula* Linn. with methanol extract is revealed the presence of various phytochemical compounds (figure 2).

GC-MS Analysis

Since the preliminary phytochemical screening in methanol bark extract of *Cassia fistula* L. and the extract contains all active phytochemical ingredients and the methanol bark extract of *C. fistula* L was subjected to GC-MS Analysis. The GC-MS Analysis revealed the presence of 31 compounds from the extract. The Chromatogram of GC-MS spectra analysis showing peaks of the number of compounds from the GC fractions of the methanol Bark extract of *C. fistula* L. is presented (figure 2). In this observation, presence of 31 different bioactive compounds namely Furfural (RT=4.21), Isopilocarpine (RT=4.21), 10-Ethyl-10H-acridin-9-one (RT=6.87), 1H-Tetrazol-5-amine (RT=7.69), 4-Iodo-1-methyl-3-nitropyrazole (RT=8.37), 1-Butene, 4,4- diethoxy-2-methyl- (RT=8.61), 2-Pyrazinecarboxylic acid, 6-hydroxy, methyl ester (RT=10.67), 1H-Tetrazol-5-amine (RT=13.52), 6,6-Dimethyl-2-(2-methyl-allyl)-1,6- dihydropyrimidine-4-carbonitrile (RT=15.10), Benzene, 1,3-bis(1,1-dimethylethyl)- (RT=15.11), 1,2,4,5-Tetrazine, 3,6-dimethyl (RT=16.59), 1,2-Benzenediol, mono(methylcarbamate) (RT=16.61), 2-Propenoic acid, 2-methyl-, octyl ester (RT=16.68), benzonitrile, 4-[[2-amino-5-(dimethylamino)phenyl]sulfonyl]- (RT=17.06), 1-Pentanol, 4-(dibenzylamino)-5-phenyl-3-(p-tosylamino)- (RT=17.39), Thiazolidine-2-carboxylic acid, 3-(4-methoxyphenyl)-, ethyl ester (RT=20.92), 1,4-Benzenedicarboxylic acid, dimethyl ester, Phenylphosphonic difluoride (RT=20.93), 3-Phenyl-5-chloromethyl-1,2,4-oxadiazole (RT=20.93), Benzonitrile, 4-hydroxy- (RT=20.93), 2-(Phenylthio)acetonitrile (RT=21.29), 1,3-Benzodioxole-5-carboxylic acid, methyl ester (RT=21.81), Ethane, 1,2-dibromo- (RT=21.90), DL-2-fluorophenylglycine, N dimethylaminomethylene-, ethyl ester (RT=22.02), Phthalic acid, 3,5-dimethylphenyl ethyl ester (RT=22.44), 1,3-Benzodioxole-5-carboxylic acid (RT=23.16), Phenethylamine, 2-methoxy-.alpha.-methyl-4,5-(methylenedioxy)- (RT=24.14), Phthalic acid, di(3-ethylphenyl) ester (RT=24.70), Ethyl 4'-methylazobenzene-3-carboxylate (RT=24.70), 1(3H)- Isobenzofuranone, 6-nitro- (RT=24.92), Dithieno[2,3-c:3',2'-e]pyridazine, 4-oxide (RT=33.62). Anti-seborrheic activities were found 8 compounds such as 1,4-Benzenedicarboxylic acid, dimethyl ester, Benzonitrile, 4-hydroxy, 2-(Phenylthio)acetonitrile, Phthalic acid, 3,5-dimethylphenyl ethyl ester, Phthalic acid, di(3-ethylphenyl) ester, 1,2,4,5-Tetrazine, 3,6-dimethyl-, Benzene, 1,3-bis(1,1-dimethylethyl)-, Phenylphosphonic difluoride. The major constituents were compounds 2-pyrazinecarboxylic acid, 6-hydroxy, methyl ester (RT=10.67), Phthalic acid, di(3-ethylphenyl) ester (RT=24.70), 1,2-Benzenediol, mono(methylcarbamate) (RT=16.61), 2-(Phenylthio)acetonitrile (RT=21.29), DL-2-fluorophenylglycine, N dimethyl amino methylene-, ethyl ester (RT=22.02) (Figure 2).





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MOLECULAR DOCKING

From the above result of GC-MS, 8 compounds have anti-seborrheic activities which is similar to that of the activities of Ketoconazole. Ketoconazole is an imidazole antifungal agent used in the prevention and treatment of a variety of fungal infections. It functions by preventing the synthesis of ergosterol, the fungal equivalent of cholesterol, thereby increasing membrane fluidity and preventing growth of the fungus. It is used as an Anti-dandruff so the compounds containing these activities are selected and these compounds are used as a ligand. The drug target for Ketoconazole is 17-alpha-hydroxylase/17,20 lyase (Figure 3). So with this target the compounds containing anti-seborrheic activities are docked. The table 3 shows the compounds that contains the anti-seborrheic activities with the respective canonical smiles [5].

From the above table 2 it is inferred that the compound Benzene. 1.3-bis(1.1-dimethylethyl)- is having a binding energy of about -5.19 Kcal and inhibitory constant of 156.45uM and has 0 hydrogen bonds. The docked conformation of the compound with 17-alpha-hydroxylase/17,20 lyase (Figure 4).The compound 1.4-Benzenedicarboxylic acid. dimethyl ester has a binding energy of -6.1 in Kcal and the inhibitory constant is 33.69 uM and it has 4 hydrogen bonds in Lig:0::3RUK:A:LYS490:O. The docked conformation of the compound with 17-alpha- hydroxylase/17,20 lyase (Figure 5). The compound Benzonitrile. 4-hydroxy has a binding energy of -5.18 in Kcal and the inhibitory constant is 158.51 uM and it has 2 hydrogen bonds in Lig:0:H::3RUK:D:ASP216:O. The docked conformation of the compound with 17-alpha- hydroxylase/17,20 lyase (Figure 6). The compound 2-(Phenylthio)acetonitrile has a binding energy of -5.48 in Kcal and the inhibitory constant is 96.08 uM and it has 1 hydrogen bond in Lig:0:S::3RUK:D:ASP216:OD1. The docked conformation of the compound with 17-alpha-hydroxylase/17,20 lyase (Figure 7).

The compound phthalic acid. 3.5-dimethylphenyl ethyl ester has a binding energy of - 6.27 and it has a inhibitory constant of 25.17 uM and it has 3 hydrogen bonds in Lig:O::3RUK:A:SER475:HN. The docked conformation of the compound with 17-alpha- hydroxylase/17,20 lyase (Figure 8). The compound Phthalic acid. di(3-ethylphenyl) ester has a binding energy of -7.26 and the Inhibitory constant is 4.78 and it has no hydrogen bond. The docked conformation of the compound with 17-alpha-hydroxylase/17,20 lyase (Figure 9). The compound 1.2.4.5-Tetrazine. 3.6-dimethyl- has a binding energy of -5.04 and the Inhibitory constant of 201.36 with 6 hydrogen bonds Lig:N::3RUK:C:ASN226:HN, Lig:NN::3RUK:C:LEU229:HN, Lig:N::3RUK:C:THR228:HN, Lig:N::3RUK:C:LEU221:O and Lig:N::3RUK:C:PHE224:O. The docked conformation of the compound with 17-alpha- hydroxylase/17,20 lyase (Figure 10). The compound Phenylphosphonicdifluoride has a binding energy of -4.91 and the inhibitory constant of 251.29 with 1 hydrogen bond in Lig:O::3RUK:D:LEU221:HN is formed. The docked conformation of the compound with 17- alpha-hydroxylase/17,20 lyase (Figure 11).

The compound ketoconazole has a binding energy of -6.73 and a inhibitory constant of 11.61 and it has one hydrogen bond in Keto:O:3RUK:A:LYS490:HN. The docked conformation of the compound with 17-alpha-hydroxylase/17,20 lyase (figure 12). From the above results it is inferred that the compound Phthalic acid. di(3-ethylphenyl) ester is having a better Electron Binding Affinity than that of the Ketoconazole. The electron binding of Phthalic acid. di(3-ethylphenyl) ester is -7.26 whereas the electron binding of Ketoconazole is -6.73. Since the Binding affinity of Phthalic acid. di(3-ethylphenyl) ester is better than that of Ketoconazole it can be used as a medicinal supplement for the drug Ketoconazole.

DISCUSSION

The Present investigation was aimed to identify the Phytochemicals present in methanol bark extract of *C.fistula*. The study reveals that *C.fistula* L. has the phytochemicals like carbohydrate, phenol, tannins, flavonoids, saponins, glycerol, steroids, terpenoid, alkaloid.etc. and proteins are absent in the bark extract. Similarly [6] result shows that the protein and sterol were absent in the bark of *C. fistula* L. The presence of secondary metabolites in plants, produce some biological activity in man and animals and therefore explains its traditional use as health remedy [7].



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also revealed that the proteins, tannins, saponins were absent in bark of *C. fistula* L. The methanol bark extract of *C. fistula* L. was subjected to GC-MS analysis and the result revealed that 31 compounds are present in the bark extract. Out of 31 compounds 2- Pyrazinecarboxylic acid, 6-hydroxy, methyl ester, Phthalic acid, di(3-ethylphenyl) ester, 1,2 Benzenediol, mono(methylcarbamate), 2-(Phenylthio)acetonitrile, DL-2-fluorophenylglycine, Ndimethylaminomethylene-,ethyl ester were identified as major compounds and from the GC- MS analysis we identify the therapeutic uses for 31 compounds by using PASS Prediction and selective compounds from extract shows anti-seborrheic activity. The potentiality of *C. fistula* L. for multidrug action was rationally understood from the present study [8].

Results also revealed that presence of 11 compounds in methanol bark extract of *C. fistula* L. by using GC-MS method and those compounds have antifungal, antibacterial, anticancer, antioxidant etc. properties and medicinal uses [5]. GC-MS results shows 23 phytochemicals was present in the methanol stem bark extract of *Cassia siamea* and also studied the therapeutic uses of bark extract. Docking studies were carried out with a help of GC-MS results by using computational tools. From the GC-MS result 8 compounds have anti-seborrheic activity and those compounds docked with drug target 17-alpha-hydroxylase/17,20 lyase, Phthalic acid, di(3-ethylphenyl) ester shows highest binding affinity then the standard ligand ketoconazole [9] analysed that Molecular docking study of bark-derived components of *Cinnamomum cassia* on aldose reductase .cinnamaldehyde, cinnamic acid and cinnamyl alcohol derived from the bark of *Cinnamomum cassia* were used to evaluate their efficiency in inhibiting AR activity.

CONCLUSION

The present study which started with the aim to identify the pharmaceutical and therapeutic activities of compounds obtained through the GC-MS Analysis of methanolic bark extract of *C. fistula* Linn. had ended with suggesting potential lead compounds against seborrhea. Although, it was a preliminary study the results are promising towards a successful lead discovery. All the other compounds also have significant therapeutic uses such as antioxidant, antimicrobial, anti-inflammatory, anti-tumor, hypoglycemic activity, bronchitis, skin diseases, liver disorder, jaundice, tuberculosis, heart diseases, leprosy, carminatives, anti- fungal, rheumatism, malaria and ulcer etc. The 8 Compounds that showed anti-seborrheic activity are Benzene. 1.3-bis(1.1-dimethylethyl), 1.4-Benzenedicarboxylic acid. dimethylester, Benzonitrile. 4-hydroxy,2-(Phenylthio)acetonitrile, Phthalic acid. 3.5- dimethylphenyl ethyl ester, Phthalic acid. Di(3-ethylphenyl) ester, 1.2.4.5-Tetrazine. 3.6- dimethyl- and Phenylphosphonicdifluoride. As a result of the docking studies the compound Phthalic acid. di(3-ethylphenyl) ester has a better binding affinity than the standard drug Ketoconazole. Although the results are promising, experimental studies are needed for further validation.

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Table –1 Compounds containing Anti-seborrheic Activities

Sl. No	Compound Name	Pa	Pi	Canonical Smile
1	Benzene. 1.3-bis(1.1- dimethylethyl)-	0.824	0.015	<chem>CC(C)(C)C1=CC(=CC=C1)C(C)(C)C</chem>
2	1.4-Benzene dicarboxylic acid. dimethyl ester	0.845	0.011	<chem>COC(=O)C1=CC=C(C=C1)C(=O)OC</chem>
3	Benzonitrile. 4-hydroxy	0.860	0.008	<chem>C1=CC(=CC=C1)C#N</chem>
4	2-(Phenylthio) acetonitrile	0.730	0.032	<chem>C1=CC=C(C=C1)SCC#N</chem>
5	Phthalic acid. 3.5- dimethylphenyl ethyl ester	0.841	0.012	<chem>CCOC(=O)C1=CC=CC=C1C(=O)OC2=CC(=CC(=C2)C)C</chem>
6	Phthalic acid. di(3- ethylphenyl) ester	0.782	0.022	<chem>CCC1=CC(=CC=C1)OC(=O)C2=CC=CC=C2C(=O)OC3=CC=CC(=C3)CC</chem>
7	1.2.4.5-Tetrazine. 3.6- dimethyl-	0.768	0.025	<chem>CC1=NN=C(N=N1)C</chem>
8	Phenylphosphonic difluoride	0.797	0.020	<chem>C1=CC=C(C=C1)P(=O)(F)F</chem>

Table – 2 Docking results of the compounds with 17-alpha-hydroxylase/17,20 lyase

S.NO.	Compound Name	Binding Energy (Kcal)	Inhibitory Constant (uM)	No of Hydrogen bonds	Hydrogen bond
1	Benzene. 1.3-bis(1.1- dimethylethyl)-	-5.19	156.45	0	-
2	1.4-Benzenedicarboxylic acid. dimethyl ester	-6.1	33.69	4	Lig:O::3RUK:A:LYS490:O
3	Benzonitrile. 4-hydroxy	-5.18	158.51	2	Lig:O:H::3RUK:D:ASP216:O
4	2-(Phenylthio)acetonitrile	-5.48	96.08	1	Lig:O:S::3RUK:D:ASP216:OD1
5	phthalic acid. 3.5- dimethylphenyl ethyl ester	-6.27	25.17	3	Lig:O::3RUK:A:SER475:HN
6	Phthalic acid. di(3- ethylphenyl) ester	-7.26	4.78	0	-
7	1.2.4.5-Tetrazine. 3.6- dimethyl-	-5.04	201.36	6	Lig:NN::3RUK:C:LEU229:HN Lig:N::3RUK:C:THR228:HN Lig:N::3RUK:C:LEU221:O Lig:N::3RUK:C:LYS227:HN Lig:N::3RUK:C:PHE224:O Lig:N::3RUK:C:ASN226:HN





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8	Phenylphosphonicdi fluoride	-4.91	251.29	1	Lig:O::3RUK:D:LEU221:HN
9	Ketoconazole	-6.73	11.61	1	Keto:O::3RUK:A:LYS490:HN



Figure:1 Habit of *Cassiafistula Linn*

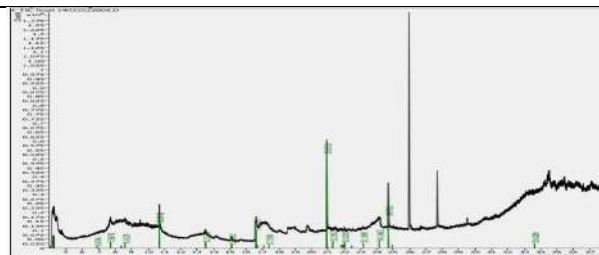


Figure:2GC-MSAnalysis



Figure: 3. -3DStructureof17-alpha-hydroxylase/17,20 lyase

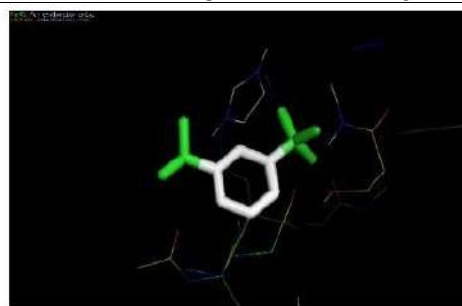


Figure: 4. Docked conformation of Benzene. 1,3-

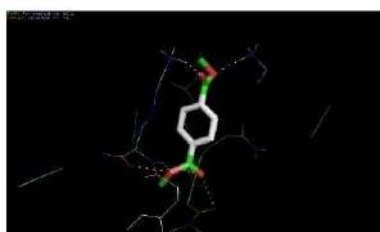


Figure 5 :- Docked conformation of 1,4-Benzenedicarboxylic acid, dimethyl ester with 17-alpha-hydroxylase/17,20 lyase

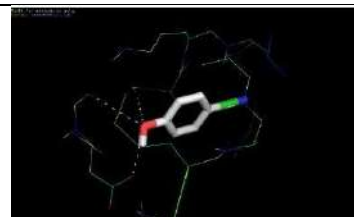


Figure 6:- Docked conformation of Benzonitrile. 4-hydroxy with 17-alpha-hydroxylase/17,20 lyase

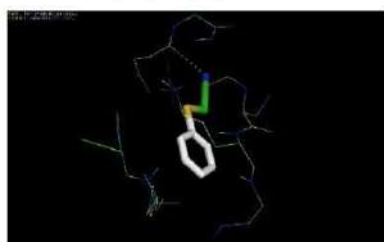


Figure 7: - Docked conformation of 2-(Phenylthio) acetonitrile with 17-alpha-hydroxylase/17,20 lyase

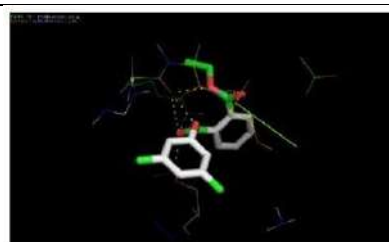
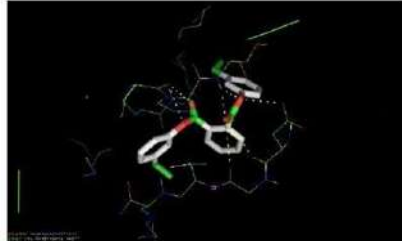
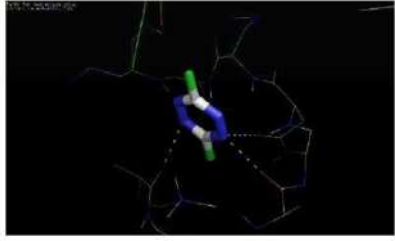
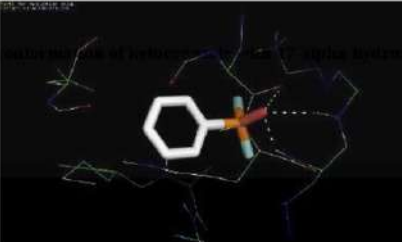
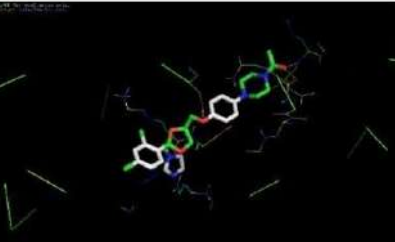


Figure 8:- Docked conformation of phthalic acid. 3,5-dimethylphenyl ethyl ester with 17-alpha-hydroxylase/17,20 lyase





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<p>Figure 9: Docked conformation of Phthalic acid, Di (3-ethylphenyl) ester with 17-alpha-hydroxylase/17,20 lyase</p>	<p>Figure 10 - Docked conformation of 1,2,4,5-Tetrazine, 3,6-dimethyl- with 17-alpha-hydroxylase/17,20 lyase</p>
	
<p>Figure 11- Docked conformation of Phenyl phosphonic difluoride with 17-alpha-hydroxylase/17,20 lyase</p>	<p>Figure 12 - Docked conformation of ketoconazole with 17-alpha-hydroxylase/17,20 lyase</p>





Anticancerous Activity of Seaweed *Padina pavonica* (L.) Thivy against Human Breast MCF -7 Cells

J. Carolin Joe Rosario*

Assistant Professor, Department of Botany, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

J. Carolin Joe Rosario

Assistant Professor,
Department of Botany,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.
E.Mail: cjoerosa@gmail.com



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ABSTRACT

Cancer is a most fatal human disease, increasing with changing Lifestyle, nutrition and global warming . Cancer treatments do not have potent medicine as the currently available drugs are causing side effects in some incidences. Since cancer is a multi- genic disease causing about one-fifth of the deaths in each year worldwide. So, it is important to find out natural waves of medication .Most of the algal extracts induce cancer cell death by inducing apoptosis or pre-apoptosis. In the present study the anti-cancerous activity of marine algae *Padina pavonica* L. were analyzed. The test for anti-cancerous activity of the selected sample was performed by using MTT Assay Technique .The cell line selected for cytotoxicity was Human Breast Carcinoma cells.

Keywords: Padina pavonica, Cytotoxic activity, Cell lines, MTT assay technique, Anti-cancerous activity.

INTRODUCTION

Plant materials might be bioactive secondary metabolites that have the potential to treat different applicants. The compounds include phenols, phenolic glycosides, unsaturated lactones, Sulphur compounds, saponins , cyanogenic glycosides and glucosinolates .Such plant derived natural products are the main focus of many scientists to develop new medication for different diseases like cardiac arrest ,diabetes, leprosy, AIDS, cancer etc.Thus herbal drug formulations are used for the prevention and treatment of cancer appeared in the last three decades and the interest on natural sources of potential chemotherapeutic agent is continuing. Cancer is the second cause of death in the modern world that affects one out of three individuals and resulting in one out of five deaths worldwide. Nowadays, advance drugs are being used in anti-tumoral therapies. The conventional chemotherapy causes severe Side Effects.



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So, the goal of current pharmacologists is to search for new drugs to combat cancer without Side Effects. Marine algae are considered as a bio-medically.

important organism in the marine environment. Marine plants use these elements in biosynthetic processes to produce compounds like halogen containing terpenoids, alkaloids, acetylenes, phenol and sulphated polysaccharides which are unique to the marine environment. Besides the ecological role, they also show good antibacterial, antifungal, antiviral, cytotoxic and pharmacological activities. *In vitro* cytotoxicity test against cancer cell culture have been used in most cases, to evaluate the anti-cancer potential of crude extracts from different marine organisms. In the present study the anti-cancerous activity of the selected sample were tested against the cell line Human Breast Carcinoma Cells, for their effective cytotoxic activity.

MATERIALS AND METHODS

Collection of the sample

The selected sample were collected from Manapad coast, Tuticorin, Tamil Nadu, India.

Preparation of algal extract

The collected species was shade dried for 15 days and then pulverized into fine powder using Willey mill grinder. The extraction was done by using Soxhlet apparatus. Different solvents were used with gradient polarity (Chloroform and methanol). The extracts were evaporated to complete dryness by vacuum distillation and stored in refrigerator for further use.

Botanical Description: *Padina pavonica*(L.) Thivy (Plate – 1)

Taxonomic Position

Division :Heterokontophyta

Class :Phaeophyceae

Order :Dictyotales

Family :Dictyotaceae

Genus :*Padina*

Species :*P. pavonica*(L.) Thivy

Padina pavonica is a brown macro alga found throughout the Indian River Lagoon called as "The peacock's tail" and it is unique Mediterranean algae with proven outstanding anti-ageing benefits. The range of *P. pavonica* extends throughout the world in warm temperate to tropical locales, including: North Carolina to Florida in the United States, the Gulf of Mexico, throughout the Caribbean and tropical Atlantic and the Eastern Atlantic, Mediterranean and Adriatic Seas. Clusters are commonly attached to shell fragments and rocks from the lower intertidal zone down to 20 m in seagrass beds, coral reefs, on tidal flats and attached to mangrove prop roots. The thallus of the alga is brown to tan, forming fan-shaped clusters. Each blade is calcified, more heavily above and lightly below and curls inward near the edges.

CELL LINE

The human cervical breast adenocarcinoma cell line (MCF7) was obtained from National Centre for Cell Science (NCCS), Pune and grown in Eagle's Minimum Essential Medium containing 10% fetal bovine serum (FBS). The cells were maintained at 37°C, 5% CO₂, 95% air and 100% relative humidity. Maintenance cultures were passaged weekly, and the culture medium was changed twice a week.

CELL TREATMENT PROCEDURE [4]

The monolayer cells were detached with trypsin-ethylene diamine tetra acetic acid (EDTA) to make single cell suspensions and viable cells were counted using a hemocytometer and diluted with medium containing 5% FBS to



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give final density of 1×10^5 cells/ml. One hundred microliters per well of cell suspension were seeded into 96-well plates at plating density of 10,000 cells/well and incubated to allow for cell attachment at 37°C, 5% CO₂, 95% air and 100% relative humidity. After 24 h the cells were treated with serial concentrations of the test samples. They were initially dissolved or dispersed in dimethyl sulfoxide and an aliquot of the sample solution was diluted to twice the desired final maximum test concentration with serum free medium. Additional four serial dilutions were made to provide a total of five sample concentrations. Aliquots of 100 µl of these different sample dilutions were added to the appropriate wells already containing 100 µl of medium, resulting in the required final sample concentrations. Following sample addition, the plates were incubated for an additional 48 h at 37°C, 5% CO₂, 95% air and 100% relative humidity. The medium containing without samples were served as control and triplicate was maintained for all concentrations.

MTT ASSAY [5]

3-[4,5-dimethylthiazol-2-yl] 2,5-diphenyltetrazolium bromide (MTT) is a yellow water-soluble tetrazolium salt. A mitochondrial enzyme in living cells, succinate - dehydrogenase, cleaves the tetrazolium ring, converting the MTT to an insoluble purple formazan. Therefore, the amount of formazan produced is directly proportional to the number of viable cells. After 48 h of incubation, 15 µl of MTT (5mg/ml) in phosphate buffered saline (PBS) was added to each well and incubated at 37°C for 4h. The medium with MTT was then flicked off and the formed formazan crystals were solubilized in 100 µl of DMSO and then measured the absorbance at 570 nm using micro plate reader.

The percentage cell growth was then calculated with respect to control as follows:

$$\% \text{ Cell Growth} = [A] \text{ Test} / [A] \text{ control} \times 100.$$

The % Cell inhibition was determined using the following formula:

$$\% \text{ Cell Inhibition} = 100 - \text{Abs (sample)} / \text{Abs (control)} \times 100.$$

Nonlinear regression graph was plotted between % Cell inhibition and Log concentration and IC₅₀ was determined using Graph Pad Prism software.

THE MECHANISM ON CANCER THERAPY

1. Inhibiting cancer cell proliferation directly by stimulating macrophage phagocytosis, enhancing natural killer cell activity.
2. Promoting apoptosis of cancer cells by increasing production of interferon, interleukin-2 immunoglobulin and complement in blood serum.
3. Enforcing the necrosis of tumor and inhibiting its translocation and spread by blocking the Blood source of tumor tissue.
4. Enhancing the number of leukocytes and platelets by stimulating the hemopoietic function.
5. Promoting the reverse transformation from tumor cells into normal cells.

RESULTS AND DISCUSSION

The cytotoxic effects of algal extracts of the selected samples on human cervical breast- adenocarcinoma cell line (MCF7) were tested by using MTT assay (Cell viability). This assay was used for the evaluation of anti-cancerous activity. The medium containing without samples were served as control and triplicate was maintained for all concentrations. Among the selected sample *Padina pavonica* determines the percentage of cell inhibition. The *Padina pavonica* extract was treated under five different concentrations against (MCF 7) cancer cell lines, the present findings exhibited 97.59% of cell inhibition in 200 µg/ml, 31.7 % cell inhibition at 100 µg/ml, 9.52 % cell inhibition at 50 µg/ml, 6.03 % of cell inhibition at 25 µg/ml and 3.82 % of cell inhibition at 12.5 µg/ml thus the percentage of cell inhibition was high based on dose dependant and in 200µg/ml showed maximum inhibition when compared with other concentrations and the results were tabulated in (Table – 1 & 2, Chart – 1 & Plate -2).





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The anticancer properties of algae are now well recognized that apoptosis is a mode of cell death used by multi-cellular organisms to eradicate cells in diverse physiological and pathological settings. Among the positive and negative regulators of apoptosis, the tumor suppressor gene is an important defense against cancer, as it suppresses tumor growth through two mechanisms, cell cycle arrest and apoptosis [1] The aim of the present study is to evaluate anti-cancerous activity in the selected algal sample. Seaweeds contain powerful antioxidant and anticancer properties to arrest the proliferation of cancer cells [3] and [2]. Breast cancer is the leading cause of death among women in many countries. Scientists have aimed to treat breast cancer without harming the patient by exploiting the differences between cancerous and normal cells. In cells treated with seaweed apoptosis was observed and the authors speculated that seaweed could be a breast cancer preventing food.

CONCLUSION

Cancer is a dreadful human disease increasing with changing of lifestyle, nutrition and global warming. Cancer treatments do not have potent medicine as the currently available drugs are causing side effects in some instances. Over the past decades algae and their extracts have generated an enormous amount of interest in the pharmaceutical industry, as a fresh source of bioactive compounds. Natural products and their derivatives represent more than aqueous of all the drugs in clinical use of the world. For many generations marine algae have been extensively used as food, organic fertilizers and traditional medicine. The high protein, lipid and vitamin content of marine algae have encouraged their cultivation and use as a food source in many parts of the world. Almost 60% of drugs approved for cancer treatment are of natural origin.

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TABLE – 1 Anti-cancerous activity of *Padina pavonicaby* MTT Assay

Conc	Cont	12.5 µg	25 µg	50 µg	100 µg	200 µg
ABS	0.369	0.353	0.323	0.22	0.119	0.009
	0.362	0.356	0.333	0.212	0.076	0.011
	0.351	0.355	0.332	0.184	0.098	0.006
Avg	0.360667	0.354667	0.329333	0.205333	0.097667	0.008667

TABLE - 2 Cell inhibition (in %)

Conc (µg/ml)	% Cell Inhibition
12.5	1.663586
25	8.687616
50	43.06839
100	72.92052
200	97.59704



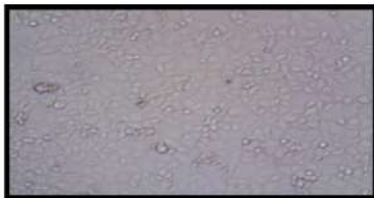


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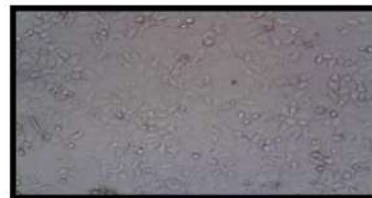


PLATE - 1 *Padina pavonica*

PLATE - 2 Anti-cancerous activity of *Padina pavonica* by MTT cell assay



12.5 µg of on MCF 7 cell lines



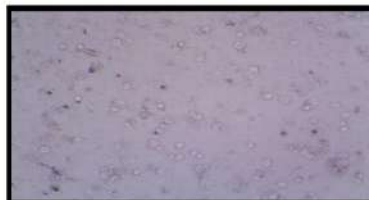
25 µg of on MCF 7 cell lines



50 µg of on MCF 7 cell



100 µg of on MCF 7 cell lines



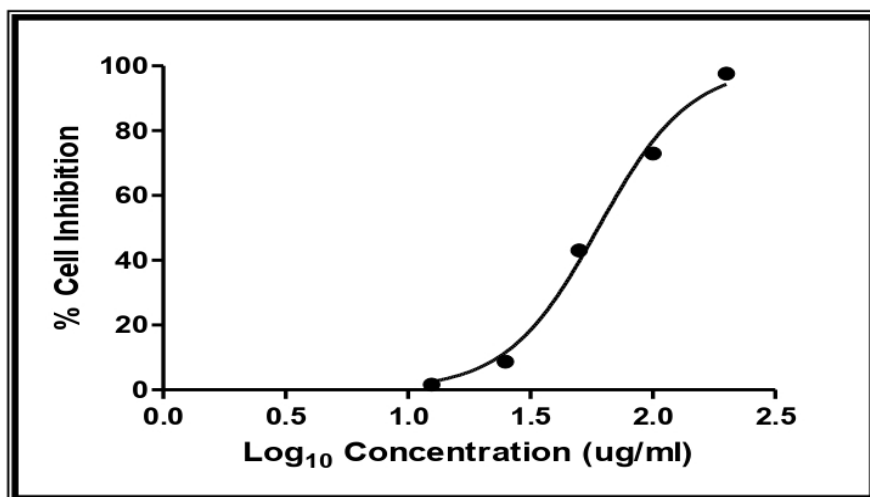
200 µg of on MCF 7 cell lines





Carolin Joe Rosario

Chart - 1 Anti-cancerous activity of *Padina pavonica* by MTT Assay





A Study on Topological Indices of Nanostar Dendrimers

Mamtha^{1*} and U.Mary²

¹Research Scholar, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Associate Professor, PG and Research, Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

Mamtha

Research Scholar,
Department of Mathematics,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.
E.Mail: mamthagurunath@gmail.com



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ABSTRACT

Molecular descriptors are numerical values encoding some information related to the molecular structure. They can be both experimental physio-chemical properties of molecules and theoretical indices calculated by mathematical formulae. Molecular descriptors also known as topological indices are of outstanding importance in the research fields of quantitative structure activity relationships(QSARs) and quantitative structure property relationships(QSPRs). Nanostar dendrimers act as a delivery tool and gene carriers in drug delivery system because of their chemical characteristics. These characteristics of chemical compounds are analysed using topological indices. In this article, we compute some neighbourhood degree based topological indices for nanostar dendrimers.

Keywords: Topological indices, Nanostar dendrimers, QSPR/QSAR, neighbourhood degree.

INTRODUCTION

In mathematical chemistry, we use mathematical methods to discuss and predict some significant features of a chemical structure. Graph theory has been extensively used in the field of chemical research in which topological indices are most helpful tool for analysing its chemical characteristics using QSAR/QSPR analysis. Cheminformatics is a brand-new discipline that combines chemistry, mathematics, and information science. Nanostar dendrimers are one of the fundamental objects of nanobiotechnology. The step-wise growth of nanostar dendrimers follow a mathematical progression.





Mamtha and Mary

Let G be a simple graph with a set of vertices V and a set of edges E . A molecular graph is a simple connected graph in which the vertices represent the atoms of the chemical compound and the edges represent their bonds. Topological descriptors are single numerical values that describe the physiochemical qualities of chemical structures under graph automorphisms.

In 1972, Gutman and Trinajestic [4] introduced first and second Zagreb indices and are defined as

$$M_1(G) = \sum_{pq \in E(G)} [deg(p) + deg(q)], M_2(G) = \sum_{pq \in E(G)} [deg(p) \times deg(q)]$$

In 2013, Shirdel et al [9] introduced first and second hyper Zagreb indices which are defined as

$$HM_1(G) = \sum_{pq \in E(G)} [deg(p) + deg(q)]^2, HM_2(G) = \sum_{pq \in E(G)} [deg(p) \times deg(q)]^2$$

In 2012, Ghorbani and Azimi [2] characterized first and second multiple Zagreb indices as

$$PM_1(G) = \prod_{pq \in E(G)} [deg(p) + deg(q)], PM_2(G) = \prod_{pq \in E(G)} [deg(p) \times deg(q)]$$

In 2004, Gutman and Das [3] defined first and second Zagreb polynomials as

$$M_1(G, x) = \sum_{pq \in E(G)} x^{deg(p)+deg(q)}, M_2(G, x) = \sum_{pq \in E(G)} x^{deg(p) \times deg(q)}$$

The degree based topological indices are stretched to neighbourhood degree topological indices. Among different topological indices, neighbourhood degree based indices have significant predictive ability of physio-chemical properties of the chemical structures. Neighbourhood degree based indices have more isomer discrimination ability than degree based indices.

Definition 1.1

The neighbourhood degree of a vertex v in G is defined [10] to be the sum of the degrees of all neighbours of v in G and is denoted by

$$\delta_G(v) = \sum_{u \in N_G(v)} deg_G(u)$$

Definition 1.2

An edge partition of a graph G is a partition of its edges $E(G)$ into subsets $\{E_s\}$, where $E_s = (d(v_i), d(v_j))$ for arbitrary i, j and s .

For basic definitions and results refer [5], [11].

Throughout this article δ_p denotes neighbourhood degree of the vertex p in G . The neighbourhood degree based topological indices are defined below.

First and second neighbourhood Zagreb indices is defined as

$$\widehat{M}_1(G) = \sum_{pq \in E(G)} [\delta_p + \delta_q], \widehat{M}_2(G) = \sum_{pq \in E(G)} [\delta_p \times \delta_q]$$

First and second neighbourhood Hyper-Zagreb indices is defined as

$$\widehat{HM}_1(G) = \sum_{pq \in E(G)} [\delta_p + \delta_q]^2, \widehat{HM}_2(G) = \sum_{pq \in E(G)} [\delta_p \times \delta_q]^2$$

First and second neighbourhood multiple Zagreb indices is defined as

$$\widehat{PM}_1(G) = \prod_{pq \in E(G)} [\delta_p + \delta_q], \widehat{PM}_2(G) = \prod_{pq \in E(G)} [\delta_p \times \delta_q]$$

First and second neighbourhood Zagreb polynomials is defined as

$$\widehat{M}_1(G, x) = \sum_{pq \in E(G)} x^{[\delta_p + \delta_q]}, \widehat{M}_2(G, x) = \sum_{pq \in E(G)} x^{[\delta_p \times \delta_q]}$$

Main Results**First type of Nanostar Dendrimer $NS_1C_5C_6[n]$**

Consider the graph G of first type of nanostar dendrimer $NS_1C_5C_6[n]$ of order $9 \times 2^{n+2} - 44$ and size $10 \times 2^{n+2} - 50$ [8]. The distribution of edge partitions of $NS_1C_5C_6[n]$ according to the neighbourhood degree of vertices are given in Table 1. We compute first and second neighbourhood Zagreb indices, first and second neighbourhood Hyper-Zagreb indices, first and second neighbourhood multiple Zagreb indices, first and second neighbourhood Zagreb polynomials for $NS_1C_5C_6[n]$ in the following theorem.

Theorem 2.1 For the first type of nanostar dendrimer $NS_1C_5C_6[n]$, we have

$$\widehat{M}_1(NS_1C_5C_6[n]) = 247 \times 2^{n+1} - 600$$





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$$\widehat{M}_2(NS_1C_5C_6[n]) = 1513 \times 2^n - 1794$$

$$\widehat{HM}_1(NS_1C_5C_6[n]) = 97 \times 2^{n+6} - 7308$$

$$\widehat{HM}_2(NS_1C_5C_6[n]) = 61805 \times 2^n - 68442$$

$$\widehat{PM}_1(NS_1C_5C_6[n]) = 2^{34 \times 2^n - 40} \times 3^{20 \times 2^n - 24} \times 5^{3 \times 2^n - 8} \times 7^{7 \times 2^n - 6} \times 13^{8 \times 2^n - 16}$$

$$\widehat{PM}_2(NS_1C_5C_6[n]) = 2^{41 \times 2^n - 20} \times 3^{19 \times 2^n - 22} \times 5^{16 \times 2^n - 18} \times 7^{34 \times 2^n - 56}$$

$$\widehat{M}_1(NS_1C_5C_6[n], x) = (3 \times 2^{n+1} - 8)x^{10} + (3 \times 2^{n+2} - 12)x^{12} + (2^{n+1} - 4)x^9 + (2^{n+1} - 4)x^{12} + (2^{n+3} - 16)x^{13} + (7 \times 2^n - 6)x^{14} + (2^{n+1})x^{15} + (2^n)x^{16}$$

$$\widehat{M}_2(NS_1C_5C_6[n], x) = (2^{n+1} - 2)x^{21} + (2^{n+2})x^{32} + (2^{n+2} - 6)x^{25} + (2^{n+3} - 12)x^{35} + (2^{n+1} - 4)x^{18} + (2^{n+1} - 4)x^{36} + (2^{n+3} - 16)x^{42} + 7 \times 2^n - 6)x^{49}(2^{n+1})x^{56} + (2^n)x^{64}$$

Proof. Let G be a graph of first type of nanostar dendrimer, $NS_1C_5C_6[n]$. The edge set is partitioned into ten sets, say $E_1, E_2, E_3, E_4, E_5, E_6, E_7, E_8, E_9, E_{10}$ based on the neighbourhood degree of the vertices where $E_1 = (3,7), E_2 = (4,8), E_3 = (5,5), E_4 = (5,7), E_5 = (6,3), E_6 = (6,6), E_7 = (6,7), E_8 = (7,7), E_9 = (7,8), E_{10} = (8,8)$.

We know that,

$$\begin{aligned} \widehat{M}_1(G) &= \sum_{pq \in E(G)} [\delta_p + \delta_q] \\ \widehat{M}_1(NS_1C_5C_6[n]) &= \sum_{pq \in E_1} [\delta_p + \delta_q] + \sum_{pq \in E_2} [\delta_p + \delta_q] + \sum_{pq \in E_3} [\delta_p + \delta_q] + \sum_{pq \in E_4} [\delta_p + \delta_q] + \sum_{pq \in E_5} [\delta_p + \delta_q] \\ &\quad + \sum_{pq \in E_6} [\delta_p + \delta_q] + \sum_{pq \in E_7} [\delta_p + \delta_q] + \sum_{pq \in E_8} [\delta_p + \delta_q] + \sum_{pq \in E_9} [\delta_p + \delta_q] + \sum_{pq \in E_{10}} [\delta_p + \delta_q] \\ &= 10(2^{n+1} - 2) + 12(2^{n+2}) + 10(2^{n+2} - 6) + 12(2^{n+3} - 12) + 9(2^{n+1} - 4) + 12(2^{n+1} - 4) + 13(2^{n+3} - 16) + 14(7 \times 2^n - 6) + 15(2^{n+1}) + 16(2^n) \\ &= 247 \times 2^{n+1} - 600 \end{aligned}$$

We know that,

$$\begin{aligned} \widehat{M}_2(G) &= \sum_{pq \in E(G)} [\delta_p \times \delta_q] \\ \widehat{M}_2(NS_1C_5C_6[n]) &= \sum_{pq \in E_1} [\delta_p \times \delta_q] + \sum_{pq \in E_2} [\delta_p \times \delta_q] + \sum_{pq \in E_3} [\delta_p \times \delta_q] + \sum_{pq \in E_4} [\delta_p \times \delta_q] + \sum_{pq \in E_5} [\delta_p \times \delta_q] \\ &\quad + \sum_{pq \in E_6} [\delta_p \times \delta_q] + \sum_{pq \in E_7} [\delta_p \times \delta_q] + \sum_{pq \in E_8} [\delta_p \times \delta_q] + \sum_{pq \in E_9} [\delta_p \times \delta_q] + \sum_{pq \in E_{10}} [\delta_p \times \delta_q] \\ &= 21(2^{n+1} - 2) + 32(2^{n+2}) + 25(2^{n+2} - 6) + 35(2^{n+3} - 12) + 18(2^{n+1} - 4) + 36(2^{n+1} - 4) + 42(2^{n+3} - 16) + 49(7 \times 2^n - 6) + 56(2^{n+1}) + 64(2^n) \\ &= 1513 \times 2^n - 1794 \end{aligned}$$

We know that,

$$\widehat{HM}_1(G) = \sum_{pq \in E(G)} [\delta_p + \delta_q]^2$$





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$$\begin{aligned} \widehat{HM}_1(NS_1C_5C_6[n]) &= \sum_{pq \in E_1} [\delta_p + \delta_q]^2 + \sum_{pq \in E_2} [\delta_p + \delta_q]^2 + \sum_{pq \in E_3} [\delta_p + \delta_q]^2 + \sum_{pq \in E_4} [\delta_p + \delta_q]^2 + \sum_{pq \in E_5} [\delta_p + \delta_q]^2 + \sum_{pq \in E_6} [\delta_p + \delta_q]^2 + \sum_{pq \in E_7} [\delta_p + \delta_q]^2 + \sum_{pq \in E_8} [\delta_p + \delta_q]^2 + \sum_{pq \in E_9} [\delta_p + \delta_q]^2 + \sum_{pq \in E_{10}} [\delta_p + \delta_q]^2 \\ &= 100(2^{n+1} - 2) + 144(2^{n+2}) + 100(2^{n+2} - 6) + 144(2^{n+3} - 12) + 81(2^{n+1} - 4) + 144(2^{n+1} - 4) + 169(2^{n+3} - 16) \\ &\quad + 196(7 \times 2^n - 6) + 225(2^{n+1}) + 256(2^n) \\ &= 97 \times 2^{n+6} - 7308 \end{aligned}$$

We know that,

$$\begin{aligned} \widehat{HM}_2(G) &= \sum_{pq \in E(G)} [\delta_p \times \delta_q]^2 \\ \widehat{HM}_2(NS_1C_5C_6[n]) &= \sum_{pq \in E_1} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_2} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_3} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_4} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_5} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_6} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_7} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_8} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_9} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_{10}} [\delta_p \times \delta_q]^2 \\ &= 441(2^{n+1} - 2) + 1024(2^{n+2}) + 625(2^{n+2} - 6) + 1225(2^{n+3} - 12) + 324(2^{n+1} - 4) + 1296(2^{n+1} - 4) + 1764(2^{n+3} - 16) + 2401(7 \times 2^n - 6) + 3136(2^{n+1}) + 4096(2^n) \\ &= 61805 \times 2^n - 68442 \end{aligned}$$

We know that,

$$\begin{aligned} \widehat{PM}_1(G) &= \prod_{pq \in E(G)} [\delta_p + \delta_q] \\ \widehat{PM}_1(NS_1C_5C_6[n]) &= \prod_{pq \in E_1} [\delta_p + \delta_q] + \prod_{pq \in E_2} [\delta_p + \delta_q] + \prod_{pq \in E_3} [\delta_p + \delta_q] + \prod_{pq \in E_4} [\delta_p + \delta_q] + \prod_{pq \in E_5} [\delta_p + \delta_q] + \prod_{pq \in E_6} [\delta_p + \delta_q] + \prod_{pq \in E_7} [\delta_p + \delta_q] + \prod_{pq \in E_8} [\delta_p + \delta_q] + \prod_{pq \in E_9} [\delta_p + \delta_q] + \prod_{pq \in E_{10}} [\delta_p + \delta_q] \\ &= 10^{(2^{n+1}-2)} + 12^{(2^{n+2})} + 10^{(2^{n+2}-6)} + 12^{(2^{n+3}-12)} + 9^{(2^{n+1}-4)} + 12^{(2^{n+1}-4)} + 13^{(2^{n+3}-16)} + 14^{(7 \times 2^n - 6)} + 15^{(2^{n+1})} + 16^{(2^n)} \\ &= 2^{34 \times 2^n - 40} \times 3^{20 \times 2^n - 24} \times 5^{3 \times 2^n - 8} \times 7^{7 \times 2^n - 6} \times 13^{8 \times 2^n - 16} \end{aligned}$$

We know that,

$$\begin{aligned} \widehat{PM}_2(G) &= \prod_{pq \in E(G)} [\delta_p \times \delta_q] \\ \widehat{PM}_2(NS_1C_5C_6[n]) &= \prod_{pq \in E_1} [\delta_p \times \delta_q] + \prod_{pq \in E_2} [\delta_p \times \delta_q] + \prod_{pq \in E_3} [\delta_p \times \delta_q] + \prod_{pq \in E_4} [\delta_p \times \delta_q] + \prod_{pq \in E_5} [\delta_p \times \delta_q] + \prod_{pq \in E_6} [\delta_p \times \delta_q] + \prod_{pq \in E_7} [\delta_p \times \delta_q] + \prod_{pq \in E_8} [\delta_p \times \delta_q] + \prod_{pq \in E_9} [\delta_p \times \delta_q] + \prod_{pq \in E_{10}} [\delta_p \times \delta_q] \\ &= 21^{(2^{n+1}-2)} + 32^{(2^{n+2})} + 25^{(2^{n+2}-6)} + 35^{(2^{n+3}-12)} + 18^{(2^{n+1}-4)} + 36^{(2^{n+1}-4)} + 42^{(2^{n+3}-16)} + 49^{(7 \times 2^n - 6)} + 56^{(2^{n+1})} + 64^{(2^n)} \\ &= 2^{41 \times 2^n - 20} \times 3^{19 \times 2^n - 32} \times 5^{16 \times 2^n - 18} \times 7^{34 \times 2^n - 56} \end{aligned}$$





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First and second Zagreb polynomials are computed.

We know that,

$$\begin{aligned} \widehat{M}_1(G, x) &= \sum_{pq \in E(G)} x^{[\delta_p + \delta_q]} \\ \widehat{M}_1(NS_1C_5C_6[n], x) &= \sum_{pq \in E_1} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_2} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_3} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_4} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_5} x^{[\delta_p + \delta_q]} \\ &\quad + \sum_{pq \in E_6} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_7} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_8} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_9} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_{10}} x^{[\delta_p + \delta_q]} \\ &= (2^{n+1} - 2)x^{10} + (2^{n+2})x^{12} + (2^{n+2} - 6)x^{10} + (2^{n+3} - 12)x^{12} + (2^{n+1} - 4)x^9 + (2^{n+1} - 4)x^{12} + (2^{n+3} - 16)x^{13} + (7 \\ &\quad \times 2^n - 6)x^{14} + (2^{n+1})x^{15} + (2^n)x^{16} \\ &= (3 \times 2^{n+1} - 8)x^{10} + (3 \times 2^{n+2} - 12)x^{12} + (2^{n+1} - 4)x^9 + (2^{n+1} - 4)x^{12} + (2^{n+3} - 16)x^{13} + (7 \times 2^n - 6)x^{14} \\ &\quad + (2^{n+1})x^{15} + (2^n)x^{16} \end{aligned}$$

We know that,

$$\begin{aligned} \widehat{M}_2(G, x) &= \sum_{pq \in E(G)} x^{[\delta_p \times \delta_q]} \\ \widehat{M}_2(NS_1C_5C_6[n], x) &= \sum_{pq \in E_1} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_2} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_3} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_4} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_5} x^{[\delta_p \times \delta_q]} \\ &\quad + \sum_{pq \in E_6} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_7} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_8} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_9} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_{10}} x^{[\delta_p \times \delta_q]} \\ &= (2^{n+1} - 2)x^{21} + (2^{n+2})x^{32} + (2^{n+2} - 6)x^{25} + (2^{n+3} - 12)x^{35} + (2^{n+1} - 4)x^{18} + (2^{n+1} - 4)x^{36} + (2^{n+3} - 16)x^{42} \\ &\quad + (7 \times 2^n - 6)x^{49} + (2^{n+1})x^{56} + (2^n)x^{64} \\ &= (2^{n+1} - 2)x^{21} + (2^{n+2})x^{32} + (2^{n+2} - 6)x^{25} + (2^{n+3} - 12)x^{35} + (2^{n+1} - 4)x^{18} + (2^{n+1} - 4)x^{36} + (2^{n+3} - 16)x^{42} + 7 \\ &\quad \times 2^n - 6)x^{49}(2^{n+1})x^{56} + (2^n)x^{64} \end{aligned}$$

Second type of Nanostar Dendrimer $NS_2PP[n]$

Consider the graph G of second type of nanostar dendrimer $NS_2PP[n]$ of order $15 \times 2^{n+3} - 95$ and size $35 \times 2^{n+2} - 112$ [8]. The distribution of edge partitions of $NS_2PP[n]$ according to the neighbourhood degree of vertices are given in Table 2. We compute first and second neighbourhood Zagreb indices, first and second neighbourhood Hyper-Zagreb indices, first and second neighbourhood multiple Zagreb indices, first and second neighbourhood Zagreb polynomials for $NS_2PP[n]$ in the following theorem.

Theorem 2.2 For the second type of nanostar dendrimer $NS_2PP[n]$, we have

$$\begin{aligned} \widehat{M}_1(NS_2PP[n]) &= 209 \times 2^{n+3} - 1352 \\ \widehat{M}_2(NS_2PP[n]) &= 1319 \times 2^{n+2} - 4284 \\ \widehat{HM}_1(NS_2PP[n]) &= 2673 \times 2^{n+3} - 17272 \\ \widehat{HM}_2(NS_2PP[n]) &= 254852 \times 2^n - 199940 \\ \widehat{PM}_1(NS_1C_5C_6[n]) &= 2^{224 \times 2^n - 192} \times 3^{112 \times 2^n - 96} \times 5^{16 \times 2^n - 12} \times 7^{8 \times 2^n - 8} \times 13^8 \times 17^{8 \times 2^n - 8} \\ \widehat{PM}_2(NS_2PP[n]) &= 2^{224 \times 2^n - 132} \times 3^{80 \times 2^n - 76} \times 5^{80 \times 2^n - 64} \times 7^{60 \times 2^n - 60} \end{aligned}$$





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$$\widehat{M}_1(NS_2PP[n], x) = (3 \times 2^{n+3} - 16)x^8 + (3 \times 2^{n+3} - 16)x^9 + (2^{n+3} - 8)x^{10} + (15 \times 2^{n+3} - 40)x^{12} + (8)x^{13} + (2^{n+3} - 8)x^{14} + (12^{n+3} - 8)x^{15} + (3 \times 2^{n+2} - 12)x^{16} + (2^{n+3} - 8)x^{17} + 4 \times x^{20} + (2^{n+3} - 8)x^{18}$$

$$\widehat{M}_2(NS_2PP[n], x) = (3^{n+3} - 16)x^{16} + (3^{n+3} - 16)x^{20} + (2^{n+3} - 8)x^{25} + (5 \times 2^{n+3} - 40)x^{35} + 8x^{40} + (2^{n+3} - 8)x^{48} + (2^{n+3} - 8)x^{56} + (3 \times 2^{n+2} - 12)x^{63}(2^{n+3} - 8)x^{72} + 4x^{96} + 2^{n+3} - 8)x^{81}$$

Proof. Let G be a graph of second type of nanostar dendrimer, $NS_2PP[n]$. The edge set is partitioned into eleven sets, say $E_1, E_2, E_3, E_4, E_5, E_6, E_7, E_8, E_9, E_{10}, E_{11}$ based on the neighbourhood degree of the vertices, where $E_1 = (4,4), E_2 = (4,5), E_3 = (5,5), E_4 = (5,7), E_5 = (5,8), E_6 = (6,8), E_7 = (7,8), E_8 = (7,9), E_9 = (8,9), E_{10} = (8,12), E_{11} = (9,9)$

We know that,

$$\begin{aligned} \widehat{M}_1(G) &= \sum_{pq \in E(G)} [\delta_p + \delta_q] \\ \widehat{M}_1(NS_2PP[n]) &= \sum_{pq \in E_1} [\delta_p + \delta_q] + \sum_{pq \in E_2} [\delta_p + \delta_q] + \sum_{pq \in E_3} [\delta_p + \delta_q] + \sum_{pq \in E_4} [\delta_p + \delta_q] + \sum_{pq \in E_5} [\delta_p + \delta_q] \\ &\quad + \sum_{pq \in E_6} [\delta_p + \delta_q] + \sum_{pq \in E_7} [\delta_p + \delta_q] + \sum_{pq \in E_8} [\delta_p + \delta_q] + \sum_{pq \in E_9} [\delta_p + \delta_q] + \sum_{pq \in E_{10}} [\delta_p + \delta_q] \\ &\quad + \sum_{pq \in E_{11}} [\delta_p + \delta_q] \\ &= 8(3 \times 2^{n+3} - 16) + 9(3 \times 2^{n+3} - 16) + 10(2^{n+3} - 8) + 12(5 \times 2^{n+3} - 40) + 13(8) + 14(2^{n+3} - 8) + 15(2^{n+3} - 8) \\ &\quad + 16(3 \times 2^{n+2} - 12) + 17(2^{n+3} - 8) + 20(4) + 18(2^{n+3} - 8) \\ &= 209 \times 2^{n+3} - 1352 \end{aligned}$$

We know that,

$$\begin{aligned} \widehat{M}_2(G) &= \sum_{pq \in E(G)} [\delta_p \times \delta_q] \\ \widehat{M}_2(NS_2PP[n]) &= \sum_{pq \in E_1} [\delta_p \times \delta_q] + \sum_{pq \in E_2} [\delta_p \times \delta_q] + \sum_{pq \in E_3} [\delta_p \times \delta_q] + \sum_{pq \in E_4} [\delta_p \times \delta_q] + \sum_{pq \in E_5} [\delta_p \times \delta_q] \\ &\quad + \sum_{pq \in E_6} [\delta_p \times \delta_q] + \sum_{pq \in E_7} [\delta_p \times \delta_q] + \sum_{pq \in E_8} [\delta_p \times \delta_q] + \sum_{pq \in E_9} [\delta_p \times \delta_q] + \sum_{pq \in E_{10}} [\delta_p \times \delta_q] \\ &\quad + \sum_{pq \in E_{11}} [\delta_p \times \delta_q] \\ &= 16(3 \times 2^{n+3} - 16) + 20(3 \times 2^{n+3} - 16) + 25(2^{n+3} - 8) + 35(5 \times 2^{n+3} - 40) + 40(8) + 48(2^{n+3} - 8) + 56(2^{n+3} - 8) \\ &\quad + 63(3 \times 2^{n+2} - 12) + 72(2^{n+3} - 8) + 96(4) + 81(2^{n+3} - 8) \\ &= 1319 \times 2^{n+2} - 4284 \end{aligned}$$

We know that,

$$\begin{aligned} \overline{HM}_1(G) &= \sum_{pq \in E(G)} [\delta_p + \delta_q]^2 \\ \overline{HM}_1(NS_2PP[n]) &= \sum_{pq \in E_1} [\delta_p + \delta_q]^2 + \sum_{pq \in E_2} [\delta_p + \delta_q]^2 + \sum_{pq \in E_3} [\delta_p + \delta_q]^2 + \sum_{pq \in E_4} [\delta_p + \delta_q]^2 + \sum_{pq \in E_5} [\delta_p \\ &\quad + \delta_q]^2 + \sum_{pq \in E_6} [\delta_p + \delta_q]^2 + \sum_{pq \in E_7} [\delta_p + \delta_q]^2 + \sum_{pq \in E_8} [\delta_p + \delta_q]^2 + \sum_{pq \in E_9} [\delta_p + \delta_q]^2 \\ &\quad + \sum_{pq \in E_{10}} [\delta_p + \delta_q]^2 + \sum_{pq \in E_{11}} [\delta_p + \delta_q]^2 \\ &= 64(3 \times 2^{n+3} - 16) + 81(3 \times 2^{n+3} - 16) + 100(2^{n+3} - 8) + 144(5 \times 2^{n+3} - 40) + 169(8) + 196(2^{n+3} - 8) \\ &\quad + 225(2^{n+3} - 8) + 256(3 \times 2^{n+2} - 12) + 289(2^{n+3} - 8) + 400(4) + 324(2^{n+3} - 8) \\ &= 2673 \times 2^{n+3} - 17272 \end{aligned}$$

We know that,

$$\overline{HM}_2(G) = \sum_{pq \in E(G)} [\delta_p \times \delta_q]^2$$





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$$\begin{aligned} \widehat{HM}_2(NS_2PP[n]) &= \sum_{pq \in E_1} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_2} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_3} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_4} [\delta_p \times \delta_q]^2 + \\ &\sum_{pq \in E_5} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_6} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_7} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_8} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_9} [\delta_p \times \delta_q]^2 + \sum_{pq \in E_{10}} [\delta_p \times \\ &\delta_q]^2 + \sum_{pq \in E_{11}} [\delta_p \times \delta_q]^2 \\ &= 256(3 \times 2^{n+3} - 16) + 400(3 \times 2^{n+3} - 16) + 625(2^{n+3} - 8) + 1225(5 \times 2^{n+3} - 40) + 1600(8) + 2304(2^{n+3} - 8) \\ &\quad + 3136(2^{n+3} - 8) + 3969(3 \times 2^{n+2} - 12) + 5184(2^{n+3} - 8) + 9216(4) + 6561(2^{n+3} - 8) \\ &= 254852 \times 2^n - 199940 \end{aligned}$$

We know that,

$$\begin{aligned} \widehat{PM}_1(G) &= \prod_{pq \in E(G)} [\delta_p + \delta_q] \\ \widehat{PM}_1(NS_2PP[n]) &= \prod_{pq \in E_1} [\delta_p + \delta_q] + \prod_{pq \in E_2} [\delta_p + \delta_q] + \prod_{pq \in E_3} [\delta_p + \delta_q] + \prod_{pq \in E_4} [\delta_p + \delta_q] + \prod_{pq \in E_5} [\delta_p + \delta_q] \\ &\quad + \prod_{pq \in E_6} [\delta_p + \delta_q] + \prod_{pq \in E_7} [\delta_p + \delta_q] + \prod_{pq \in E_8} [\delta_p + \delta_q] + \prod_{pq \in E_9} [\delta_p + \delta_q] + \prod_{pq \in E_{10}} [\delta_p \\ &\quad + \delta_q] \prod_{pq \in E_{11}} [\delta_p + \delta_q] \\ &= 8(3 \times 2^{n+3} - 16) + 9(3 \times 2^{n+3} - 16) + 10(2^{n+3} - 8) + 12(5 \times 2^{n+3} - 40) + 13(8) + 14(2^{n+3} - 8) + 15(2^{n+3} - 8) + 16(3 \times 2^{n+2} - 12) + 17(2^{n+3} - 8) \\ &\quad + 20(4) + 18(2^{n+3} - 8) \\ &= 2224 \times 2^n - 192 \times 3^{112} \times 2^n - 96 \times 5^{16} \times 2^n - 12 \times 7^8 \times 2^n - 8 \times 13^8 \times 17^8 \times 2^n - 8 \end{aligned}$$

We know that,

$$\begin{aligned} \widehat{PM}_2(G) &= \prod_{pq \in E(G)} [\delta_p \times \delta_q] \\ \widehat{PM}_2(NS_2PP[n]) &= \prod_{pq \in E_1} [\delta_p \times \delta_q] + \prod_{pq \in E_2} [\delta_p \times \delta_q] + \prod_{pq \in E_3} [\delta_p \times \delta_q] + \prod_{pq \in E_4} [\delta_p \times \delta_q] + \prod_{pq \in E_5} [\delta_p \times \delta_q] \\ &\quad + \prod_{pq \in E_6} [\delta_p \times \delta_q] + \prod_{pq \in E_7} [\delta_p \times \delta_q] + \prod_{pq \in E_8} [\delta_p \times \delta_q] + \prod_{pq \in E_9} [\delta_p \times \delta_q] + \prod_{pq \in E_{10}} [\delta_p \\ &\quad \times \delta_q] + \prod_{pq \in E_{11}} [\delta_p \times \delta_q] \\ &= 16(3 \times 2^{n+3} - 16) + 20(3 \times 2^{n+3} - 16) + 25(2^{n+3} - 8) + 35(5 \times 2^{n+3} - 40) + 40(8) + 48(2^{n+3} - 8) + 56(2^{n+3} - 8) + 63(3 \times 2^{n+2} - 12) \\ &\quad + 72(2^{n+3} - 8) + 96(4) + 81(2^{n+3} - 8) \\ &= 2224 \times 2^n - 132 \times 3^{80} \times 2^n - 76 \times 5^{80} \times 2^n - 64 \times 7^{60} \times 2^n - 60 \end{aligned}$$

First and second Zagreb polynomials are computed.

We know that,

$$\begin{aligned} \widehat{M}_1(G, x) &= \sum_{pq \in E(G)} x^{[\delta_p + \delta_q]} \\ \widehat{M}_1(NS_2PP[n], x) &= \sum_{pq \in E_1} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_2} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_3} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_4} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_5} x^{[\delta_p + \delta_q]} \\ &\quad + \sum_{pq \in E_6} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_7} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_8} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_9} x^{[\delta_p + \delta_q]} + \sum_{pq \in E_{10}} x^{[\delta_p + \delta_q]} \\ &\quad + \sum_{pq \in E_{11}} x^{[\delta_p + \delta_q]} \\ &= (3 \times 2^{n+3} - 16)x^8 + (3 \times 2^{n+3} - 16)x^9 + (2^{n+3} - 8)x^{10} + (5 \times 2^{n+3} - 40)x^{12} + 8x^{13} + (2^{n+3} - 8)x^{14} + (2^{n+3} \\ &\quad - 8)x^{15} + (3 \times 2^{n+2} - 12)x^{16} + (2^{n+3} - 8)x^{17} + 4x^{20} + (2^{n+3} - 8)x^{18} \end{aligned}$$

We know that,

$$\widehat{M}_2(G, x) = \sum_{pq \in E(G)} x^{[\delta_p \times \delta_q]}$$





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$$\begin{aligned} \widehat{M}_2(NS_2PP[n], x) &= \sum_{pq \in E_1} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_2} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_3} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_4} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_5} x^{[\delta_p \times \delta_q]} + \\ &\sum_{pq \in E_6} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_7} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_8} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_9} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_{10}} x^{[\delta_p \times \delta_q]} + \sum_{pq \in E_{11}} x^{[\delta_p \times \delta_q]} \\ &= (3 \times 2^{n+3} - 16)x^{16} + (3 \times 2^{n+3} - 16)x^{20} + (2^{n+3} - 8)x^{25} + (5 \times 2^{n+3} - 40)x^{35} + 8x^{40} + (2^{n+3} - 8)x^{48} + (2^{n+3} - 8)x^{56} \\ &\quad + (3 \times 2^{n+2} - 12)x^{63} + (2^{n+3} - 8)x^{72} + 4x^{96} + (2^{n+3} - 8)x^{81} \end{aligned}$$

CONCLUSION

In this paper, we consider two families of nanostar dendrimers. Different invariants such as first and second neighbourhood Zagreb indices, first and second neighbourhood Hyper-Zagreb indices, first and second neighbourhood multiple Zagreb indices, first and second neighbourhood Zagreb polynomials are estimated for nanostar dendrimers using edge partition based on neighbourhood degree of vertices of the corresponding chemical graphs. These indices are used to describe the thermodynamic properties like boiling points, heat of combustion, enthalphy of formation etc and several boiling properties of chemical structures. In future, this method of computation of these indices can extended for other family of dendrimers.

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Table 1: (δ_p, δ_q) -type edge partition of $NS_1C_5C_6[n]$

(δ_p, δ_q)	(3,7)	(4,8)	(5,5)	(5,7)	(6,3)	(6,6)	(6,7)	(7,7)	(7,8)	(8,8)
No.of edges	$2^{n+1} - 2$	2^{n+2}	$2^{n+2} - 6$	$2^{n+3} - 12$	$2^{n+1} - 4$	$2^{n+1} - 4$	$2^{n+3} - 16$	$7 \times 2^n - 6$	2^{n+1}	2^n

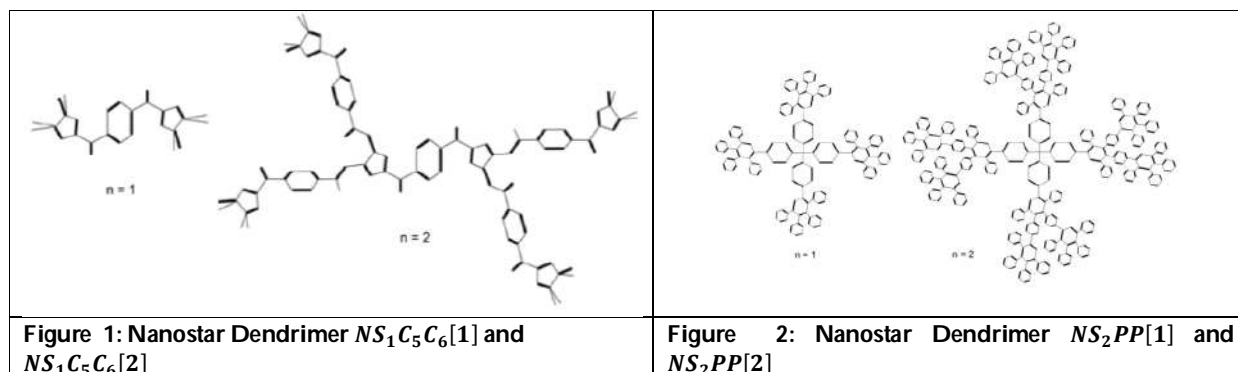




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Table 2: (δ_p, δ_q) -type edge partition of $NS_2PP[n]$.

(δ_p, δ_q)	(4,4)	(4,5)	(5,5)	(5,7)	(5,8)	(6,8)	(7,8)	(7,9)	(8,9)	(8,12)	(9,9)
No.of edges	$3 \times 3^{n+3}$ - 16	$3 \times 2^{n+3}$ - 16	2^{n+3} - 8	$5 \times 2^{n+3}$ - 40	8	$2^{n+3} - 8$	2^{n+3} - 8	$3 \times 2^{n+2}$ - 12	2^{n+3} - 8	4	2^{n+3} - 8





Antimicrobial Activity of Essential Oil of *Pogostemon mollis* (Lamiaceae) – A Promising Ethno-Medicinal Plant

Kavi Malar.S* and Saradha.M

¹Research Scholar, Department of Botany, Nirmala College for Women, Coimbatore – 641 018, Tamil Nadu, India.

²Department of Botany, Nirmala College for Women, Coimbatore – 641 018, Tamil Nadu, India.

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*Address for Correspondence

Kavi Malar S

Research Scholar,
Department of Botany,
Nirmala College for Women,
Coimbatore – 641 018, Tamil Nadu, India.
E. Mail: saradha.bio@gmail.com



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ABSTRACT

This study aims to assess the antimicrobial activity of essential oil of aerial part of *Pogostemon mollis* against gram positive and gram-negative bacterial strains (*Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Kelbsella pneumonia*) as well as fungal strains of *Candida albicans* and *Candida tropicalis*. The strains isolated were employed, and their antibiotic sensitivity was assessed using the Agar well diffusion method against the standard chloramphenicol and fluconazole. The essential oil was extracted by steam distillation and the oil produced highest zone of inhibition against gram positive bacteria - *S.aureus* (2.7±0.5mm), and gram negative bacteria- *E.coli*(2.9±0.5mm). The fungal strains also revealed the potential zone of inhibition against *Candida tropicalis* (2.5±1.9mm) when compared with *Candida albicans* (2.4±0.8mm). The Essential oil from *Pogostemon mollis* can be considered as a new source, new drugs to treat microbial infections, particularly infections caused by strains that are resistant to antibiotics.

Keywords: Antimicrobial, Antibacterial, Antifungal, Lamiaceae, *Pogostemon mollis*

INTRODUCTION

The development of resistance in microbes to existing antibiotics and the emergence of new pathogenic organisms is a great challenge. The plants are uniquely endowed with the natural ability to synthesize and evolve new compounds over time in order to survive the harsh environmental conditions during microbial attacks. Since ancient times, plant essential oils and extracts have been employed in natural remedies, medicines, alternative medicine, and food preservation [14],[7]. The evolution of resistant microorganisms has the way for the creation of illnesses that can only be treated by a few number of antimicrobial medicines, despite the fact that pathogenic bacteria have long been



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recognized as a major source of mortality in humans[9]. Novel antimicrobial chemicals, particularly those that are effective against bacterial infections, can be found in essential oils. Numerous studies highlight the significance of essential oils and its ability to combat a variety of resistance, specifically against multidrug resistant bacteria, Gram-positive and Gram-negative bacteria[3],[18],[12],[16]. Strong antimicrobial agents with a broad spectrum of activity, essential oils have the ability to control a variety of plant pathogens, postharvest agricultural spoilage, and human pathogenic diseases[15].

Western Ghats Provide a rich source of medicinal plants, having Natural Products viz., essential oils and oleo resins with biological activity[13]. Essential oils are made up of molecules of oxygenated substances such as esters, aldehydes, ketones, alcohols, phenols, and oxides and hydrocarbons, the majority of which are terpenes. Essential oils, or fluids produced from plants, have been used for topical applications like antiseptics for wound healing and bathing soaps[6]. They have shown potential as anti-bacterial agents, disinfectants, anti-fungal agents, insecticides and as herbicides[1],[10],[17],[19]. The Extracts from several medicinal plants have been used extensively to treat a variety of ailments because of their antibacterial qualities.

Pogostemon mollis Benth. is a medicinal plant of Lamiaceae family. There are more than 85 species in the genus *Pogostemon* and were used to treat some ailments in the villages of Southern Western Ghats in Kerala, India. *Pogostemon mollis* is an aromatic plant with volatile and odoriferous compounds that appear as essential oils in the leaf and aerial sections of the plant. As possible natural agents of antimicrobials, the natural ingredients isolated from aromatic and medicinal plants attracted special attention. Hence considering the aforesaid, this study aimed to highlight the antimicrobial activity of essential oil obtained from the aerial part of *pogostemon mollis* against some selected bacterial and fungal strains so as to justify its traditional medicine practice.

MATERIALS AND METHODS

Sampling and Extraction of Essential Oil

Nelliampathy is a hill station in Southern Western Ghats, located 60 kilometers(37m) from Palakad District, at a height of 467 to 1,572 m above sea level in Kerala, India. The aerial part of the plant was collected during the September-November 2022 washed and shade dried. Chopped and powdered raw material (1Kg) were Steam distilled using (EYELA CA-1116A) at 100°C for 3 hours and the essential oil gave off a pleasant odor that was stored immediately in an opaque amber bottle at a temperature at 4°C and the composition of the essential oil was expressed in percentage (2%).

Selection of Microbial strains

All the bacterial and fungal strains were obtained from microbiology Bioline laboratory, R.S Puram Coimbatore district. Two gram positive strains such as *Bacillus subtilis*, *Staphylococcus aureus* and two negative strains such as *Escheria coli* and *Klebsiella pneumoniae* bacterial strains and two fungal strains such as *candida albicans* and *candida tropicalis* were used to assess the antimicrobial properties of oil extracted from *Pogostemon mollis*. Bacterial and fungal strains were maintained on 1% semisolid nutrient agar at 4°C and it was sub cultured every two weeks in microbiology laboratory. The activity of oil from *Pogostemon mollis* on selected bacterial and fungal strains were assayed by well diffusion method. Antimicrobial susceptibility was tested on solid media such as nutrient agar and potato dextrose agar media in petri-plates respectively.

Antimicrobial assay

Nutrient agar medium was prepared and poured on the petri-plates and was left on sterile surface until the agar has solidified. The plates were swabbed with (sterile cotton swabs) 24 hours old culture of bacterial strains. Wells were made in each of these plates using sterile cork borer. Stock solution of each solvent extract viz., ethanol and ethyl acetate were prepared at a concentration of 1mg/mL. About 100µL of different oil extracts of *Pogostemon mollis* were added using sterile syringe into the wells and allowed to diffuse at room temperature for 2 hours. Chloramphenicol



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for bacteria and fluconazole for fungi were used as a positive control. All the bacterial and fungal plates were incubated at 37°C for 18-24 hours. The antimicrobial activity was assayed by measuring the diameter of the inhibition zone formed around the well.

Preparation of the Inoculums for Bacterial and fungal Culture

Stock cultures were maintained at 4°C on slopes of nutrient agar and Potato dextrose agar. Active culture for experiments were prepared by transferring a loop full of cells from stock culture of test tubes of 50ml nutrient broth incubated at 27°C for 3-5 days. Each suspension of bacterial and fungal organism was subsequently stroke out on nutrient agar media and potato dextrose agar respectively. Bacterial cultures then incubated at 37°C for 24 hours and fungal culture incubated at 27°C for 3-5 days.

Agar Well Diffusion Method

Using a sterile Pasteur pipette, the wells were made on the surface of the agar that had already been seeded with the indicator strain. Using agar well diffusion techniques, the essential oil of *Pogostemon mollis* 25µl, 50 µl, and 75 µl were tested for their antimicrobial activities. Bacterial cultures of *E. coli*, *B. subtilis*, *S. aureus*, and *K. pneumonia*, fungal cultures of *Candida albicans* and *Candida tropicalis* were employed. After 24 hours of incubation at 29°C for bacteria and 39°C for fungi, the diameters of the zone of inhibition were measured with a calliper. Growth inhibition was evaluated after 24 hours and compared with those results obtained from the controls Chloramphenicol and fluconazole for bacteria and fungi respectively. Zone of inhibition for each microorganisms were noted.

RESULTS AND DISCUSSION**Antimicrobial activity**

Table 1 and 2 depicts the antimicrobial potential of oil extracted from *Pogostemon mollis* against different bacterial and fungal strains. Among the four species of Gram-positive and Gram-negative bacterial strains, one species of each was susceptible towards the essential oil of *Pogostemon mollis*. The oil of *Pogostemon mollis* was found most effective against *Staphylococcus aureus* and *Escherichia coli*. However remarkable activity was noted against *Candida tropicalis* when compared with the Standard fluconazole. As shown in the table: 1, the antibacterial activity of essential oil of *Pogostemon mollis* showed significant zone of inhibition against *Staphylococcus aureus* and *Escherichia coli* with an inhibition zone of (2.7±0.5mm) and (2.9±0.5mm) respectively, when compared with that of the standard chloroamphenicol. The inhibition activity of Gram-positive and Gram-negative bacteria were in the order of 75 µl >50 µl >20 µl and 75 µl >20 µl >50 µl respectively. The conducted antibacterial studies proved the efficacy of essential oils of the *Pogostemon* was found most effective against *Staphylococcus aureus* among the selected bacteria tested [18]. Whereas, the ethanolic extract of *Pogostemon cablin* exhibited the greatest activity against methicillin resistant with a significant zone of inhibition against *S. aureus* was reported [2]. Thus, essential oil of *Pogostemon mollis* seems to be effective antibacterial agents with good activity on controlling pathogenic resistant.

Candida species are harmless yeast like fungi in healthy humans, that can cause superficial as well as life-threatening systemic infection under immune-compromised situation [4]. Essential oil obtained from *Pogostemon mollis* showed potential antifungal activity against two selected fungal strains as represented in the table 2. The significant zone of inhibition was exhibited against *Candida tropicalis* at (2.5±1.9mm) at 50 µl. Whereas *Candida albicans* was moderately susceptible for the essential oil of *Pogostemon mollis* at (2.4±1.5mm) at 75 µl when compared with the standard fluconazole. Similarly, the study on Essential oil obtained from three different species of *Pogostemon* showed effective antifungal activity against *Candida albicans* and the selected eight strains of the fungi [18]. The moderate antifungal activity of Essential oil of *Pogostemon parviflorus* was noted when compared with the pure standard [5]. Furthermore, these fungal strains exhibited more susceptible for the essential oil of *Pogostemon mollis* and can be effective against various pathogens. This microbial activity showed a broad spectrum of activity against the bacterial and fungal strains. Hence the results implies that oil of *Pogostemon mollis* can be used to treat diseases caused by the micro-





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organisms. All values are Mean of triplicate determination (n=3) ± Standard deviation, and represented using statistically significance at P<0.005^{a>} ^{b>} ^{c>} ^{d>} in each column

CONCLUSION

The Essential oil extracted from aerial part of *Pogostemon mollis* exhibited remarkable antimicrobial activity against all the selected microbe. The promising species *Pogostemon mollis* significantly exerted repellency on *S.aureus*, *E.coli* and *Candida tropicalis*. Hence the oil from *P.mollis* safe for human and can be further used as an anti- microbicides for human pathogenic infection.

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Table 1: Antibacterial activity of essential oil of *Pogostemon mollis*

Volume (μ l/ml)	Zone of inhibition(mm)			
	Gram positive		Gram Negative	
	<i>Bacillus subtilus</i>	<i>Staphylococcus aureus</i>	<i>Escherichia Coli</i>	<i>Kelbsella pneumonia</i>
25	2.2 \pm 1.5 ^d	2.3 \pm 0.3 ^d	2.1 \pm 0.7 ^d	2.2 \pm 1.7 ^c
50	2.4 \pm 0.5 ^c	2.5 \pm 0.2 ^c	2.6 \pm 1.8 ^c	2.2 \pm 1.3 ^d
75	2.4 \pm 1.0 ^b	2.7\pm0.5^b	2.9\pm0.5^b	2.5 \pm 2.0 ^b
Standard (Chloramphenicol)	2.7 \pm 1.3 ^a	2.9 \pm 1.5 ^a	3.0 \pm 1.1 ^a	2.8 \pm 1.0 ^a

All values are Mean of triplicate determination (n=3) \pm Standard deviation, and represented using statistically significance at P<0.005 ^{a> b>c>>d}in each column

Table 2: Antifungal activity of essential oil of *Pogostemon mollis*

Volume (μ l/ml)	Zone of Inhibition (mm)	
	<i>Candida albicans</i>	<i>Candida tropicalis</i>
25	2.2 \pm 1.1 ^a	2.3 \pm 1.5 ^b
50	2.4\pm0.8^c	2.5\pm1.9^a
75	2.4 \pm 1.5 ^b	2.0 \pm 0.8 ^c
Standard (Flucanazole)	2.7 \pm 0.5 ^d	2.6 \pm 1.2 ^d





Comparative Studies on Morphology and Phytochemical Screening of *Plumbago* Species (Plumbaginaceae)

Saradha.M^{1*}, P. Samydurai² and P.Jansirani³

¹Department of Botany, Nirmala College for Women, Coimbatore – 641 018, Tamil Nadu, India.

²Department of Botany, Bharathiar University, Coimbatore – 641 046, Tamil Nadu, India.

³ Department of Botany, The Madura College, Madurai, Tamil Nadu, India.

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*Address for Correspondence

Saradha M

Department of Botany,
Nirmala College for Women,
Coimbatore – 641 018,
Tamil Nadu, India.

E. Mail: saradha.bio@gmail.com



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ABSTRACT

The genus *Plumbago* belongs to the family Plumbaginaceae. It is widely distributed in tropical and subtropical regions. The present investigation was carried out to study the quantitative trait variation and phytochemical variation among *Plumbago zeylanica* and *P. rosea*. The analysis of morphological data revealed significant differences among phenotypes for all measured traits. Different phytoconstituents such as alkaloid, flavonoids, glycosides, tannins, saponins, terpenoids, phenol and steroids were identified in the ethyl acetate and ethanol extracts. The results will provide preliminary interpretation of morphological characters and phytochemicals of these species.

Keywords: Phenotypic traits, phytochemicals, *Plumbago*, Plumbaginaceae

INTRODUCTION

Since time immemorial the plant species are identified based on morphological characters. Plants are polymorphic in nature however the plants are quite varying from other organism in their form and structure. Within a single individual, the same parts may express difference in form and structure especially leaves, stems and flowers show variation among themselves. This variation can occur due to positional effects, environmental effects and juvenility¹. Many biologist put efforts to explore structures in many different plants of the same or different species, which can be compared, measured, counted and described to assess the differences or similarities in plant taxa and thereby can solve the taxonomic problems^[1,2]. The genus *Plumbago* L. to the family Plumbaginaceae with two taxa *Plumbago zeylanica* L and *Plumbago rosea* L. In Tamil it is called as Venkodivaeli and Senkodiveli respectively. The plants have

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been widely distributed in tropical and subtropical regions of India, Australia, Asia and Africa and cultivated in parts of Southern India for its tuberous roots [3]. Traditionally the plants have been used for the treatment of skin diseases, gastrointestinal disorder, arthritic pain [4]. The root of *Plumbago* species is the chief source of chemical compound Plumbagin. Several reports have been proved that Plumbagin possesses various pharmacological activities antimicrobial, antiplasmodial, anticancer and antifertility activity, cytotoxic effects, antimalarial, antioxidant, cordiotonic, antimutagenic, insecticidal activities[5-7] and also used to treat oedema, piles, intestinal worms, leucoderma, secondary syphilis, short leprosy[8,9]. In this study morphological characters and phytochemical analysis of two taxa in the genus *Plumbago* are investigated and compared.

MATERIALS AND METHODS

Collection of Plant Materials

Two species were selected from the genus *Plumbago* and they are: *P. zeylanica* L and *P. rosea* L. These two specimens were collected from different location within the Coimbatore district.

Morphological Studies

The habit and habitat of each species were recorded. Qualitative morphological characters studied include leaf shape, base and apex, their margins, vein, petioles, arrangements, flower colour, calyx colour, calyx shape, corolla shape, anther shape, ovule placentation, fruit types, their shape were observed and recorded. Quantitative morphological characters measured include plant height, plant spread, length and breadth of leaf, length of petiole, number and length of calyx, number of corolla, length of corolla tube length of anther filament, length of style, number of corpel, size and shape of fruits and number of seeds this was done by the use of a metric ruler and the measurements were taken to the nearest centimeters. Counts were taken of the number of calyx, corolla, corpel, seeds and gynoecium locule. Fresh materials collected in the field were pressed and processed immediately as voucher specimens and they were deposited at Botany Herbarium, Nirmala College for Women, Coimbatore, Tamilnadu, India.

Preparation of Plant Extracts

To know the presence of major phytochemicals, the shade dried leaves and of the study species were made into a fine powder of 40 mesh size using the pulverizer. Following that, 50 g of the powder was filled in the filter paper and successively extracted using 250 mL solvents viz., Ethy acetate and Ethanol by using cold extraction method¹⁰. The extract was filtered through Whatman No.1 filter paper to remove all undissolved matter, including cellular materials and other constitutions that are insoluble in the extraction solvents.

Preliminary Phytochemical Studies

The extracts were subjected to preliminary phytochemical tests to determine the groups of secondary metabolites present in the plant material. Alkaloids, Flavonoids, Glycosides, Saponins, Tannins, Terpenoids, Steroids, Phenols were analysed according to standard phytochemical methods as described by Trease and Evans¹¹, Sofowora¹² and Horbone [13].

RESULTS

Morphological Characters of the Study Plants

The morphological characters of *Plumbago rosea* and *P. zeylanica* was described for their variation of the phenotypical traits of the two threatened medicinal plants from Coimbatore district, Western Ghats of Tamilnadu, India. Totally 40 morphological characters of both the species were registered and depicted by microscopical features. The morphological traits were instability in each category of the state and morphological features of plant height, habit, habitat, leaf characters, inflorescence, fruiting and seeds of the both *Plumbago* species were shown in Table 1.





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Preliminary Phytochemical Screening

P. zeylanica and *P. rosea* leaf extracts (Ethyl acetate and Ethanol) obtained by continuous cold extraction method were subjected to standard qualitative phytochemical tests to identify the presence of chemical constituents (viz., alkaloids, flavonoids, glycosides, saponins, tannins, terpenoids, steroids, and phenols). Preliminary phytochemical screening mainly revealed the presence of alkaloid, flavonoid, saponins, tannins, terpenoids and phenols in ethyl acetate extract of *P. zeylanica*; alkaloid, flavonoid, saponins, steroids and phenols in ethanol extract of *P. zeylanica*; flavonoids, glycosides, tannins, and terpenoids in ethyl acetate extract of *P. rosea*; alkaloid, flavonoid, saponins and steroids in ethanol extract of *P. rosea* (Table 2).

DISCUSSION

Study of morphological characters enhances the taxonomy of the *Plumbago* species. Habit encountered in these species is quite variable, *P. zeylanica* consisting of sub shrub and *P. rosea* consisting of shrub. Floral characters are also shows variable among the selected species. Colour is different from one another. *P. zeylanica* is white in colour and *P. rosea* is red in colour. Further, some characters like leaf base, inflorescence type, corolla shape and style of these two species are vary from each other rest of the other studied characters are similar for the study species. This is the indication of closely relativeness of these two species. Ferrero et al [14] studied heterostyly and pollinators in *Plumbago auriculata* as of which they found that flowers of *P. auriculata* show reciprocal heterogamy, with anthers and style differing in lengths between morphs and positioned reciprocally in flowers of both morphs. Therefore, it is evident that there would be variation in style among Plumbaginaceae species. Alice Kurian et al., [15] found that highly significance variation in all characters studied in *P. rosea* except leaf size. Scrutiny of the morphological characters could be employed in separating the species and also handy for the selection of high yielding types.

Further, the findings of phytochemical screening of the Ethyl acetate and ethanol leaf extracts of *Plumbago zeylanica* and *P. rosea* revealed the presence of Alkaloid, flavonoids, glycosides, tannins, saponins, terpenoids, phenol and steroids (Table 2). Medicinal plants play an important role for the health benefit of human being in many developing countries [16]. The secondary metabolites have significant activity against infective microorganisms [17,18]. The various phytochemical compounds detected from the leaf extracts are known to have beneficial importance in medicines. Due to the presence of phyto constituent crude medicinal preparations of *Plumbago zeylanica* and *P. rosea* were used in the Indian system of medicine. Recently a number of studies have been carried out on the phytochemistry of plants across the world [19]. It has been reported previously that ethanol extract and petroleum ether extract from the leaves and stem of *Plumbago zeylanica* L. have antimicrobial properties [20]. On the basis of many studies referred above, it is evident that the leaf extract of *P. zeylanica* L. and *P. rosea* L. have a wide range of bioactive secondary metabolites. The information acquired in the present study would be sensible to work out some measures to protect the studied *Plumbago* species and also prevent it from large differentiation in morphological variation.

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Table 1. Morphological characters of *Plumbago zeylanica* and *Plumbagorosea*.

S.No.	Plant characters	<i>Plumbagozeylanica</i>	<i>Plumbagorosea</i>
1	Habit	Subshrub	Shrub
2	Habitat	Dry deciduous	Deciduous
3	Plant Height	0.5-1 m	0.5–2 m
4	Plant spread (cm)	10-50 cm	11.0 -70.5 cm
6	Leaf length	8 – 15 cm	7.0 - 14.0 cm
7	Leaf breadth	3 – 5.5 cm	4.0 - 8.5 cm
8	Leaf shape	ovate or oblong	oblong-elliptic
9	Leaf arrangement	alternate	alternate
10	Petiole length	0-5 mm	1 cm
11	Leaf base	Amplexicaul	Attenuate
12	Leaf apex	acute	acute
13	Leaf margin	entire	entire
14	Leaf venation	reticulate	reticulate
15	Flower colour	white	Red
16	Flower length	2 cm	4 cm
17	Inflorescence type	Terminal raceme	Scarlet racemes
18	Inflorescence length	6–30 cm	25-60 cm
19	No. of Calyx	5	5
20	Calyx length	7–11 mm	1 cm





21	Calyx colour	Green	Red
22	Calyx shape	Cylindrical	Cylindrical
23	Glands	Present on calyx	Present on calyx
24	Colour of glands	Green	Red
25	No. of Corolla	5	5
26	Corolla tube length	1.5 cm	3.5 cm
27	Corolla shape	Slender and tubular	Obovate
28	Stamen	5	5
29	Filament length	2 cm	3 cm
30	No. of locule	1	1
31	Style	Filiform	Base hairy
32	Style length	1.7 cm	2.2 cm
33	Stigma	5 fid	5 fid
34	Ovary	superior	superior
35	Carpel Number	1	1
36	Ovule Placentation	Marginal	Marginal
37	Fruit size	7.5–8 mm	8.5-9.5 mm
38	Fruit shape	Oblong	Oblong
39	Fruit type	Capsule	capsule
40	Seed numbers	1	1

Table 2. Preliminary phytochemical analysis of leaf extracts of *Plumbago* species.

S. No.	Phytoconstituents	<i>Plumbagozeylanica</i>		<i>Plumbagorosea</i>	
		Ethyl acetate	Ethanol	Ethyl acetate	Ethanol
1.	Alkaloids	++	+	-	+++
2.	Flavonoids	++	+	++	++
3.	Glycosides	-	-	+++	-
4.	Saponins	+	+	-	+++
5.	Tannins	+	-	+++	-
6.	Terpenoids	+++	-	+++	-
7.	Steroids	-	+	-	++
8.	Phenols	++	+++	-	-





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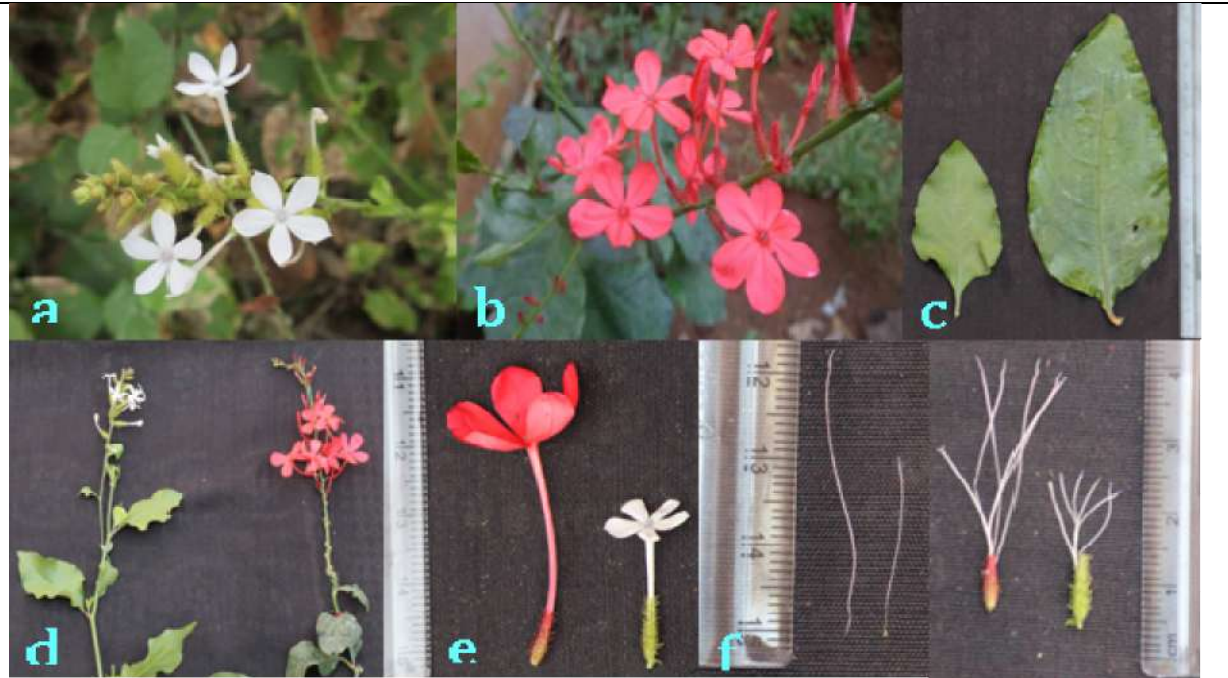


Figure 1. Morphological variations of *Plumbago* species; a &b. habit of *P.zeylanica*and *P.rosea*.c. Size of Leaf; d. Type of inflorescence; e. Length of corolla tube with petals;f. Length of stamens; g. Ovary attached with stamen filament and stigma

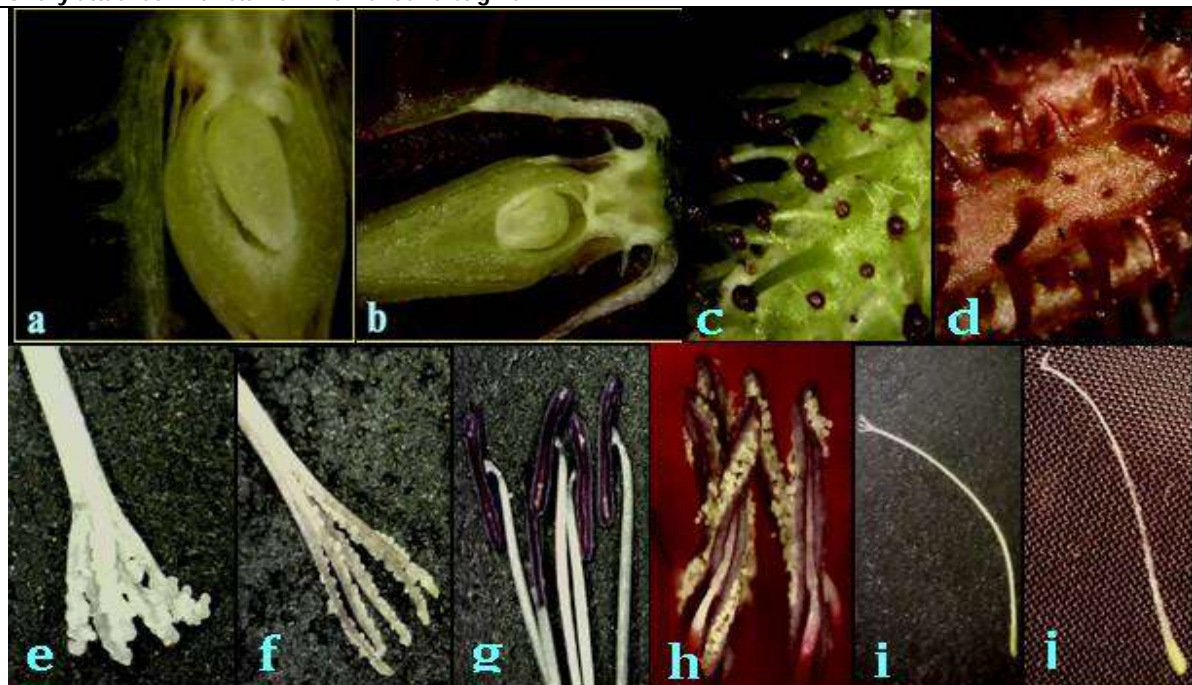


Figure 2. Microscopical observations of *Plumbago* species; a-b. L.S of ovary; c-d. Calyx with glandular trichomes; e-f Enlarged view of anther; g-h Stamens attached with filaments; i-j Style with stigma





Marine Vertebrate Facilitated Biogenic Synthesis of Zinc Oxide Nanoparticles and Assay of its Biological Activity

Dhivya.P*

Assistant Professor, Department of Chemistry, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

Dhivya.P

Assistant Professor,
Department of Chemistry,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.
Email: dhivsanto@gmail.com



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ABSTRACT

Fabrication of nanoparticles from the waste materials has become an innovative attempt in the field of nanotechnology; significantly in the biological processes. The contemporary work discusses the synthesis of zinc oxide nanoparticles from the fish scales of *Sardinella longiceps* which is a waste material from the marine products. The synthesized ZnO nanoparticles are characterized by UV and FESEM. The antimicrobial activity of the synthesized zinc oxide nanoparticles was evaluated against Gram positive bacteria Methicillin resistant *Staphylococcus aureus* (MRSA), Gram negative bacteria *Pseudomonas aeruginosa* (MTCC 201) and their anti-fungal activity is analysed against Fluconazole resistant *Candida albicans* (FRCA). Their anti-oxidant activity was evaluated using DPPH assay and H₂O₂ assay.

Keywords: *Sardinella longiceps*, Zinc oxide, nanoparticles, antimicrobial, antioxidant.

INTRODUCTION

In the recent past, various interdisciplinary branches help to develop and fabricate nanomaterials via two approaches: top down - reducing the size of bulk materials and bottom up - fabricating nanostructures in a controlled manner [1,2]. Quite important to consider is the bottom-up method, this initiates several natural processes that are similar to protein synthesis, DNA replication [3]. The most classic example of a bottom-up approach involves the reduction of citrate or sodium borohydride salts for metal nanoparticles formation [4,5]. However, these reactions involve the use of toxic and harsh chemicals, which may have adverse environmental effects, which in turn, point to a need for non-polluting, biocompatible and eco-friendly nano materials fabricated via a green approach





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[6,7]. The present scenario underlines a growing importance towards the synthesis of novel nanomaterials using various routes constantly with innovative contributions. Most significantly, the biological synthesis, well known as green synthesis is considered as an imperative additive to synthesis nanoparticles [8]. This technology implies the production of nanoparticles with greater scientific interest without harming the environment. Even though many researchers have found out many ways to biologically synthesize the nanoparticles from the phyto products, the synthesis of the nanoparticles from marine products are seen rare [9].

Marine organisms are rich source of bioactive compounds with remarkable impact in the field of pharmaceutical, industrial and biotechnological product development [10]. Fish is a predominant constituent of human diet and one of the quality animal protein available to million across the world. Fish serves as a vital health food owing to its higher protein, beneficial fat and various millions micronutrients [11]. Moreover, during the past several decades, fisheries and aquaculture are subsidized to global food security, poverty alleviation, rural livelihood, employment and income generation [12]. Fish scales comprise approximately 2% of fish weight [13]. The indecorous disposal of these fish bio waste may cause earnest environment contamination with offending scent. Hence the optimized usage of these secondary products, particularly exploited for prime high economic valued products, is a likely means to decrease the expenditure of disposition and in turn earn additional income for the manufacturer [14]. In this quest, the present work is so designed such that it will directly address the important usage of vast marine resources and its mediated NPs synthesis, thus briefly portraying the prospective scope of research in this field without any negative impact on the environment.

MATERIALS AND METHODS

All the reagents were purchased commercially and are of analytical grade. The solvents were purified by standard methods.

Collection of Fish Scales

Sardinella longiceps was purchased from local fish market (Ukkadam, Coimbatore, Tamil Nadu). Fish scales of *Sardinella longiceps* were isolated manually with a knife. The scales were washed with tap water followed by distilled water to remove the unwanted debris.

Preparation of Fish Scale Extract

The isolated fish scales were shade dried for about two weeks and then finely powdered. Fine powdered fish scales (12g) was placed in a 500 mL Erlenmeyer flask containing 450 mL distilled water and heated at 80°C for 30 minutes. This was centrifuged at 4000 rpm for 20 minutes and the supernatant was then filtered. The extract was stored in a refrigerator at 4°C for further analysis.

Bio Synthesis of ZnO Nanoparticles

20 mL aqueous fish scale extract of *Sardinella longiceps* was added to 0.025 M aqueous zinc acetate and adjusted the pH 12. The resulted solution was pale white in color. After stirring, the precipitate was washed against with distilled water followed by ethanol to get free of impurities. The solution was vacuum dried and used for characterization of ZnO-NPs.

Characterization of Zinc Nanoparticles.

UV-Vis spectra analysis

The purity ZnO nanoparticles were monitored by measuring the UV-Visible spectrum of the reaction medium at 5 hours after diluting a small aliquot of the sample into distilled water. UV-Visible analysis was done by using UV-Vis spectrophotometer. UV-Vis spectroscopic analysis was done at Nirmala College for Women, Department of Chemistry, Coimbatore.



**Dhivya****Scanning Electron Microscope (SEM) study**

The SEM characterization was carried out using a scanning electron microscope. The solution of fish scale extract was dried and the synthesized ZnO-NPs were examined by scanning electron micrograph (SEM). SEM analysis was done in the Karunya University, Department of Nanoscience, Coimbatore.

Biological Application**Antimicrobial activity**

The antimicrobial susceptibility of the ZnO-NPs from *Sardinella longiceps* was carried out by disc diffusion method [15]. The synthesized ZnO nanoparticles were screened for their antimicrobial activity against the Gram-positive bacteria, methicillin resistant *Staphylococcus aureus* (MRSA) and Gram-negative bacteria, *Pseudomonas aeruginosa* (MTCC 201) and fluconazole resistant *Candida albicans* (FRCA). Microbial cultures were spread equally onto the agar plate. The prepared sterile paper discs containing 10 µL of the concentrations of ZnO nanoparticles were placed onto the bacterial cultured agar plate on sterilized disc (0.5 cm diameter). A pre diffusion for 2 hours was carried out at 4 °C before incubation. Inhibition zones were measured after 24 h incubation period at 37 °C for micro-organisms. The Minimal Inhibitory Concentration (MIC) of various concentration of the test samples were examined.

Antioxidant activity**DPPH Radical Scavenging activity**

The antioxidant activity was determined using standard reported literature [16]. According to which, various concentrations of the extract with a fixed concentration of the synthesized ZnO NPs were mixed with 3.0 mL of methanolic solution containing DPPH radical (6×10^{-5} mol/L). The mixture was shaken vigorously and left to stand for 60 min in the dark. The reduction of the DPPH radical was determined by recording the absorbance at 517 nm using UV-Vis spectrophotometer. DPPH radical – scavenging activity was calculated by the following equation,

$$\text{DPPH radical - Scavenging activity (\%)} = [(A_{\text{DPPH}} - A_{\text{sample}}) / A_{\text{DPPH}}] \times 100$$

Where A_{DPPH} is the absorbance without samples and A_{sample} is the absorbance in the presence of samples. A lower absorbance of the reaction mixture indicated a higher DPPH radical – scavenging activity.

H₂O₂ Scavenging activity:

The Hydrogen peroxide scavenging ability of the synthesized ZnO nanoparticles with different concentrations of the extract was determined following a standard procedure as reported by Keshari et al [16]. A solution of H₂O₂ (40 mM) was prepared in phosphate buffer accounting to a pH of 7.4. Different concentrations of the extracts with a fixed concentration of the synthesized ZnO nanoparticles, ie, 0.1 ml of AgNPs (25 µg/mL) in phosphate buffer (50 mM, pH= 7.4) was allowed to react with 0.6 mL of hydrogen peroxide solution. The absorbance value of the reaction mixture was recorded at 230 nm using UV- Vis spectrophotometer after ten minutes. The blank solution contained the phosphate buffer (50 mM, pH= 7.4) without H₂O₂. Vitamin C was used as standard. The percentage of H₂O₂ scavenging of the synthesized ZnO nanoparticles and standard compounds was calculated as,

$$\% \text{ scavenged [H}_2\text{O}_2] = [(A_{\text{control}} - A_{\text{sample}}) / A_{\text{control}}] \times 100$$

Where A_{control} is the absorbance of the control and A_{sample} is the absorbance of the sample.

RESULTS AND DISCUSSION

In the present work, ZnO NPs were synthesized from the scales of *Sardinella longiceps*.



**Dhivya****Characterization of Gelatin**

The gelatin present in the fish scales extract of *Sardinella longiceps* were characterized using UV-Visible spectroscopy and is depicted in Fig 1. The maximum absorption peak was obtained at 231nm which was in close agreement with the reported literature [17].

Characterization of Synthesized ZnO Nanoparticles

The synthesized nanoparticles were characterized by using UV-Visible spectroscopy, and Field emission scanning electron microscope (FESEM).

Evaluation of UV-VIS Spectroscopy Analysis

The UV spectrum of the synthesized nanoparticles was observed at 349nm, which was in close agreement with the reported literature.

Examination of ZnO NPs by Scanning Electron Microscope Analysis

The images of scanning electron microscope analysis are represented as Figure (2) and (3).

Biological Application**Antimicrobial activity**

The results pertaining to the antimicrobial activity of the synthesized ZnO nanoparticles from the scales of *Sardinella longiceps* is tabulated in Table. The results shows the superiority of ZnO NPs. The diameter of the inhibition zone depends on the species of bacteria and fungi. As on date, there is no clear mechanism on the microbial effect of nanoparticles. However, certain postulates suggest the penetration of ZnO NPs through the cell wall and inactivate the enzymes and generate hydrogen peroxide, which eventually causes cell death. It was noted that the ZnO NPs showed more bactericidal activity against Gram negative bacterium in comparison with Gram positive bacterium. A detailed literature analysis also represents that the thin cell wall with peptidoglycan in Gram negative bacterium enables easier permeability when compared to thick cell walled Gram positive bacterium [20-22].

Antioxidant activity**DPPH Scavenging activity**

The radical scavenging activity of various concentrations of the extract with a fixed concentration of the synthesized ZnO NPs was estimated by comparing the percentage inhibition of formation of DPPH radical with that of vitamin C and is presented in Table 2. DPPH is a stable free radical at room temperature and accepts an electron or hydrogen radical to become stable diamagnetic molecules. DPPH radical is scavenged through donation of hydrogen forming the reduced form of DPPH. Then the colour changes from purple to yellow after reduction, which can be quantified by its decrease absorbance at wavelength 517 nm. The decrease in absorbance of DPPH radical caused by anti-oxidant, because of the reaction between anti-oxidant molecule and radical progresses, resulting in the noticeable discoloration from purple to yellow. The tested samples showed moderate antioxidant activity when compared to Vitamin C.

H₂O₂ Scavenging activity

The hydrogen peroxide radical-scavenging activity of various concentrations of the extract with a fixed concentration of the synthesized ZnO nanoparticles was estimated by comparing the percentage inhibition of formation of peroxy radicals with that of vitamin C. Hydrogen peroxide scavenging activity of the tested samples are presented in Table 2. The tested samples showed moderate inhibition against peroxy radical which was less in comparison with vitamin C. The results however showed that the samples are high potent in neutralizing hydrogen peroxide radicals. Most of the hydrogen peroxide was scavenged by the extracts. IC₅₀ value was observed around 55.2µg/mL where as that of Vitamin C was at 28.53 µg/mL. Vitamin C has a strong hydrogen peroxide scavenging activity as compared with the synthesized ZnO nanoparticles.





CONCLUSION

The present work describes the synthesis of ZnO nanoparticles with the help of fish scale extracts of *Sardinella longiceps*. The fish scale extracts of *Sardinella longiceps* have bioactive compounds which are responsible for the reduction and capping of zinc acetate into ZnO nanoparticles. The capping agent provides stability to the ZnO NPs. The synthesized ZnO NPs exhibited appreciable antimicrobial and antioxidant - hydrogen peroxide and DPPH radical scavenging activity. This activity occurs due to the presence of functional groups on the surface of ZnO NPs. These nanoparticles might be used as antibiotics in future due to non-toxic, cheap, eco-friendly and highly effective against the pathogens.

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Table 1 Antimicrobial activity of ZnO nanoparticles

SI. No.	Microbial Strain	Zone of inhibition
		Ag NPs
1.	Gram positive <i>Staphylococcus aureus</i> (MRSA)	38
2.	Gram negative <i>Pseudomonas aeruginosa</i> (MTCC 201)	43
3.	<i>Candida albicans</i> (FRCA)	25

Table 2 Antioxidant activity of ZnO nanoparticles

DPPH radical scavenging activity (%)						
SI. No.	Conc of ZnO NPs $\mu\text{g/mL}$	Concentrations $\mu\text{g/mL}$ of Extract	Test Sample	IC50 $\mu\text{g/mL}$	Vitamin C	IC50 $\mu\text{g/mL}$
1.	25	20	18.35 \pm 0.32	na	12.67 \pm 0.68	45.75
2.	25	40	25.23 \pm 0.08		44.16 \pm 0.16	
3.	25	60	30.12 \pm 0.15		74.35 \pm 0.12	
4.	25	80	36.23 \pm 0.56		89.56 \pm 0.01	
5.	25	100	41.87 \pm 0.19		96.25 \pm 0.08	
Hydrogen peroxide radical scavenging activity (%)						
S. No.	Conc of ZnO NPs $\mu\text{g/mL}$	Concentrations $\mu\text{g/mL}$ of Extract	Test Sample	IC50 $\mu\text{g/mL}$	Vitamin C	IC50 $\mu\text{g/mL}$
1.	25	20	22.24 \pm 0.38	55.2	41.88 \pm 0.68	28.53
2.	25	40	36.34 \pm 0.30		58.17 \pm 0.56	
3.	25	60	47.45 \pm 0.23		72.33 \pm 0.52	
4.	25	80	65.77 \pm 0.34		81.27 \pm 0.31	
5.	25	100	73.47 \pm 0.39		90.71 \pm 0.38	





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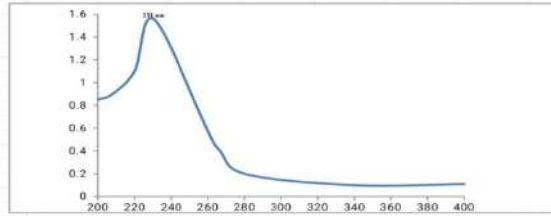


Fig.1. UV-Visible absorption spectra of gelatin in fish scales of *Sardinel lalongiceps*

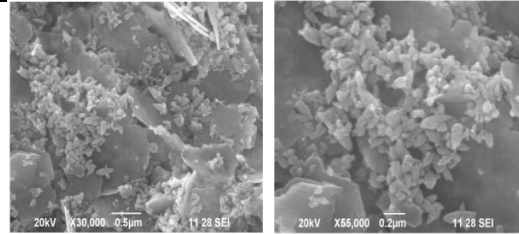


Fig.2. and Fig.3. Field emission scanning electron microscope image of ZnO NPs synthesized from the fish scales of *Sardinel lalongiceps*





Phytochemical and Biochemical Analysis of *Myristica fragrans* Houtt, *Quercus infectoria* Olivier and *Terminalia chebula* Retz

Yaazhini.J¹ and U.Danya^{2*}

¹Ph.D Research Scholar, Department of Botany, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Assistant Professor, Department of Botany, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

U.Danya

Ph.D Research Scholar,
Department of Botany,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.
E. Mail: danya.bio@gmail.com



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ABSTRACT

Traditional plants have been shown to be an innovative source for medical treatments. The beneficial medicinal effects of plant materials typically result from combinations of secondary products present in the plant, making the therapeutic actions specific to particular plant species or groups. In the present study the following three Indian spices *Myristica fragrans* seed (Myristicaceae), *Quercus infectoria* gall (Fagaceae) and *Terminalia chebula* fruit (Combretaceae) were used. *M.fragrans* seed has been utilised extensively in daily life for medical purposes from ancient times. *Q.infectoria* gall is extensively documented with variety of medicinal effects. *T.chebula* is one of the most significant medicinal plants used in ayurvedic, siddha, unani and homoeopathic remedies. Methanolic and Ethyl acetate extracts were prepared by soxhlation method whereas aqueous was done by hot water extraction. The phytochemical screening of ethyl acetate extract showed the presence of alkaloids, flavonoids, tannins, phenols, carbohydrates, glycosides, terpenoids, proteins and steroids. Carbohydrate content was maximum in *M. fragrans* (384.08 ± 4.6 mg/100g) whereas higher protein and phenol content was observed in *Q. infectoria* with 169.91 ± 3.45 mg/100g and 287.34 ± 4.21 mg GAE/g respectively. The flavonoid content in *T.chebula* 43.34 ± 1.5mg QE/g was higher than the other samples. On the basis of the above results the ethyl acetate extract was taken for further studies.

Keywords: *Myristica fragrans*, *Quercus infectoria*, *Terminalia chebula*, Phytochemical screening, Secondary metabolites.





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INTRODUCTION

The oldest known type of healing is herbal medicine, which dates back to 1600 BC and was developed by the ancient Greeks. To maintain, improve or restore health and completeness, it includes using plant elements like leaves, flowers, fruits, bark, seeds, roots and other plant parts [1]. Plants may create a vast range of chemical compounds that are utilised to carry out crucial biological processes and protect themselves from predators. When taken by humans, many of these phytochemicals have positive long-term health impacts and can be utilised to treat a variety of human ailments [2]. *Myristica fragrans* is a member of the Myristicaceae family in the Magnoliales order, which has more than 3000 species and 150 genera. Commonly known as nutmeg, *M. fragrans* produces the spices: mace and nutmeg. In India it is also referred as Jaiphal and Javitri [3]. *M. fragrans* is a spreading evergreen tree that typically reaches heights of 5 to 13 metres, but can also reach 20 metres. Watery pink or scarlet sap can be found in the bark. The pointed dark shiny green leaves are borne on 1cm long leaf stalks and alternately placed along the branches. Male and female flowers can occasionally be found on the same tree, although most flowers are single-sexed. The large, ovoid seeds are firm, meaty, pale and have reddish-brown veins running through them. The aril's colour changes from brilliant scarlet when it's young to more horny, brittle and yellowish-brown after drying. With a distinctive pleasant aroma and a mildly warming flavour, nutmeg has a number of therapeutic benefits [4]. The trees don't start to bloom until they are about 9 years old, but once they do, they continue to bloom for another 75 years. Nutmeg is the fruit's seed kernel, while mace is the scarlet lacy covering that covers it [5]. A common flavouring ingredient, hair colour and folk remedy is mace. Additionally, it has anti-inflammatory, anti-carcinogenic and anti-papillomagenic properties [3].

Quercus infectoria is a small shrub or tree of about two meters high belonging to the family Fagaceae. The tree succumbs to galls that appear on its shoots as a result of depositing the eggs by the gall wasp, *Cynpis gallaetincotariae* [6]. Locally known as Manjakani in Malaysia and Machikai in Tamil, it is one of Asia's most popular traditional remedies. The gall has a globular or irregular shape, an external colour of greenish-yellow and a very astringent flavor [7]. The major components of *Q. infectoria* galls are tannin, along with a trace quantity of free gallic and ellagic acids. Pharmacological studies have shown that the galls have antiviral, antiseptic, antipyretic, derivative, analgesic, expectorant, antibacterial, larvicidal and antifungal properties [2]. The medium to large-sized *Terminalia chebula* tree is found all throughout Asia and is a member of the Combretaceae family. Ink tree, dark myrobalan and chebulic myrobalan are a few of its common names. In India, it is referred to as Kadukai in Tamil, Karkchettu in Telugu and Harada in Marathi. It is known as the King of Medicine in Tibetan medicine [8]. Myrobalan is a deciduous tree that can grow to a height of 25 to 30 m and has spreading branches. The trunk is frequently cylindrical and not very long. The leaf is 12 to 15 cm long and 5 to 6 m wide, spirally arranged on the stem and deciduous throughout the cold season. Young leaves, branches and leaf buds have silky, lustrous reddish brown hairs covering them. Short-stemmed, monoecious, dark white to yellow blooms are in simple terminal spikes and have a strong, disagreeable odour. Fruit is an ellipsoid-shaped drupe that is green when unripe and brown when dry [9]. It is a plant with antibacterial, antifungal, anticarcinogenic, antioxidant, antidiabetic, anti-inflammatory and anti-aging properties [10].

Phytochemicals are bioactive substances derived from plants. They are regarded as secondary metabolites because the plants that produce them may not have a great need for them. All of the plant's body parts, including the bark, leaves, stem, root, flowers, fruits and seeds are naturally generated sources of these active ingredients [11]. Phytochemicals can vary from one plant part to another in terms of quality and quantity. Actually, there is a dearth of knowledge regarding the distribution of active substances, which are found in some plant parts [12]. Phytochemicals have long been acknowledged as the foundation of traditional herbal medicine, which is still practised in some parts of the world [13]. Researchers occasionally investigate leads supplied by regional healers in the hunt for phytochemicals that might be useful to the pharmaceutical business. Following such leads, plant parts are typically examined for any potential phytochemicals. A phytochemical of interest may be further isolated, purified and characterised if it is present. It serves as the foundation for a brand-new pharmaceutical product. The kind of solvent employed during the extraction process has a significant impact on the outcome of the determination



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of biologically active chemicals from plant material¹. The present study deals with the preliminary phytochemical screening of the *Myristica fragrans*, *Quercus infectoria* and *Terminalia chebula* to estimate the secondary metabolites present in the samples. The assessment of carbohydrate, protein, phenol and flavonoid content in the samples to quantify the best samples.

MATERIALS AND METHODS**Plant material and Extraction**

The three dried samples, which included *M. fragrans* seed, *Q. infectoria* gall and *T. chebula* fruit, were bought at a local market in Coimbatore's Town hall region. The samples were crushed, weighed and then extracted using a soxhlet with methanol and ethyl acetate solvents. The hot water method was used to make the aqueous extraction.

Phytochemical analysis

Preliminary phytochemical analysis was done for the detection of the presence of different Phyto-constituents in the plant extracts. The test for carbohydrates, proteins, alkaloids, flavonoids, glycosides, steroids, terpenoids, tannins, phenols, saponins and gums was carried out based on the standard methods [14,15]

Test for Carbohydrates: Add Molisch reagent to 2 to 3 ml of the extract and thoroughly shake the mixture. Conc. H₂SO₄ should be added to the test tube's sidewalls. The presence of carbohydrates are indicated by a violet ring.

Test for Proteins: Ninhydrin reagent (0.25% w/v) was added to the extract and heated for a few minutes. Purple colour formation indicates the presence of proteins.

Test for Alkaloids: The extracts were filtered after being treated with a few drops of Conc.HCl. The solution was poured in a few drops into the middle of a watch glass. Mayer's reagent is applied in drops to the sides of the watch glass using a glass rod and the gelatinous white precipitate is observed.

Test for Flavonoids: The extract is heated with 10ml of ethyl acetate in boiling water for 3 minutes. The mixture was filtered and the filtrate was shaken with 1ml of dilute ammonia solution (1%). The layers were allowed to separate. A yellow colouration at the ammonia layer indicates the presence of flavonoids.

Test for Glycosides: To the extract 2ml of glacial acetic acid along with 5% FeCl₃ and Conc. H₂SO₄ were added. Reddish Brown colouration at the junction of two liquid layers and bluish green in the upper layer indicates the presence of glycosides.

Test for Steroids: 2ml Acetic anhydride was added to 2ml of extract along with Sulphuric acid. The presence of steroids is confirmed by the colour changing from violet to blue or green.

Test for Terpenoids: The extract was combined with 2 ml of chloroform and then 3 ml of Conc. H₂SO₄ was carefully added to form a layer. The interface develops a reddish brown colouring to demonstrate the presence of terpenoids.

Test for Tannins: To the extract 1ml of 5% ferric chloride solution was added, formation of bluish black or greenish black precipitate indicates the presence of tannins.

Test for Phenols: 1ml of distilled water was heated with 100 mg of the extract and then it is filtered. In a test tube, 2ml of the filtrate was mixed with 2ml of a 1% ferric chloride solution. The presence of phenols is indicated by the colour of bluish green.



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Test for Saponin: A little amount of extract was diluted with 4ml of distilled water. After rapidly shaking the mixture for about 30 seconds, a layer of persistent foam formed, signifying the presence of saponin.

Test for Gums: The extract was treated with 25 ml of absolute alcohol and filtered. The filtrate will examine for its swelling properties.

Total Carbohydrate content: The total carbohydrate content was estimated by Anthrone reagent method.

Total Protein content: The total protein present in the samples was estimated by the Lowry method.

Total phenolic content: Phenolic contents of various samples were determined according to the Folin–Ciocalteu colorimetric method. Gallic acid was used for calibration of standard curve. The results were expressed as mg gallic acid equivalents (GAE)/100 g [16].

Total Flavonoid Content: The total flavonoid content was determined using the colorimetric method. To 0.5 ml of sample, 0.5 ml of 2% AlCl_3 ethanol solution was added. After 1 hr at room temperature, the absorbance was measured at 420 nm. Total flavonoid contents were expressed as mg of quercetin equivalents (QE)/100 g [17].

RESULT AND DISCUSSION

Preliminary phytochemical analysis

The preliminary phytochemical screening obtained from various extracts of *Myristica fragrans*, *Quercus infectoria* and *Terminalia chebula* are represented in Table I. In this study, ethyl acetate extracts of all samples shows more phytochemicals. The *M. fragrans* shows the presence of alkaloids, flavonoids, tannins, terpenoids, phenols, carbohydrates and protein. Abhilasha *et al.*, 2016 observed similar results in the methanolic extract of *M. fragrans* which exhibits the presence of alkaloids, saponins, flavonoids, tannins, terpenoids, carbohydrates and phenolics. In *Q. infectoria* the presence of alkaloids, flavonoids, tannins, glycosides, phenols, carbohydrates and protein were detected. The phytochemical screening of Magbool *et al.*, 2018 indicates the presence of tannins, flavonoids, saponins, triterpenes, anthraquinones and coumarins in the ethanolic extract. The presence of alkaloids, flavonoids, steroids, saponins, terpenoids, phenols, carbohydrates and protein were observed in *T. chebula*. A study by Baliahand Astalakshmi, 2014 revealed the presence of alkaloids, flavonoids, saponins and carboxylic acid in the various extracts of *T. chebula*. It has been claimed that tannins have antiviral, antibacterial and anti-tumor properties [20]. Particularly saponins found in plants, which have a cardiotonic nature, have an expectorant action that is highly helpful in the management of upper respiratory tract irritation [6].

Table II represents the total carbohydrate, protein, phenol and flavonoid content in the three samples. The results obtained show that higher amount of carbohydrate is observed in *M. fragrans* with 384.08 ± 4.6 mg/100g and the lower amount in *T. chebula* with 52.12 ± 4.2 mg/100g respectively. *Q. infectoria* has the higher protein (169.91 ± 3.45 mg/100g) and phenolic content (287.34 ± 4.211 mg GAE/g). The flavonoid content about 43.34 ± 1.5 mg QE/g is observed in *T. chebula*. Plant phenols are a class of naturally occurring substances with a wide range of structural characteristics that are widely known for their health benefits [21]. There is evidence that flavonoids have anti-inflammatory, anti-allergenic, antiviral, anti-aging and anti-carcinogenic properties. Their antioxidant qualities can be used to explain a major portion of the therapeutic effects [2].

CONCLUSION

According to the present study, *Myristica fragrans*, *Quercus infectoria* and *Terminalia chebula* may contain a sizable amount of phytochemicals that are responsible for a variety of medicinal effects. The samples carbohydrate, protein,





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phenol and flavonoid content provide proof that the extracts can be used to further isolate certain components. These substances might have valuable medical properties that might be investigated further.

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Table I: Preliminary Phytochemical Analysis of various extracts of *Myristica fragrans* (Mf), *Quercus infectoria* (Qi) and *Terminalia chebula* (Tc).

Phytochemicals	Methanolic extract			Ethyl Acetate Extract			Aqueous Extract		
	Mf	Qi	Tc	Mf	Qi	Tc	Mf	Qi	Tc
Alkaloids	-	-	-	+++	+++	+	++	-	++
Flavonoids	++	-	-	++	++	++	-	+	+
Tannins	++	-	+++	+	++	-	-	+	+
Glycosides	-	+++	-	-	++	-	++	+	-
Steroids	-	-	+++	-	-	+++	-	-	+++
Saponin	-	-	-	-	-	+	-	-	-
Terpenoids	-	++	-	+++	-	++	+	+	-
Gums	-	-	+	-	-	-	+	-	-
Phenols	-	-	+++	++	+++	-	-	+++	+
Carbohydrates	+++	++	-	++	+	+++	-	+++	-
Proteins	+	++	+	++	-	+	-	+	+

Total Carbohydrate, Protein, Phenol and Flavonoid content:

Table II: Total Carbohydrate, Protein, Phenol and Flavonoid content in the samples.

S.No	Total Content	<i>M.fragrans</i>	<i>Q. infectoria</i>	<i>T.chebula</i>
1.	Carbohydrate(mg/100g)	384.08±4.6	90.364±5.61	52.12±4.2
2.	Protein (mg/100g)	8.30±1.02	169.91±3.45	82.73±1.3
3.	Phenol(mg GAE/g)	243.90±2.16	287.34±4.211	172.61±8.67
4.	Flavonoid(mg QE/g)	38.5±0.5	24.62±0.7	43.34±1.5





More on R- Union and R- Intersection of Neutrosophic Spherical Cubic Sets

Shalini Tharanya.J* and Trinita Pricilla.M

Department of Mathematics, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

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*Address for Correspondence

Shalini Tharanya.J

Department of Mathematics,
Nirmala College for Women,
Coimbatore, Tamil Nadu, India.
E.Mail: akgupta.in@gmail.com



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ABSTRACT

R-unions and R-intersections of T-external (I - external, F - external) Neutrosophic spherical cubic sets are considered. Examples to show that the R-intersection and R-union of T-external (I - external, F-external) neutrosophic spherical cubic sets may not be a T-external (I-external, F - external) neutrosophic cubic set are provided. Conditions for the R-union and R-intersection of T- external (I - external, F-external) neutrosophic spherical cubic sets to be a T-external (I-external, F-external) Neutrosophic spherical cubic set are discussed.

Keywords: Truth-internal (indeterminacy-internal, falsity-internal) neutrosophic cubic set, truth-external (indeterminacy-external, falsityexternal) neutrosophic cubic set, R-union, R-intersection.

INTRODUCTION

In 1965, Zadeh [15] introduced the concept of Fuzzy set where we consider the degree of belongingness to a set as a membership function. Following him in 1986, Atanassov [1] introduced the degree of non membership and defined intuitionistic fuzzy set. Further researches were done in these fields but these two sets were not enough to meet all the uncertainties in real physical problems. Hence in 1995 Smarandache [8, 9, 10] coined neutrosophic logic and neutrosophic sets to deal with truth, indeterminate and falsehood. Neutrosophy provides a foundation for a whole family of new mathematical theories with the generalization of both classical and fuzzy counterparts. In a neutrosophic set, an element has three associated defining functions such as truth membership function T , indeterminate membership function I and false membership function F defined on a universe of discourse X . These three functions are independent completely. Neutrosophic set is basically studies the origin, nature and scope





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of neutralities and their interactions with ideational spectra. Neutrosophic set generalizes the concept of classical fuzzy set, and so on. The neutrosophic set has vast applications in various fields.

Y. B. Jun et al.[4, 5, 3] coined cubic set by using a fuzzy set and an interval-valued fuzzy set, and also extended the concept of cubic sets to the neutrosophic cubic sets. On the other Kutlu Gundogdu, Fatmaa, Kahraman, Cengiz introduced spherical fuzzy sets and spherical fuzzy TOPSIS method. They introduced generalized three dimensional spherical fuzzy sets (SFS) including some essential differences from the other fuzzy sets. Shalini et. al [7] Introduced Neutrosophic spherical cubic set and the notion of truth-internal (indeterminacy-internal, falsity-internal) neutrosophic spherical cubic sets and truth-external (indeterminacy-internal, falsity-internal)neutrosophic spherical cubic sets.

As a continuation of the paper [7], we consider R- unions and R -intersections of T-external (I-external, F-external) neutrosophic cubic sets. We provide examples to show that the R-intersection and the R-union of T- external (resp. I-external and F-external) neutrosophic cubic sets may not be a T-external (resp. I-external and F-external) neutrosophic cubic set. We discuss conditions for the R union of T-external (resp. I-external and F-external) neutrosophic cubic sets to be a T-external (resp. I-external and F- external) neutrosophic cubic set. We consider a condition for the R-intersection of T-external (resp. I-external and F -external) neutrosophic cubic sets to be a T-external (resp. I-external and F-external) neutrosophic cubic set.

Preliminaries

Definition 2.1. [15] A fuzzy set in a set is defined to be a function $\lambda : X \rightarrow [0, 1]$. Denote by $[0, 1]^X$ the collection of all fuzzy sets in a set X . Define a relation \leq on $[0, 1]^X$ as follows $(\forall \lambda, \mu \in [0, 1]^X) , \lambda \leq \mu \Leftrightarrow (\forall x \in X)(\lambda(x) \leq \mu(x))$

Definition 2.2. [10] Let X be a non-empty set. A neutrosophic set (NS) in X is a structure of the form: $\lambda = (x; \lambda_T(x), \lambda_I(x), \lambda_F(x)) | x \in X$ where $\lambda_T : X \rightarrow [0, 1]$ is a truth membership function, $\lambda_I : X \rightarrow [0,1]$ is an indeterminate membership function, and $\lambda_F X \rightarrow [0, 1]$ is a false membership function.

Definition 2.3. [2]Let X be a non-empty set. A is an interval valued neutrosophic set (IVNS) in $X \rightarrow [0, 1]$ is a structure of the form:
 $A = (x; A_T(x), A_I(x), A_F(x)) | x \in X$ where A_T, A_I and A_F are interval-valued fuzzy sets in X, which are called an interval truth membership function, an interval indeterminacy membership function and an interval falsity membership function, respectively.

Definition 2.4. [4] Let be a non-empty set. A cubic set in is a structure of the form $\varsigma = x, A(x), \lambda(x) / x \in X$
 where is an interval valued fuzzy set in X and λ is a fuzzy set in X .

Definition 2.5. [3] Let X be a non-empty set. A neutrosophic cubic set (NCS) in X is a pair $\Lambda = (A, \lambda)$ where
 $A = (x; A_T(x), A_I(x), A_F(x)) | x \in X$ is an interval neutrosophic set in X and
 $\lambda = (x; \lambda_T(x), \lambda_I(x), \lambda_F(x)) | x \in X$ is a neutrosophic set in X .

Definition 2.6. [6] A Spherical Fuzzy Set Λ_S of the universe U is given by
 $\Lambda_S = \{ \langle u, \mu_{\Lambda_S}(u), \gamma_{\Lambda_S}(u), \pi_{\Lambda_S}(u) \rangle / u \in U \}$
 where $\mu_{\Lambda_S}, \gamma_{\Lambda_S}, \pi_{\Lambda_S}, U \rightarrow [0, 1]$ and
 $0 \leq \mu_{\Lambda_S}^2(u) + \gamma_{\Lambda_S}^2(u) + \pi_{\Lambda_S}^2(u) \leq 1 \forall u \in U .$





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Definition 2.7. Let X be a non-empty set. A Neutrosophic Spherical set in X is of the form

$$A_s = \langle x : T_{A_s}(x), I_{A_s}(x), F_{A_s}(x) \rangle / x \in X$$

where $T_{A_s}(x)$ is truth degree membership
 $I_{A_s}(x)$ is indeterminate degree membership
 $F_{A_s}(x)$ is false degree membership.
 where $T_{A_s}(x), I_{A_s}(x), F_{A_s}(x) / x \in X \rightarrow [0, 1]$
 $0 \leq [T_{A_s}(x)]^2 + [I_{A_s}(x)]^2 + [F_{A_s}(x)]^2 \leq \sqrt{3}$

Definition 2.8. [7] Let X be a non-empty set. A Neutrosophic spherical cubic set (NSCS) in x is a structure of the form $C_s = \{(x, A_s(x), \lambda_s(x)) / x \in X\}$ where $A_s(x)$ is an interval valued Neutrosophic spherical set and $\lambda_s(x)$ is a Neutrosophic spherical set.

Definition 2.9. Let X be a non-empty set. A interval-valued Neutrosophic Spherical set in X is of the form

$$\Lambda_s = x : [T_{\Lambda_s}^-(x), [T_{\Lambda_s}^+(x)]] [I_{\Lambda_s}^-(x), [I_{\Lambda_s}^+(x)]] [F_{\Lambda_s}^-(x), [F_{\Lambda_s}^+(x)]] / x \in X$$

where $T_{\Lambda_s}^-(x), I_{\Lambda_s}^-(x), F_{\Lambda_s}^-(x) / x \in X \rightarrow [0, 1]$
 $0 \leq [T_{\Lambda_s}^-(x)]^2 + [I_{\Lambda_s}^-(x)]^2 + [F_{\Lambda_s}^-(x)]^2 \leq \sqrt{3}$
 and $T_{\Lambda_s}^+(x), I_{\Lambda_s}^+(x), F_{\Lambda_s}^+(x) / x \in X \rightarrow [0, 1]$
 $0 \leq [T_{\Lambda_s}^+(x)]^2 + [I_{\Lambda_s}^+(x)]^2 + [F_{\Lambda_s}^+(x)]^2 \leq \sqrt{3}$

For further particulars on the notions of T (resp., I, F)-internal NSCSs, T (resp., I, F)-external NSCSs, R-union and R-intersection of NSCS. The read is referred to in the paper.

R-Union and R-Intersection of Neutrosophic spherical cubic sets

We know that R-union and R-intersection of T (resp., I and F)-external NSCSs (ENSCSs) may not be a T (resp., I and F)-internal NSCSs (INSCSs) as seen in the following example.

Example 3.1. Let $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ be NSCSs in X on $[0, 1]$ where

$$A_s = \{ \langle x; [0.4, 0.6], [0.3, 1.0], [0.3, 0.4] \rangle / x \in [0, 1] \}$$

$$\lambda_s = \{ \langle x; 0.5, 0.2, 0.5 \rangle / x \in [0, 1] \}$$

$$B_s = \{ \langle x; [0.2, 0.4], [0.3, 1.0], [0.5, 0.6] \rangle / x \in [0, 1] \}$$

$$\psi_s = \{ \langle x; 0.5, 0.2, 0.5 \rangle / x \in [0, 1] \}.$$

Then $\mathcal{A}_s = [A_s, \lambda_s]$ and $\mathcal{B}_s = [B_s, \psi_s]$ are I-ENSCSs in $X = [0, 1]$. The R-union $\mathcal{A}_s \cup_R \mathcal{B}_s = (A_s \cup B_s, \lambda_s \wedge \psi_s)$ of $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ is given as follows:

$$A_s \cup B_s = \{ \langle x; [0.4, 0.6], [0.3, 1.0], [0.5, 0.6] \rangle / x \in [0, 1] \}$$

$$\lambda_s \wedge \psi_s = \{ \langle x; 0.5, 0.2, 0.5 \rangle / x \in [0, 1] \}$$

and its not an I-ENSCSs in $X = [0, 1]$.

We provide a condition for the R-union of two T (resp., I and F)-ENSCSs to be T (resp., I and F)-internal.





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Theorem 3.2. Let $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ be I-ENSCSs in X such that

$$\begin{aligned} & \max [\min \{I_{A_s}^+(x), I_{B_s}^-(x)\}, \\ & \quad \min \{I_{A_s}^-(x), I_{B_s}^+(x)\}] \leq (I_{\lambda_s} \wedge I_{\psi_s})(x) \\ & \quad < \min [\max \{I_{A_s}^+(x), I_{B_s}^-(x)\}, \\ & \quad \quad \quad \max \{I_{A_s}^-(x), I_{B_s}^+(x)\}] \end{aligned}$$

for all $x \in X$. Then the R-union $\mathcal{A}_s \cup_R \mathcal{B}_s = (A_s \cup B_s, \lambda_s \wedge \psi_s)$ is an I-ENSCS in X .

Proof. For any $x \in X$, let

$$\begin{aligned} a_x &= \max [\min \{I_{A_s}^+(x), I_{B_s}^-(x)\}, \min \{I_{A_s}^-(x), I_{B_s}^+(x)\}] \\ \text{and } b_x &= \min [\max \{I_{A_s}^+(x), I_{B_s}^-(x)\}, \max \{I_{A_s}^-(x), I_{B_s}^+(x)\}]. \end{aligned} \tag{1}$$

Then $b_x = I_{A_s}^-(x)$, $b_x = I_{B_s}^-(x)$, $b_x = I_{A_s}^+(x)$ or $b_x = I_{B_s}^+(x)$.

The following cases $b_x = I_{B_s}^-(x)$ and $b_x = I_{B_s}^+(x)$ are possible only because the other cases are similar to these.

If $b_x = I_{B_s}^-(x)$ then $I_{A_s}^+(x) \leq I_{B_s}^-(x)$ and so

$$I_{A_s}^-(x) \leq I_{A_s}^+(x) \leq I_{B_s}^-(x) \leq I_{B_s}^+(x).$$

Thus $a_x = I_{A_s}^+(x)$ and so

$$(I_{A_s} \cup I_{B_s})^-(x) = I_{B_s}^-(x) = b_x > (I_{\lambda_s} \wedge I_{\psi_s})(x).$$

Hence, $(I_{\lambda_s} \wedge I_{\psi_s})(x) \notin ((I_{A_s} \cup I_{B_s})^-(x), (I_{A_s} \cup I_{B_s})^+(x))$.

If $b_x = I_{B_s}^+(x)$ then $I_{A_s}^-(x) \leq I_{B_s}^+(x) \leq I_{A_s}^+(x)$ and thus $a_x = \max \{I_{A_s}^-(x), I_{B_s}^-(x)\}$.

Suppose that $a_x = I_{A_s}^-(x)$ then

$$I_{B_s}^-(x) \leq I_{A_s}^-(x) = a_x \leq (I_{\lambda_s} \wedge I_{\psi_s})(x) < b_x = I_{B_s}^+(x) \leq I_{A_s}^+(x). \tag{2}$$

It follows that

$$I_{B_s}^-(x) \leq I_{A_s}^-(x) < (I_{\lambda_s} \wedge I_{\psi_s})(x) < I_{B_s}^+(x) \leq I_{A_s}^+(x). \tag{3}$$

(or)

$$I_{B_s}^-(x) \leq I_{A_s}^-(x) = (I_{\lambda_s} \wedge I_{\psi_s})(x) < I_{B_s}^+(x) \leq I_{A_s}^+(x). \tag{4}$$

The case (3) induces a contradiction. (4) implies

$$(I_{\lambda_s} \wedge I_{\psi_s}) \notin ((I_{A_s} \cup I_{B_s})^-(x), (I_{A_s} \cup I_{B_s})^+(x))$$

since $(I_{\lambda_s} \wedge I_{\psi_s})(x) = I_{A_s}^-(x) = (I_{A_s} \cup I_{B_s})^-(x)$.

Now, if $a_x = I_{B_s}^-(x)$ then

$$I_{A_s}^-(x) \leq I_{B_s}^-(x) = a_x \leq (I_{\lambda_s} \wedge I_{\psi_s})(x) < b_x = I_{B_s}^+(x) \leq I_{A_s}^+(x). \tag{5}$$

Hence, we have

$$I_{A_s}^-(x) \leq I_{B_s}^-(x) < (I_{\lambda_s} \wedge I_{\psi_s})(x) < I_{B_s}^+(x) \leq I_{A_s}^+(x). \tag{6}$$





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(or)

$$I_{A_s}^-(x) \leq I_{B_s}^-(x) < (I_{\lambda_s} \wedge I_{\psi_s})(x) < I_{B_s}^+(x) \leq I_{A_s}^+(x). \tag{7}$$

The case (6) induces a contradiction. (7) implies

$$(I_{\lambda_s} \wedge I_{\psi_s}) \notin ((I_{A_s} \cup I_{B_s})^-(x), (I_{A_s} \cup I_{B_s})^+(x)). \tag{8}$$

Therefore the R-union $\mathcal{A}_s \cup_R \mathcal{B}_s = (A_s \cup B_s, \lambda_s \wedge \psi_s)$ is an I-ENSCS in X . □

Similarly, we have the following theorems.

Theorem 3.3. Let $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ be T-ENSCSs in X such that

$$\begin{aligned} \max [\min\{T_{A_s}^+(x), T_{B_s}^+(x)\}, \\ \min \{T_{A_s}^-(x), T_{B_s}^-(x)\}] \leq (T_{\lambda_s} \wedge T_{\psi_s})(x) \\ < \min [\max\{T_{A_s}^+(x), T_{B_s}^-(x)\}, \\ \max \{T_{A_s}^-(x), T_{B_s}^+(x)\}] \end{aligned}$$

for all $x \in X$. Then the R-union $\mathcal{A}_s \cup_R \mathcal{B}_s = (A_s \cup B_s, \lambda_s \wedge \psi_s)$ is an T-ENSCS in X .

Theorem 3.4. Let $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ be F-ENSCSs in X such that

$$\begin{aligned} \max [\min\{F_{A_s}^+(x), F_{B_s}^-(x)\}, \\ \min \{F_{A_s}^-(x), F_{B_s}^+(x)\}] \leq (F_{\lambda_s} \wedge F_{\psi_s})(x) \\ < \min [\max\{F_{A_s}^+(x), F_{B_s}^-(x)\}, \\ \max \{F_{A_s}^-(x), F_{B_s}^+(x)\}] \end{aligned}$$

for all $x \in X$. Then the R-union $\mathcal{A}_s \cup_R \mathcal{B}_s = (A_s \cup B_s, \lambda_s \wedge \psi_s)$ is an F-ENSCS in X .

Corollary 3.5. Let $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ be ENSCS. Then the R-union of $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ is an ENSCS in X when the condition in Theorems 3.2, 3.3 and 3.4 are valid.

The following example shows that the R-intersection of two T-external (resp., I and F) NSCSs may not be an T-external (resp., I and F) NSCS.

Example 3.6. Let $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ be neutrosophic spherical cubic soft sets in $X = [0, 1]$, where

$$\begin{aligned} A_s &= \{ \langle x; [0.2, 0.3], [0.4, 1.0], [0.4, 0.5] \rangle / x \in [0, 1] \} \\ \lambda_s &= \{ \langle x; 0.35, 0.25, 0.55 \rangle / x \in [0, 1] \} \\ B_s &= \{ \langle x; [0.4, 0.6], [0.4, 1.0], [0.2, 0.3] \rangle / x \in [0, 1] \} \\ \psi_s &= \{ \langle x; 0.25, 0.35, 0.45 \rangle / x \in [0, 1] \}. \end{aligned}$$

Then $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ are T-ENSCSs in $X = [0, 1]$. The R-intersection $\mathcal{A}_s \cap_R \mathcal{B}_s = (A_s \cap B_s, \lambda_s \vee \psi_s)$ of $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ is given as follows:





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$$A_s \cap B_s = \{ \langle x; [0.2, 0.3], [0.4, 1.0], [0.2, 0.3] \rangle / x \in [0, 1] \}$$

$$\lambda_s \vee \psi_s = \{ \langle x; 0.35, 0.35, 0.55 \rangle / x \in [0, 1] \}$$

and it is not a T-ENSCSs in $X = [0, 1]$.

We provide a condition for the R-intersection of two T-external (resp., I and F) NSCSs to be T-external (resp., I and F) NSCS.

Theorem 3.7. Let $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ be T-ENSCSs in X , such that

$$\begin{aligned} \max [\min \{ T_{A_s}^+(x), T_{B_s}^-(x) \}, \\ \min \{ T_{A_s}^-(x), T_{B_s}^+(x) \}] &< (T_{\lambda_s} \vee T_{\psi_s})(x) \\ &\leq \min [\max \{ T_{A_s}^+(x), T_{B_s}^-(x) \}, \\ &\qquad \qquad \qquad \max \{ T_{A_s}^-(x), T_{B_s}^+(x) \}] \end{aligned}$$

for all $x \in X$. Then the R-intersection $\mathcal{A}_s \cap_R \mathcal{B}_s = (A_s \cap B_s, \lambda_s \vee \psi_s)$ is a T-ENSCS in X .

Proof. For any $x \in X$, let $c_x := \max [\min \{ T_{A_s}^+(x), T_{B_s}^-(x) \}, \min \{ T_{A_s}^-(x), T_{B_s}^+(x) \}]$ and $d_x := \min [\max \{ T_{A_s}^+(x), T_{B_s}^-(x) \}, \max \{ T_{A_s}^-(x), T_{B_s}^+(x) \}]$.

Then $d_x = T_{A_s}^-(x)$, $d_x = T_{B_s}^-(x)$, $d_x = T_{A_s}^+(x)$ or $d_x = T_{B_s}^+(x)$.

The following cases $d_x = T_{A_s}^-(x)$ and $d_x = T_{A_s}^+(x)$ are possible only because the other cases are similar to these. If $d_x = T_{A_s}^-(x)$, then $T_{B_s}^-(x) \leq T_{B_s}^+(x) \leq T_{A_s}^+(x) \leq T_{A_s}^-(x)$. Thus, $c_x = T_{B_s}^+(x)$ and so

$$T_{B_s}^-(x) = (T_{A_s} \cap T_{B_s})^-(x) \leq (T_{A_s} \cap T_{B_s})^+(x) = T_{B_s}^+(x) = c_x < (T_{\lambda_s} \vee T_{\psi_s})(x).$$

Hence

$$(T_{\lambda_s} \vee T_{\psi_s})(x) \notin ((T_{A_s} \cap T_{B_s})^-(x), (T_{A_s} \cap T_{B_s})^+(x)).$$

If $d_x = T_{A_s}^+(x)$, then $T_{B_s}^-(x) \leq T_{A_s}^+(x) \leq T_{B_s}^+(x)$ and thus $c_x = \max \{ T_{A_s}^-(x), T_{B_s}^-(x) \}$.

Suppose that, $c_x = T_{A_s}^-(x)$. Then

$$T_{B_s}^-(x) \leq T_{A_s}^-(x) = c_x < (T_{\lambda_s} \vee T_{\psi_s})(x) \leq d_x = T_{A_s}^+(x) \leq T_{B_s}^+(x). \quad (9)$$

It follows that

$$T_{B_s}^-(x) \leq T_{A_s}^-(x) \leq (T_{\lambda_s} \vee T_{\psi_s})(x) < T_{A_s}^+(x) \leq T_{B_s}^+(x) \quad (10)$$





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(or)

$$T_{B_s}^-(x) \leq T_{A_s}^-(x) < (T_{\lambda_s} \vee T_{\psi_s})(x) = T_{A_s}^+(x) \leq T_{B_s}^+(x). \quad (11)$$

The case (10) induces a contradiction. (11) implies that

$$(T_{\lambda_s} \vee T_{\psi_s})(x) \notin ((T_{A_s} \cap T_{B_s})^-(x), (T_{A_s} \cap T_{B_s})^+(x))$$

since $(T_{\lambda_s} \vee T_{\psi_s})(x) = T_{A_s}^+(x) = (T_{A_s} \cap T_{B_s})^+(x)$.

Now if $c_x = T_{B_s}^-(x)$, then

$$T_{A_s}^-(x) \leq T_{B_s}^-(x) = c_x < (T_{\lambda_s} \vee T_{\psi_s})(x) \leq d_x = T_{A_s}^+(x) \leq T_{B_s}^+(x). \quad (12)$$

Hence, we have

$$T_{A_s}^-(x) \leq T_{B_s}^-(x) < (T_{\lambda_s} \vee T_{\psi_s})(x) \leq T_{A_s}^+(x) \leq T_{B_s}^+(x) \quad (13)$$

(or)

$$T_{A_s}^-(x) \leq T_{B_s}^-(x) < (T_{\lambda_s} \vee T_{\psi_s})(x) = T_{A_s}^+(x) \leq T_{B_s}^+(x) \quad (14)$$

The case (13) induces a contradiction. The case (14) induces

$$(T_{\lambda_s} \vee T_{\psi_s})(x) \notin ((T_{A_s} \cap T_{B_s})^-(x), (T_{A_s} \cap T_{B_s})^+(x)).$$

Therefore, the R-intersection $\mathcal{A}_s \cap_R \mathcal{B}_s = (A_s \cap B_s, \lambda_s \vee \psi_s)$ is a T-ENSCS in X . □

Similarly we have the following theorem.

Theorem 3.8. Let $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ be I-ENSCSs in X such that

$$\begin{aligned} & \max [\min\{I_{A_s}^+(x), I_{B_s}^-(x)\}, \min\{I_{A_s}^-(x), I_{B_s}^+(x)\}] \\ & < (I_{\lambda_s} \vee I_{\psi_s})(x) \leq \min [\max\{I_{A_s}^+(x), I_{B_s}^-(x)\}, \max\{I_{A_s}^-(x), I_{B_s}^+(x)\}] \end{aligned} \quad (15)$$

for all $x \in X$. Then the R-intersection $\mathcal{A}_s \cap_R \mathcal{B}_s = (A_s \cap B_s, \lambda_s \vee \psi_s)$ is an I-ENSCS in X .

Theorem 3.9. Let $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ be F-ENSCSs in X such that

$$\begin{aligned} & \max [\min\{F_{A_s}^+(x), F_{B_s}^-(x)\}, \min\{F_{A_s}^-(x), F_{B_s}^+(x)\}] \\ & < (F_{\lambda_s} \vee F_{\psi_s})(x) \leq \min [\max\{F_{A_s}^+(x), F_{B_s}^-(x)\}, \max\{F_{A_s}^-(x), F_{B_s}^+(x)\}] \end{aligned} \quad (16)$$

for all $x \in X$. Then the R-intersection $\mathcal{A}_s \cap_R \mathcal{B}_s = (A_s \cap B_s, \lambda_s \vee \psi_s)$ is a F-ENSCS in X .





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Corollary 3.10. Let $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ be ENSCSs in X . Then the R -intersection of $\mathcal{A}_s = (A_s, \lambda_s)$ and $\mathcal{B}_s = (B_s, \psi_s)$ is an ENSCS in X when the condition in Theorems 3.7, 3.8 and 3.9 are valid.

CONCLUSION

In this paper we have introduced the notion of R -union and R -intersection of Neutrosophic spherical cubic sets. For the future prospects, we will extend this work by using topological structures and commit to exploring the real life applications.

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Pythagorean Neutrosophic Semi Open and Semi Closed Hypersoft Sets

G. Ramya^{1*} and A. Francina Shalini²

¹Research Scholar, Nirmala College for Women, Coimbatore, Tamil Nadu, India.

²Assistant Professor, Nirmala College for Women, Coimbatore, Tamil Nadu, India

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*Address for Correspondence

G.Ramya

Research Scholar,

Nirmala College for Women,

Coimbatore, Tamil Nadu, India.

E.Mail: ramyasrisai11@gmail.com



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ABSTRACT

The aim of this paper is to introduce Pythagorean Neutrosophic Semi Open and Semi Closed Hypersoft sets. Also, some of their characterizations are discussed along with few basic properties. Finally, we discuss Pythagorean Neutrosophic semi-interior Hypersoft and Pythagorean Neutrosophic semi-closure Hypersoft set.

Keywords: Pythagorean Neutrosophic Semi Open Hypersoft set, Pythagorean Neutrosophic Semi Closed Hypersoft, Pythagorean Neutrosophic Semi-Interior Hypersoft, Pythagorean Neutrosophic Semi-Closure Hypersoft closure.

INTRODUCTION

Many theories are discussed by Researchers for dealing with uncertain or vague data. In 1965, Zadeh introduced fuzzy set (FS) theory [9] where an element is assigned by the degree of membership. In 1983, Intuitionistic Fuzzy set theory [8] was introduced by Atanassov as a generalization of FS, where an element is assigned by the degree of membership and non-membership. In 1998, Neutrosophic set theory [11] was developed by Smarandache, where an element is assigned by truth, Indeterminate, Falsity values. However, all of these theories have their own risk and are pointed out in [13]. In 1999, Molodtsov [2] introduced soft set(SS)theory dealing with uncertainty. Later Maji et al [16] defined various basic concepts of soft theory.

Decision- making(D-M) is a most difficult problem due to Indeterminate situation particularly when attributes are more than one. To solve such types of problems, the concept of Neutrosophic Hypersoft set (NHSS) was generalized by Smarandache [10], by transforming the function with a multi-argument function in the form of cartesian product with a distinct set of parameters. In D-M problems, the idea of HS is more applicable and is more suitable structure





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than the SS. The concept of fuzzy HSS was applied to fuzzy topological spaces, and fuzzy Hypersoft topological spaces were presented by Ajay and Charisma in [3]. Later, fuzzy Hypersoft topology has been extended to Intuitionistic and Neutrosophic Hypersoft topological spaces. Also, the idea of semi-open sets in fuzzy Hypersoft topological spaces with their characterization and are extended to semi open sets in Intuitionistic and Neutrosophic Hypersoft topological spaces. This paper is organized as follows. Section 2 recalls few Definitions of Pythagorean Neutrosophic Hypersoft Set topological spaces (PNHSTS). In section 3, we define Pythagorean Neutrosophic semi open Hypersoft Set (PNSOHS) and Pythagorean Neutrosophic semi closed Hypersoft Set (PNSCHS) in PNHSTS along with some of their properties.

Preliminaries

Definition (DF) 2.1. (PNHSS)

Let \check{U} be the Universe (UE) and $\check{P}(\check{U})$ be the Power Set of \check{U} . Consider $\check{C}_1, \check{C}_2, \dots, \check{C}_f$ be the pairwise disjoint set of parameters (S.O.P). Let \check{C}_i be the non-empty subset of \check{C}_i for each $i=1, 2, \dots, f$. A PNHSS over \check{U} defined as the pair $(\check{S}, \check{C}_1 \times \check{C}_2 \times \dots \times \check{C}_f); \check{S}: \check{C}_1 \times \check{C}_2 \times \dots \times \check{C}_f \rightarrow \check{P}(\check{U})$ and $\check{S}(\check{C}_1 \times \check{C}_2 \times \dots \times \check{C}_f) = \left\{ \left(\check{\eta}, < \check{\tau}, \check{\omega}_{\check{\eta}}(\check{x}), \check{j}_{\check{\omega}(\check{\eta})}(\check{x}), \check{F}_{\check{\omega}(\check{\eta})}(\check{x}) > : \check{x} \in \check{U}, \check{\eta} \in \check{C}_1, \check{\tau} \in \check{C}_2, \check{\omega} \in \check{C}_f \right) \right\}$, where $\check{\tau}, \check{j}, \check{F}$ are the belonging values of Truthiness, Indeterminacy and Falsity respectively such that $\check{\tau}_{\check{\omega}(\check{\eta})}(\check{x}), \check{j}_{\check{\omega}(\check{\eta})}(\check{x}), \check{F}_{\check{\omega}(\check{\eta})}(\check{x}) \in [0,1]$ also $0 \leq \left(\check{\tau}_{\check{\omega}(\check{\eta})}(\check{x}) \right)^2 + \left(\check{j}_{\check{\omega}(\check{\eta})}(\check{x}) \right)^2 + \left(\check{F}_{\check{\omega}(\check{\eta})}(\check{x}) \right)^2 \leq 1$.

2. For clarity, Let us take $\check{E} = \check{C}_1, \check{C}_2, \dots, \check{C}_f; \check{C} = \check{C}_1 \times \check{C}_2 \times \dots \times \check{C}_f; \check{\eta} \in \check{C}$. The family of all PNHSS over \check{U} is denoted by PNHSS (\check{U}, \check{E}) .

DF 2.2. Let PNHSS (\check{U}, \check{E}) be the family of all PNHSSs over \check{U} and $\check{\tau} \in$ PNHSS (\check{U}, \check{E}) .

Then $\check{\tau}$ is called PNHSS topology on \check{U} if

- (i) $\check{O}_{(\check{U}_{PNHSS}, \check{E})}, \check{I}_{(\check{U}_{PNHSS}, \check{E})} \in \check{\tau}$
- (ii) $(\check{O}, \check{G}), (\check{O}, \check{G}) \in \check{\tau} \Rightarrow (\check{O}, \check{G}) \cap (\check{O}, \check{G}) \in \check{\tau}$.
- (iii) $\left\{ (\check{O}, \check{G})_i \mid i \in \check{L} \right\} \Rightarrow \prod_{i \in \check{L}} (\check{O}, \check{G})_i \in \check{\tau}$.

Then $(\check{U}, \check{E}, \check{\tau})$ is called a PNHSTS. Each member of $\check{\tau}$ is said to be Pythagorean Neutrosophic open Hypersoft set (PN_OHSS). The complement of a PN_OHSS is called Pythagorean Neutrosophic Closed Hypersoft set (PN_CHSS).





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DF 2.3. Let $(\check{U}, \check{E}, \check{r})$ be a PNHSTS over \check{U} , $(\check{w}, \check{z}) \in$ PNHSS (\check{U}, \check{E}) . Then, the PNHS interior $(PNHS_{int})$ of (\check{w}, \check{z}) , denoted $(\check{w}, \check{z})^\circ$ is defined as the PNHS union of all PN_{OHS} subsets of (\check{w}, \check{z}) .

DF 2.4. Let $(\check{U}, \check{E}, \check{r})$ be a PNHSTS over \check{U} , $(\check{w}, \check{z}) \in$ PNHSS (\check{U}, \check{E}) . Then, the PNHS closure $(PNHS_{cl})$ of (\check{w}, \check{z}) , denoted $\overline{(\check{w}, \check{z})}$, is defined as the PNHS intersection of all PN_{cHS} subsets of (\check{w}, \check{z}) .

3. Pythagorean Neutrosophic Semi Open and Semi Closed Hypersoft Sets

DF 3.1. Let $(\check{U}, \check{E}, \check{r})$ be a PNHTS and $(\check{w}, \check{z}) \in$ PNHSS (\check{U}, \check{E}) . If $(\check{w}, \check{z}) \in$ PNHS $_{cl}(PNHS_{int}(\check{w}, \check{z}))$, then (\check{w}, \check{z}) is called a PN_{SOHS} . The set of all PN_{SOHS} s by $PN_{SOHS}(\mathcal{X})$. The compliment of a PN_{SOHS} is called a PN_{ScHS} . The set of all PN_{ScHS} is denoted by $PN_{ScHS}(\mathcal{X})$.

Example (EX) 3.2. Let $X = \{\check{x}_1, \check{x}_2, \check{x}_3\}$ and the attributes be $E_1 = \{\check{e}_1, \check{e}_2, \check{e}_3\}$, $E_2 = \{\check{f}_1, \check{f}_2\}$, and $E_3 = \{\check{g}_1, \check{g}_2\}$. The PNHST space is

$$\tau = \left\{ \begin{aligned} &< (\check{e}_1, \check{f}_1, \check{g}_2), \{\check{x}_1(.8, .7, .5), \check{x}_2(.3, .7, .2), \check{x}_3(.5, .2, .7)\} >, \\ &< (\check{e}_1, \check{f}_2, \check{g}_2), \{\check{x}_1(.6, .7, .5), \check{x}_2(.5, .6, .6), \check{x}_3(.6, .5, .3)\} >, \\ &< (\check{e}_1, \check{f}_1, \check{g}_1), \{\check{x}_1(.8, .6, .4), \check{x}_2(.7, .5, .4), \check{x}_3(.3, .5, .6)\} >, \\ &< (\check{e}_3, \check{f}_1, \check{g}_1), \{\check{x}_1(.5, .3, .6), \check{x}_2(.5, .2, .7), \check{x}_3(.6, .4, .5)\} >, \\ &< (\check{e}_1, \check{f}_1, \check{g}_2), \{\check{x}_1(.8, .7, .5), \check{x}_2(.3, .7, .2), \check{x}_3(.5, .2, .7)\} >, \\ &< (\check{e}_1, \check{f}_2, \check{g}_2), \{\check{x}_1(.6, .7, .5), \check{x}_2(.5, .6, .6), \check{x}_3(.6, .5, .3)\} >, \\ &< (\check{e}_1, \check{f}_1, \check{g}_1), \{\check{x}_1(.8, .6, .4), \check{x}_2(.7, .5, .4), \check{x}_3(.3, .5, .6)\} >, \\ &< (\check{e}_3, \check{f}_1, \check{g}_1), \{\check{x}_1(.5, .3, .6), \check{x}_2(.5, .2, .7), \check{x}_3(.6, .4, .5)\} > \end{aligned} \right.$$

Two PN_{SOHS} are,

$$(\check{w}_1, \check{z}_1) = \left\{ \begin{aligned} &< (\check{e}_1, \check{f}_1, \check{g}_2), \{\check{x}_1(.8, .6, .4), \check{x}_2(.4, .5, .1), \check{x}_3(.6, .1, .5)\} >, \\ &< (\check{e}_1, \check{f}_2, \check{g}_2), \{\check{x}_1(.7, .5, .1), \check{x}_2(.6, .4, .2), \check{x}_3(.7, .3, .2)\} >, \\ &< (\check{e}_1, \check{f}_1, \check{g}_1), \{\check{x}_1(.8, .4, .3), \check{x}_2(.8, .3, .1), \check{x}_3(.4, .2, .5)\} >, \\ &< (\check{e}_3, \check{f}_1, \check{g}_1), \{\check{x}_1(.6, .2, .5), \check{x}_2(.6, .1, .3), \check{x}_3(.7, .3, .2)\} > \end{aligned} \right.$$





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$$(\check{\omega}_2, \check{\vartheta}_2) = \left\{ \begin{array}{l} \langle (\check{e}_1, \check{f}_1, \check{g}_2), \{\check{x}_1(.9, .5, .3), \check{x}_2(.5, .6, .2), \check{x}_3(.7, .2, .4)\} \rangle, \\ \langle (\check{e}_1, \check{f}_2, \check{g}_2), \{\check{x}_1(.7, .4, .3), \check{x}_2(.7, .5, .3), \check{x}_3(.8, .4, .1)\} \rangle, \\ \langle (\check{e}_1, \check{f}_1, \check{g}_1), \{\check{x}_1(.9, .5, .2), \check{x}_2(.8, .2, .3), \check{x}_3(.5, .3, .4)\} \rangle, \\ \langle (\check{e}_3, \check{f}_1, \check{g}_1), \{\check{x}_1(.7, .1, .4), \check{x}_2(.7, .2, .5), \check{x}_3(.8, .2, .3)\} \rangle \end{array} \right\}$$

DF 3.3. Let $(\check{U}, \check{E}, \check{\tau})$ be a PNHTS and $(\check{\omega}, \check{\vartheta}) \in \text{PNHSS}(\check{U}, \check{E})$. Then, the Pythagorean Neutrosophic Semi-Hypersoft interior ($PN_{SHS}Int$) and Pythagorean Neutrosophic Semi-Hypersoft closure ($PN_{SHS}Cl$) of $(\check{\omega}, \check{\vartheta})$ is defined as,

$$PN_{SHS}Int(\check{\omega}, \check{\vartheta}) = \cup \{(\check{\chi}, \check{\vartheta}) : (\check{\chi}, \check{\vartheta}) \subseteq (\check{\omega}, \check{\vartheta}), (\check{\chi}, \check{\vartheta}) \in PN_{SO}HS(X)\}$$

$$PN_{SHS}Cl(\check{\omega}, \check{\vartheta}) = \cap \{(\check{\xi}, \check{\vartheta}) : (\check{\xi}, \check{\vartheta}) \supseteq (\check{\omega}, \check{\vartheta}), (\check{\xi}, \check{\vartheta}) \in PN_{SC}HS(X)\}$$

Theorem 3.4. Let $(\check{U}, \check{E}, \check{\tau})$ be a PNHTS and $(\check{\omega}, \check{\vartheta}) \in \text{PNHSS}(\check{U}, \check{E})$. Then $(\check{\omega}, \check{\vartheta})$ is $PN_{SO}HS$ set iff $(\check{\omega}, \check{\vartheta}) \subseteq PN_{HS}_{cl}(PN_{HS}_{int}(\check{\omega}, \check{\vartheta}))$.

Proof:

Let $(\check{\omega}, \check{\vartheta}) \subseteq PN_{HS}_{cl}(PN_{HS}_{int}(\check{\omega}, \check{\vartheta}))$. Then $(\check{\Gamma}, \check{\vartheta}) = PN_{HS}_{int}(\check{\omega}, \check{\vartheta})$. By the definition of $PN_{SO}HS$, $(\check{\Gamma}, \check{\vartheta}) \subseteq (\check{\omega}, \check{\vartheta}) \subseteq PN_{HS}_{cl}(\check{\Gamma}, \check{\vartheta})$. Conversely, let $(\check{\omega}, \check{\vartheta})$ be $PN_{SO}HS$ set in $(\check{U}, \check{E}, \check{\tau})$. Then $(\check{\Gamma}, \check{\vartheta}) \subseteq (\check{\omega}, \check{\vartheta}) \subseteq PN_{HS}_{cl}(\check{\Gamma}, \check{\vartheta})$ for some $PN_{O}HSS(\check{\Gamma}, \check{\vartheta})$. But $(\check{\Gamma}, \check{\vartheta}) \subseteq PN_{HS}_{int}(\check{\omega}, \check{\vartheta})$, thus $PN_{HS}_{cl}(\check{\Gamma}, \check{\vartheta}) \subseteq PN_{HS}_{cl}(PN_{HS}_{int}(\check{\omega}, \check{\vartheta}))$. Hence $(\check{\omega}, \check{\vartheta}) \subseteq PN_{HS}_{cl}(PN_{HS}_{int}(\check{\omega}, \check{\vartheta}))$.

Theorem 3.5. Let $(\check{U}, \check{E}, \check{\tau})$ be a PNHTS. Every $PN_{O}HSS$ set in $(\check{U}, \check{E}, \check{\tau})$ is $PN_{SO}HS$ set in $(\check{U}, \check{E}, \check{\tau})$.

Proof:

Let $(\check{\Gamma}, \check{\vartheta})$ be $PN_{O}HSS$ in $(\check{U}, \check{E}, \check{\tau})$.

$$(\check{\Gamma}, \check{\vartheta}) = PN_{HS}_{int}(\check{\Gamma}, \check{\vartheta}). \text{ Also, } PN_{HS}_{int}(\check{\Gamma}, \check{\vartheta}) \subseteq PN_{HS}_{cl}(PN_{HS}_{int}(\check{\Gamma}, \check{\vartheta})).$$

$$\Rightarrow (\check{\Gamma}, \check{\vartheta}) \subseteq PN_{HS}_{cl}(PN_{HS}_{int}(\check{\Gamma}, \check{\vartheta})). \text{ Hence } (\check{\Gamma}, \check{\vartheta}) \text{ is } PN_{SO}HS \text{ set in } (\check{U}, \check{E}, \check{\tau}).$$

Remark 3.6. Every $PN_{SO}HS$ set need not be a $PN_{O}HSS$ set in $(\check{U}, \check{E}, \check{\tau})$.





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EX 3.7. Let $\check{U}=\{\check{x}_1, \check{x}_2, \check{x}_3\}$ be the UE and $\check{C}_1, \check{C}_2, \check{C}_3$ be the set of attributes, whose corresponding attribute values are $\check{C}_1 = \{\check{\alpha}_1, \check{\alpha}_2, \check{\alpha}_3\}, \check{C}_2 = \{\check{\beta}_1, \check{\beta}_2\}, \check{C}_3 = \{\check{\gamma}_1, \check{\gamma}_2\}$. Consider $\check{\tau} = \left\{ \check{0}_{(\check{U}_{PNHSS}, \check{E})}, \check{1}_{(\check{U}_{PNHSS}, \check{E})}, (\check{\omega}_1, \check{\xi}_1), (\check{\omega}_2, \check{\xi}_2) \right\}$ over \check{U} . Then some of the $PN_{SO}HSSs$ $(\check{\omega}_1, \check{\xi}_1), (\check{\omega}_2, \check{\xi}_2), (\check{\omega}_3, \check{\xi}_3), (\check{\omega}_4, \check{\xi}_4)$ on \check{U} as follows.

$$(\check{\omega}_1, \check{\xi}_1) = \left\{ \begin{array}{l} \langle (\check{\alpha}_1, \check{\beta}_1, \check{\gamma}_1), \{\check{x}_1(.7, .7, .1), \check{x}_2(.6, .5, .2), \check{x}_3(.4, .6, .1)\} \rangle, \\ \langle (\check{\alpha}_1, \check{\beta}_2, \check{\gamma}_2), \{\check{x}_1(.7, .6, .6), \check{x}_2(.4, .7, .1), \check{x}_3(.6, .5, .3)\} \rangle \end{array} \right\}$$

$$(\check{\omega}_2, \check{\xi}_2) = \left\{ \begin{array}{l} \langle (\check{\alpha}_1, \check{\beta}_1, \check{\gamma}_1), \{\check{x}_1(.8, .6, .1), \check{x}_2(.7, .4, .1), \check{x}_3(.5, .5, .1)\} \rangle, \\ \langle (\check{\alpha}_1, \check{\beta}_2, \check{\gamma}_2), \{\check{x}_1(.8, .3, .4), \check{x}_2(.5, .6, .1), \check{x}_3(.7, .5, .2)\} \rangle \end{array} \right\}$$

$$(\check{\omega}_3, \check{\xi}_3) = \left\{ \begin{array}{l} \langle (\check{\alpha}_1, \check{\beta}_1, \check{\gamma}_1), \{\check{x}_1(.9, .5, .1), \check{x}_2(.8, .3, .1), \check{x}_3(.6, .4, .1)\} \rangle, \\ \langle (\check{\alpha}_1, \check{\beta}_2, \check{\gamma}_2), \{\check{x}_1(.9, .2, .3), \check{x}_2(.6, .5, .1), \check{x}_3(.8, .4, .1)\} \rangle \end{array} \right\}$$

$$(\check{\omega}_4, \check{\xi}_4) = \left\{ \begin{array}{l} \langle (\check{\alpha}_1, \check{\beta}_1, \check{\gamma}_1), \{\check{x}_1(.8, .4, .1), \check{x}_2(.7, .2, .1), \check{x}_3(.5, .3, .1)\} \rangle, \\ \langle (\check{\alpha}_1, \check{\beta}_2, \check{\gamma}_2), \{\check{x}_1(.8, .1, .2), \check{x}_2(.7, .5, .1), \check{x}_3(.8, .2, .1)\} \rangle \end{array} \right\}$$

Here $(\check{\omega}_3, \check{\xi}_3), (\check{\omega}_4, \check{\xi}_4)$ are $PN_{SO}HSs$ but are not PN_{OHSSs} .

Theorem 3.8. Let $(\check{U}, \check{E}, \check{\tau})$ be a PNHTS and $(\check{\omega}, \check{\xi}) \in PN_{SO}HS(\mathcal{X})$.

- (i) Arbitrary PNHS union of $PN_{SO}HS$ is a $PN_{SO}HS$
- (ii) Arbitrary PNHS intersection of $PN_{SC}HS$ is a $PN_{SC}HS$.

Proof:

(i) Let $\left\{ (\check{\omega}_j, \check{\xi}_j) : j \in J \right\} \subseteq PN_{SO}HS(\mathcal{X})$.

$$\cup_j (\check{\omega}_j, \check{\xi}_j) \subseteq \cup PNHS_{cl} \left(PNHS_{int} (\check{\omega}_j, \check{\xi}_j) \right) \subseteq PNHS_{cl} \left(PNHS_{int} \cup_j (\check{\omega}_j, \check{\xi}_j) \right)$$

Hence the proof.

Similarly, (ii) is proved.





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Theorem 3.9. Let $(\check{u}, \check{e}, \check{r})$ be a PNHSTS, $(\check{w}_1, \check{z}_1), (\check{w}_2, \check{z}_2) \in \text{PNHSS}(\check{u}, \check{e})$. If either $(\check{w}_1, \check{z}_1) \in \text{PN}_{SO}\text{HS}(\mathcal{X})$ or $(\check{w}_2, \check{z}_2) \in \text{PN}_{SO}\text{HS}(\mathcal{X})$, then $\text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_1, \check{z}_1) \cap (\check{w}_2, \check{z}_2)) = \text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_1, \check{z}_1)) \cap \text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_2, \check{z}_2))$.

Proof:

Let $(\check{w}_1, \check{z}_1), (\check{w}_2, \check{z}_2) \in \text{PNHSS}(\check{u}, \check{e})$.

$\text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_1, \check{z}_1) \cap (\check{w}_2, \check{z}_2))$

$\subseteq \text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_1, \check{z}_1)) \cap \text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_2, \check{z}_2))$

$\text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_1, \check{z}_1) \cap \text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_2, \check{z}_2))) \subseteq$

$\text{PNHS}_{cl}[\text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_1, \check{z}_1)) \cap \text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_2, \check{z}_2))]$

$= \text{PNHS}_{cl}[\text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_1, \check{z}_1) \cap \text{PNHS}_{int}(\check{w}_2, \check{z}_2))]$

$\Rightarrow \text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_1, \check{z}_1) \cap \text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_2, \check{z}_2))) \subseteq \text{PNHS}_{cl}$

$(\text{PNHS}_{int}(\check{w}_1, \check{z}_1) \cap (\check{w}_2, \check{z}_2))$.

Hence the proof.

EX 3.10. Consider attributes and PN_{SO}HSs $(\check{w}_1, \check{z}_1), (\check{w}_2, \check{z}_2)$ of Example-3.3. In this case,

$\text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_1, \check{z}_1) \cap (\check{w}_2, \check{z}_2)) = \text{PNHS}_{cl}(\text{PNHS}_{int}(\check{w}_1, \check{z}_1)) \cap \text{PNHS}_{cl}$

$(\text{PNHS}_{int}(\check{w}_2, \check{z}_2)) = \check{1}_{\check{u}_{\text{PNHSS}}(\check{e})}$

Proposition 3.11. Let (\check{x}, \check{y}) be a PNHSS in $(\check{u}, \check{e}, \check{r})$. Then, (\check{x}, \check{y}) is said to be PN_{SC}HSS if

there exists a $\text{PN}_{CHSS}(\check{t}, \check{z})$ such that $\text{PNHS}_{int}(\check{t}, \check{z}) \subseteq (\check{x}, \check{y}) \subseteq (\check{t}, \check{z})$.

Theorem 3.12. Let $(\check{u}, \check{e}, \check{r})$ be a PNHTS and $(\check{x}, \check{y}) \in \text{PNHSS}(\check{u}, \check{e})$. Then (\check{x}, \check{y}) is

PN_{SC}HSS iff $\text{PNHS}_{int}(\text{PNHS}_{cl}(\check{x}, \check{y})) \subseteq (\check{x}, \check{y})$.

Proof:

Let $\text{PNHS}_{int}(\text{PNHS}_{cl}(\check{x}, \check{y})) \subseteq (\check{x}, \check{y})$. $(\check{t}, \check{z}) = \text{PNHS}_{cl}(\check{x}, \check{y})$. By the definition of

PN_{SC}HSS , $\text{PNHS}_{int}(\check{t}, \check{z}) \subseteq (\check{x}, \check{y}) \subseteq (\check{t}, \check{z})$. Conversely, let (\check{x}, \check{y}) be PN_{SC}HSS in

$(\check{u}, \check{e}, \check{r})$. Then $\text{PNHS}_{int}(\check{t}, \check{z}) \subseteq (\check{x}, \check{y}) \subseteq (\check{t}, \check{z})$ for some $\text{PN}_{CHSS}(\check{t}, \check{z})$. But





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$PNHS_{cl}(\check{\xi}, \check{\zeta}) \subseteq (\check{\theta}, \check{\zeta}), PNHS_{int}(PNHS_{cl}(\check{\xi}, \check{\zeta})) \subseteq PNHS_{int}(\check{\theta}, \check{\zeta})$. Hence $PNHS_{int}(PNHS_{cl}(\check{\xi}, \check{\zeta})) \subseteq PNHS_{int}(\check{\theta}, \check{\zeta}) \subseteq (\check{\xi}, \check{\zeta})$.

Theorem 3.13. Every $PN_C HSS$ is a $PN_{SC} HSS$ in $(\check{U}, \check{\Xi}, \check{\tau})$, but the converse need not be true.

Proof:

Let $(\check{\theta}, \check{\zeta})$ be $PN_C HSS$ in $(\check{U}, \check{\Xi}, \check{\tau})$. Then $(\check{\theta}, \check{\zeta}) = PNHS_{cl}(\check{\theta}, \check{\zeta})$. Also $PNHS_{int}(PNHS_{cl}(\check{\theta}, \check{\zeta})) \subseteq PNHS_{cl}(\check{\theta}, \check{\zeta})$.

$\Rightarrow PNHS_{int}(PNHS_{cl}(\check{\theta}, \check{\zeta})) \subseteq (\check{\theta}, \check{\zeta})$. Hence $(\check{\theta}, \check{\zeta})$ is $PN_{SC} HSS$ in $(\check{U}, \check{\Xi}, \check{\tau})$.

Remark 3.14. The converse of the above theorem need not be true.

EX 3.15. Let $\check{U} = \{\check{x}_1, \check{x}_2, \check{x}_3\}$ be the UE and $\check{\zeta}_1, \check{\zeta}_2, \check{\zeta}_3$ be the S.O.P, whose corresponding attribute values are $\check{\zeta}_1 = \{\check{\alpha}_1, \check{\alpha}_2, \check{\alpha}_3\}, \check{\zeta}_2 = \{\check{\beta}_1, \check{\beta}_2\}, \check{\zeta}_3 = \{\check{\gamma}_1, \check{\gamma}_2\}$. Consider $\check{\tau} =$

$\left\{ \check{\tau}_{(PNHSS, \check{\Xi})}^{\check{U}}, \check{\tau}_{(PNHSS, \check{\Xi})}^{\check{U}}, (\check{\omega}_1, \check{\zeta}_1), (\check{\omega}_2, \check{\zeta}_2) \right\}$ over \check{U} and $\tau^c = \left\{ \check{\tau}_{(PNHSS, \check{\Xi})}^{\check{U}}, \check{\tau}_{(PNHSS, \check{\Xi})}^{\check{U}}, (\check{\omega}_1, \check{\zeta}_1)^c, (\check{\omega}_2, \check{\zeta}_2)^c \right\}$. Some of the $PN_{SC} HSSs$ $(\check{\omega}_1, \check{\zeta}_1), (\check{\omega}_2, \check{\zeta}_2), (\check{\omega}_1, \check{\zeta}_1)^c, (\check{\omega}_2, \check{\zeta}_2)^c$ on \check{U} as follows.

$$(\check{\omega}_1, \check{\zeta}_1) = \left\{ \begin{aligned} &< (\check{\alpha}_1, \check{\beta}_1, \check{\gamma}_1), \{\check{x}_1(.7, .6, .1), \check{x}_2(.6, .4, .2), \check{x}_3(.4, .5, .1)\} >, \\ &< (\check{\alpha}_1, \check{\beta}_2, \check{\gamma}_2), \{\check{x}_1(.7, .1, .6), \check{x}_2(.4, .6, .1), \check{x}_3(.6, .5, .3)\} > \end{aligned} \right\}$$

$$(\check{\omega}_2, \check{\zeta}_2) = \left\{ \begin{aligned} &< (\check{\alpha}_1, \check{\beta}_1, \check{\gamma}_1), \{\check{x}_1(.8, .5, .1), \check{x}_2(.7, .3, .1), \check{x}_3(.5, .4, .1)\} >, \\ &< (\check{\alpha}_1, \check{\beta}_2, \check{\gamma}_2), \{\check{x}_1(.8, .1, .4), \check{x}_2(.5, .4, .1), \check{x}_3(.7, .3, .2)\} > \end{aligned} \right\}$$

$$(\check{\omega}_2, \check{\zeta}_2)^c = \left\{ \begin{aligned} &< (\check{\alpha}_1, \check{\beta}_1, \check{\gamma}_1), \{\check{x}_1(.8, .5, .1), \check{x}_2(.7, .3, .1), \check{x}_3(.5, .4, .1)\} >, \\ &< (\check{\alpha}_1, \check{\beta}_2, \check{\gamma}_2), \{\check{x}_1(.8, .1, .4), \check{x}_2(.5, .4, .1), \check{x}_3(.7, .3, .2)\} > \end{aligned} \right\}$$

$$(\check{\omega}_1, \check{\zeta}_1)^c = \left\{ \begin{aligned} &< (\check{\alpha}_1, \check{\beta}_1, \check{\gamma}_1), \{\check{x}_1(.1, .4, .7), \check{x}_2(.2, .6, .6), \check{x}_3(.1, .5, .4)\} >, \\ &< (\check{\alpha}_1, \check{\beta}_2, \check{\gamma}_2), \{\check{x}_1(.6, .9, .7), \check{x}_2(.1, .4, .4), \check{x}_3(.3, .5, .6)\} > \end{aligned} \right\}$$

$$(\check{\omega}_2, \check{\zeta}_2)^c = \left\{ \begin{aligned} &< (\check{\alpha}_1, \check{\beta}_1, \check{\gamma}_1), \{\check{x}_1(.1, .5, .8), \check{x}_2(.1, .7, .7), \check{x}_3(.1, .6, .5)\} >, \\ &< (\check{\alpha}_1, \check{\beta}_2, \check{\gamma}_2), \{\check{x}_1(.4, .9, .8), \check{x}_2(.1, .6, .5), \check{x}_3(.2, .7, .7)\} > \end{aligned} \right\}$$

$$(\check{\omega}_3, \check{\zeta}_3) = \left\{ \begin{aligned} &< (\check{\alpha}_1, \check{\beta}_1, \check{\gamma}_1), \{\check{x}_1(.1, .6, .9), \check{x}_2(.1, .8, .7), \check{x}_3(.1, .7, .6)\} >, \\ &< (\check{\alpha}_1, \check{\beta}_2, \check{\gamma}_2), \{\check{x}_1(.3, .9, .8), \check{x}_2(.1, .8, .6), \check{x}_3(.1, .8, .7)\} > \end{aligned} \right\}$$





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Here the $PN_{SC}HSSs$ are $(\check{\omega}_1, \check{\xi}_1)^C$, $(\check{\omega}_2, \check{\xi}_2)^C$ and $(\check{\omega}_3, \check{\xi}_3)$. Also $(\check{\omega}_3, \check{\xi}_3)$ is $PN_{SC}HSS$ but is not $PN_C HSS$.

Theorem 3.16. Let $(\check{U}, \check{E}, \check{r})$ be a PNHTS, $(\check{\omega}_1, \check{\xi}_1), (\check{\omega}_2, \check{\xi}_2) \in PNHSS(\check{U}, \check{E})$. Then, the following properties hold:

- (i) $PN_{SHS}Int(\check{\omega}_{(PNHSS, \check{E})}) = \check{\omega}_{(PNHSS, \check{E})}$
- (ii) $PN_{SHS}Int(\check{\Gamma}_{(PNHSS, \check{E})}) = \check{\Gamma}_{(PNHSS, \check{E})}$
- (iii) $PN_{SHS}Int(\check{\omega}, \check{\xi}) \subseteq (\check{\omega}, \check{\xi})$
- (iv) $(\check{\omega}, \check{\xi})$ is $PN_{SO}HSS$ in $(\check{U}, \check{E}, \check{r}) \Leftrightarrow PN_{SHS}Int(\check{\omega}, \check{\xi}) = (\check{\omega}, \check{\xi})$
- (v) $PN_{SHS}Int(\check{\omega}, \check{\xi})$ is the largest $PN_{SO}HSS$ contained in $(\check{\omega}, \check{\xi})$
- (vi) If $(\check{\omega}, \check{\xi}) \subseteq (\check{\psi}, \check{\vartheta})$, then $PN_{SHS}Int(\check{\omega}, \check{\xi}) \subseteq PN_{SHS}Int(\check{\psi}, \check{\vartheta})$
- (vii) $PN_{SHS}Int(PN_{SHS}Int(\check{\omega}, \check{\xi})) = PN_{SHS}Int(\check{\omega}, \check{\xi})$
- (viii) $PN_{SHS}Int(\check{\omega}, \check{\xi}) \cup PN_{SHS}Int(\check{\psi}, \check{\vartheta}) \subseteq PN_{SHS}Int[(\check{\omega}, \check{\xi}) \cup (\check{\psi}, \check{\vartheta})]$
- (ix) $PN_{SHS}Int[(\check{\omega}, \check{\xi}) \cap (\check{\psi}, \check{\vartheta})] \subseteq PN_{SHS}Int(\check{\omega}, \check{\xi}) \cap PN_{SHS}Int(\check{\psi}, \check{\vartheta})$

Theorem 3.17. Let $(\check{U}, \check{E}, \check{r})$ be a PNHTS, $(\check{\omega}_1, \check{\xi}_1), (\check{\omega}_2, \check{\xi}_2) \in PNHSS(\check{U}, \check{E})$. Then, the following properties hold:

- (i) $PN_{SHS}Cl(\check{\omega}_{(PNHSS, \check{E})}) = \check{\omega}_{(PNHSS, \check{E})}$
- (ii) $PN_{SHS}Cl(\check{\Gamma}_{(PNHSS, \check{E})}) = \check{\Gamma}_{(PNHSS, \check{E})}$
- (iii) $PN_{SHS}Cl(\check{\xi}, \check{\zeta}) \subseteq (\check{\xi}, \check{\zeta})$
- (iv) $(\check{\xi}, \check{\zeta})$ is $PN_{SC}HSS$ in $(\check{U}, \check{E}, \check{r}) \Leftrightarrow PN_{SHS}Cl(\check{\xi}, \check{\zeta}) = (\check{\xi}, \check{\zeta})$
- (v) $PN_{SHS}Cl(\check{\xi}, \check{\zeta})$ is the smallest $PN_{SC}HSS$ contained in $(\check{\xi}, \check{\zeta})$
- (vi) If $(\check{\xi}, \check{\zeta}) \subseteq (\check{\zeta}, \check{\zeta})$, then $PN_{SHS}Cl(\check{\xi}, \check{\zeta}) \subseteq PN_{SHS}Cl(\check{\zeta}, \check{\zeta})$
- (vii) $PN_{SHS}Cl(PN_{SHS}Cl(\check{\xi}, \check{\zeta})) = PN_{SHS}Cl(\check{\xi}, \check{\zeta})$
- (viii) $PN_{SHS}Cl(\check{\xi}, \check{\zeta}) \cup PN_{SHS}Cl(\check{\zeta}, \check{\zeta}) \subseteq PN_{SHS}Cl[(\check{\xi}, \check{\zeta}) \cup (\check{\zeta}, \check{\zeta})]$
- (ix) $PN_{SHS}Cl[(\check{\xi}, \check{\zeta}) \cap (\check{\zeta}, \check{\zeta})] \subseteq PN_{SHS}Cl(\check{\xi}, \check{\zeta}) \cap PN_{SHS}Cl(\check{\zeta}, \check{\zeta})$

Theorem 3.18. Let $(\check{\theta}, \check{\zeta})$ be a PNHSS in $(\check{U}, \check{E}, \check{r})$.





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- (i) $[PN_{SHS}Int(\check{\theta}, \check{\zeta})]^c = PN_{SHS}Cl\left[\left((\check{\theta}, \check{\zeta})\right)^c\right]$
- (ii) $[PN_{SHS}Cl(\check{\theta}, \check{\zeta})]^c = PN_{SHS}Int\left[\left((\check{\theta}, \check{\zeta})\right)^c\right]$

Proof:

- (i) W.K.T,
 $PN_{SHS}Int(\check{\theta}, \check{\zeta}) = \cup \{(\check{\chi}, \check{\xi}) : (\check{\chi}, \check{\xi}) \subseteq (\check{\theta}, \check{\zeta}), (\check{\chi}, \check{\xi}) \in PN_{SO}HS(X)\}$
 $[PN_{SHS}Int(\check{\theta}, \check{\zeta})]^c = \left[\cup \{(\check{\chi}, \check{\xi}) : (\check{\chi}, \check{\xi}) \subseteq (\check{\theta}, \check{\zeta}), (\check{\chi}, \check{\xi}) \in PN_{SO}HS(X)\} \right]^c$
 $= \cap \{(\check{\chi}, \check{\xi})^c : (\check{\chi}, \check{\xi})^c \supseteq (\check{\theta}, \check{\zeta})^c, (\check{\chi}, \check{\xi})^c \in PN_{SC}HS(X)\}$
 $\therefore [PN_{SHS}Int(\check{\theta}, \check{\zeta})]^c = PN_{SHS}Cl\left[\left((\check{\theta}, \check{\zeta})\right)^c\right]$
- (ii) Proof is the same that of (i).

CONCLUSION

In this paper, the concept of *PN_{SO}HSs* and *PN_{SC}HSs* is defined along with basic characterizations. The validity and implementation of the definition are verified by presenting suitable example. In future, many concept such as continuity and separation axioms can be studied on *PNHSTs*.

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