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May this endeavour grow and remain evergreen like an olive tree to create renewed awareness, dimensional consciousness and enlightenment.

- Editors

CONTENTS

Structural and electronic properties of 3,4-DimethoxyBenzaldehyde – Quantum Chemical Approach

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ABSTRACT

A novel type of benzaldehyde derivative known as 3,4-Dimethoxy Benzaldehyde has been studied using density functional theory (DFT) model, performed by GAUSSIAN 09 packages, based on the Becke, 3-parameter, Lee–Yang–Parr (B3LYP) exchange correlation functions augmented with 6–311++(d,p) basis set. The geometric equilibrium, charge transfer interactions and the stereo-electronic interactions, leading to the stability, bioactivity, has been confirmed using natural bond orbital analysis.

Keywords: Density functional theory (DFT), Natural bond orbital, HOMO-LUMO, Hirshfeld surface

Introduction

3,4- DimethoxyBenzaldehyde is an organic compound that is widely used as an flavorant and odorant. The compound is structurally related to benzaldehyde. The molecule consists of two methoxy group and acarbonyl groups on benzene. Benzaldehyde (C_6H_5CHO) an extremely straight forward agent of fragrant aldehydes, happens normally as glycoside amygdalin. Benzaldehyde is a colorless liquid with the scent of almond oil It has a liquefying point of -26°c(-14.8°F) 179°c(354.2°F). It is slightly soluble in water and completely soluble in ethanol and diethyl ether. Benzaldehyde goes through concurrent oxidation and decreases with alcoholic potassium hydroxide (Cannizzaro response) [1], giving potassium benzoate and benzyl liquor; with alcoholic potassium cyanide. Veratraldehyde can be used as an intermediate in the synthesis of some pharmaceutical drugs including amiquinsin [2], hoquizil, piquizil, toborinone, verazide and vetrabutine [3]. The prime focus of the present study is on the investigation of the structure of 3,4-DimethoxyBenzaldehyde to elucidate the electronic properties.

Computational details

Quantum chemical calculations was done with the Gaussian '09 program package, using density functional theory (DFT) with B3LYP function and 6-31G+(d,p) basis set. Natural bond analysis has been carried out using NBO 3.1 version [4,5,].

Results discussion

Optimized geometry

The optimized structure of the isolated 3,4-dimethoxy benzaldehyde molecules

calculated using DFT theory at the B3LYP functional together with the 6-311G (d,p) basis set is shown in Figure 1. The calculated parameters were compared with the experimental parameters [6]
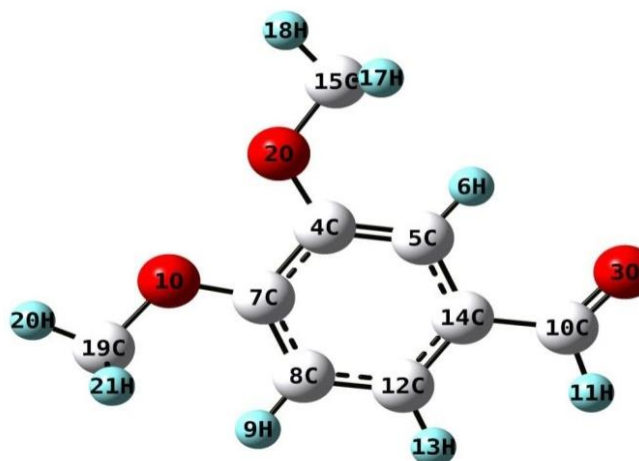
Figure 1. Optimized molecular structure of 3,4-dimethoxy benzaldehyde

The molecular structure of 3,4-dimethoxy benzaldehyde consists of a benzene ring with two methoxy group at 3,4 position and a alcohol group in the 1-position. Calculated geometrical parameters agree well with the experimental values except some exceptions. The planarity of the benzene ring is distorted owing to the heavy substituted methoxy group at the 3,4 position as revealed by an increase in the O2 — C4 — C7 —O1torsional angle by 1.28°. In the phenyl ring the bond angle C4— C5—C14 has been increased by 1° and the bond angle C5— C4—C7 has been decreased by 1° from the experimental value due to the presence of the adjacent methoxy group. A significant decrease in bond lengths of O1—C7,O1—C14, O2—C15 and O2—C15 is noticed. The occurrence of this effect is due to the redistribution of partial charges on O2 as the lone pair electron is delocalized and thereby reveals the effects of resonance in this part of the molecule [7,8]. Calculated geometrical parameters are given in the supplementary table Table S1, S2 and S3

Natural bond orbital study

In order to probe the second order perturbation energy of the hyperconjugative interactions between the donor and acceptor atoms natural bond orbital analysis was carried out[9]. The most prominent interactions resulting from the second order perturbation energy E(2) of the Fock matrix have been tabulated (Table 1). The second-order perturbation theory analysis of Fock matrix in 3,4- Dimethoxybenzaldehyde shows the presence of intramolecular hyperconjugative interactions [9]. The quantum of charges transferred from lone pairs of n(O1), n(O2) of the methyl group and n(O3) into the σ antibond orbitals of the phenyl ring

leads to the stabilization energy of 5–8 kcal mol−1 except for the second lone pairs n2(O1), n2(O2) involved in the π bond interactions show stabilization energies of 33.56 kcal mol−1 and 31.68 kcal mol−1 Also, The quantum of charges transferred from lone pairs of n(O3) of the keto group into the σ antibond orbitals of the phenyl ring leads to the stabilization energy of 22.45 kcal mol−1 and 18.93 kcal mol−1 because of the energy differences between orbitals. Considerable changes are noticed in para substituted keto group than the ortho and meta substituted methyl group.

Table 1. Second Order Perturbation Theory Analysis of Fock Matrix of 3,4-Dimethoxybenzaldehyde

Donor (i)	Acceptor (j)	E(2)kcal/mol	E(j)− E(i) a.u.	F(i,j) a.u
n1(O 1)	σ*(C7 - C8)	7.45	1.11	0.081
n2(O 1)	π*(C7 - C8)	33.56	0.34	0.1
n2(O 1)	σ*(C 19 - H 21)	5.25	0.74	0.058
n2(O 1)	σ*(C 19 - H 22)	5.25	0.74	0.058
n1(O2)	σ*(C4 - C5)	7.44	1.13	0.082
n2(O2)	π*(C4 - C5)	31.68	0.34	0.097
n2(O2)	σ*(C 15 - H 16)	5.3	0.74	0.058
n2(O2)	σ*(C 15 - H 17)	5.3	0.74	0.058
n2(O3)	σ*(C 10 - H 11)	22.45	0.67	0.111
n2(O3)	σ*(C 10 - C14)	18.93	0.72	0.106

Mullikan population analysis

Atomic charge distribution based on Mullikan Charge analysis has been represented in Table2. From the table it has been observed that, in 3,4- Dimethoxybenzaldehyde the carbon atom attached to the oxygen atom are more positively charged when compared to the carbon atoms attached to the hydrogen atom.

Table 2. Mullikan charge of 3,4- Dimethoxybenzaldehyde

SI NO	Atom Number	Charge (e)
1	O1	-0.50063
2	O2	-0.513224
3	O4	-0.428977
4	C4	0.329946
5	C5	-0.161024

6	H6	0.115357
7	C7	0.336616
8	C8	-0.140584
9	H9	0.091427
10	C10	0.252797
11	H11	0.053215
12	C12	-0.136921
13	H13	0.089851
14	C14	0.047146
15	C15	-0.082298
16	H16	0.118509
17	H17	0.118499
18	H18	0.126987
19	C19	-0.083463
20	H20	0.132267
21	H21	0.117256
22	H22	0.117248

It has been observed that C7 has the most positive charge (0.336616) followed by C4 (0.329946). The distribution of charge over C7 and C4 is due to the charge transfer interactions take place between n1(O 1) → σ*(C7 - C8), n2(O 1) → π*(C7 - C8), n1(O2) → σ*(C4 - C5) and n2(O2) → π*(C4 - C5) with the stabilization energy of 7.45 kcal/mol, 33.56 kcal/mol, 7.44 kcal/mol, 31.68 kcal/mol respectively. Fig. 2 illustrates the plot of atomic charges to the atom number.
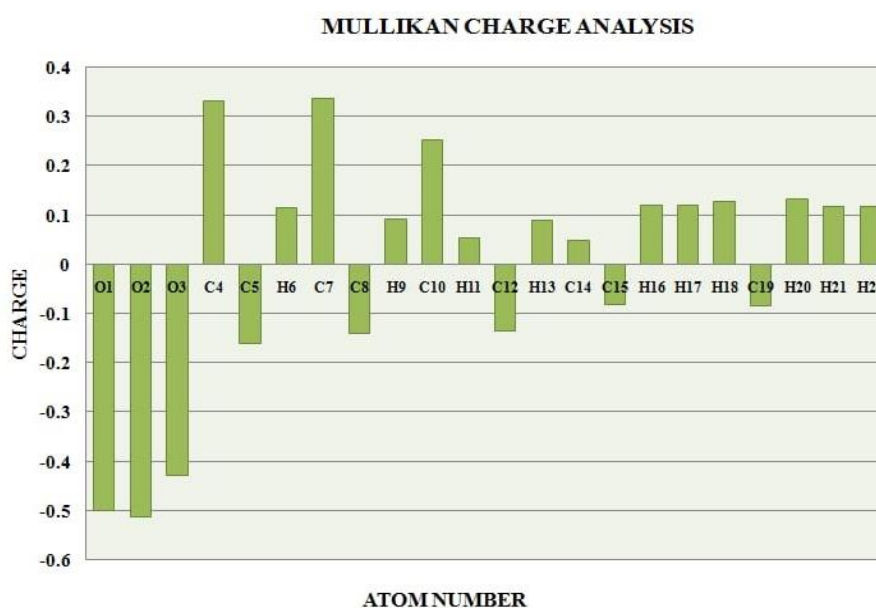
Figure 2. Mullikan charge of 3,4- Dimethoxybenzaldehyde

HOMO - LUMO

The frontier molecular orbitals, HOMO and LUMO plays an important role in the electric and optical properties, as well as in chemical reactions. The frontier molecular orbital gives a clear description about the reactivity of the molecule and the active sites of the molecule. The calculated energy for HOMO and LUMO s been shown in Table 3.

Table 3. Global reactivity descriptors of 3,4-Dimethoxybenzaldehyde

Parameters	Value
EHOMO	- 5.2193
ELUMO	- 2.1307
Electron affinity (A)	2.1307
Ionization potential (I)	5.2193
Electronegetivity	3.656
Chemical potential (μ)	-4.776
Chemical Hardness (η)	1. 8443
Chemical Softness(S)	0.27110

In HOMO, the charges are concentrated on the phenyl moiety whereas in LUMO, the charge distribution is over the entire molecule except the methyl group. The calculated low energy gap (ΔE=3.089 ev) reflects that the molecule is highly active. From the HOMO-LUMO energies, the global reactivity descriptors such as ionization potential I=-EHOMO, electron affinity A= -ELUMO, chemical hardness $\eta = (I-A)/2$; chemical potential $\mu = -(I+A)/2$ and electrophilicity index $\omega = \mu 2 /2\eta$ were calculated.

Conclusion

The Spectrocopic study of molecule 3,4 dimethoxybenzaldehyde has been investigated. The influence of CH3, C-H, C-C and C=O on the vibrational frequencies of the molecule 3,4 dimethoxy benzaldehyde were also discussed. The optimized structure of isolated 3,4 dimethoxy benzaldehyde molecules calculated using DFT theory at B3LYP functional together with the 611G (dp) basic set. The optimized bond length, bond angle, and dihydral angle of the molecule has been estimated with the experiment value. NBO reveals the transferred of charges from lone pair to antibond and π bond. Muliken charge analysis reveal the atomic charge distribution, from this 3,4 dimethoxybenzaldehyde the carbon atom attached to oxygen atom are more positively charged when compared to carbon atom attached to hydrogen atom. From HOMO - LUMO, energies of global reactivity descriptors such as ionization potential, electron affinity, chemical hardness, chemical potential and electrophilicity index were calculated.

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Pressure induced metallisation in Caesium Chloride

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ABSTRACT

The pressure dependent band structures, density of states and total energies of CsCl is calculated and used the result to study the metallization under pressure. The metallization pressure for Caesium Chloride was 0.155 Mbar. The relation between lattice constant and pressure, pressure and band gap, reduced volume and lattice constant, reduced volume and pressure, band structure and density of states were drawn.

1. Introduction

The electronic band structure study in the crystalline materials play a basic role in condensed matter physics because the better understanding of the various physical properties of solids mainly depend upon their band structure [1]. Currently there is a lot of interest in the high pressure behavior of materials. The physical properties of materials undergo a variety of changes when they are subjected to high pressure. The increase of pressure means significant decrease in volume, which results in the change of electronic states and crystal structure. With the development of high pressure experimental techniques, investigations on pressure–induced structural phase transition, semiconductor- metal transition and super conducting transition are getting the attention of all [1,2]. In the present paper, we give more extensive discussion about the band structure, density of states. The metallization is investigated and analyzed. We have given the calculational procedure and electronic band structure at various pressure.

2. Band satstructure and density of states of Cscl under pressure

2.1 Band structure and density of states at normal pressure

The normal pressure band structure of CsCl is given in Fig.1. At normal pressure (Fig.1) there is a separation of valance band and conduction band confirming the insulating nature of CsCl. A single band which is positioned at the bottom of the valance band arise from Cl-3s electrons and the triplet bands nearer to the single band are due to 5p electrons of Cs. The three bands appearing just below the Fermi energy E_F are from Cs- 6s and Cl- 3p electrons of CsCl (Fig.1). The empty conduction bands above the Fermi level are due to 6p, 5d states of Cs and 3s, 3d states of Cl (Fig.1). The overall topology of the band structure at V/V_o (reduced volume)=1 is same for previous calculations (Fig.1). Similar to previous band structure calculations, in the present investigation also the valance band maximum is located at the $\square$

point[3,4].This feature is similar to CsBr . At normal condition, the band gap E_g is found to be 6.960 eV for CsCl. The experimental band gap is 6.96 eV for CsCl . The general features of band structures are similar to previous calculations [5,6]. From our calculation, CsCl is direct band gap insulator at normal pressure. The Density of states (DOS) histogram of CsClat normal pressure is given in Fig.2. Fermi level E_F is denoted by the dotted line. It separates valance band and conduction band of CsCl. From the histogram it is seen that at normal pressure the levels arising from Cs- 5p electrons give the longest spike (Fig.2). The spike near the origin is due to Cl- 3s electrons and the short spikes near the E_F are due to Cs- 6s, Cl-3p electrons. The short spikes above the Fermi energy E_F are due to the 6p 5d states of Cs and 3s 3p states of Cl (Fig.2). The maximum density of states in the y- axis is nearly 400 states/ Ry. cell.

2.2 Band gap and density of states at high pressure

The band structure of Caesium chloride at metallization pressure is shown in Fig 3. When pressure increases, the value of E_F and density of states at E_F increases. The band structure and density of states of CsCl (for HCP structure) corresponds to pressure =0.155 Mbar is given in Fig.3. Fermi level is indicated by dotted horizontal line. In Fig.3.there is a direct band gap closure between valance band maximum at Γ point and conduction band maximum at X point confirming the metallic nature of CsCl. A single band, which is positioned at the bottom of the valance band, arises from Cl-3s electrons and the triplet bands nearer to the single band are due to 5p electrons of Cs. The three bands appearing just below the Fermi energy E_F are from Cs- 6s and Cl- 3p electrons of CsCl (Fig.3). The empty conduction bands above the Fermi level are due to 6p, 5d states of Cs and 3s, 3p states of Cl (Fig.3). At pressure= 0.155 Mbar, the band gap E_g is found to be 0 eV for CsCl. From our calculation, CsCl is direct band gap closure at pressure= 0.155 Mbar. In the CsCl, direct closure of band gap (Fig.3) takes place at the reduced volume of V/V_o =0.747 (at $\square$ and H-point), above the metallization pressure (P_M) is 0.155 Mbar. At metallization pressure = 0.155 Mbar the band gap E_g is found to be Zero eV for CsCl. From the histogram it is seen that at metallization pressure the levels arising from Cs- 5p electrons give the longest spike.
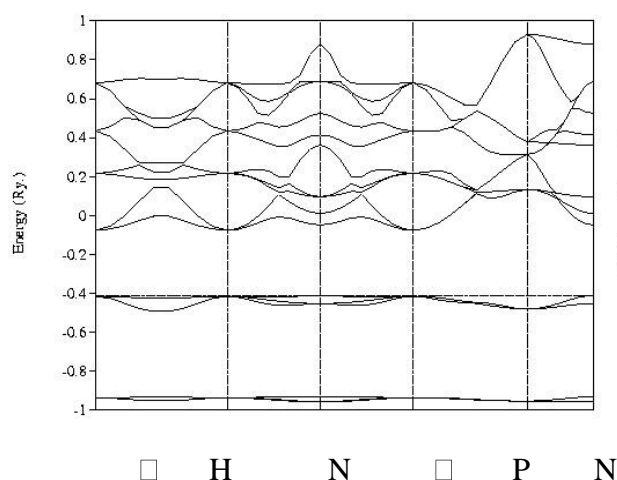
Fig 1. Band structure of CsCl at V/V₀=1 (Normal pressure)
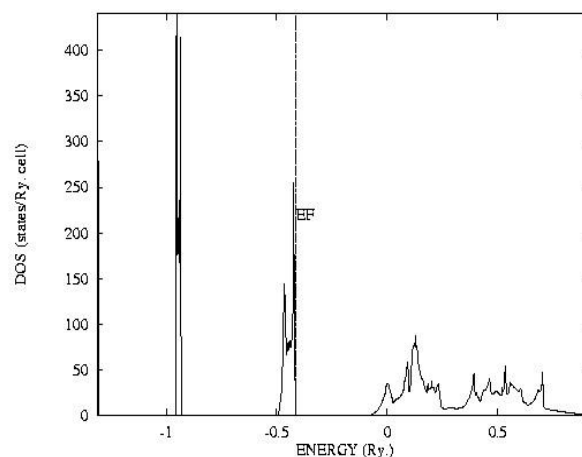
Fig 2. Density of states of CsCl at V/V₀=1 (Normal pressure)
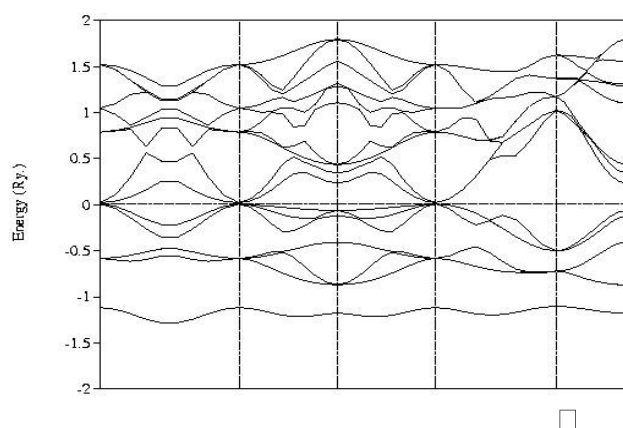
Fig 3. Band structure of CsCl at V/V₀=0.747 in HCP structure (P=0.155 Mbar)
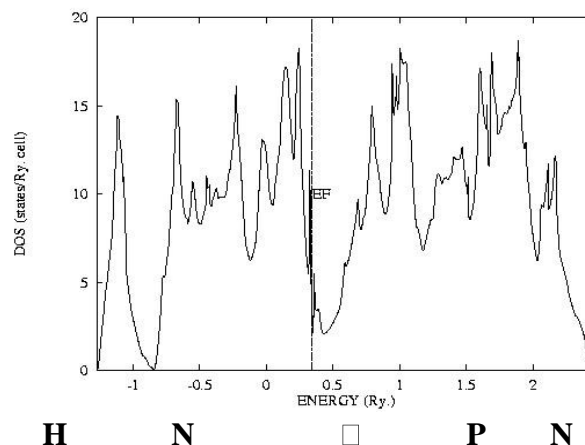
Fig 4. Density of states of CsCl at V/V₀=0.747 in HCP structure (P=0.155 Mbar)

The spike near the origin is due to Cl- 3s electrons and the short spikes near the E_F are due to Cs- 6s, Cl-3p electrons. The short spikes above the Fermi energy E_F are due to the 6p 5d states of Cs and 3s ,3p states of Cl. The density of states (DOS) histogram of CsCl at pressure= 0.155 Mbar is given in Fig.4. Like in the previous calculations Fermi level E_F lies in a minimum of the DOS curve (DOS value ≠ 0 at E = E_F) (Fig.4).

When pressure increases the value of the DOS at fermi level increases. The normal pressure DOS trend is changed under high pressure [7,8]. This increase of pressure leads to the broadening of bands and decrease of states value in most of the energy regions. It also increases the width of the valence band and the empty conduction bands.

3. Results and Discussion

3.1. Ground state and its properties

The ground state of a quantum-mechanical system is its stationary state of lowest energy; the energy of the ground state is known as the zero-point energy of the system. An excited state is any state with energy greater than the ground state. The relation connecting reduced volume and lattice constant is shown in Fig.5. In this figure the reduced volume increases and lattice constant also increases.   The relation between reduced volume and pressure is shown in Fig.6. This figure shows that reduced volume decreases with increase of pressure. The relation between lattice constant and pressure is shown in Fig.7. In this figure shows that lattice constant decreases with pressure increases. In certain pressure the band gap reaches zero (closure of band gap). This denotes metallization in CsCl (Fig 8).Lattice constant is calculated using the formula,

$$a = (V/Vo)^{1/3} \, ao$$

The energy gap is calculated using the formula,

$$Eg(P) = Eg(0) - KP$$

Murnaghan's equation of state to obtain the equillibrium lattice ground state properties. Pressure is calculated using the formula,

$$P = 1.5B_o[(V_o/V)^{7/3} - (V_o/V)^{5/3}][1 + 0.75 (B_o^1 - 4)\{(V_o/V)^{2/3} - 1\}].$$ In the above formula, V is the specific volume , Vo is the critical volume.
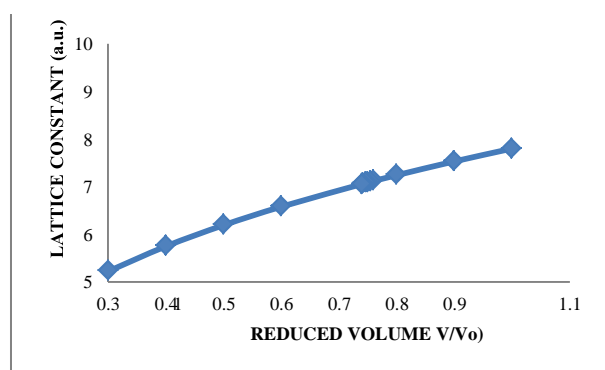
| Fig 5. Relation connecting reduced volume and lattice constant | Fig 6. Relation connecting reduced volume and pressure |
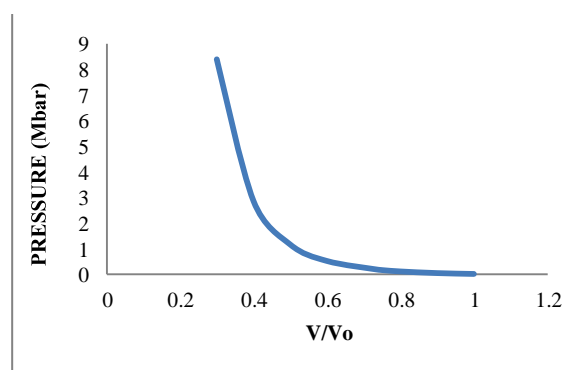
In Figure 2 &4 density of states increases steadily and reaches maximum with increase of pressure. The table 1 shows the calculated values of reduced volume, lattice constant, pressure and energy gap of CsCl. At 0.155 Mbar of pressure the cesium chloride becomes metallized. Our estimated bulk modulus of CsCl is 0.229 Mbar. The calculated   equilibrium lattice constant (a_o), bulk modulus (B_o) and band gap (E_g) values of CsCl is given in Table.3.

The metallization pressure and reduced volume values of CsCl are given in Table.2. The bulk modulus at normal pressure B_o is a parameter of great physical significance in high-pressure physics and few other thermo-physical properties. The value of B_o is related to the electron density. The structure with highest B_o will have low electron density and vice versa [9].
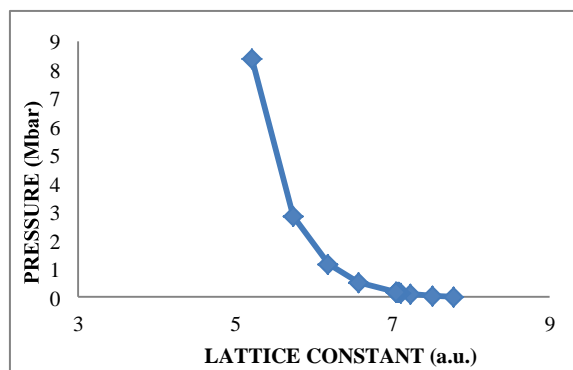
Fig 7. Relation connecting lattice constant pressure and pressure
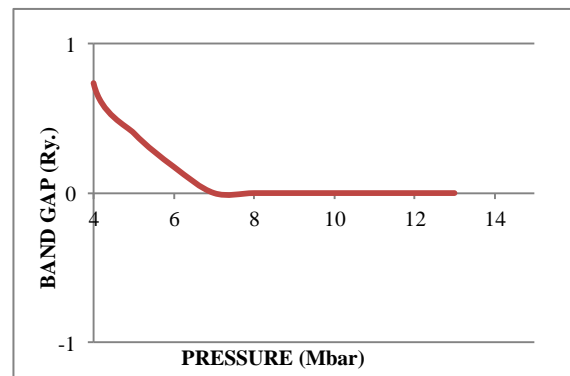
Fig 8. Relation connecting and band gap

Table 1. Reduced volume, Lattice constant, Pressure and Energy gap values of CsCl

Reduced volume V/V0	Lattice constant (a.u)	Pressure (Mbar)	Energy gap (ev)
1	7.791	0	6.960
0.9	7.522	0.032	5.488
0.8	7.232	0.097	2.585
0.76	7.1099	0.0 13	0.729
0.754	7.0911	0.145	0.401
0.75	7.0785	0.150	0.175
0.747	7.0691	0.155	0
0.742	7.0533	0.161	0
0.74	7.0469	0.163	0
0.6	6.5711	0.505	0
0.5	6.1837	1.148	0
0.4	5.7404	2.845	0
0.3	5.2155	8.376	0

Table 2. Metallization value of CsCl

Compound	Metallization	
	P_M (Mbar)	Reduced volume $(V/V_0)_M$
CsCl	0.155	0.747

Table 3. Equilibrium lattice constant, bulk modulus and band gap values of CsCl

Compound	Present work FP LMTO			Experiment XRD			Previous theory		
	a0 a.u	B_0 Mbar	E_ge V	a0 a.u	B_0 Mbar	Eg eV	a0 a.u	B_0 Mbar	E_geV
CsCl	7.791	0.229	6.96	8.2	0.1358	7.36	7.89	0.152	6.65

3.2 Metallization

At normal pressure, CsCl is a wide gap insulator with Eg=6.96ev (Fig.1). As pressure is increased, there is a charge transfer from s, p to d state; this causes the increase in the width of the valance band and also the empty conduction bands. These changes lead to the narrowing of the band gap and at particular pressure; there is a closing of band gap. CsCl becomes metals under pressure. The band structure and density of states corresponding to metallization of CsCl is shown in Figs.2 respectively. In CsCl, the direct closure of band gap (Fig 3) takes place at the reduced volume of V/V_o =0.747 the corresponding metallization pressure (P_M) is 0.1546 Mbar (Table 2). The metallization occurs because of the closure of band gap between p-like valance band and d -like conduction band (Fig.3). The increase of pressure causes the broadening of bands, which results in the decrease of density of states value in most of the energy regions of DOS histogram. Thus in Fig.4, the height of the spikes are considerably reduced. When pressure is increased E_F increases whereas no density of states is available at the Fermi level up to metallization pressure. There are appreciable values for DOS at V/V_o =0.747 (Fig.4) for CsCl indicating metallization. Further increase in pressure leads to enhanced density of states at the Fermi level, which induces superconductivity in CsCl.

4. Conclusion

The high pressure band structure, density of states, and metallization of CsCl is investigated. When the pressure is increased there is enhanced overlapping between the wave functions of the neighbouring atoms. As a result the width of valence and conduction band increases. These changes leads to narrowing and closing of band gaps (Metallization).The metallization pressure of CsCl is found to be 0.155 Mbar.

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Synthesis and Characterization of Vanadium Pentoxide (V$_2$O$_5$) Nanoparticles

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ABSTRACT

Vanadium Pentoxide (V$_2$O$_5$) nanoparticles have been prepared using a Hydrothermal method by Ammonium metavanadate as a precursor and Cetyl trimethyl ammonium bromide (CTAB) as surfactant. They are characterized using P-XRD, UV-Vis spectroscopy, FESEM, EDAX and Antimicrobial investigations. As there are many forms of vanadium oxides produced during this process, X-ray diffraction (XRD) technique was used to identify V$_2$O$_5$ phases. The size of as- prepared nanoparticles was around 45 nm. UV spectra indicate that the samples exhibit absorption bands below 400 nm which shows that there is a blue shift due to the quantum confinement of developed nanoparticles. The morphological properties of the V$_2$O$_5$ were investigated by FESEM.

Keywords: Hydrothermal, Surfactant, Morphological, FESEM, Structural

1. Introduction

V$_2$O$_5$ has been gained significant interest in the applied research to range of applications [1]. V$_2$O$_5$ is the most stable among all vanadium oxides and has high oxidation state [2, 3]. The outstanding properties such as a direct band gap in the visible-light region (Eg = 2.2 to 2.7 eV) [4], multi-valance, good chemical and thermal stability, excellent thermoelectric property make V$_2$O$_5$ nanostructure is a suitable material for solar cells [5], gas sensor [6], optical-electrical switches [7], chemical sensing [8], electrochromic devices [9], and optoelectronic devices [10,11]. Therefore, one dimensional (1D) nanostructures of V$_2$O$_5$ are considered to be more appropriate for the device applications as compared with its other forms. V$_2$O$_5$ nanostructures have been prepared by different techniques including chemical vapor deposition [12], magnetron sputtering [13], sol-gel method [14], pulsed laser deposition [15], electron beam evaporation [16], electro spinning [17], spray pyrolysis [18] and hydrothermal synthesis [19].

Transition metal oxides have been a subject of research in recent years in view of their fundamental and technological aspects. Among these, vanadium creates many compounds with oxygen; these have different structural, optical and chemical properties. Meaningful differences between the properties of different phases of vanadium oxides like VO, VO$_2$, V$_2$O$_3$ and V$_2$O$_5$ depend on their structure, which determines other properties [20, 21].

Vanadium pentoxide (V_2O_5) is a thermodynamically stable form which exhibits electrochromic properties. In this article, vanadium pentoxide nanoparticles are fabricated by using hydrothermal method. Structural and surface morphological properties have been studied.

2. Experimental Detail

The synthesis of V_2O_5 nanoparticles have been carried out by a surfactant assisted hydro thermal method. V_2O_5 was prepared by mixing of 3.52gm of Ammonium meta vanadate (NH_4VO_3) along with 0.01 mol of CTAB which dissolved in ethanol and mixed with distilled water. The 5ml of nitric acid has been added slowly in the above mixture for about 1 hour at 70°c with continuous stirring to reach the pH level '2'. The resulting solution was kept inside the hot air oven around 2 hours at 180°C for precipitation. After two hours, the precipitate was washed with distilled water for 10 times and then washed with ethanol. Finally, the sample was dried at room temperature and then calcinated at 400°C and 600°C for about 2 hours. After the completion of the above procedure the prepared nanoparticles are characterized using XRD, UV, FESEM with EDAX.

3. Result and Discussion

3.1. XRD Analysis of Pure V_2O_5 Nanoparticle

The average grain size of V_2O_5 nanoparticles has been estimated from full width at half maximum (FWHM) and the crystalline size was calculated with the help of Debye-Sherrer formula, which is given as

$$D = 0.9\lambda/\beta \cos \theta$$

Where, D is the crystalline size, β is the full width at half maximum (FWHM) of the most intense diffraction peak in radiance, θ the diffraction angle and λ the wavelength of X–ray radiation.
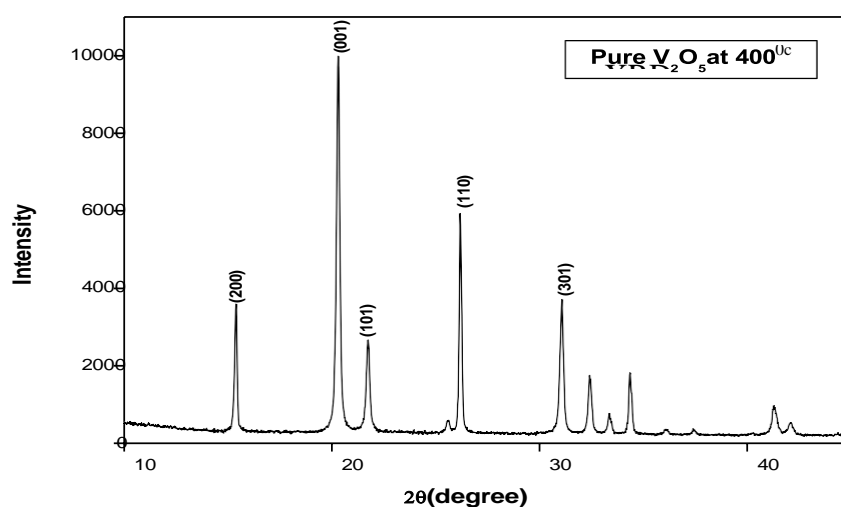
Fig 1. XRD spectrum of V_2O_5 nanoparticles at 400°C

The observed d-spacings and the relevant prominent peaks for the V_2O_5 nanoparticles correspond to reflections of (200), (001), (101), (110) and (301) planes and are in good a g r e e m e n t with the standard data (JCPDS card no: 77.2418; a = 11.51Å, b=3.564Å,c=4.368Å) and the PXRD peaks of V_2O_5 are at $2\theta = 15.414^0$, 20.329^0, 21.764^0, 26.196^0 and 31.078^0 respectively. No other impurities are observed. XRD spectrum shows orthorhombic structure of V_2O_5 annealed at 400°C. The mean size of the annealed V_2O_5 nanoparticles was found to be around 45nm from Debye-Sherrer equation.

Table 1. Comparison of JCPDS and observed d-spacing values of V_2O_5 nanoparticles at 400°C

Position 2θ (Degree)	FWHM (β) (Degree)	Observed d-spacing (Å)	JCPDS d-spacing (Å)	(hkl) Values	Relative Intensity (%)
31.078	0.115	2.875 42	2.8780	(301)	37.3
26.196	0.100	3.399 18	3.4045	(110)	67.2
21.764	0.113	4.080 28	4.0839	(101)	24.6
20.329	0.106	4.364 88	4.3680	(001)	100.0
15.414	0.100	5.743 85	5.7560	(200)	34.3

3.2 UV-Vis Absorbance Spectroscopy
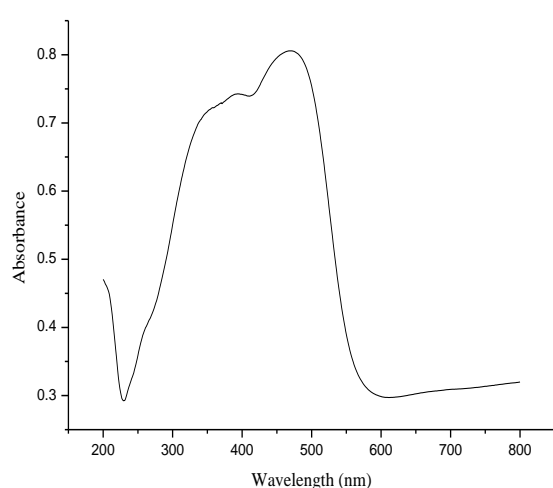
Fig 2. UV-Vis Absorbance Spectroscopy of V_2O_5 nanoparticles
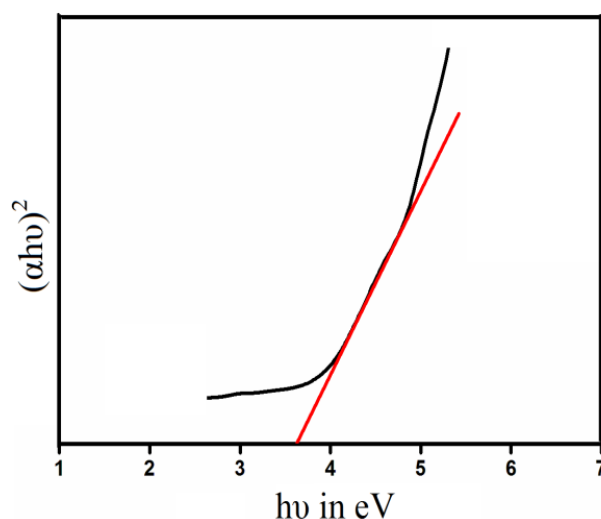
Fig 3. UV Bandgap energy of V_2O_5 nanoparticles

The UV-Vis absorption spectra were used to record 0.001 M of V_2O_5 which dissolved in ethanol. UV–Vis optical properties in the range (200–800) nm at temperature (400°C) showed temperature-dependent absorbance as given in Fig. It can be seen that the absorption peaks of V_2O_5 nanoparticles appear around 350 nm and the bandgap energy calculated from Tauc plot is found to be around 3.6 eV.

3.3 FESEM and EDAX of V_2O_5 Nanoparticles
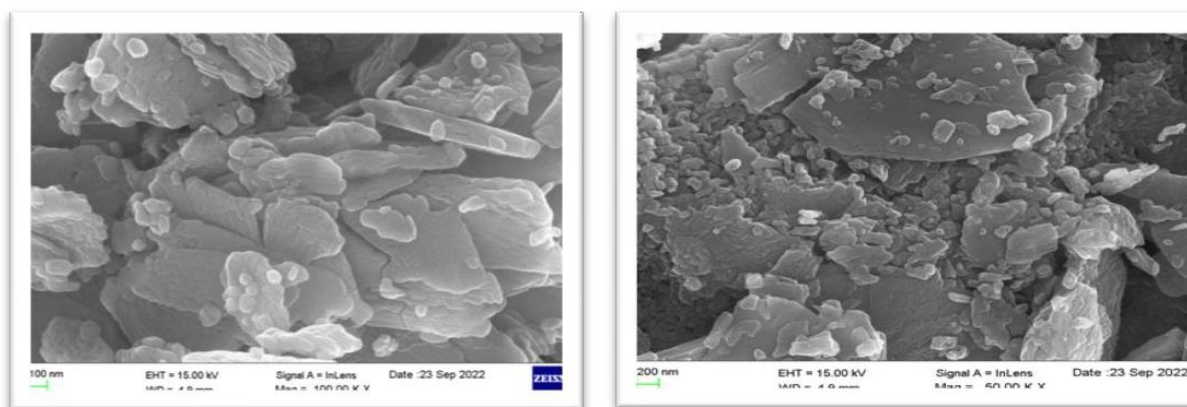
Fig 4. FESEM images of V_2O_5 nanoparticles at 400°C
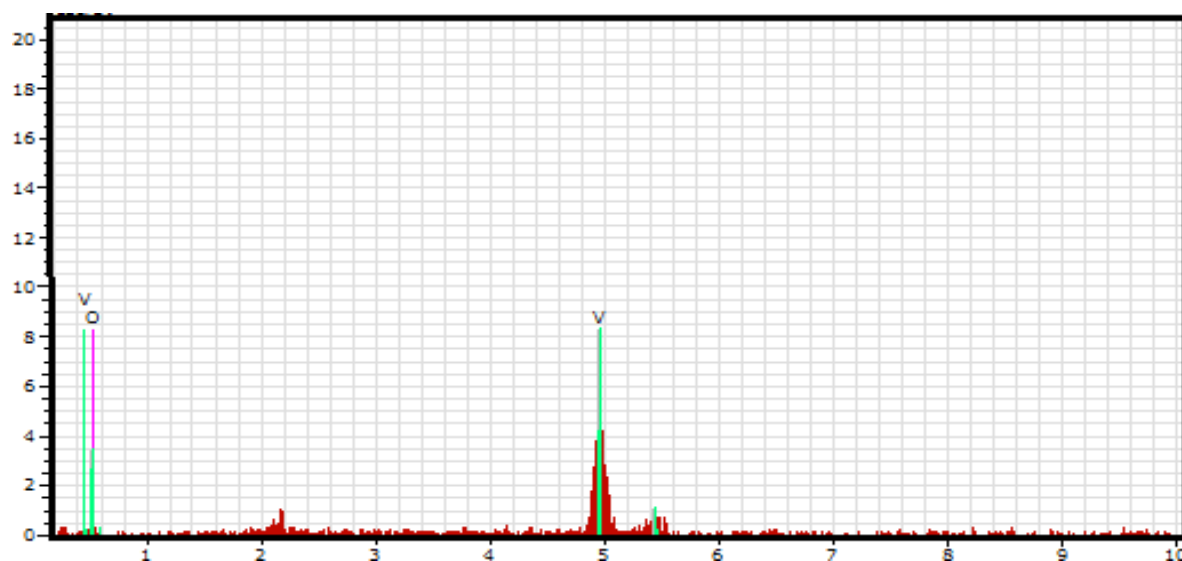
Fig 5. EDAX spectrum of V_2O_5 nanoparticles at 400°C

The surface morphology of the V_2O_5 nanoparticle is characterized by FESEM analysis and suggested rod like morphology. The elemental analysis (qualitative and quantitative) of the prepared sample was analyzed by EDAX spectrum. The EDAX spectrum confirms the elements present in the sintered sample are V and O ratio 23:1.

Conclusion

Vanadium oxide nanoparticles were successfully prepared using simple hydrothermal method by ammonium metavanadate as precursor and CTAB as surfactant. XRD spectrum shows orthorhombic structure of V_2O_5 annealed at 400^oC. The morphological properties of the V_2O_5 were investigated by FESEM. From FESEM images, it is clear that with increasing temperature the morphology of the particles changes to nanoparticle shaped and the size of particles decrese to 10 nm. UV-Visible spectra of V_2O_5 nanoparticles with surfactant exhibited absorption at 350 nm and the bandgap energy calculated from Tauc plot is found to be around 3.6eV.

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Growth of Cupric Oxide (CuO) and Zn Doped CuO Nanostructures on Glass Substrates: Water and Soil Repulsion Activity

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ABSTRACT

In the present work the superhydrophobic CuO and Zn doped CuO nanostructured thinfilms were synthesized by Sol-gel dip coating method. From the XRD analysis, the diffraction peaks along the (111), (111) and (311) planes confirm the monoclinic structure of CuO and the average crystalline sizes are 11.19 nm, 13.31 nm and 6.5 nm for Pure CuO, 0.05M Zn doped CuO and 0.09M Zn doped CuO respectively. Nano-flower morphologies of CuO with size ranging from 1-1.5 µm is observed by SEM images. The prepared CuO thinfilm exhibit superhydrophobicity repels the water droplet and sand and thus involves in self-cleaning activity.

Keywords: CuO Nanoparticles, Zn doped CuO, PEG, superhydrophobicity, self-cleaning.

1. Introduction

Research interest in nanotechnology has increased exponentially because of the unique chemical and physical features of nanomaterials, different of those from bulk one including electrical resistivity, electrical conductivity, strength and hardness, chemical reactivity and versatile biological activity [1,2,3]. Metal oxide nanoparticle CuO is a p-type semiconductor metal with a band gap between 1.4 – 2.1eV. CuO crystallizes in a monoclinic structure with the lattice parameters of a=4.684 Å, b=3.425 Å, c=5.129 Å, and β=99.28° [4,5,6]. CuO thin films are useful for light emitting diodes (electrical devices), computer memory, interference and electrochromic filters, magnetic films (data storage), solar cells, anti-reflective liquid crystal devices films, compact discs (optical storage devices), and electroluminescent devices [7,8]. CuO thin film transmittance is 20% in the visible spectrum and can reach 90% in the high wavelength visible area between 2 to 2.5 refractive index. Refraction, conductivity, reflection and anti-reflection can be sculpted and customised by calibrating material selection, thin layer thicknesses, and thinfilm layers [9]. In the preparation of CuO thin films, various techniques have been used such as spray pyrolysis, chemical vapor deposition, electro deposition, thermal oxidation, sputtering process, sol-gel and so forth [10]. Sol-gel approach has been used to manufacture CuO nanoparticles because it is easy, low-cost, and requires no specialist equipment [11]. Other than that, dip coating represents an efficient route to coat large surfaces [12]. Superhydrophobic surfaces repel water droplets. This unusual behaviour enables

self-cleaning, anti-icing, antimicrobial, oil-water separation, corrosion resistance, etc [13]. Coating surfaces with nanoparticles produces UV-blocking, antibacterial, antistatic, flame retardant, water and oil repellent, wrinkle-resistant, and self-cleaning surfaces. Now a days there is a rapid demand for the surfaces that resist dirt and contaminants [14].

2. Experimental method

2.1. Materials and method

Glass substrate, Copper nitrate trihydrate ($Cu(NO_3)_2 \cdot 3H_2O$), Zinc acetate dihydrate ($Zn(CH_3COO)_2 \cdot 2H_2O$), Polyethylene Glycol, ($HO(C_2H_4O)_nH$)), Ammonia (NH_4OH), Ethanol, Acetone and Distilled water.
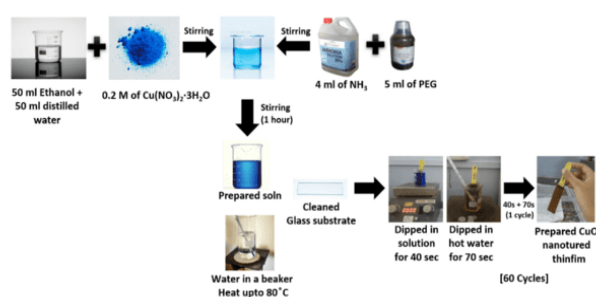
Fig 2.1 Synthesis of Pure CuO Nanostructured thinfilm

2.2 Synthesis of Pure CuO Nanostructured thinfilm

0.2M Copper nitrate is used as a copper source which is prepared by dissolving the solvent of Ethanol and distilled water in the ratio 1:1. 4 ml of diluted Ammonia is added to the above solution until the gel is formed. This gel acts as a precursor for the deposition of CuO nanostructures on glass substrates. 5 ml of PEG is added, which acts as a catalyser and stabilizer. Then the solution is stirred for one hour. The cleaned glass substrate is dipped in the precursor for 40 seconds followed by dipping in the double distilled water at 80˚C for 70 sec. The cycle is repeated for 60 times to attain uniformity of the substrate.
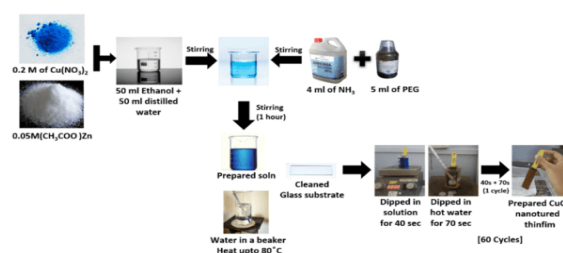
Fig 2.2 Synthesis of Zn doped CuO Nanostructured

2.3 Synthesis of Zn doped CuO Nanostructured thinfilm

0.2M Copper nitrate and 0.05M Zinc acetate is dissolved in the mixed solvent i.e., 1:1 ratio of Ethanol and distilled water. Thus, the solution is prepared. 4 ml of diluted Ammonia is added to the above solution until the gel is formed. This gel acts as a precursor for the deposition of CuO nanostructures on glass substrates. 5 ml of PEG is added, which acts as a substrate is dipped in the precursor for 40 sec followed by dipping in the double distilled water at 80˚C for 70 sec. The cycle is repeated for 60 times to attain uniformity of the substrate. Similarly, 0.09M Zn doped CuO Nanostructured thinfilm is prepared.

Result and Discussion

3.1 XRD

X-ray diffraction determined the phase purity and crystallinity of CuO nanostructured thinfilms. Fig.3.1 shows XRD patterns for pure and Zn-doped CuO films deposited on glass at 40 kV and 30 mA.

From Fig 3.1, it is clear that the obtained diffraction peaks of all the three samples correspond to the monoclinic phase of copper oxide (CuO) which is well matched with the
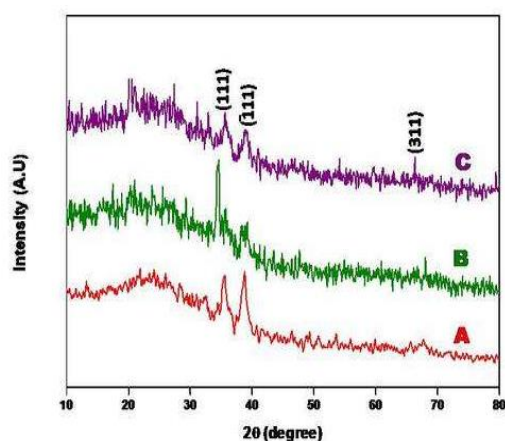
Fig 3.1XRD pattern of CuO nanostructured thinfilms
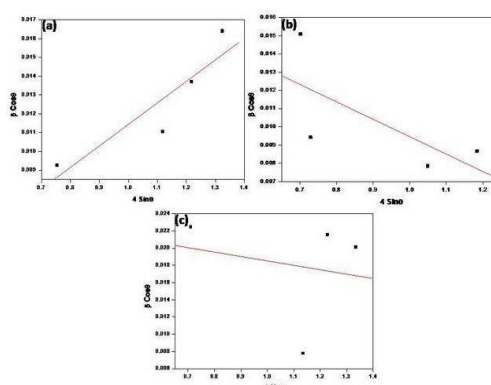
Fig 3.2 Williamson-Hall (W-H) Plot of CuO nanostructured thinfilms

standard JCPDS(PDF#05-0661) file. The deposited film for Pure and Zn doped CuO exhibit peaks at (-111) and (111). The peak intensity is varied with the addition of 0.05M Zn & 0.09M Zn which is attributed to the more available volume of grains in CuO thin films as seen in Fig. 3.1. Cu^{2+} ions in the lattice structure were replaced by Zn^{2+} ions as there were no much difference in the ionic radius of Cu^{2+} (0.73 Å) and Zn^{2+} (0.74 Å). Therefore, there is very small difference in intensity or shift in peak position is observed [15].

The mean crystalline sizes of the samples were determined using the well-known Scherrer formula are 11.19 nm, 13.31 nm and 6.5 nm for Pure CuO, 0.05M Zn doped CuO and

0.09M Zn doped CuO respectively. The mean crystalline sizes are also calculated using the Williamson Hall (W-H) plot and the values are found to be 10.85 nm, 12.38 nm and 5.59 nm for Pure CuO, 0.05M Zn doped CuO and 0.09M Zn doped CuO respectively. The grain size calculated from the XRD is comparable with the W-H plot calculations.

Table 3.1 Crystalline size of CuO nanostructured thinfilms

Nanostructured Thin films	Crystalline size (nm) Debye-Scherrer's Formula	Crystalline size(nm) W-H Plot
Pure CuO	11.19	10.85
0.05M Zn doped CuO	13.31	12.38
0.09M Zn doped CuO	6.5	5.59

3.2 SEM

SEM was used to study CuO nanostructured thinfilms for shape, size, and self-assembly. Fig.3.3 shows pure CuO and Zn-doped CuO nanostructured thinfilms. Images show regular,
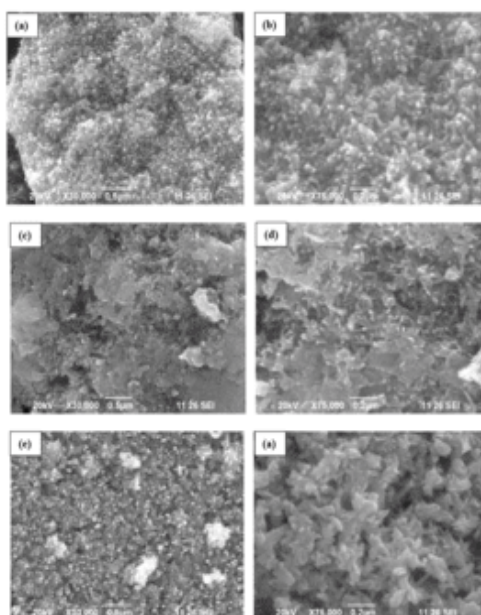
Fig 3.3 SEM images of (a), (b): Pure CuO (c), (d): 0.05M Zn doped CuO and (e), (f) 0.09M Zn doped CuO nanostructured thinfilms

homogenous nanoparticles with and without dopant. As dopant is added, surface nano grains nucleate and grow closer together. It is observed that as the addition of Zinc dopant, the particles assembled closer to each other and attain a fixed morphology. Self-assembly of nanoparticles is due to the weak interaction of Vander wall force. The particle sizes are found in the range of 1-1.5 µm.

3.3 Superhydrophobicity and Self-Cleaning activity of prepared CuO Nanostructured Thinfilms

Superhydrophobic surfaces of CuO are prepared without any surface adaptation in a simple way. Fig.3.4 shows the superhydrophobic behaviour of CuO and Zinc doped CuO nanostructured thinfilms. The prepared CuO thinfilm repels the water droplet and acquires the sense of the self-cleaning. The enhanced superhydrophobic behaviour is observed for Zinc-CuO nanostructured thinfilms. The self-cleaning activity of sand in Pure and Zinc doped CuO thinfilms are depicted in Fig.3.5.
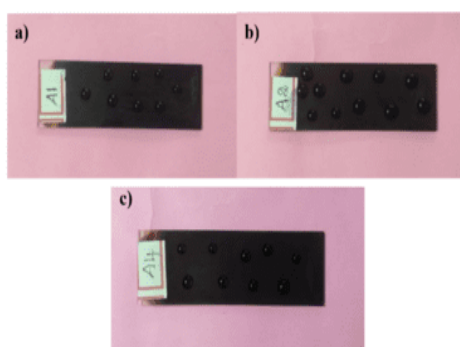
Fig 3.4 Superhydrophobic nature of (a): CuO (b): 0.05 M Zn doped CuO (c): 0.09M Zn doped CuO nanostructured thinfilm
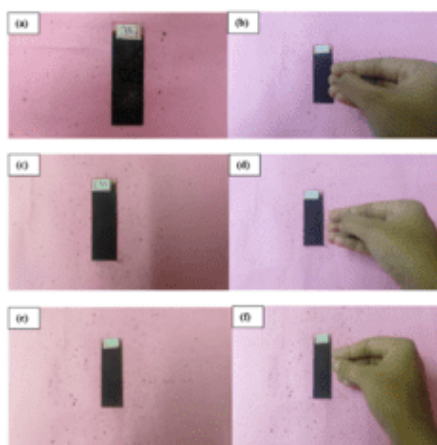
Fig 3.5 Self-cleaning of Sand in (a),(b): CuO (c),(d): 0.05 M Zn doped CuO (e), (f): 0.09M Zn doped CuO nanostructured thinfilms

3. Conclusion

The most prominent and utilizable CuO nanostructured thinfilm is fabricated using dip coating method. Its structural and morphological properties have been studied using XRD and SEM respectively. CuO nanostructures were deposited in the presence and absence of the Zinc dopant. In XRD the dominating intensity of the diffracted peaks (-111), (111) reveal the improved crystallinity of CuO nanostructures. It is identified from XRD that CuO is belongs

to the Monoclinic structure. The change in intensity of the diffracted peaks by CuO coating can clearly observe. The average grain size was calculated by De-bye Scherer's formula. The various morphologies of prepared films were observed through SEM images. The prepared CuO thinfilm was subjected to self-cleaning activity using water and sand and it revealed its excellent hydrophobic nature and soil repellent property.

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Physico-chemical and Thermal analysis of shell powder and fibres obtained from Tamarindus indica fruits

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ABSTRACT

To protect our mother nature, nowadays most of the synthetic products are replaced by natural products which are bio degradable. One such product is the composite material. These composite materials have various applications in industries such as automotive, construction, transportation, defence, furniture and so on. Composite materials may be made using manmade or natural fibres reinforced with resins. Natural fibre reinforced composites are the material of interest today because of its degradable nature. In the present work, Tamarindus indica (TI) fruits from Kanyakumari district are collected and their shells and fibres are seperated for investigation to be used as reinforcement in composite materials. They are characterized using p-XRD, FTIR, CHNS, SEM, TGA-DTA and chemical analysis. Also, the density of untreated and treated samples are found, so that it can be employed in making lightweight composites. The results indicated that the sample materials obtained from Tamarindus indica can be efficiently used as potential reinforcements in composites for attractive applications.

Keywords: natural fibres, bio degradable, composites, shells, light weight

1. Introduction

Environmental challenges, the depletion of oil reserves, and issues with global garbage are all growing increasingly severe nowadays as modern society advances [1]. Scientists and researchers have recently been working to maximize the potential of natural fibres to create the most sustainable, bio degradable and high-quality natural fibre products [2]. The quality of natural fibres is greatly influenced by various factors like the age of the plant, species, growing environment, harvesting, humidity, quality of soil, temperature, and processing steps [3]. In various applications, natural fibres extracted from plants are used as reinforcements in both thermoplastic and thermoset resins [4]. Natural fibres now dominate the automotive, construction and sports industries by their superior mechanical properties [5]. Mechanical properties of natural fibres can be increased by giving surface treatments to fibres [6]. The major advantages of using natural fibres in composites are the cost of materials, their sustainability and low density as compared to glass fibres [7].

2. Materials and Methods

Tamarindus indica (TI) is most commonly known as Tamarind tree. Tamarindus indica (TI) tree is of medium to large size, it is evergreen, 12-18 m in height and 7 m in girth [8]. Tamarindus indica (TI) fruits are collected from the villages of Kollachal, Kanyakumari district of Tamil Nadu, South India. The shell is extracted and then it is washed and dried in sunlight for 6 to 8 hrs. It has to be blend to produce the powder. The fruit fibres of Tamarindus indica are washed and dried. Then they are cut into small pieces inorder to get the sample material [9].

2.1 Treatment of fibres

Hydrophilic nature of composites is reduced and their mechanical properties are improved by chemical treatment of fibres. Even its density value changes due to the surface treatment of fibres [10]. In this work, Tamarind shells are treated with sea water, alkali (KOH) and permanganate ($KMnO_4$) solutions.

3. Results and Discussions

3.1. p-XRD Analysis of untreated TI shell powder

The Percentage Crystallinity (% Cr), Crystallinity Index (CI) and Crystalline Size (CS) of natural fibres are measured by p-XRD analysis using the equations given below.

$$\text{Crystallinity \%} = \frac{I_{200}}{I_{200}+I_{am}} \text{ x } 100$$

$$\text{Crystallinity Index} = \frac{I_{200}-I_{am}}{I_{200}}$$

where, I_{200} and I_{am} are the crystalline and amorphous intensities at 2θ scale.

$$\text{Crystallite Size} = \frac{\kappa\lambda}{\beta cos\theta}$$

where, K = 0.9; λ = 1.54060 x 10^{-10} m; $\beta = \frac{\pi}{180} \times FWHM$; θ = Bragg's angle.

The increased crystal size in natural fibre makes the fibre more stable because the water absorption ability of the bio-fibre depends on their crystal sizes [11]. Increase in crystallite size tends to show decreased hydrophilic behaviour [12]. The chemical reactivity of the fibre also decreases with increase in crystallite size and thus mechanical strength gets increased [13]. The crystallite size is 25.822 nm and is comparable with the result obtained by Gaba et al. in the XRD analysis of pineapple leaf fibres [14].
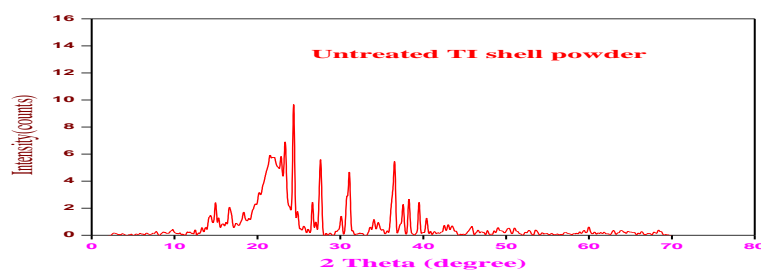
Fig 1. p-XRD pattern of untreated TI shell powder

Table 1. Crystallographic information obtained from p-XRD analysis

Parameters	Untreated TI shell
Crystallinity %	80.02
Crystallinity Index	0.7503
Crystallite Size (nm)	25.822

3.2. FTIR Analysis of untreated TI shell powder

The functional groups associated with untreated TI shell powder is determined using the Fourier transform infrared analysis. The FTIR spectrum of the experimental fibres were noted in the region between 4500- 400 cm^{-1}. The resolution was kept at 4 cm^{-1} [15].

Table 2. Vibrational band assignment of untreated TI shell powder

Wavenumber (cm $^{-1}$)	Vibrational band assignments
3449.46	O-H stretching of cellulose
2998.66	C-H stretching of cellulose
2920.70	C-H stretching vibration of cellulose
2851.71	C-H symmetric stretching vibration of hemicellulose
2362.24	O=C=O stretching
1648.24	Carboxyl stretch of C-O, indicating the presence of acetyl group in hemicellulose
1384.38	Asymmetric COC stretching of lignin
1060.52	C-O stretching
786.65	CO stretching
610.72	Out of plane bending vibration involving ring structure

Fig 2. FTIR spectrum of untreated TI Shell powder
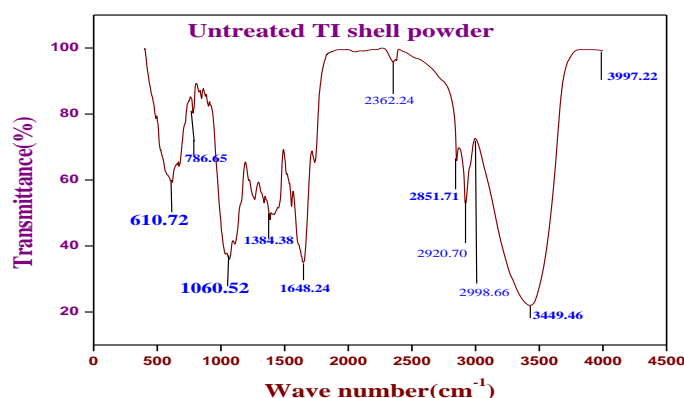
3.3. CHNS Analysis of untreated TI shell powder

The high percent of carbon indicates the hardness of the shell, high thermal & chemical stability and low density.

Table 3. Weight percent of C, H, N & S in untreated TI shell powder

S. No	Sample Name	N%	C%	S%	H%
1	Untreated TI shell powder	0.64	43.16	ND	6.52

ND: not detected

3.4 SEM Analysis of untreated TI shell powder

Surface morphology is a very important feature that decides whether the desired fibre material can act as a good reinforcement material or not [16]. The images of the sample surface is captured at different magnifications. Rough surface will have good adhesive nature with the smooth surface. The surface of tamarind shell powder is rough and so it can create good intermolecular bonding with the resin [17].
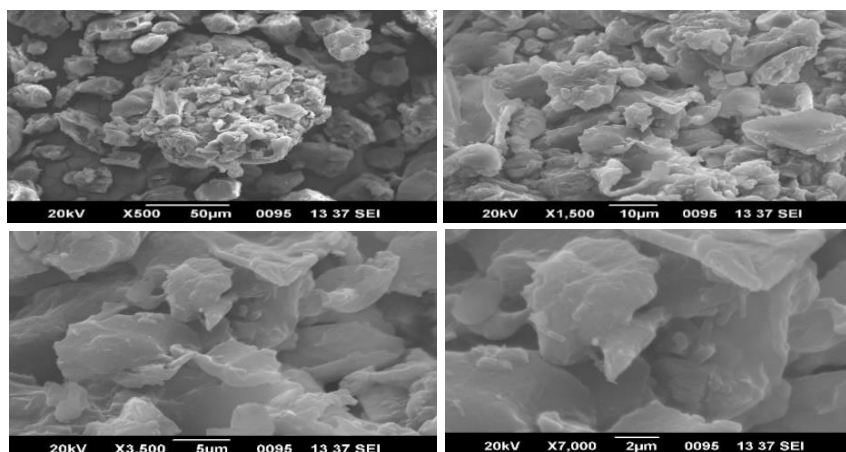
Fig 3. SEM images of untreated TI shell powder

3.4.1 EDAX Analysis of untreated TI shell powder

EDAX can be used to determine the amount of elements present on the surface of the sample.

Table 4. Weight % and Atomic % of elements present in untreated TI shell powder
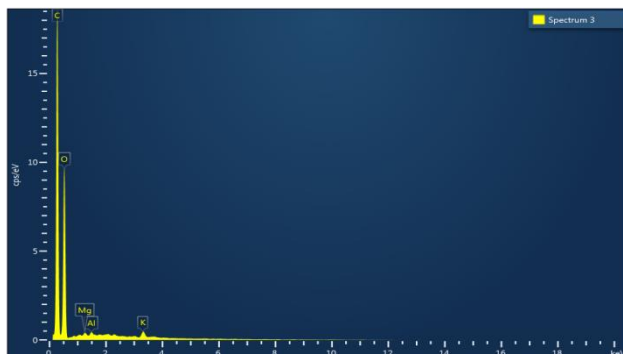
Elements	Untreated TI Shell powder	
	Wt %	At %
C	56.05	49.61
O	42	49.52
Mg	0.45	0.26
Al	0.42	O.22
K	1.08	0.39

Fig 4. EDAX spectrum of untreated TI shell powder

3.5. TGA-DTA Analysis of untreated TI shell powder

Physical properties of the material is affected due to the change in temperature [18]. The maximum degradation peak is found from DTG curve.

Table. 5 Thermal studies of untreated TI shell powder
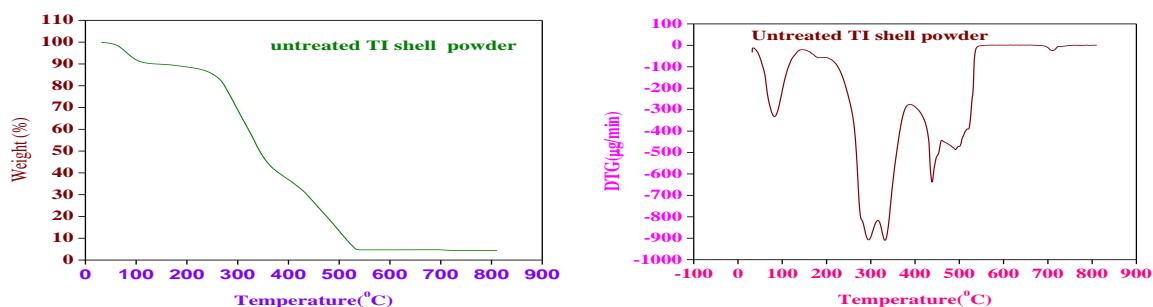
Fig 5. TG and DTG curve of untreated TI shell powder

3.6. Chemical Analysis of untreated TI shell powder

Sample	Temperature during mass loss (^{0}C)	Mass loss (%)	Residual char at 800^{0}C	Maximum Temperature limit (^{0}C)
Untreated TI shell powder	36-230	12.94	3.69	537
	230-384	47.61		
	384-537	34.42		

Different constituents of fibres have influence on various physical properties of the fibres.

Table 6. Chemical Composition of TI shell powder

On the whole, from analysis of the chemical composition of Tamarindus indica shell powder, it can be concluded that the percentage of chemical constituents of TI shell powder matches with many other natural fibres and also it has many advantageous properties.

3.7 Density of Tamarindus indica fibres

Density for fibres obtained from *Tamarindus indica* before and after chemical modifications is tabulated here.

Table 7. The Density of different fibres obtained from Tamarindus indica

Samples	Untreated Shell Powder	Sea water treated Shell Powder	KOH treated Shell Powder	KMnO₄ treated Shell Powder	Fruit fibres
Density (g/cm³)	1.22	1.04	1.15	1.31	1.09

4. Future Directions

Tamarind shells from different localities and from different ages of Tamarind trees can be obtained and examined for its properties. Hybrid composites can be prepared by using other natural fibre materials along with tamarind shell powder and its properties can be analysed by various studies.

5. Conclusion

Untreated TI shell powder exhibits good thermal and mechanical characteristics which are the most crucial needs for a natural fibre to be used as reinforcement in composites. Sea water treated sample is found to have the least density. Fruit fibres have the second least value. Therefore both these samples are advantageous to be used in the preparation of light weight

Chemical Composition	Cellulose (wt.%)	Hemi cellulose (wt.%)	Lignin (wt.%)	Pectin (wt.%)	Wax (wt.%)	Ash (wt.%)	Moisture (wt.%)
Untreated TI Shell Powder	55.23	21.63	10.72	15.62	0.65	2.96	10.80

biocomposites rather than other natural fibre samples.

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Facile Synthesis and Characterization of Nickel (III) Oxide Nanoparticles for Smart window Device Application

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ABSTRACT

In the present work Nickel (III) oxide nanoparticles were synthesized by means of simple chemical precipitation method. Nickel chloride and Oxalic acid was used as a starting material and the aqueous solution potassium hydroxide solution was used for this synthesis. The prepared nanoparticles of metal oxide nanoparticles, nickel (III) oxide nanoparticles were characterized by using X-Ray Diffraction (XRD) and Ultra Violet-Visible (UV-Vis) spectroscopic techniques. The average particle size, crystalline structure, phase identification and dislocation densities were determined using XRD analysis. The optical characters such as position of band gap, valance band edge, conduction band edges were analyzed by using UV-Vis Technique.

Keywords: Nickel Oxide, UV Spectroscopy, XRD.

1. Introduction

When compared to their bulk counterparts, nanomaterials have dramatically improved properties such as mechanical, electrical, magnetic, thermal, catalytic, and optical capabilities, which have greatly stimulated the attention [1, 2]. Due to its huge surface areas, peculiar adsorptive qualities, surface flaws, and quick diffusivities, nanosized crystalline metal oxides have attracted more and more attention in recent years [3]. Numerous products, including electro chromic films, magnetic materials, p-type transparent conducting films, gas sensors, catalysts, alkaline battery cathodes, and solid oxide fuel cells anodes, can be manufactured using nickel oxide nanoparticles [4]. Crystalline oxide particles with nanoscale dimensions have been created using a variety of mechanical and chemical processes. The primary goal is to reduce the costs of chemical synthesis and to produce materials for technological applications [5].

In the present work, our aim is to the synthesis of nickel oxide nanoparticles by the simple chemical precipitation method. The novelty of the work is the aqueous solution potassium hydroxide is used in the first time for the synthesis process; it reduces the particle size of the synthesis nanoparticles below 10 nm. Further the structural and optical properties of the nanoparticles were analysed using the characterization techniques.

2. Materials and Methods

A facile chemical approach was used to synthesize nickel (III) oxide nanoparticles. Oxalic acid and nickel chloride are the starting materials used in the synthesis process. The temperature controlled magnetic stirrer was used to effectively mix 0.5 Mole of nickel chloride hexahydrate into 50 ml of deionized water. In a similar manner, 50 ml of distilled water was used to dissolve 0.5 M of oxalic acid. Until it dissolved, the solution was thoroughly agitated using a magnetic stirrer. Oxalic acid and the nickel chloride solution was gradually added together and thoroughly agitated for about 30 minutes.

An aqueous solution of potassium hydroxide was prepared by adding 4 Mole of potassium hydroxide into 50 ml of distilled water. The as prepared aqueous solution was added to the mixture of solution that contains the precursor's cations and anions. The ions in the aqueous solution precipitate as an insoluble nickel (III) oxide nanoparticles. The chemical reaction takes place during the preparation process is as follows:

$NiCl_2. 6(H_2O) + C_2H_2O_4 + KOH \rightarrow NiO + KCl_2 + 7(H_2O) + C_2H0_4$
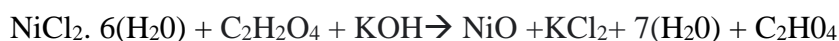
The solution contains solid nickel (III) oxide nanoparticles and also the potassium chloride, water in the solution form. The sub products were removed by washed using distilled water three instances consistent with day, washing system repeated for 2 days. After washing, the solution was stored in hot air oven at $100°$ C to get dried. Then the dried sample was powdered using the mortar and then kept in muffle furnace for heating at $300°$ C and subsequently preferred nickel (III) oxide nanoparticles was obtained.

3. Results and Discussion

The X- Ray Diffraction pattern of the as prepared nickel (III) oxide nanoparticles was recorded using X- Ray Diffractometer interfaced 'X' pert software with Cu-K Alpha radiations of wavelength of 1.54060 Å. The XRD pattern obtained for the synthesized Nickel (III) Oxide nanoparticles is shown in fig. 1 and the computed structuralparameters such as angle 2θ, d-spacing, miller indices and relative intensity data's are tabulated in Table 1.
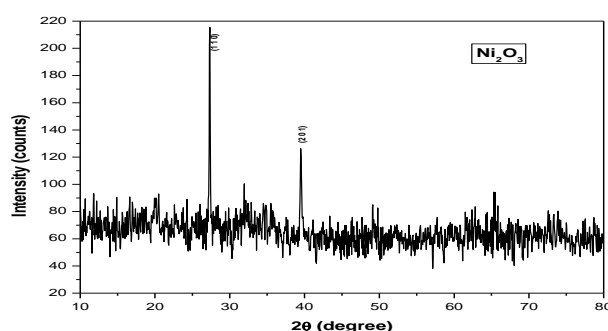
Fig 1. XRD pattern of Nickel (III) Oxide nanoparticles.

Table 1. Computed XRD parameters of Nickel (III) Oxide nanoparticles.

2θ (degree)	d-spacing (A°)	Miller Indices (h kl)	Relative Intensity (%)
27.3269	3.26366	110	100.00
39.5181	2.28044	201	41.33

From the XRD pattern, it was confirmed that the prepared nickel oxide nanoparticles show poor crystalline nature due to the reason that the samples were calcinated at low temperature as 300° C for an hour. Furthermore, the pattern indicates that the synthesized nickel (III) oxide nanoparticles belongs to hexagonal crystal system with preferred (1 0 0) orientation. The phase identifications were also carried out from the XRD and it was identifies the Ni_2O_3 phase which is highly agreed with the report of Kh M. Haroun et.al [6]. In order to know more about the particles nature, the average grain size or particle size and the dislocation densities were found out are shown in table 2. The average grain size of the as-synthesized nanoparticles is found out from the powder XRD pattern using Scherer's formula,

$$D = \frac{0.9\lambda}{\beta cos\theta} \text{ nm} \qquad (1)$$

Where λ is a wavelength (λ=1.5406 A°), β is full width at half maximum of the diffraction line and θ is the angle of diffraction.   The Dislocation density of the prepared sample was determined using the relation;

$$\delta = \frac{1}{D^2} \text{ lines/m}^2 \qquad (2)$$

Table 2. Calculated Particle size and Dislocation density

Angle2θ (degree)	θ (degree)	β (radian)	Grain size (nm)	Dislocation density 10^{15} (lines / m²)
27.3269°	13.66345°	0.1476°	9.669	0.001069
39.5181°	19.75905°	0.1968°	7.486	0.001784

The calculated average particle size and dislocation density values are 8.5775 nm and 0.001426×10^{15} lines / m² respectively. The particle size calculation conforms that the prepared materials are nanomaterials. Thus from the structural analysis, it was concluded that the aqueous solution used potassium hydroxide reduces the particle size of the nickel (III) oxide nanoparticles below 10 nm.

UV-VIS-NIR spectrum of the nickel (III) oxide nanoparticles were recorded in the wavelength range between 190 to 1100 nm using UV-VIS-NIR spectrophotometer. The optical properties of the nickel (III) oxide nanoparticles were analysed with the aid of the recorded absorbance and reflectance spectrum shown in fig. 2 and 3.
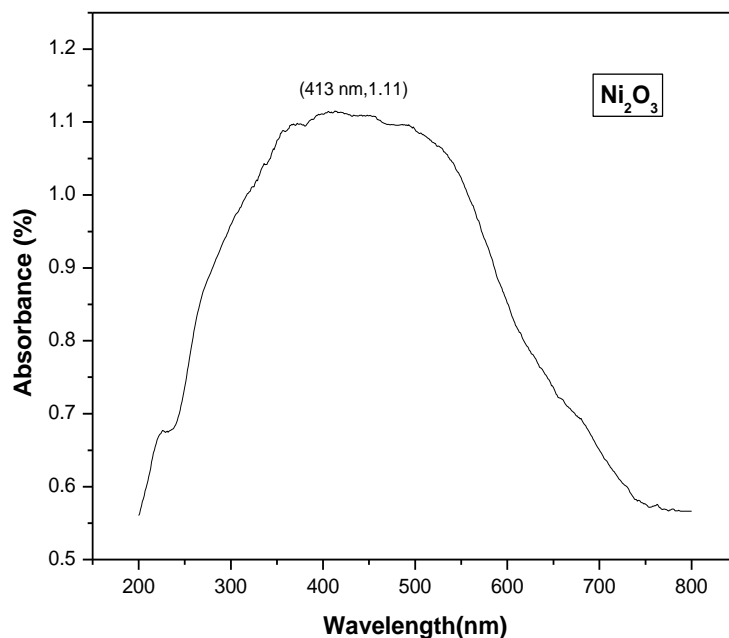
Fig 2. Optical absorbance spectrum
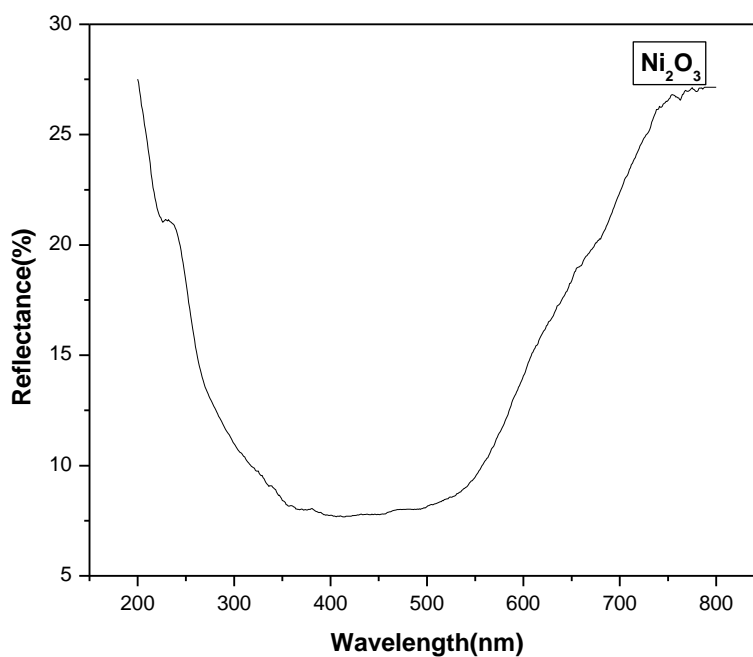
Fig 3. Optical Reflectance spectrum

According to Miessya et al [7], the characteristic absorbance peak at 413 nm wavelengthrange is due to the Ni_2O_3 nanoparticles. Nickel (III) oxide nanoparticles experience maximum absorbance of 1.1% at 413 nm wavelength. Reflectance spectrum confirms the maximum reflectance at the lower wavelength (200 nm) and higher wavelength (800 nm) of about 27.5 %. The lower reflectance of 7.5 % observed at the 413 nm wavelength. The optical band gap (E_g) value at the maximum absorbance wavelength (λ) is evaluated using the relation [8],

$$Eg = \frac{hc}{\lambda} \tag{3}$$

Where h and c are Plank's constant and velocity of light respectively. Furthermore, the position of the valance and conduction band [9] of the nickel oxide nanoparticles can be determined using the relations as follows;

$$E_{(CB)} = \chi - E^c - 0.5Eg \tag{4}$$

$$E_{(VB)} = E_{(CB)} + Eg \tag{5}$$

χ represents absolute electro negativity of the nickel oxide compound, calculated as the arithmetic mean of electron affinity and first ionization energy. E^c denotes the energy of free electrons on the hydrogen scale i.e. 4.5 eV. Where $E_{(CB)}$ is the band edge position of the valance band, $E_{(VB)}$ is the band edge position of the conduction band.

Table 3. Calculated optical parameters.

Optical Parameters	Calculated Value
Band Gap (eV)	3.00
Electro negativity	6.5
Position of valance Band (eV)	27.75
Position of conduction Band(eV)	30.7

The calculated optical parameters are tabulated in table 3. Wide band gap semiconductors are the semiconductor materials which have the optical band gap in the range above 1.5 eV. From the calculation it was known that the prepared nickel (III) oxide nanoparticles are wide band gap third generation semiconductor materials with electro negativity 6.5 value can be used as smart windows in power devices.

4. Conclusion

Nickel oxide nanoparticles of particle size 8.5775 nm were successfully synthesized by a simple chemical precipitation method. The preparation process is faster, cheaper and cost effective. From the structural characterization, it was confirmed that the synthesized nickel

oxide nanoparticles belongs to hexagonal crystal system and Ni_2O_3 phase. It was also interesting to note that, the aqueous solution used potassium hydroxide is used in the synthesis process; it reduces the particle size of the nickel oxide nanoparticles below 10 nm. The optical properties of the prepared nanoparticles were analysed using UV-Vis spectrophotometer. The prepared nanoparticle shows lower absorbance percentage, which confirms that the nanoparticles have higher transmittance. Thus the third generation semiconductor materials nickel oxide with lower absorbance and higher transmittance percentage materials can be used as smart windows in power devices. The future scope is the work can be extended to analyse the materials morphological and magnetic properties.

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Development of ZnFe$_2$O$_4$ Nanofiller Embedded Epoxy Composites

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ABSTRACT

In this analysis the ZnFe$_2$O$_4$ nanoparticle was synthesized by a simple physical method using ZnO and Fe$_2$O$_4$ as precursors. The pure epoxy sheet was initially formed by solution casting method and further the nanocomposite was synthesized. FTIR of epoxy reveals the formation of polymeric groups in sheet. The composite spectrum has slight shift in absorption band due to ZnFe$_2$O$_4$ nanofiller. The dielectric loss, dielectric constant, and AC conductivity values shows the influence of metal-based nanoparticle ZnFe$_2$O$_4$ incorporation and its activity corresponding to temperature and frequency.

Keywords: Metal oxide, Epoxy, Nanoparticle, Nanocomposite, Electric analysis

1. Polymers

Polymer is a one large molecule which consists of repeated structural units linked by the covalent bonds. Polymer composites are manufactured commercially for many diverse applications such as flooring, sporting goods, aerospace components automobiles etc [1]. The polymers can be classified according to their origin into two groups as natural polymers, synthetic polymers, but there is an additional group which exist between natural and synthetic polymers, which is semi-synthetic polymer [2]. Polymer and composite materials are much times lighter than typical metals. Polymer materials thrive far better than metals in chemically harsh environments [3]. This increases the life span of the aircraft and avoids costly repairs brought about by corroding metal components. Polymers have low specific gravity and specific strength and it has low coefficient of friction, good corrosion resistance, low density, economical, low mechanical properties, poor temperature resistance, poor tensile strength, can be produced transparent or in other colors etc [4]. Epoxy is the family of basic components or cured end products of epoxy resins. Epoxy resins, also known as polyepoxides, are a class of reactive prepolymers and polymers which contain epoxide groups [5].

Epoxy based composite materials are widely used in load-bearing applications e.g. automotive, aerospace and marine industries, because of their low cost, high specific strength, super adhesiveness as well as good heat and solvent resistance [6]. Unlike standard epoxy composites, dispersant addition of only small quantity is needed for enhancements in properties of epoxy nano composites, making them suitable for aerospace applications [7].

2.   Materials and Methods

Fig .1: Photograph of the ZnFe₂O₄ nanofiller embedded epoxy composite samples

2.1. Epoxy Resin

Epoxy resin LY556 with hardener HY951is taken for experiment. The Zinc ferrite nanoparticle was synthesized using Zinc oxide and ferrite oxide nanoparticles.

2.2. Synthesis of ZnO Nanoparticle

Pure $ZnFe_2O_4$ sample was prepared by solid state reaction method. High purity ZnO (99.5%) and Fe_2O_4 (99.5%) powders were carefully weighted in stoichiometric proportion and thoroughly mixed and hand grained in an agate mortar and pestle for about 1 hour. Then the mixture was calcined at the temperature of 700°C for 12 hours.

2.3. Preparation of pure epoxy sheet

Epoxy resin of 60gm and hardener of 6gm were stirred for 10 minutes using a Mechanical stirrer. Then the mixture was poured into the metal mould and undisturbed for an hour at room temperature, finally it was cured in an oven at 100 degrees Celsius for 2 hours. When the mould attains the room temperature the neat epoxy sheet obtained.

2.4. Nanocomposite sample preparation

Nanocomposite was prepared using a solution casting method. In the mechanical stirrer the particles were mixed with the epoxy resin in a high shear mechanical mixer at a speed of 700 rpm. Initially the epoxy resin and hardener were taken in two different beakers and they both degassed at 40°C for 2 hours. Similarly, the $ZnFe_2O_4$ nanoparticles were vacuum dried at 900°C, before mixing it to epoxy. Approximately, 60ml of resin was poured with the required quantity of filler particles and is slowly dispersed into the epoxy resin with continuous hand stirring. The mechanical mixer was then operated at 700 rpm for 90 minutes and the beaker is sonicated for 60 minutes. Then the appropriate amount of hardener was taken into the beaker, mixed vigorously for few minutes, and poured into the metal mold. The mold was left for curing inside an oven at 100°C for 2 hours. Likewise, the sheet was prepared for pure, 3wt% and 5wt% and was shown in figure 1.

3.   Results and Discussion

3.1. Fourier transform infared spectroscopy

Fourier Transform Infra-Red spectroscopy is used to characterize the functional groups of prepared pure epoxy and $ZnFe_2O_4$ epoxy - nanocomposite samples. The mode used in the

FTIR characterization is transmission. The FTIR spectrum for all prepared samples is shown below in figure 2-4.

Fig 2. FTIR spectrum of pure epoxy
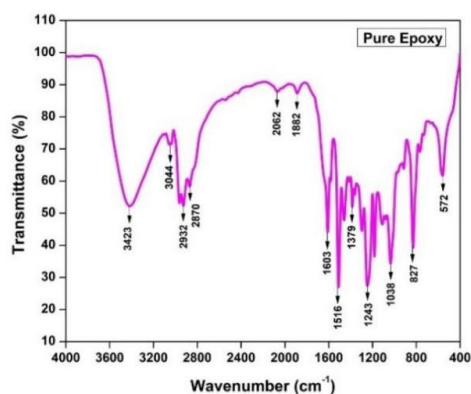
Fig 3. FTIR spectrum of Epoxy+3wt% ZnFe$_2$O$_4$ nanocomposite
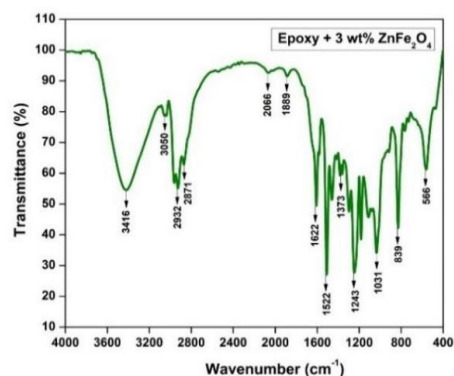
Fig 4. FTIR spectrum of Epoxy +5wt% ZnFe$_2$O$_4$ nanocomposite
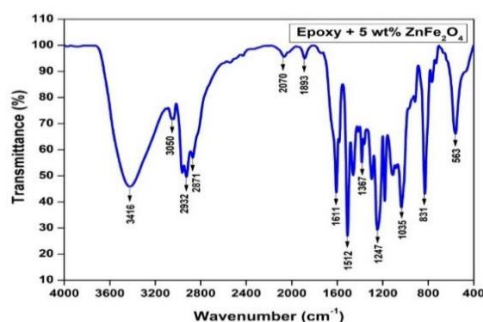
Wave Number (cm^{-1})			Assignments
Pure Epoxy	Epoxy + 3wt% ZnFe$_2$O$_4$	Epoxy + 5wt% ZnFe$_2$O$_4$	
3423	3416	3416	O-H stretching
3044	3050	3050	Stretching of C-H of the oxirane ring
2932	2932	2932	Asymmetric C-H stretching of CH$_3$ group
2870	2871	2871	Asymmetric C-H stretching of CH$_2$ group
2062	2066	2070	N=C=S stretching
1882	1899	1893	Overtone
1603	1622	1611	C=O stretching of aromatic rings
1516	1522	1512	C-C stretching vibration in aromatic
1376	1373	1367	O-H bending
1243	1243	1247	C-N stretching in amine
1038	1031	1035	Symmetrical aromatic C-O stretch
827	839	831	C-H out of plane deformation in aromatic
572	560	563	Bending vibration of C-H

Table 1. Frequency assignments for Pure Epoxy, Epoxy + 3wt% ZnFe$_2$O$_4$ and Epoxy + 5wt% ZnFe$_2$O$_4$

The spectrum data of obtained samples were listed in table 1. From the data FTIR spectrum of pure epoxy the band found at 3423 cm^{-1} corresponds to the vibration of hydroxyl group. The band at 2870 cm^{-1} corresponds to the Asymmetric C-H stretching of CH$_2$ group. The band at 2062 cm^{-1} corresponds to the stretching of the N=C=S [9]. The band at 1882 cm^{-1} corresponds to the overtone band of the vibration spectrum. The band at 1603 cm^{-1} corresponds to the C=C stretching of aromatic rings [8]. The appearance of band at 572cm^{-1} indicates the bending vibrations of C-H bond. The sharpness and intensity vary for different weight percentage of ZnFe$_2$O$_4$ nanofiller added epoxy nanocomposite [9]. A slight shift in absorption bands is observed for ZnFe$_2$O$_4$ nanofiller added epoxy systems. This is due to strong attraction of ZnFe$_2$O$_4$ nanoparticles with epoxy [10].

3.2. Dielectric analysis

3.2.1. Dielectric constant

Dielectric spectroscopy is based on the phenomena of electrical polarization and electrical conduction in materials. In the present work the relative permittivity and the loss tangents (tan δ) are determined from dielectric measurements using the instrument HIOKI 3532-50 LCR Hitester, over a frequency range 10^2 –10^6 Hz, at three temperatures 50°C, 100°C and 150°C. For testing, the sample is cut into the dimension of 7.5 X 6 X 4 mm. The applied voltage is set to 1V and during all the measurements, room temperature is maintained.

Temperature (ºC)	Dielectric constant of pure epoxy				Dielectric Constant of epoxy + 3Wt% ZnFe$_2$O$_4$				Dielectric Constant of epoxy + 5Wt% ZnFe$_2$O			
	1KHz	10KHz	100KHz	1MHz	1KHz	10KHz	100KHz	1MHz	1KHz	10KHz	100KHz	1MHZ
150	0.8511	0.5156	2.2149	1.6585	2.8590	1.6583	2.2145	2.5563	3.6883	1.5302	2.7901	3.8956
140	0.7373	0.4634	0.5422	1.6155	2.8345	1.6537	2.1860	2.5453	3.3929	1.5229	2.7453	3.6453
130	0.6282	0.3708	0.5091	1.9135	2.7221	1.6040	2.1551	2.5348	3.0452	1.4832	2.7351	3.4204
120	0.6224	0.3299	0.4801	1.8698	2.6659	1.4166	2.1405	2.5303	2.9226	1.4321	2.6906	3.3843
110	0.5116	0.3148	0.4768	1.8520	2.5406	1.3768	2.1226	2.5275	2.7456	1.3429	2.6714	3.2844
100	0.4313	0.2755	0.4465	1.8406	2.3447	1.3045	2.1089	2.5184	2.7351	1.2983	2.6314	2.9215
90	0.3717	0.2387	0.4287	1.8183	2.2859	1.1959	2.0981	2.5007	2.5439	1.1483	2.4500	2.8635
80	0.3513	0.2257	0.4101	1.8029	2.1396	1.0599	2.0135	2.4569	2.3425	0.9423	2.3162	2.8083
70	0.2737	0.1943	0.4117	1.7870	1.8817	0.0952	1.9810	2.4412	1.9423	0.7948	2.2274	2.7756
60	0.1996	0.1786	0.3641	1.7674	1.7796	0.8572	1.9542	2.4309	1.7924	0.5243	2.1927	2.7395
50	0.1035	0.1032	0.334	1.7739	1.4873	0.5181	1.9364	2.4111	1.6428	0.3481	2.1796	2.6686
40	0.0334	0.0753	0.308	1.7257	1.3753	0.4832	1.9059	2.3154	1.5496	0.1178	2.0733	2.6036

Table 2. Dielectric constant at various frequencies

Fig 5. Dielectric constant Vs   **Fig 6. Dielectric constant Vs**

Temperature at 1KHz   **Frequency at 40˚C**
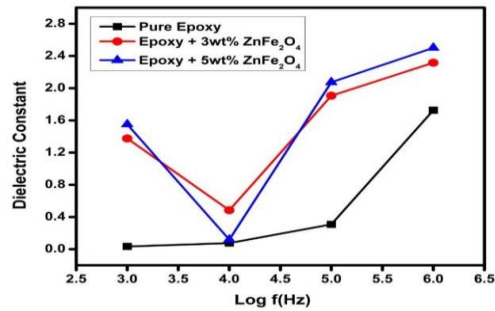
The dielectric constant of unfilled epoxy nanocomposites has a variation from nanofilled epoxy with respect to frequency. From Figure 5, the dielectric constant increases with the increase in temperature for all tested nanocomposites. In Figure 6 the further increasing frequency was found, the ε value increases for $ZnFe_2O_4$, displays strong ionic polarization and therefore has a high value of dielectric constant [11]. The other interesting observation from this study is that 3wt% and 5wt% $ZnFe_2O_4$ nanofiller added epoxy system has high dielectric constant.

3.2.2. Dielectric loss

Dielectric loss depends on the electrical conductivity which in turn depends on the number of charge carriers in the bulk of the material, the relaxation time of the charge carriers and the frequency of the applied electric field.

Table 3. Dielectric loss values of Epoxy and nanocomposites

Temperature (ºC)	Pure Epoxy				Epoxy + 3% $ZnFe_2O_4$				Epoxy + 5% $ZnFe_2O_4$			
	1 KHz	10KHz	100KHz	1MHz	1KHz	10KHz	100KHz	1MHz	1KHz	10KHz	100KHz	1MHz
150	0.0982	0.0487	0.0869	0.0087	0.1047	0.1921	0.0713	0.0247	0.2843	0.0548	0.0145	0.0249
140	0.0877	0.0474	0.0828	0.0086	0.0988	0.0973	0.0704	0.0235	0.2596	0.0523	0.0139	0.0239
130	0.0763	0.0453	0.0782	0.0071	0.0773	0.0773	0.0593	0.0228	0.1874	0.0479	0.0103	0.0232
120	0.0753	0.0427	0.0754	0.0068	0.0754	0.6768	0.0573	0.0227	0.1827	0.0454	0.0101	0.0294
110	0.0724	0.0395	0.0672	0.0064	0.0721	0.0716	0.0492	0.0226	0.1663	0.0382	0.0100	0.0251
100	0.0668	0.0382	0.0634	0.0060	0.0675	0.0674	0.0475	0.0225	0.1642	0.0299	0.0054	0.0240
90	0.0571	0.0369	0.0593	0.0059	0.0557	0.0473	0.0462	0.0217	0.1620	0.0190	0.0025	0.0230
80	0.0442	0.0352	0.0493	0.0056	0.047	0.0392	0.0354	0.0187	0.1483	0.0185	0.0022	0.0195
70	0.0323	0.0339	0.0489	0.0043	0.0449	0.0221	0.0279	0.0157	0.1398	0.0172	0.0021	0.0173
60	0.0301	0.0316	0.0477	0.0040	0.0400	0.0198	0.0175	0.0153	0.1368	0.0045	0.0020	0.0108
50	0.0289	0.0297	0.0465	0.0037	0.0398	0.0171	0.0153	0.0135	0.1283	0.0023	0.0019	0.0098
40	0.0271	0.0258	0.0458	0.0032	0.0286	0.0021	0.0112	0.0112	0.1148	0.0019	0.0019	0.0086

Fig 7. Variation of Tan delta Vs Temperature at 1KHz
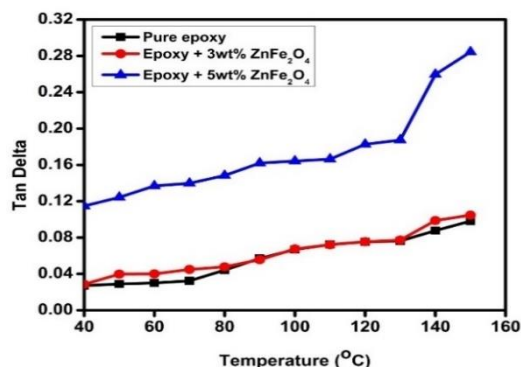
Fig 8. Variation of Tan delta Vs Frequency at 40˚C
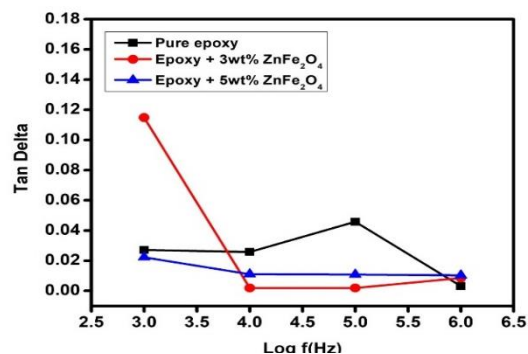
From table 3, the dielectric loss increases with increase in temperature for all the tested samples were analysed. In figure 7 the dielectric loss values decrease with increasing frequency up to1kHz and then slowly start to increase beyond 10kHz [12]. This observation probably is due to the presence of significant number of nanoparticles in the system which influences the electrical conductivity mechanism in the nanocomposites.

3.1.1. AC conductivity

The AC conductivity values for pure and $ZnFe_2O_4$ added epoxy nanocomposites are tabulated in tables 4.

| Temperature (°C) | Ac conductivity ($\sigma_{a.c}10^{-6}$) mho m^{-1} | | | | | | | | | | | |
| | Pure epoxy | | | | Epoxy + 3wt% $ZnFe_2O_4$ | | | | Epoxy + 5wt% $ZnFe_2O_4$ | | | |
	1 KHz	10 KHz	100 KHz	1 MHz	1KHz	10 KHz	100 KHz	1MHz	1KHz	10 KHz	100 KHz	1MHz
150	0.0046	0.0139	0.2839	0.8047	0.0173	0.1815	0.8821	3.5581	0.0206	0.0202	0.5918	2.1620
140	0.0036	0.0123	0.2495	0.7695	0.0148	0.0902	0.8577	3.3654	0.0193	0.0192	0.4503	1.6508
130	0.0027	0.0093	0.2211	0.7519	0.0113	0.0710	0.7153	3.2275	0.0175	0.0173	0.4149	1.5901
120	0.0026	0.0078	0.2011	0.7025	0.0107	0.0682	0.6805	3.1881	0.0172	0.0172	0.3786	1.5547
110	0.0021	0.0069	0.1782	0.6633	0.0094	0.0565	0.5804	3.1747	0.16	0.0166	0.3309	0.8849
100	0.0018	0.0058	0.1572	0.6148	0.0086	0.0519	0.5567	3.1506	0.0161	0.0161	0.3301	0.4187
90	0.0016	0.0049	0.1419	0.5912	0.0066	0.0347	0.5387	3.0215	0.0158	0.0157	0.3205	0.3509
80	0.0009	0.0044	0.1129	0.5601	0.0049	0.0252	0.3995	2.5658	0.0125	0.0125	0.2934	0.3131
70	0.0005	0.0036	0.1117	0.4291	0.0044	0.0130	0.3049	2.1247	0.0105	0.0111	0.2571	0.2703
60	0.0003	0.0031	0.0966	0.3939	0.0033	0.0105	0.1933	2.0698	0.0096	0.0100	0.1928	0.2475
50	0.0002	0.0017	0.0863	0.3677	0.0031	0.0085	0.1679	1.8037	0.0073	0.0100	0.1327	0.2362
40	0.00005	0.0011	0.0784	0.3098	0.0020	0.0061	0.1186	1.4451	0.0042	0.0086	0.0849	0.2192

Table 4. AC conductivity values for pure and $ZnFe_2O_4$ nanofiller added epoxy

AC conductivity increases with increase in temperature, especially conductivity values of nanocomposites are getting higher relative to increase in filler percentage were observed in figure 9. Thus, dielectric spectroscopy results of pure epoxy and epoxy $ZnFe_2O_4$ nano composites show different dielectric behaviors depending on the frequency and on the filler concentration [13]. From figure 10 the AC conductivity increases with increase in frequency for all the tested nanocomposites. Hence, using a low content of these fillers in epoxy the dielectric behavior is neither improved nor worsened. But the AC conductivity get increased by adding filler in higher concentration [14].

4. Conclusion

In this work, pure epoxy, epoxy +3wt% $ZnFe_2O_4$ and epoxy + 5Wt% $ZnFe_2O_4$ nano composites were synthesized by solution casting method. The size of developed sheets is approximately 22.64 mm thickness. FITR study proved the occurrence of epoxy and amine hardener and interaction with $ZnFe_2O_4$ nano particles. A slight shift in absorption bands is observed for $ZnFe_2O_4$ nano filler added epoxy system due to strong attraction of $ZnFe_2O_4$

Fig.9: Variation of AC Conductivity Vs Temperature at 1KHz
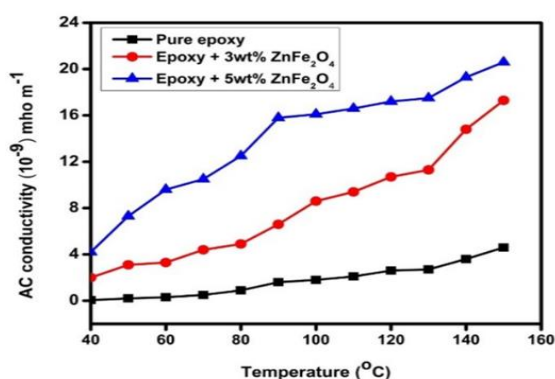
Fig.10: Variation of AC Conductivity Vs Frequency at 40°C
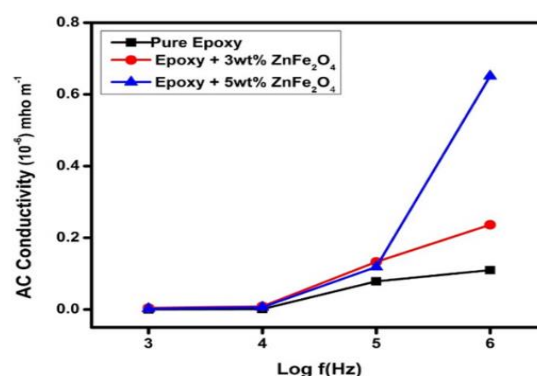
nanoparticles with epoxy. At low temperatures, the orientational mode cannot contribute to polarization. This leads to a lower dielectric constant at low temperatures. The presence of the significant number of nanoparticles in the system which influences the electrical conductivity mechanism in nanocomposites. The AC Conductivity increases highly with increase in frequency. The future scope of the work was analyzing its thermal stability and mechanical strength for suggesting the material in aerospace components and automobile industries.

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Multifunctional Applications of Hydroxyapatite: A Review

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ABSTRACT

The number of revision surgeries increases over time as life expectancy increases and more implants are placed in younger patients. Therefore, there is a growing demand for new ways to extend the longevity of load-bearing implants in vivo. In that case, Hydroxyapatite could be a better choice, especially in biomedical applications due to its bioactive properties. HAp is an inorganic biomaterial that belongs to the apatite family and has a similar structure to bone and teeth. The most important properties required for biomedical applications are biocompatibility, osteoconductivity, osteoinductivity, biodegradability, non-toxicity and environmental friendliness etc., which HAp has inherently. Moreover, these properties can be enhanced by changing some features, which could lead to better biomaterials and improved results. Apart from biomedical applications, HAp's also used to remove heavy metals from waste water, where it acts as an excellent adsorbent. This review focuses on the use of hydroxyapatite in applications such as bone tissue engineering, drug delivery, coatings, and the removal of heavy metals.

Keywords: Hydroxyapatite, biomedical, bone tissue engineering, osteoinductivity, biocompatibility

1. Introduction

In recent trends biomaterials take a major place due to its increase in properties such as biocompatibility, osteoconductive, non-toxic, biodegradability etc. These properties are rich in Calcium Phosphate biomaterial which is in recent trends. Depending on the Calcium and phosphate ratio present, these Calcium Phosphate biomaterials commonly known as Apatite family and is divided in to various types such as Monocalcium phosphate monohydrate with Ca/P ratio 0.5, Monocalcium phosphate (anhydrous) (Ca/P ratio 0.5), Dicalcium phosphate anhydrous (Ca/P ratio 1), Dicalcium phosphate dihydrate (Ca/P ratio 1), a-Tricalcium phosphate (Ca/P ratio 1.5), b-Tricalcium phosphate (Ca/P ratio 1.5), Calcium-deficient hydroxyapatite (Ca/P ratio 1.5–1.6), Hydroxyapatite (Ca/P ratio 1.67), Fluorapatite (Ca/P ratio 1.67), Tetracalcium phosphate (Ca/P ratio 2) [1]. Among the apatite family group Hydroxyapatite (HAp) takes a separate special place due to its chemical structures and properties similar to human bones. HAp is an inorganic biomaterial with chemical formula of $Ca_{10}(PO_4)_6(OH)_2$ with Ca/P ratio of 1.67 [2]. HAp can be synthesized in two ways i.e. synthetic and non-synthetic methods. Synthetic methods includes solgel, hydrothermal, precipitation methods, microwave assisted methods, mechano chemical etc. Changes in molar ratio, parameters, pH and temperatures can produce Stoichiometric HAp and addition of organic

modifiers controls the morphology of HAp. Though HAp from synthetic methods has some advantages, it may lead to side effects or toxicity when using in biomedical applications [2]. Extracting HAp from natural sources may produce non-toxicity, environmental friendly biomaterial. Numerous natural sources such as marine sources, shells, plants, minerals, mammal bones are available. By simple calcination at particular temperature of these sources produces HAp. HAp has been used in many applications mainly in bone tissue engineering as an implant material, drug carrying agent, removing toxic metals due to their resemblance of chemical structure of bone [3]. This review gives a detailed explanation of application of Hydroxyapatite.

2. Applications of Hydroxyapatite

2.1 Bone Tissue engineering

The number of motor vehicles and accidents increases in tandem with the population. In cases of minor injuries, bones can heal by themselves; but, in case of bone breakages, there is a need for implantation, which can be accomplished using biomaterials. Hydroxyapatite commonly used biomaterial for the bone tissue regeneration process since its chemical structure similar to bone. These biomaterials are typically employed as scaffolds during the implantation procedure. For a biomaterial to be used as an implant, it must also possess bioactivity, biocompatibility, osteoconductive properties, and other critical qualities. In addition to other requirements, the implant's mechanical strength must be comparable to that of the bone. Consequently, the mechanical strength difference between the implant and bone should not surpass a factor of 55 (between moduli) with regard to cortical bone [3]. A.Pal et al. performed in vitro test in MG63cells and found that the quantity of live cells grew over time and MTT results unambiguously show that the FBHAp is not cytotoxic. The optical density of the solution, which is related to the quantity of living cells on the surface, was determined using MTT assay. The concentration of live cells will increase as optical density increases [4]. A material's ability to completely produce new bone and support cellular activity must be met for superior bone replacement which can be tested by ALP activity [5]. Moreover, Hardness, compressive strength, tensile strength of the FSHAp scaffold studied by B.Mondal et al. is found to be 1.08GPa, 0.8GPa, 1.87 MPa. Also the implantation done on rabbit model and femur bones of wistor rats showed good osteoconductive properties [6]. D. Gopi et al carried out antibacterial activity on two bacteria's E. coli and Klebsiella using Malic acid mediated HAp with four different volumes of HAp i.e. 25µl, 50 µl, 75 µl, and 100 µl by agar well diffusion method and concluded that for 100 µl HAp concentration shows increased zone of inhibition upto a 4 and 4 mm for both the bacteria. Also, natural malic acid mediated HAp is found to be

higher due to the presence of minerals such as Mg, Na and Zn [7]. E.coli is the most used bacteria for antibacterial studies since it is found more commonly in bone infections known as osteomyelitis [8]. Additionally, an invitro test performed in an SBF solution over a period of time will reveal the creation of a porous apatite layer, confirming the material's osteoconductive capabilities [9]. Pectins from plant parts also contain antimicrobial, wound healing properties inherently which can used for proliferation of cells and enhances osteoconductive properties in bone tissue engineering [10, 11]. Other than this recent researches taken place for improved hardness, strength and bioactivity of the material using different fabrications such as HAp/Collagen, HAp/PMMA, HAp/PLA [3].

2.2 Hydroxyapatite as Coating material

The synchronisation between the implanting material and bone throughout the bone remodelling process is the first challenge that frequently arises. The methods used for implantation sometimes results in infections and other problems. This could be repaired using the right material coated with the implant [3]. Although HAp has all the bioactive properties, good tensile and compressive strength but in some cases sintered HAp has low fatigue properties and leads to fracture within few days due to the formation of extremely strong connections with living bone, sintered Hydroxyapatite (HAp) implants are prone to fatigue failure. These problems can be rectified by coating HAp on metal substrate such as Ti since its reactivity is high with HAp. The shear strength of the material is found to be 64MPa and concluded that implant coated HA resembles cortical bone in appearance. [12]. J.He et al also used titanium surface using plasma spraying method and showed good results in cell proliferation, differentiation. Layer by layer coatings is one of the methods used where the process includes dipping of implants in polyelectrolyte solutions. The efficiency of loading can be controlled by changing certain parameters such as concentration of solution, number of layers. The outcomes showed that the OH groups had a significant impact on the dynamics of collagen self-assembly and the creation of fibrous networks. In comparison to the Ti surface, the hydroxyapatite surface may also play a significant role in encouraging collagen self-assembly and the development of a fibrous network. Hence, these materials have an importance in surface designs of biomaterials [13].

2.3 Hydroxyapatite as Drug delivery carrier

Polymers have been important in the drug distribution process since the very beginning of the biomedical field. Recently bioceramic materials such as HAp become the important drug delivery agent due to its low solubility in physiological conditions and bioactive properties. HAp can be used in different forms such as polymer coated HAp/ nHAp particles, porous

HAp/nHAp granular particles [3, 14]. Desheng Feng et al. prepared a hollow hybrid HAp using HAp microparticles/ chitosan/sodium alginate multilayer and exhibited a maximum releasing efficiency of 90% [14]. Yang et al prepared Hierarchical porous HAp with drug loading efficiency of 31.6% [15].

But still, there are losses in orthopaedic applications due to the host tissue response being crucially linked to the implants. By using polyelectrolyte coated implants using LBL technique helps to carry the drugs and also increases the fragile proteins. BMP-2 coated implants were constructed which controls the host tissue's reaction to stimulate the production of bone from native progenitor cells. These BMP2 coated films are tested in MC3T3 E1S4 cells and results shows that BMP2 released promotes the bone differentiation [16]. Son et al. prepared HA coated on Ti discs using DEX loaded PLA nanoparticles with excellent osteinductivity by low temperature high collision method [17]. Zhenhua Li et al [18] constructed Gd doped Sr HAp nano vehicle using aptamer as a capping agent. The as prepared material tested in MCF7 and NIH3T3 cell lines. Pores have been opened by the use of aptamers and drugs were released resulting in the triggering of cancer cells. Moreover this has been a new method of killing cancer cells [18]. Apart from all sources, Ibrahim et al loaded ibuprofen in HAp prepared from eggshells. The as prepared HAp contains large pore size, small particle size and surface area [19].

2.4 Hydroxyapatite in Dental Applications

Dental work is typically necessary when harmful bacteria colonise the dentine, enamel form marginal gaps, and cause decay. Replacement of unhealthy or damaged teeth is the main goals of dental restorative materials which can be performed by biomaterials ought to be durable enough, simple to handle in a clinical setting and be commercially viable [20]. J.-H. Chung et al. prepared nanocomposites using HAp crystal as inorganic component and natural polymers (chitosan, alginate and albumin) as organic components which is tested in MG-63 cells and showed no cytotoxicity. Though HAp used for improvement of bone tissues, however, their bonding strength and fragility prevented them from being used more widely as implants in bone tissue engineering. In order to replenish nutrients and facilitate cell adhesion, the size of HA crystals is crucial in bone tissue engineering.

For the biological environment to be conducive for cell attachment, proliferation, tissue growth, and proper nutrient flow, a highly porous and nano crystal structure is necessary [21]. HAp also used as semiabsorbable alloplastic material and bone ingrowth/resorption is influenced by the HAp structure. The main advantage of using alloplastic materials is that there will be no transportation of diseases. To specifically allow for new bone ingrowth, the pore

size must be more than 100 mm. G. Carotenuto et al prepared such porous HAp material by slip casting technology where it produced the first layer of Macroporous HAp and second layer of dense HAp. First layer material helps in ingrowth of bones and second layer material is for the enhancement of mechanical properties. This method produced a highly porous material which is rid of cracks and fractures [22]. F ion and Sr commonly found in tooth enamel can be mixed with HAp so that it can reduce solubility and restore the minerals in tooth enamel could be a better choice in producing biomaterials for dental applications. Alireza Rajabnejadkeleshter et al synthesized strontium Fluoride- HAp where Strontium and Fluoride has a significant effect on the promotion of cell differentiation Growth by substituting HAp. From the cell viability results it is seen that as biomaterial showed improvement in cell proliferation and differentiation. Increase substitution of strontium leads to cell growth but also sometimes produces minor toxicity to the samples. From this it is clear that addition of Sr in proper concentration may help in promoting cell growth [23].

2.5 Removal of heavy metals

Water has been the most valuable resources of living beings which is polluted by many toxic elements of industrial wastes and disposals. Heavy metal such as Cr(III) and Cr(VI) found to be toxic produced from textile industries, paint manufacturing, fertilizer which creates severe problems to liver, heart and kidney. Some of the methods to remove heavy metals are adsorption, ion –exchange, coagulation, membrane etc. Adsorption is the most commonly used method which is low cost. In order to absorb the heavy metals, there is a need of adsorbent where activated carbon materials, MOF etc are used. Apart from these materials, HAp has a faster adsorption capacity and is also found to be regenerable [24].

Fe3O4@n-HApAlg beads were synthesized by periyasamy et al for the removal of chromium (VI) by hydrothermal method. The mechanism includes electrostatic attraction of positively charged Fe^{3+} and Ca^{2+} ions of the Fe_3O_4@n-HApAlg beads towards negatively charged chromate ions. The adsorption capacity is found to be 29.14 mg/g and adsorption isotherms had a better agreement with Freundlich, Langmuir and Dubinin-Radushkevich (D-R) isotherms. It is clear that reaction is impulsive and endothermic in nature by thermodynamics parameters. Moreover recyclability of the adsorbent is tested and results shows that material can be reused up to 5 cycles. Another added advantage of the adsorbent is that material can be taken back using magnet. Additionally field experiment was carried out in the water taken from Begambur in the Dindigul district of Tamilnadu where lot of people suffered from skin diseases due to the presence of chromium. Results shows that addition of Fe3O4@n-HApAlg beads as an adsorbent in to water successfully removed the chromium ions.

Sanna Hokkanen et al. removed Cr(VI) using Calcium HAp microfibrillated cellulose composite with adsorption capacity is found to be 2.208 mmol/g at 25°C. The process includes firstly, electrostatic interaction of adsorbent surface which is positively charged and adsorbate which is negatively charged, secondly attraction between adsorbent surface hydroxyl group and adsorbate, third step includes Ligand or ion-exchange reaction between adsorbent surface and adsorbate and final process is Dissolution – precipitation where the phosphate ions reacts with the chromium metal and forms an insoluble phase. From the Langumir isotherm it is seen that adsorption of chromium has been increased and thermodynamic process shows the reaction is endothermic and impulsive. For a material to be adsorbent, The kinetic data must fit with several isotherms such as Langumir, Freundlich and sips. Langumir isotherm is the model for the adsorption of monolayer in to surface. Freundlich equation is for the multilayer adsorption on to heterogeneous surface. Sips isotherms is the combination of Langumir and Freundlich but it well expresses the heterogeneous surface in a better way than other two isotherms [25]. Pawar et al. using avocado peel derived HAp and removed Cr(VI) with adsorption capacity of 50 to 200 mg/L at 30°C with adsorption efficiency of 91.27% at 0.5g of adsorbent dosage. It is seen that increase in adsorption efficiency as increase in concentration of adsorbent. Also Freundlich isotherm and pseudo second order model shows a better fit with the data observed in adsorption process [26]. Other than chromium, Selenium which is mostly found in Se (IV) and Se (VI) oxidation forms, is drained from soil and taken up by plants through their roots which will cause serious illness. Animal consumption of this causes serious illnesses. Although there are several ways to get rid of selenium, they don't work fully. Kongsri et al. prepared fish scale derived HAp with high absorption capacity due to electrostatic contact forces between the negatively charged selenite and the positive charge on the FHAp. The adsorption isotherm fits well with Freundlich and pseudo second order model [27]. Avram et al. removed ten heavy metals i.e. Co, Cr, Fe, Ni, Al, Mn, Cd, Cu, Pb, and Zn from mine waste water using low crystallinity HAp. Moreover, still studies have been going on to increase the surface area, porosity by adding cellulose, chitosan, gelatine and biopolymers [28].

3. Future outlook

New biomaterials are frequently created for a variety of uses due to advances in materials science and nanotechnology. HAp is utilised as a covering for metallic objects, an orthopaedic implant, as a drug delivery agent and in removal of heavy metals. Yet there is a limitation of using HAp as a load due to low mechanical strength which can be rectified by integrating natural polymers. Also by combining HAp with other Calcium Phosphate materials leads to increase in mechanical strength and other biological properties such biocompatibility,

osteoconductive etc [3]. Apart from these limitations, infections could be major problem leads to serious side effects which can be eliminated by using natural sources derived HAp since it has the biological properties inherently that needed for biomedical applications. Research is being continued to produce novel biomaterials as carries or fillers, to improve durability, mineralisation and also to promote bio film formation of biomimicking biomaterials. Though several adsorbents such as zeolite, cocoa shell, sawdust, distillery sludge and sugar beet pulp are available HAp's are produced to act as an adsorbent in various ways. Adsorbent percentage has to be increased for faster adsorbtion range which can be done by changing the selective parameters such as pH, dosage, temperature, adsorbent concentration etc.

4. Conclusion

New materials are frequently produced for a variety of uses due to advances in materials science and nanotechnology. Hydroxyapatite, a novel biomaterial took an interest among researchers from earlier days due to its similar structure to bone and teeth. Though it is found naturally in bones of living beings, it could be synthesized in two ways i.e. synthetic and non-synthetic methods. Synthetics methods produces a stoichiometric Hydroxyapatite but still sometimes causes a side effects since chemicals have been used. So, natural source becomes better choice which produces toxic free biomaterial. HAp's are used in wide variety of applications especially in biomedical applications due to its bioactive properties and also used as an excellent adsorbent in removing heavy metals from waste water which is a outstanding application producing fresh water in this water crisis world. Moreover, Hydroxyapatite will rule the future world in many applications with no further doubt.

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Albumen mediated green synthesis of Copper Ferrite Nanoparticles

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ABSTRACT

Copper Ferrite, a spinel ferrite nanoparticle with general formula AB_2O_4 possessing appealing magnetic and electrical properties due to their thermal and chemical persistence is synthesized using a simple self-combustion technique is made with the aid of albumen. The albumen plays the role of fuel in the process of combustion. Powder X-ray diffraction (PXRD) and Fourier Transform Infrared Spectroscopy (FTIR) findings confirmed that the prepared nanoparticles are of single phase and have a spinel structure. FTIR data revealed the functional groups present in the prepared nanoparticles. The agglomerated coalescence nature of ferrite nanoparticles is disclosed by the High-Resolution Scanning Microscope (HRSEM).

Keywords: *ferrite; PXRD; FTIR; HRSEM; albumen; spinel.*

1. Introduction

The Greek word dwarf inspired the prefix nano [1]. Many key technologies of the new millennium rely heavily on nanoscience and nanotechnology. It is the production, design, characterization, and application of structures, devices, and systems at the smallest possible scale by controlling shape and size (nanometre scale). The study and application of extremely small things is the focus of nanoscience and nanotechnology. These are applicable to all other science fields, including Chemistry, Physics, Biology, Engineering, and Material Science.

Ferrites are unusually viable due to their electrical, magnetic, and mechanical properties, which can be tailored to device manufacturing and biological applications. Magnetic nanoparticles are finding application in a range of biomedical applications, including disease diagnostics, magnetic resonance imaging, sensors, actuators, magnetic storage devices, and so on. The most significant magnetic materials that have yet to be thoroughly investigated in terms of their physical and chemical properties are nano-sized ferrites of MFe_2O_4 type [2].

Transition metal ferrite nanoparticles have recently gained attention due to their unique properties, which allow them to be used in fields such as magnetic storage, biomedicine, ferrofluids, catalysis, and magnetic refrigeration systems. Copper ferrite, which has a high electric resistivity and a low eddy current loss, is one of them. This ferrite has ferromagnetism, excellent creep and radiation damage resistance, high thermal conductivity, high electrical

resistivity, controllable saturation magnetization, moderate thermal expansion coefficients, energy transfer efficiency, and narrow line width in ferromagnetic resonance. Copper ferrite's properties make it suitable for a wide range of device applications, including magnetic materials, sensors, anode materials for batteries, catalysts, lasers, and microwaves.

Nanoparticles can be produced through physical, chemical, mechanical, and thermal processes such as coprecipitation, sol-gel, combustion, and ball milling. Green synthesis of nanoparticle is superior to other methods because it is simple, cost-effective, and relatively reproducible, and it frequently results in more stable materials. Microorganisms can also be used to produce nanoparticles, but the rate of synthesis is slow, and the method is limited to a limited number of sizes and shapes when compared to routes involving plant-based materials. There is no need for high pressure, energy, temperature, or toxic chemicals in the green synthesis method [3]. Santi Maensiri et al. [4] were the first to use albumen-enriched egg white to prepare ferrites substituted for transition metals.

In this research work, X-ray diffraction, Scanning Electron Microscope, and Fourier Transfer Infrared Spectroscopy are used to investigate the physical and chemical properties of nanoparticles. The ultimate goal of this research is to investigate the physical, chemical, and morphological properties of Copper Ferrite nanoparticles.

1.1. Experimental Procedure Preparation

Copper Ferrite magnetic nanoparticles were produced using ferric nitrate nonahydrate and copper nitrate hexahydrate of high chemical purity in addition with freshly prepared egg white. Egg white (albumen protein) are known for their foaming and blending features and it is simply soluble in water which makes it associate with metal ions effortlessly, egg white also contributes as binder cum gel for forming nanomaterials. Egg White and double distilled water are taken in 3:1 molar ratio to form homogeneous solution by forceful stirring at room temperature for two hours. Cu $(NO_3)_2$.$6H_2O$ and Fe $(NO_3)_3$.$9H_2O$ are combined in a 1:2 mole ratio and gradually added to a homogeneous egg white solution, which is vigorously stirred at room temperature for four hours; no pH adjustments are made during the process. The mixed solution was then heated on a hot plate at $80^{o}C$ for several hours, yielding a dried precursor. The powder was then calcined in a muffle furnace at $600^{o}C$ for 3 hours. [5, 6].

1.2. Characterization

X-ray diffractometer, Fourier Transform Infrared spectroscopic analysis with KBr pellets, and High-Resolution Scanning Electron Microscopy were used to characterise the calcined Copper Ferrite nanoparticle. X-ray diffraction with an XPERT PRO diffractometer confirmed the crystallite phase of the Copper Ferrite. The Fourier Transform infrared analysis

was reported using a Bruker IFS66V FT-IR spectrometer. High Resolution Scanning Electron Microscopy was used to examine the morphology of the prepared sample.

2.   Results and Discussion

2.1. X-ray diffraction Analysis

Figure 1 depicts the PXRD profile of $CuFe_2O_4$ nanoparticles. The typical reflections in the figure at (2 2 0), (3 1 1), (4 0 0), (5 1 1), and (4 4 0) correspond to face-cantered cubic spinel structure of $CuFe_2O_4$ and match extremely well with JCPDS card No. 22-1012 [7]. UNITCELL software determines the lattice parameter of the prepared Copper ferrite nanoparticle to be a = 8.406Å. Particle size D of synthesis was calculated using the Debye Scherrer formula and found to be 40 nm. $CuFe_2O_4$ nanoparticles' X-ray density and hopping length were determined to be P_x = 5.34 g/cc d_A = 3.639Å and d_B = 2.972Å, respectively [8].
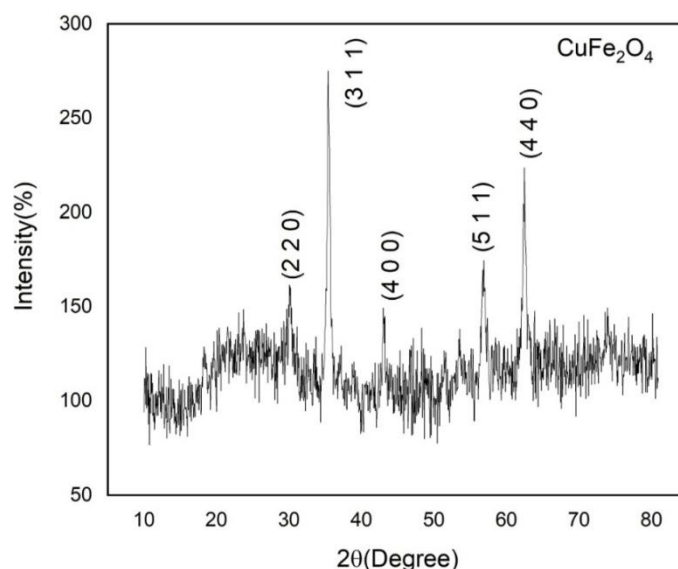
Fig 1. PXRD pattern of $CuFe_2O_4$

The particle size of the copper ferrite nanoparticles was determined from the full width at half maximum (FWHM) of the XRD patterns using the Scherer formula [9]

$$d = 0.9\lambda/\beta \cos\theta,$$

where d is the crystallite size (nm),

β is the full width at half maximum of the diffraction peak in radians,

λ is the X-ray wavelength and

θ is the Bragg angle.

The actual (X-ray) density of $CuFe_2O_4$ nanoparticles is calculated using the formula [10]

$$P_x = 8M/Na^3,$$

Where Mis the molecular weight of the sample,

N the Avogadro's number and

'a' the lattice constant

The distance between magnetic ions (hopping length) in A site (tetrahedral) and B site (octahedral) were calculated using the relations [11]

$$d_A = 0.25 \times a\ (3)^{1/2}$$

$$d_B = 0.25 \times a\ (2)^{1/2}$$

2.2. Fourier transform infrared analysis (FT-IR) measurement

FTIR confirms the formation of the spinel structure in $CuFe_2O_4$. FTIR spectra of the prepared Copper Ferrite sample was recorded in the wave number range of 4000 to 400cm^{-1} and portrayed in Figure 2. The intensive broad band at 3429 cm^{-1} and the less intensive band at around 1630 cm^{-1} are due to O-H stretching vibration interacting through H bonds. Traces of adsorbed or atmospheric CO_2 are evidenced by the very small absorption peak around 2924 cm^{-1}. The v (C=O) stretching vibration of the carboxylate group (CO_2^{2-}) is observed around 1389 cm^{-1} and the band at around 1102 cm^{-1} corresponds to nitrate ion traces. In the range of 1000 – 400 cm^{-1}, two main metal – oxygen bands at around 560 and 450 cm^{-1} were observed in the spectra of copper substituted spinel ferrite nanoparticles. The band at 566 cm^{-1} corresponds to intrinsic stretching vibrations of the metal at the tetrahedral site (Fe - O), whereas the band at 477 cm^{-1} is assigned to octahedral – metal stretching (Cu - O) [11, 12].
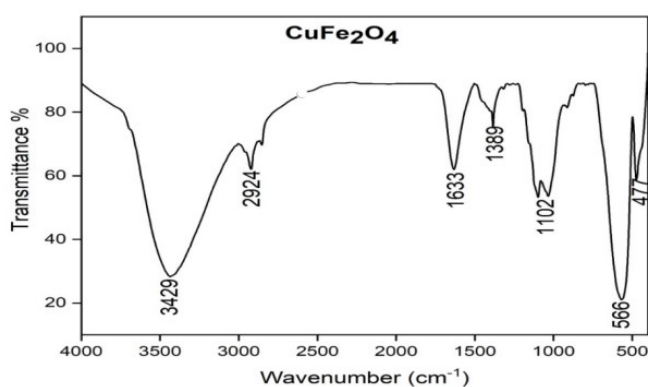
Fig 2. FTIR pattern of CuFe$_2$O$_4$

2.3. HR - SEM analysis

HR-SEM is used to record the morphology of the synthesised Copper Ferrite nanoparticles. Figure 3 depicts an HR-SEM image of $CuFe_2O_4$ at a magnification of 500 nm. There has been a significant accumulation of uniform spherically formed Copper ferrite nanoparticles. This is because of their magnetic nature and the binding of primary particles held together by fragile surface interactions such as Vander Waals force, ferrite nanoparticles accumulate. [13, 14].
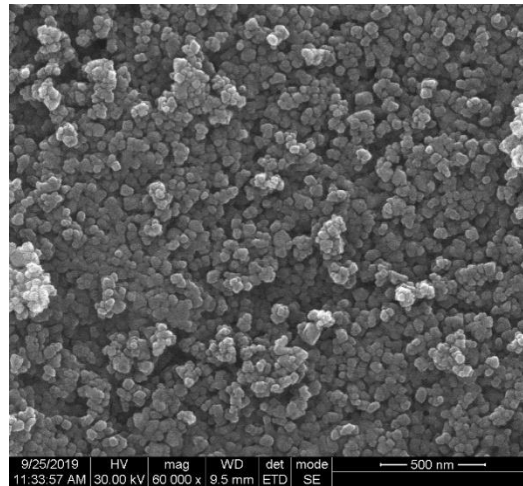
Fig 3. HR-SEM image of CuFe$_2$O$_4$

4. Conclusion

CuFe$_2$O$_4$ nanoparticles were successfully prepared using a simple self-combustion method with albumen (an egg white protein) as fuel. The gel formed by water soluble egg white served as a matrix for metal ion entrapment. According to the XRD analysis, CuFe$_2$O$_4$ has a cubic spinel structure with a particle size of 40 nm. The two main broad metal oxygen bands in the FTIR spectra confirmed the spinel structure. HR-SEM analysis revealed that the prepared Copper Ferrite nanoparticles were an accumulation of uniform spherical particles.

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Role of hexamine in the formation of Nickel Oxide Nano honeycombs by Hydrothermal method at different growth temperature

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ABSTRACT

Nickel Oxide (NiO) is a potential semiconductor being investigated for a variety of applications as many are dependent upon its typical shape. Nickel Oxide (NiO) nano honeycombs were perfectly prepared by hydrothermal method using equimolar solutions of Nickel Nitrate and Hexamethylenetetramine (HMTA) followed by calcination. This study aims to investigate the effects of hexamine on morphology of the Nickel Oxide structures. The structural and morphological analysis was done by the techniques such as X-ray Diffraction, Field Electron Scanning Electron Microscopy and Energy Dispersive X-ray Analysis was also dealt in detail. In addition, the NiO nanoparticles were subjected to photocatalytic degradation of Methylene Blue under UV irradiation and its efficiency was calculated.

Keywords: Hydrothermal method, Nickel Oxide, Hexamethylenetetramine (HMTA), XRD, FESEM, EDX

1. Introduction

Pollution of water and air due to intensive human activity is undoubtedly a major concern worldwide. The amount of wastewater from the textile industries has been increasing together with the effects of the growing demand for textile products. The release of waste water into the environment can be the reason for serious health and environmental issues. The dye stuffs that the textile waste waters contain and their breakdown products might have toxic and mutagenic features to life [1]. Without any treatment, these dyes can be stable and remain in the environment. To obtain the purity of these media without imposing more strain on the environment, the scientific community look for sustainable, green solutions. Metal oxide nanostructures play a vital role in providing potential solution for this problem. Even though number of metal oxide nanostructures (such as TiO_2 and ZnO) were used as photocatalysts [2,3], NiO is suitable for the purification and detoxification of water which satisfies the requirements of photocatalysts such as stability, non-toxicity and photo-activity of material. NiO is a p-type antiferromagnetic semiconductor with a wide band gap of 3.6–4.0 eV which is used in various fields such as gas sensors, electrochromic films, catalysis, fuel cell electrodes, and magnetic materials [4,5].

In the present work, we have investigated the effect of hexamine on the structure, crystallite size, surface morphology and optical properties of NiO nanoparticles prepared using the simple and cost effective hydrothermal method and its photocatalytic action on organic pollutants such as Methylene blue.

2. Materials and methods

2.1 Materials

Nickel nitrate, Urea, Hexamine, Ethylene Glycol, Distilled water.

2.2 Experimental process

The 0.3M $Ni(NO_3)_2$ solution was prepared in Distilled Water and Ethylene Glycol in the ratio1:1. Also, 0.1M urea solution was prepared in the same ratio of DW & amp; EG and added ropwise into the nitrate solution. The pH of nickel nitrate solution was adjusted to 12 by adding aqueous ammonia and continuously stirred for 30 min. Then, 1g of Hexamine was added to the resultant solution and stirred for 2h to make a homogeneous mixture. This homogeneous mixture was further transferred to Teflonlined stainlesssteel autoclave. The hydrothermal reaction was carriedout at 180^0C for 12h and cooled down to room temperature naturally. The final precipitate was washed several times with distilled water to remove the impurities and dried in hot air oven at 100^0C. Finally, the obtained powder was calcined at 400^0C for 2hours for the transformation of Ni(OH)2 to NiO [6]. The reactions were carried out by varying the amount of Hexamine.

3. Results and Discussion

3.1 XRD Analysis

Fig.1 shows the XRD spectra of nickel oxide nanoparticles prepared with 0.5g , 1.0g, 1.5g and 2.0g of Hexamine. It is composed of various characteristic diffraction peaks of nickeloxide nanoparticles. The changing amount of nickeloxide nanoparticles are belong to tetragonal structure symmetry with slight variation in diffraction peak intensity and the unit cell parameters [7]. The unit cell parameters of all the grown crystals are tabulated in Table 1.

Nanoparticle Samples	Dopants added	Average grain size (nm)	Dislocation density x 10^{14} (lines/m^2)
NiO	Hexamine 0.5 g(H_1)	55.8080	3.2107
NiO	Hexamine 1.0 g(H_2)	34.2445	8.5274
NiO	Hexamine 1.5 g(H_3)	24.9099	16.1159
NiO	Hexamine 2.0 g(H_4)	13.9229	51.5870

Table 1. Dislocation density value of NiO nanoparticles synthesized using 0.5 g, 1.0 g, 1.5 g and 2.0 g of hexamine
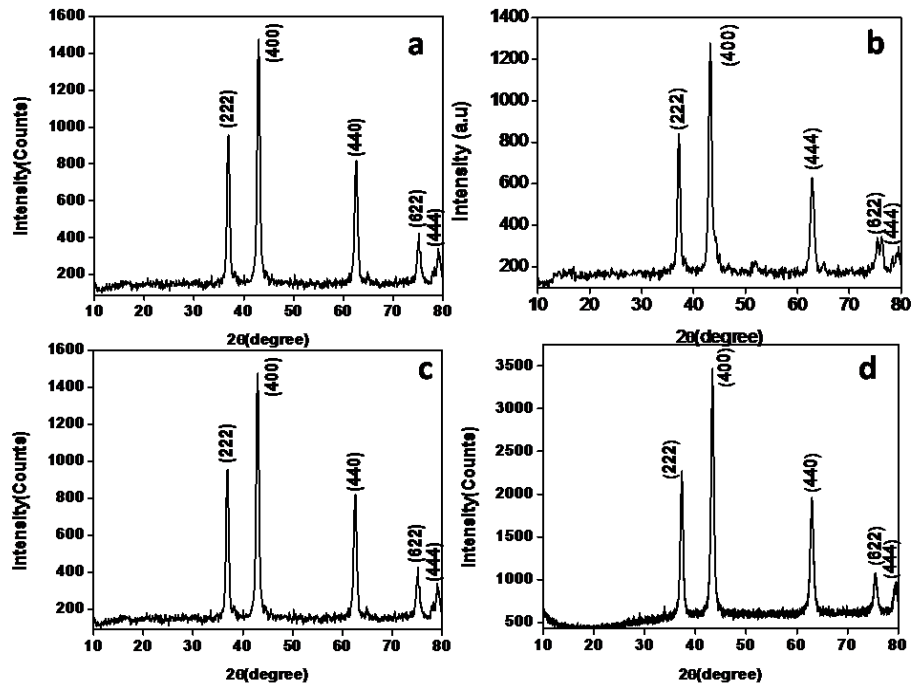
Fig 1. XRD spectra of Nickel Oxide Nanoparticles synthesized

using 0.5 g, 1.0 g, 1.5 g and 2.0 g of hexamine

3.2 UV Spectroscopy

A UV-Vis spectrum of the sample is taken in the wavelength between 200nm and 800nm. The absorbance and transmittance spectra of the prepared NiO nanoparticles (a,b,c,d) as shown in Fig 2 & 3.
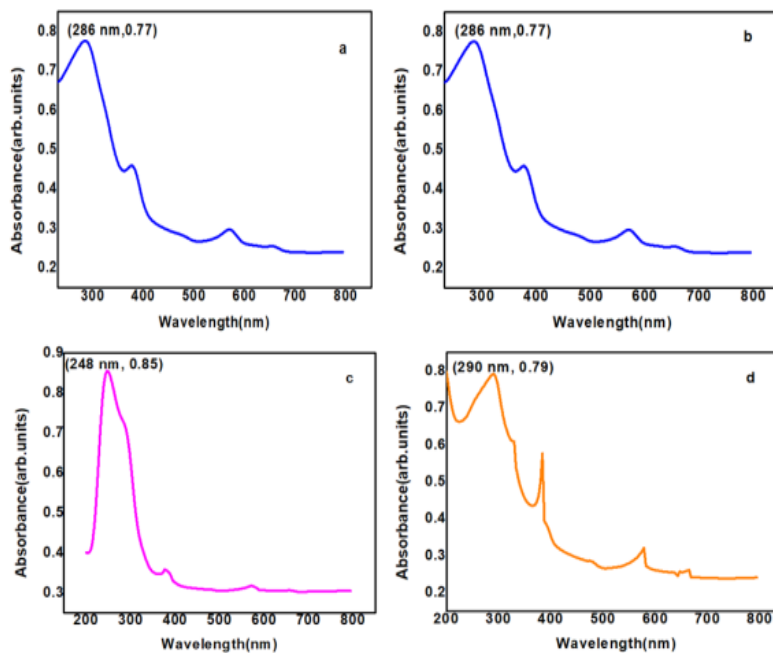
Figure 2. UV-V is absorbance spectra for NiO Nanoparticles synthesized

using 0.5 g, 1.0 g, 1.5 g and 2.0 g of hexamine
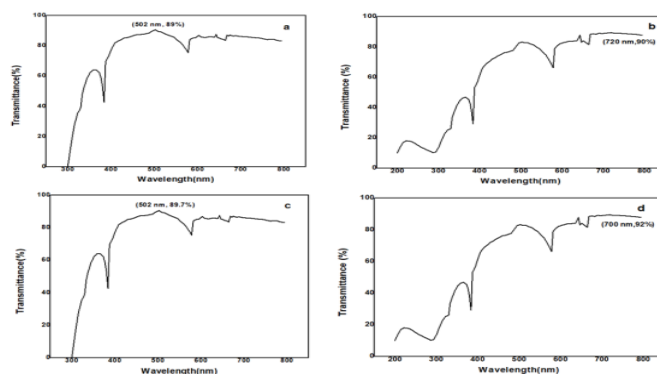
Figure 3. Transmittance spectra for NiO Nanoparticles synthesized

using 0.5 g, 1.0 g, 1.5 g and 2.0 g of hexamine

Nickel oxide sample	Band gap energy
NiO (hexamine 0.5g)	3.4eV
NiO (hexamine 1.0g)	3.85eV
NiO (hexamine 1.5g)	3.45eV
NiO (hexamine 2.0g)	3.35eV

Table 2. Band gap of nickel oxide nanoparticles

3.3 Scanning Electron Microscope

The FESEM images depict morphological features of NiO nanostructures in Fig 4. The honey comb like structure appeared was shown in Fig 4. The honey comb like structure was obtained when 1,5 g of hexamine was used. In Fig (4a), it is seen that the nucleation results in incomplete growth due to average-proficient when the amount of hexamine used is minimum. The NiO nanostructure formation when minimum amount of hexamine was used (Fig 3b), were not well oriented and dispersed. As the amount of hexamine increased above 1.5 g, the particles turned to honey comb like structure which is shown in Fig 4c and 4d.
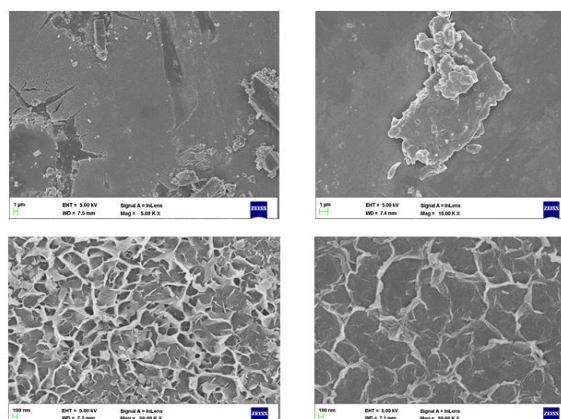
Fig 4. SEM image of NiO nanoparticles synthesized

using 0.5 g, 1.0 g, 1.5 g and 2.0 g of hexamine

3.4 Edx

EDX can be used to determine the amount of elements present on the surface of the sample and can be used to estimate their relative abundance. The distribution of the element nickel oxide has the average value specified with aid of EDX, which is attached on the scanning electron microscope. Fig 5 offered the amount of elements distributed on the surface of nickel oxide in terms of the atomic and weight percent. Specifically it was observed that oxygen and nickel are on major peak for all the samples. But the oxygen content is decreased in weight percentage and increased in atomic percentage. But nickel content was slightly increased in weight percentage and decreased in atomic percentage such variation may take place because of the absence of vacuoles in the treated sample which is also confirmed in SEM analysis [8].

ELEMENT	WEIGHT%	ATOMIC %
O	33.60	64.99
Ni	66.40	35.01
TOTAL	100.00	

Table 3. The weight % and atomic % of various element present in NiO
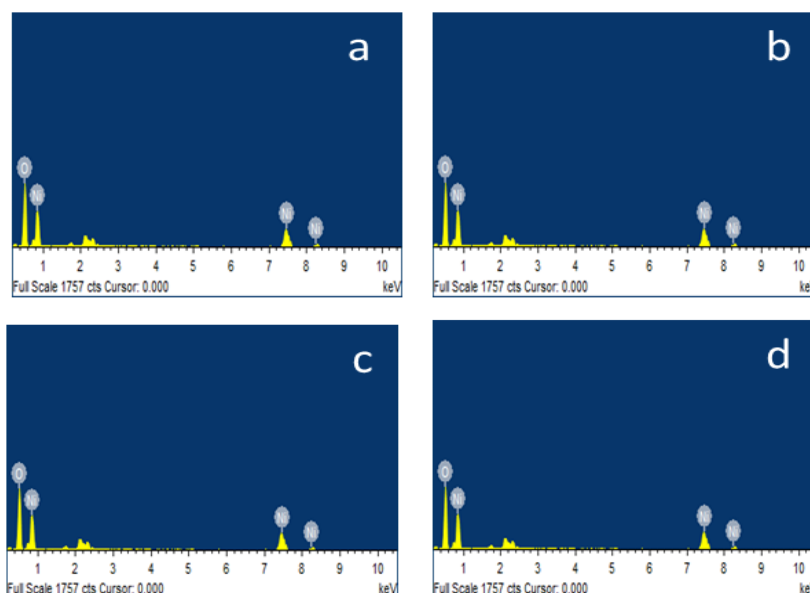
Fig 5. Energy dispersive X-ray spectroscopy of NiO nanoparticles synthesized using 0.5 g, 1.0 g, 1.5 g and 2.0 g of hexamine

3.5 Photo Catalytic activity

Photo catalytic is essential to clean up water and environmental detoxification through visible light induced and also consists of various applications. Here we conducted the photo catalytic test with methylene blue dye for samples prepared with 0.5g, 1 g, 1.5 g and 2 g of hexamine. Nickle has a band gap (2.83 eV) [9] that confirms photo catalytic properties. Photo

catalytic efficiency was confirmed with 80% degradation of methylene blue.

The absorption spectra obtained for MB as well as their concentrations in solution when sampled at regular intervals of 10 min are presented in Fig 6. From Fig 6 it is evident that the absorption peaks of the dye decreased gradually as the exposure time increased from 0 to 40 min and 0 to 70 min. With the increase of irradiation time, the intensity of the maximum adsorption peak located near 664 nm for aqueous MB dye gradually decreased, indicating the degradation of the dye solution. Thereby it demonstrates the ability of the NiO nanohoneycomb to effectively degrade various cationic dyes.
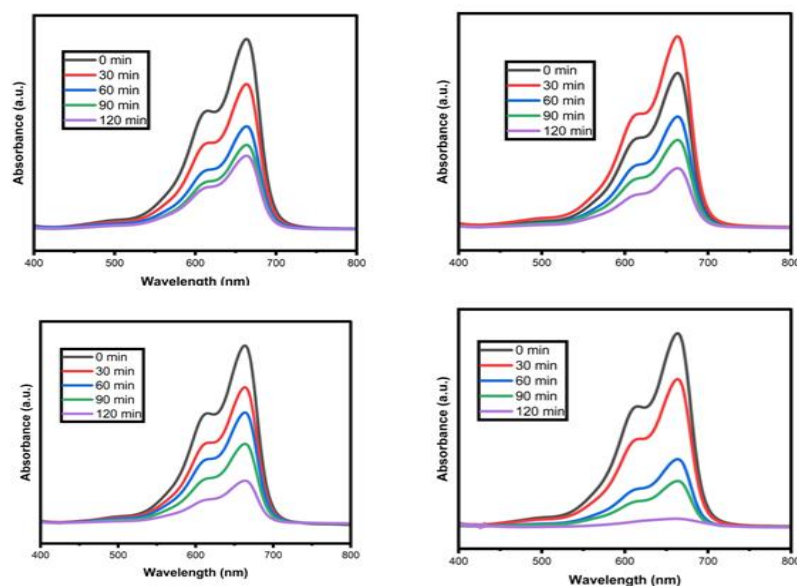
Figure 6. Photocatalytic degradation of NiO nanoparticles synthesized using 0.5 g, 1.0 g, 1.5 g and 2.0 g of hexamine

The photocatalytic activity was evaluated by the degradation of methylene blue under UV light. The effect of parameters such as the amount of catalyst, initial concentration of the dye and pH of the dye solution on the removal efficiency of methylene blue was investigated. Methylene Blue solution is used to stain the cells. The purpose of staining with methylene blue is to determine cell mortality. When methylene blue stain is given to a sample, a healthy cell causes the stain to become colourless [10].

4. Conclusion

In this present work, nickel oxide nanoparticles are synthesized by hydrothermal method with different amount of hexamine 0.5g, 1.0g, 1.5g & 2.0g. The procedure developed in the present study offers homogenous particle distribution good reactivity between components. The preparation process has advantage of simple technology, good yield and short preparation cycle.

XRD suggested the crystallite sizes of Nio nanoparticles are in the nano scale range. The grain size of NiO nanoparticles by adding different amount of hexamine 0.5g, 1.0g, 1.5g & 2.0g was found to be 55.80nm, 34.24nm, 24.90nm & 13.92nm. UV visible spectra of nanoparticles with surfactant exhibit absorption at wavelengths 286 nm, 248 nm and 290 nm. UV visible spectra of nanoparticles with surfactant exhibit transmittance at wavelengths 502 nm, 720 nm and 700 nm. The optical band gap energy values of the prepared nanopaticles vary between the range 3.35 eV to 3.85 eV. The surface morphology of the nanopaticles is characterized by SEM analysis. EDX spectrum confirms the presence of Ni and O. In future this work can be extended to synthesis nanohexagons without the use of surfactants.

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Structural and Optical Properties of NiO-Mn$_2$O$_3$ and NiO-CdO Nanocomposites Synthesized by Chemical Method

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ABSTRACT

The NiO nanoparticles and NiO-Mn$_2$O$_3$, NiO -CdO nanocomposites are prepared by co-precipitation method. The structural and optical properties are studied by Powder X-Ray Diffraction (PXRD), Photoluminescence (PL) and Ultraviolet Visible (UV-Vis) techniques. The PXRD divulges that NiO, Mn$_2$O$_3$ and CdO possess cubic structure in the nanocomposites. The average gain size of pure NiO nanoparticles is found to be 12.81 nm using Debye Scherrer's formula. From PL technique, the peaks are formed around 340nm to 560nm, which represents blue and green shift emission in the visible region. The UV–Vis spectroscopy is used to study optical properties of nanoparticles and their composites. Thus, the synthesized NiO-Mn$_2$O$_3$, NiO-CdO nanocomposites can be used a suitable material for photocatalysis applications.

Keywords: Nanocomposites, Nanoparticles, PXRD, Nickel Oxide

1. Introduction

Nickel oxide (NiO) is an important transition metal oxide with cubic lattice structure. NiO nanoparticles has attracted increasing attention owing to its potential use in a variety of applications such as catalysis, battery cathodes [1,2], gas sensors [3], electro chromic films [4] and magnetic materials [5,6]. It can also be extensively used in dye sensitized photo cathodes [7]. NiO semiconductor has become a motivating topic in the new area of research. Because of the volume effect, the quantum size effect, the surface effect and the macroscopic quantum tunnel effect, nanocrystalline NiO is expected to possess many improved properties than those of micrometer-sized NiO particles. Nanocomposites are formed by mixing two or more oxides on a nanometer scale having properties that depend on the concentration of each constituent oxide in the mixture [8]. The nanomaterials like manganese oxide and cadmium oxide have significant applications in the field of photocatalysis, optoelectronics, sensors and solar cells. An attempt is made in this project to synthesize pure NiO nanoparticles and NiO nanocomposites are synthesized through co- precipitation method [9] because this method is found to be cheap, effective and highly convenient.

2. Materials and Methods

In the present work, co-precipitation method is used to prepare NiO nanoparticles and their nanocomposites. All the precursors used for synthesis are of analytical grade (Merck).

Pure nickel acetate, manganese acetate, cadmium acetate, double distilled water, urea and ammonium hydroxide solution are used to synthesize NiO nanoparticles and their nanocomposites.

2.1 Synthesis of NiO nanoparticles

Nickel acetate (0.25 M) is dissolved in double distilled water (100 ml) separately and stirred well for 30 minutes. Then, urea (0.75 M) is dissolved in double distilled water (100 ml) separately and stirred well. Then, both nickel acetate and urea solutions are mixed together. Ammonium hydroxide solution (32 M) is added drop by drop to maintain the pH of 10. The obtained green color precipitate is kept in the hot air oven at 100°C for drying. After grinding in agate mortar, the powder is kept in the muffle furnace at 400°C for 2 hours and the black color powder is obtained.

2.2 Synthesis of NiO nanocomposites

Manganese acetate (0.25 M) is dissolved in double distilled water separately and stirred well for 30 minutes. Then, manganese acetate solution is added to the nickel acetate and urea solutions which are already mixed together. Ammonium hydroxide solution is added dropwise to maintain the pH of 10. The brown color precipitate is dried at 100°C in the hot air oven. After grinding the sample, it is kept in the muffle furnace at 400°C for two hours. Similar procedure is adopted for synthesizing NiO-CdO nanocomposites. Instead of manganese acetate, cadmium acetate is used for preparing NiO-CdO nanocomposites.

3. Results and Discussion

3.1 Experimental Techniques

The synthesized nanoparticles of nickel oxide and their nanocomposites are characterized using techniques like PXRD analysis, photoluminescence, and UV analysis. The powder X-ray diffraction (PXRD) spectra of pure nickel oxide nanoparticles and nickel oxide nanocomposites is recorded using X-ray diffractometers with Cu- k_α as the radiation source (wavelength: 1.54056 Å) over the 2θ range of 10° to 80°. Photoluminescence (PL) studies for the synthesized NiO nanoparticles and their nanocomposites are carried out using a photoluminescence spectrophotometer (Cary Eclipse) and the emission spectra are recorded at a scan rate of 600 nm/min. A UV-Vis absorption spectrophotometer (Hitachi U-2900) with a 400 nm/min scan speed in the range of 190 nm - 800 nm is used to analyze the absorption characteristics of the synthesised samples.

3.2 PXRD analysis

The average grain size is calculated using the Debye-Scherrer's formula [10]

$$D = 0.9 \, \lambda \, / \, \beta \cos\theta$$

The powder X-ray diffractogram of the pure nickel oxide (NiO) nanoparticles is depicted in Fig.1(a). The high intensity peaks are seen at (222), (400), (440), (622) and (444) that correlate to 2θ =37.1837°, 2θ = 43.0249°, 2θ = 62.7973°, 2θ = 75.5182° and 2θ= 79.1847° respectively. Using the Scherrer's equation, the average grain size of pure NiO nanoparticles is calculated to be 12.81 nm. The 2θ values obtained from PXRD data of the as-prepared pure NiO nanoparticles matched well with that of the JCPDS File No. 89-5881 and it exhibits a cubic structure. The pure NiO nanopowder sample is synthesized and the intense PXRD peaks clearly show that it is crystalline in nature. The peak (222) is similar to that obtained by F. Davar et al. [11] for pure NiO nanoparticles.

Mn_2O_3 peaks can be observed at (200), (420) and (541) which correspond to 2θ = 17.9683°, 2θ = 43.3949° and 2θ = 63.1432°. Peaks of NiO can be found at (222), and (400) corresponding to 2θ =37.4338° and 2θ = 43.3949° respectively. The 2θ values obtained from PXRD data of Mn_2O_3 and NiO matched well with that of the JCPDS File No. 71-0636 and 89-5881. Both of their structure is found to be cubic.

The PXRD pattern of the nickel oxide (NiO) and cadmium oxide (CdO) nanocomposites are illustrated in Fig. 1(c). The peaks of CdO are observed at (200), (220) and (311) corresponding to 2θ = 38.3191, 2θ = 55.3556, and 2θ = 65.9575 respectively. The peaks of NiO are observed at (222) and (531) corresponding to 2θ = 36.8575and 2θ = 65.9575. The 2θ values obtained from PXRD data matched well with that of the JCPDS File No. 05-0640 [a = b= c= 4.695Å] and 89-5881. The structure of both NiO and CdO was found to be cubic [12].
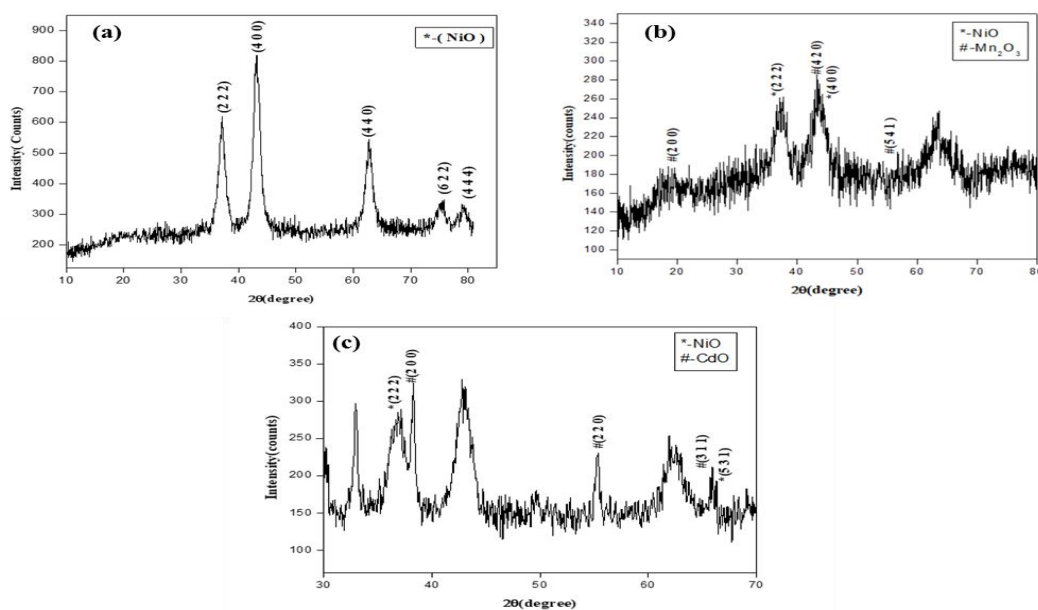
Fig 1. PXRD pattern of (a) NiO nanoparticles (b) NiO-Mn₂O₃ nanocomposites (c) NiO-CdO nanocomposites

Fig 1. Photograph of (d) NiO nanoparticles (e) NiO-Mn₂O₃ nanocomposites (f) NiO-CdO nanocomposites

3.3 Photoluminescent (PL) analysis

Fig. 2(a) depicts the photoluminescence (PL) emission spectra of NiO nanoparticles showing a maximum peaks at 344 nm, 360 nm and other peaks at 410nm and 490 nm. High intense peaks centered at 360 nm are assigned to band edge emission of NiO nanocrystallites. This emission spectra range is just similar to Petronela Pascariu Dorneanuet et al.[13] The PL emission spectra of NiO-Mn₂O₃ nanocomposites is shown in Fig.2(b) which shows prominent peak at 360 nm. The PL intensity is small for the peak at 360 nm when compared to that of the pure NiO nanoparticles. Other small peaks are observed at 376 nm, 386 nm, and 491nm. The Photoluminescence emission spectra of NiO-CdO nanocomposites are shown in Fig.2(c). The PL spectrum shows blue emission band at 343 nm and 360 nm. The PL spectrum shows green emission band at 395nm and 550 nm. The intensity of the maximum peak is decreasing when compared to the pure NiO nanoparticles. The PL spectra of NiO-CdO nanocomposites is similar with that of Amrut S. Lanje et al.[14]
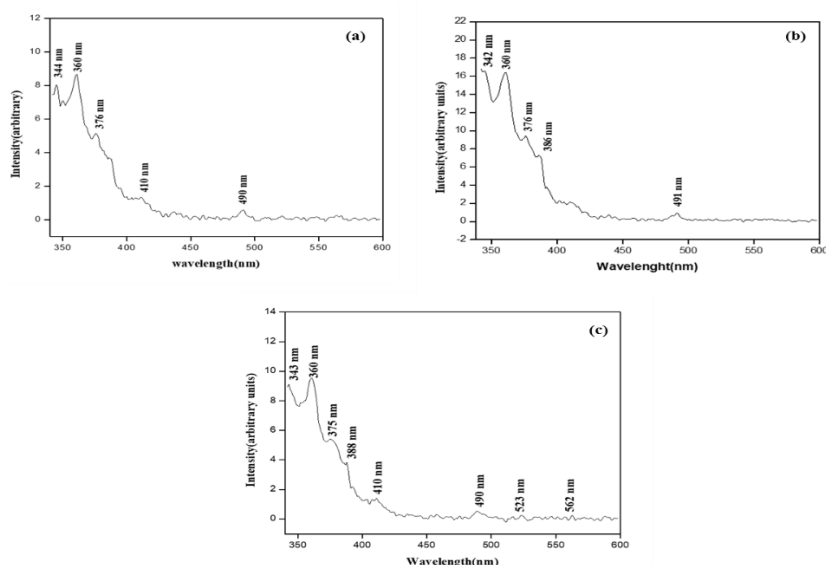
Fig 2. PL emission spectra of (a) NiO nanoparticles (b) NiO-Mn₂O₃ nanocomposites (c) NiO-CdO nanocomposites

3.4 UV – Visible analysis

The absorbance spectra of the synthesized pure NiO nanoparticles is shown in Fig.3(a) which exhibits a maximum peak at 402 nm with absorbance 1.08(arbitrary units). The optical

absorbance spectra of NiO-Mn$_2$O$_3$ nanocomposites is shown in Fig.3(b) which shows that the absorption peak is observed at 433nm, due to blue shift as compared to the bulk material. The blue shifting effects are caused due to the quantum size effect. The optical absorbance spectra of NiO-CdO nanocomposites are shown in Fig.3(c) which exhibits maximum peak at 447 nm with absorbance 1.0 (arbitrary units).
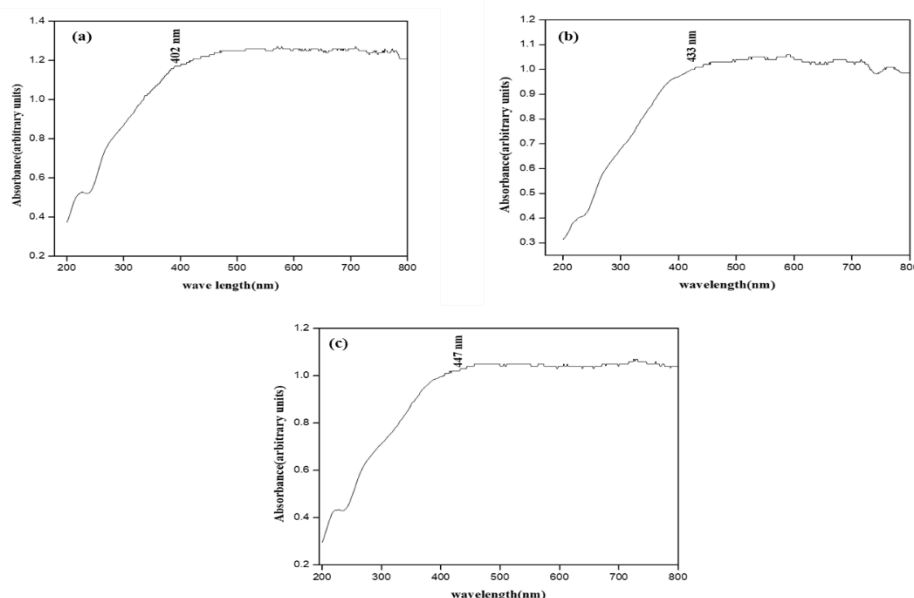
Fig 3. UV-Vis absorption spectrum of (a) NiO nanoparticles (b) NiO-Mn$_2$O$_3$ nanocomposites (c) NiO-CdO nanocomposites

4. Conclusion

In this work, the NiO nanoparticles and their nanocomposites are prepared by co-precipitation method. The structure of prepared NiO nanoparticles is cubic. In NiO-Mn$_2$O$_3$ nanocomposites, the structure of NiO is cubic and the structure of Mn$_2$O$_3$ is also cubic. In the NiO-CdO nanocomposites, the structure of CdO is cubic and the structure of NiO is also cubic. Thus there is formation of the pure NiO nanoparticles and their nanocomposites. No impurity peaks are obtained. The PL emission peaks are formed around 340 nm to 560 nm, representing blue and green shift emission in the visible region. The optical absorbance characteristics of the NiO nanoparticles and their corresponding nanocomposites have strong absorption peaks in the UV region. Further research can be proceeded with different concentrations of different other compounds with nickel oxide to produce various novel nanocomposites for photocatalytic applications.

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Isolation of Dna from Guava Fruit and its Binding Interaction with Tris(2,2′-Bipyridine) Ruthenium (Ii) Complexes

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ABSTRACT

Isolation of DNA from guava and its binding interaction with three Ru(II)-bipyridine complexes[Ru(bpy)$_3$]$^{2+}$, [Ru(dmbpy)$_3$]$^{2+}$and [Ru(dtbpy)$_3$]$^{2+}$(bpy = 2,2'-bipyridine, dmbpy = 4,4'-dimethyl-2,2'-bipyridine and dtbpy = 4,4'-di-ter-butyl-2,2'-bipyridine) have been investigated by UV-Visible absorption spectral studies. The complexes [Ru(bpy)$_3$]$^{2+}$, [Ru(dmbpy)$_3$]$^{2+}$ and [Ru(dtbpy)$_3$]$^{2+}$show metal to ligand charge transfer absorption peaks in the region 455-465 nm. The absorption spectrum of DNA isolated from guava shows a shoulder peak at 255 nm. Theaddition of [Ru(bpy)$_3$]$^{2+}$, [Ru(dmbpy)$_3$]$^{2+}$ and [Ru(dtbpy)$_3$]$^{2+}$complexes with the DNA isolated from guava exhibits hyperchromic and bathochromic shifts. This indicates that the complexes interact with the DNA through intercalative and electrostatic modes of binding. The binding constant (K$_b$) of these complexes with the DNA is determined from the Benesi-Hildebrand plot. The K$_b$ value of [Ru(dtbpy)$_3$]$^{2+}$complex is higher than that of [Ru(bpy)$_3$]$^{2+}$ and [Ru(dmbpy)$_3$]$^{2+}$complexes. This is due to the hydrophobic nature of Ru(dtbpy)$_3$]$^{2+}$ complex. The obtained results reveal that the complexes bind strongly with the DNA in the MLCT region and theK$_b$ values depend on the nature of the ligands present in the complexes.

Keywords: *Guava DNA, Ru(II)-bipyridine complexes, Binding Constant, Intercalative interaction, Electrostatic interaction*

1. Introduction

DNA is the molecule that carries genetic information for the development and functioning of an organism. The DNA molecule directs the synthesis of protein and contains all the genetic information that is passed on to new cells. DNA can be easily extracted from fruits because they are soft and easy to pulverize. Guava is a tropical fruit that grows in dry or humid heat. Guavas are rich in dietary fiber, vitamin C, vitamin A, iron, calcium, and potassium.

Transition metal complexes containing heterocyclic ligands have been of considerable interest in terms of structural chemistry, catalysis and biological functions [1,2]. Metal complexes have been found to bind with DNA through multitude of interactions and to cleave the duplex by virtue of their intrinsic chemical, electrochemical and photochemical reactivities. The biological function of the metal complexes mainly depends on the interaction between the

ligand-binding residues and metal ions present in the complex [3,4]. The modification of the metal or ligands in the complexes leads to substantial changes in the binding properties.

Among the transition metal complexes, Ru(II)-polypyridine complexes undergo binding with DNA, RNA and proteins and act as therapeutic agents [5]. These complexes are reasonably stable to light, electricity and heat, because the bonds between the central metal and polypyridyl ligands are very strong. These complexes possess specific optical and electrochemical properties; moreover, these complexes exhibit strong absorption MLCT band in the visible region. The MLCT absorption band, emission wavelength, and lifetime can be easily varied by the introduction of various substituents in the polypyridine ligands. In order to understand the role of Ru(II) complexes with DNA, the present study focuses on the binding of $[Ru(bpy)_3]^{2+}$, $[Ru(dmbpy)_3]^{2+}$ and $[Ru(dtbpy)_3]^{2+}$(bpy = 2,2′-bipyridine, dmbpy = 4,4′-dimethyl-2,2′-bipyridine and dtbpy = 4,4′-di-*ter*-butyl-2,2′-bipyridine) complexes with the DNA isolated from guava extract.

2. Materials and Methods

2.1 Materials

RuCl$_3$.3H$_2$O, bpy, dmbpy and dtbpywere purchased from Sigma-Aldrich. Analytical grade solvents were used for the synthesis of the complex. Double distilled deionized water was used as a solvent for the binding studies.

2.2 Synthesis of Ru(II)-bipyridine Complexes

2.2.1 Synthesis of [Ru(bpy)₃](BF₄)₂ complex

RuCl$_3$. 3H$_2$O (1 mM) and bpy (3 mM) were treated with 25 mL of ethanol and was refluxed for 20 h. The red orange complex formed was remained in the ethanolic solution. The product was filtered, washed with cold water and diethyl ether and dried in a vacuum desiccator.The tetrafluoroborate salt of $[Ru(bpy)_3]^{2+}$ complex was prepared from the corresponding chloride salt by adding a concentrated solution of sodiumtetrafluoroborate to the aqueous solution of the complex. The precipitate was filtered and washed with water, ethanol and diethyl ether. The complex was purified by column chromatography using silica gel as the adsorbent and n-propanol as eluent and on subsequent evaporation to recover the complex.

2.2.2 Synthesis of [Ru(dmbpy)₃](BF₄)₂ and [Ru(dtbpy)₃](BF₄)₂complexes

RuCl$_3$.3H$_2$O (1 mM) and 4,4′-dimethyl-2,2′-bipyridine (3 mM) were dissolved in 20 mL of ethylene glycol and refluxed for 4 h. The solution was cooled and filtered to remove any insoluble impurities. A saturated solution of sodium tetrafluoroborate was then added dropwise into the filtrate until an orange precipitate formed. The product was filtered, washed with cold water and diethyl ether and further dried in a vacuum desiccator. The product was further

purified by recrystallisation from water. Similar procedure was adopted for the synthesis of $[Ru(dtbpy)_3]^{2+}$ complex.

2.3 Extraction of DNA from Guava Extract

The guava fruit was mashed in a zipper bag. The extraction buffer was prepared by adding liquid soap and salt in 50 mL of water. The extraction buffer was added into the guava extracts and kept aside for 5 minutes. The content was transferred into a 100 mL beaker, 10 mL of ice-cold ethanol was added into it and allowed to stand for 5 minutes. The DNA of guava was separated as white strands. The isolated DNA from the extract was collected and used as such for the binding studies.

2.4 Equipment

The absorption spectral measurements of the $Ru(bpy)_3]^{2+}$, $[Ru(dmbpy)_3]^{2+}$ and $[Ru(dtbpy)_3]^{2+}$ complexes and the binding studies of the synthesised complexes with the DNA isolated from guava extract were carried out using Shimadzu UV-1800 spectrophotometer. All the spectral measurements were carried out at room temperature.

2.5 Determination of Purity and Quantity of Isolated DNA

The purity of the DNA isolated from guava extract was measured by spectrophotometric methods. The absorbance of the isolated DNA was measured at 260 and 280 nm using UV-Visible spectrophotometer and its ratio (A_{260}/A_{280}) was calculated. The DNA concentration was calculated as:

$$\text{Total DNA concentration (ng/µL)} = A_{260} \times 50 \text{ ng/µL} \times 100$$

2.6 Determination of Binding Constant

The binding of $Ru(bpy)_3]^{2+}$, $[Ru(dmbpy)_3]^{2+}$ and $[Ru(dtbpy)_3]^{2+}$ complexes with the isolated DNA at various concentrations (5×10^{-5} - 3×10^{-4} M) in aqueous medium has been studied separately by absorption spectral technique. The solutions for the binding studies were prepared by dissolving the DNA and the complex in distilled water. The binding constant (K_b) of the complexes with the DNA isolated from guavais determined from the Benesi-Hildebrand equation using absorption intensity data [6].

$$1/\Delta A = 1/K_b\Delta\varepsilon\ [H] + 1/\Delta\varepsilon\ [G]$$

The plot of $1/\Delta A$ *vs* $1/[G]$ gives a straight line. The K_b can be obtained from the ratio of Y-intercept to the slope of the straight line.

3. Results and Discussion

The structure of the synthesized complexes used in the present study is shown in **Fig. 1.** The absorption spectrum of the $[Ru(bpy)_3]^{2+}$, $[Ru(dmbpy)_3]^{2+}$ and $[Ru(dtbpy)_3]^{2+}$ complexes in aqueous medium shows a high energy absorption at 285-295 nm corresponding to the ligand

centered π - π^* transition and the low energy absorption at 455-465 nm assigned to the dπ - π^* metal to ligand charge transfer (MLCT) transition (**Fig. 2**).
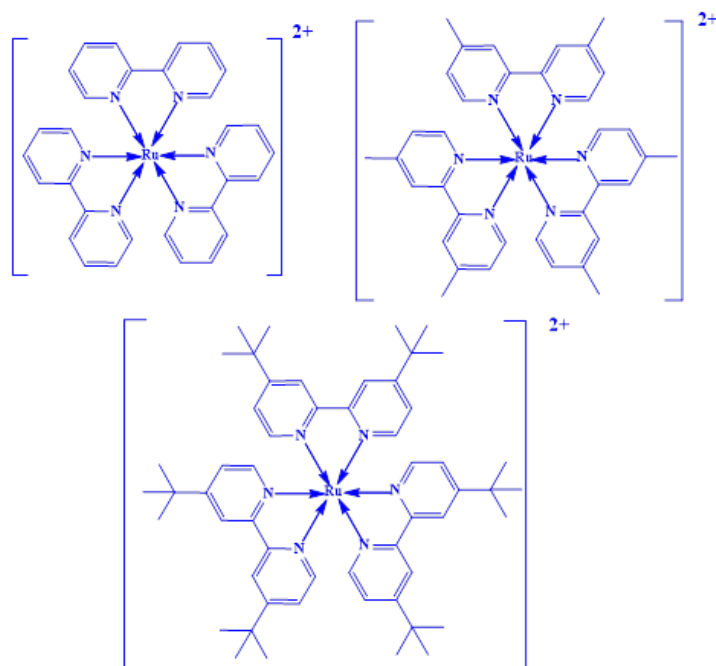
Fig 1. Structure of the synthesised complexes
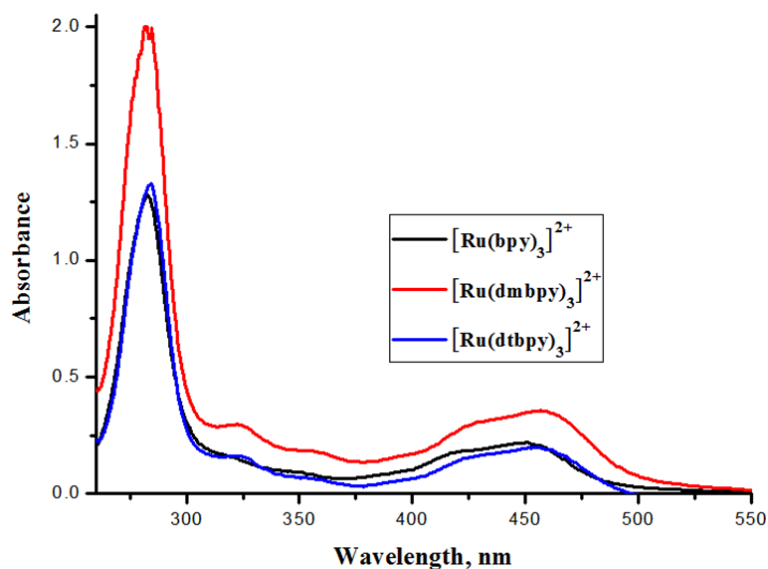
Fig 2. UV spectrum of the synthesised complexes

The DNA isolated from the guava extract is shown in **Fig 3**. The absorption spectrum of the guava DNA shows a shoulder peak at 255 nm and it does not show any peak in the MLCT region of the synthesised complexes. The purity and the concentration of the DNA isolated from guava extract is found to be 1.37 and 732 ng/µL.
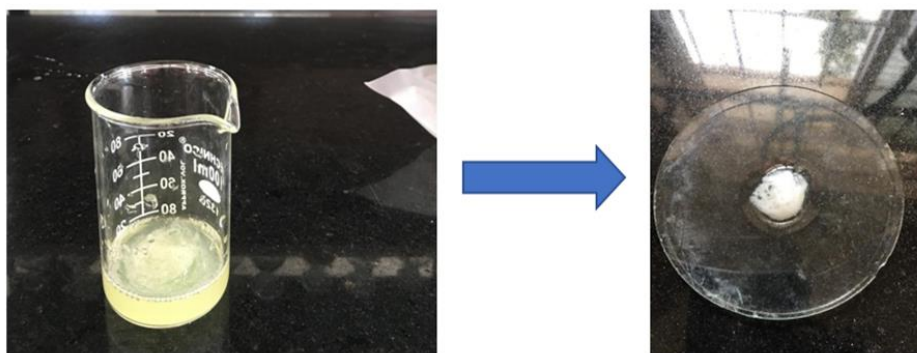
Fig 3. DNA isolated from guava extract

The absorption spectrum of the DNAwith the incremental addition of $[Ru(bpy)_3]^{2+}$, $[Ru(dmbpy)_3]^{2+}$ and $[Ru(dtbpy)_3]^{2+}$ complexes in aqueous medium shows an increase in the MLCT absorption maximum, this indicates the formation of ground state complex (**Figs. 4-6**). The K_b values calculated from the Benesi-Hildebrand plots is represented in **Table 1**.
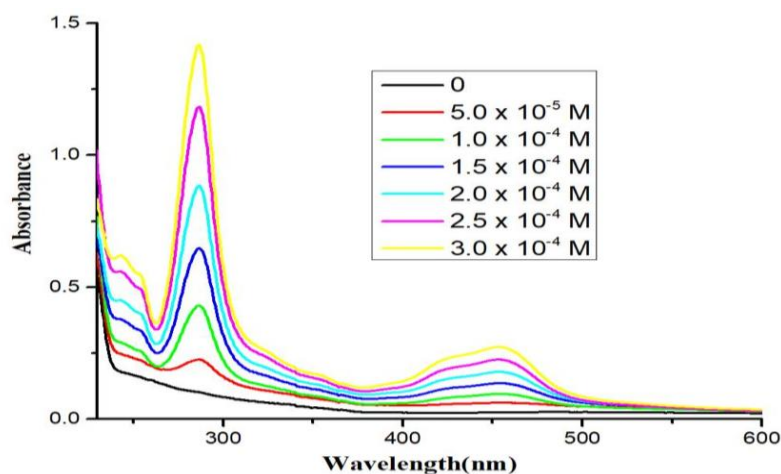
Fig 4. UV spectrum of guava DNA with the incremental addition of $[Ru(bpy)_3]^{2+}$ complex
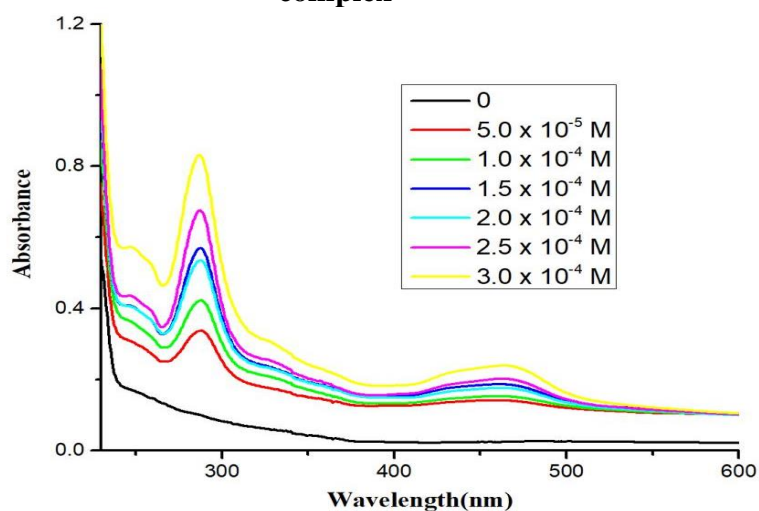
Fig 5. UV spectrum of guava DNA with the incremental addition of $[Ru(dmbpy)_3]^{2+}$ complex
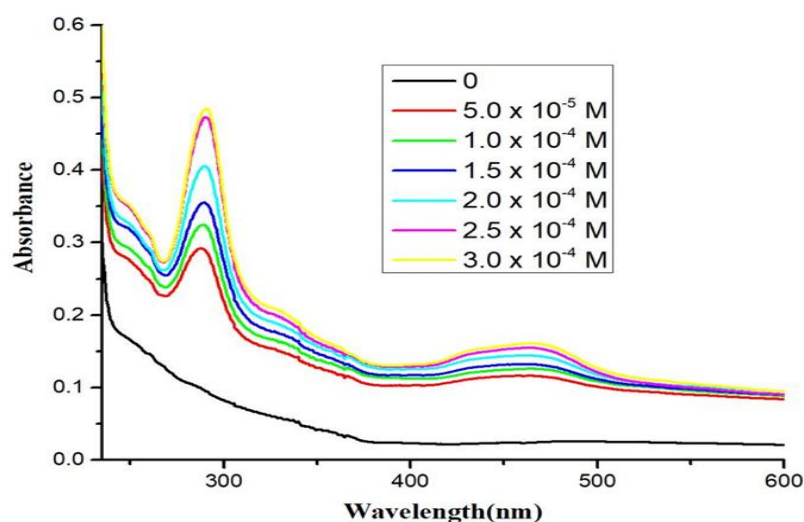
Fig 6. UV spectrum of guava DNA with the incremental addition of $[Ru(dtbpy)_3]^{2+}$ complex

Table 1. Binding constant, K_b (M^{-1}) of the synthesised complexes with guava DNA

Complex	Binding constant, K_b (M^{-1})
$[Ru(bpy)_3]^{2+}$	2.08×10^3
$[Ru(dmbpy)_3]^{2+}$	2.19×10^3
$[Ru(dtbpy)_3]^{2+}$	3.75×10^3

The results reveal that the $[Ru(bpy)_3]^{2+}$, $[Ru(dmbpy)_3]^{2+}$ and $[Ru(dtbpy)_3]^{2+}$ complexes strongly bind with the guava DNA. The K_b value of $[Ru(dtbpy)_3]^{2+}$ complex with guava DNA is higher than that of $[Ru(bpy)_3]^{2+}$ and $[Ru(dmbpy)_3]^{2+}$ complexes. This is due to the hydrophobic nature of $[Ru(dtbpy)_3]^{2+}$ complex. As the hydrophobic nature of the complex increases binding also increases [7]. Thus the $[Ru(dtbpy)_3]^{2+}$ complex strongly binds with the base pair of the DNA.

Binding studies of all the three synthesised complexes on the DNA isolated from guava displays hyperchromic and bathochromic shifts and this clearly picturizes that the complexes interact with the DNA through intercalative and electrostatic modes of binding. The intercalative interaction is mainly due to the π-π stacking interaction between the aromatic ligands present in the complex and the DNA base pairs. The cationic complexes bind with the DNA base pair through electrostatic interaction. The hyperchromic shift is due to the partial uncoiling of the helical structure of the DNA. The existence of hyperchromic shift leads to electrostatic binding between the positively charged complexes and the negatively charged species of the phosphate backbone of the DNA double helical structure at the peripheral region.

The binding of $[Ru(bpy)_3]^{2+}$, $[Ru(dmbpy)_3]^{2+}$ and $[Ru(dtbpy)_3]^{2+}$ complexes to the DNA base pair leads to breakage in the DNA double helix and bind through intercalative and electrostatic modes which gives better binding property [8]. The hydrogen bond formation between the DNA base pairs and the vander Waals interactions between the complex and the base pairs of the DNA leads to strong binding. This result is in accordance with the DNA binding studies of various complexes [9,10]. The obtained results of the present investigation reveals that the $[Ru(bpy)_3]^{2+}$, $[Ru(dmbpy)_3]^{2+}$ and $[Ru(dtbpy)_3]^{2+}$ complexes strongly bind with the guava DNA and the K_b values depends on the nature of the ligands present in the complexes.

4. Conclusion

The DNA binding affinity of $[Ru(bpy)_3]^{2+}$, $[Ru(dmbpy)_3]^{2+}$ and $[Ru(dtbpy)_3]^{2+}$ complexes on the DNA isolated form guava extract has been investigated by absorption spectral techniques. The K_b valuesof $[Ru(bpy)_3]^{2+}$, $[Ru(dmbpy)_3]^{2+}$ and $[Ru(dtbpy)_3]^{2+}$ complexes clearly depictthestrong binding affinity towards guava DNA through intercalative and electrostatic modes of binding. The K_b of $[Ru(dtbpy)_3]^{2+}$ complex with guava DNA is higher than that of $[Ru(bpy)_3]^{2+}$ and $[Ru(dmbpy)_3]^{2+}$ complexes and the K_b values of the complexes depend on the nature of the ligands present in the complexes. The binding of Ru(II)-bipyridine complexes with the DNA isolated from guava extract leads to better binding property which paves a way for applicability in various medicinal and biological field.

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A Study on Photophysical Properties of 4- Dimethyl Amino Benzaldehyde Inclusion complex with a-CD

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ABSTRACT

The present study aims to improve the photophysical property of 4-dimethyl amino benzaldehyde (DMAB) by complexing with α-CD. The photophysical properties of the complex are investigated by UV- Visible, Fluorescence and FTIR spectroscopy. The association constant of the inclusion complex is determined by the Benesi – Hildebrand relation and the inclusion ratio is found to be 1:1. The water solubility of 4-dimethyl amino benzaldehyde is increased by inclusion with α-CD according to the phase solubility diagram. The result obtained from FTIR spectroscopy confirms the inclusion of 4-dimethyl amino benzaldehyde into cyclodextrin cavity.

Keywords: DMAB, α-CD, complexation, photophysical property.

1. Introduction

Benzaldehyde derivatives are the most interesting carbonyl containing system and they are used chiefly in the synthesis of other organic compounds, ranging from pharmaceuticals to plastic additives. Due to the highly interesting nature of the aldehyde group with the surrounding media and conjugation of the phenyl ring, they are important intermediates for the processing of perfume and flavouring compounds and in the preparation of certain aniline dyes [1]. Recent spectroscopic studies of the benzaldehydes and their derivatives have been motivated because the vibrational spectra are very useful for the understanding of specific biological process and for the analysis of relatively complex systems. The properties such as optical transmission, refractive index, electro-optic effect and dielectric constant of 4-dimethyl amino benzaldehyde (DMAB) have been evaluated.

4-dimethyl amino benzaldehyde (DMAB) is an organic compound containing amine and aldehyde moieties which is used in Ehrlich's reagent and Kovac's reagent to test for indoles[2]. It has a role as chromogenic compound. It also is a member of benzaldehydes, a substituted aniline and a tertiary amino compound.

Several vibrational spectroscopic studies on mono-, di-, tri- substituted benzaldehydes have been reported. In this chapter the effect of α-CD on the absorption and fluorescence spectra of 4-dimethyl amino benzaldehyde have been investigated. The possible inclusion complex and comparision of spectral properties of this complex with α-CD are studied. The

inclusion complex formed is confirmed by UV-Visible spectroscopy, Fluorescence spectroscopy, Phase solubility study and FTIR spectroscopy.
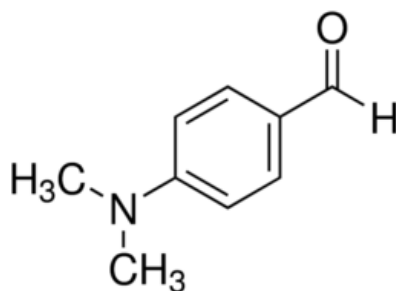
Fig 1. Chemical Structure of 4-dimethyl amino benzaldehyde

This chapter deals with the identification and characterization of 4-dimethyl amino benzaldehyde. The effect of α-CD on the absorption and fluorescence spectra of 4-dimethyl amino benzaldehyde have been investigated in this chapter. Different analytical techniques such as Fourier transform Infrared spectroscopy (FTIR) and phase solubility studies have been used to confirm the inclusion complex formation.

2. Materials and Methods

4-dimethyl amino benzaldehyde was obtained as gift sample from IPCA laboratories ltd. Mumbai, India. α-CD was purchased from Sigma Aldrich. Both were used as received with no further purification. All other reagents and chemicals were of analytical grade.

2.1 Preparation of liquid inclusion complex

The liquid inclusion complex was prepared by adding constant volume of 4-dimethyl amino benzaldehyde drug separately into 10mL volumetric flask containing the absence and presence of increasing concentrations (2-10mM) of α-CD.

2.1.1 UV- Visible Spectral analysis

The UV-Visible spectra were carried out with systronic Double beam spectro photometer-2203. All UV–Visible spectra were taken with reference to the corresponding blank solution.

2.1.2 Fluorescence emission

Fluorescence spectral measurements were carried out with JASCO Spectrofluorometer FP-8200.

2.1.3 Phase solubility studies

Phase solubility studies were performed according to the method reported by Higuchi and Cornors [3] 4-dimethyl amino benzaldehyde in amounts that exceeded its solubility , were taken into vials to which were added 15mL of distilled water (pH 6.8) containing various concentration of α-CD (2-10mM). These flasks were sealed and shaken at room temperature

for 5 days to reach equilibrium and the samples were filtered immediately through a 0.45μ nylon disc filter and appropriately diluted. A portion of the sample was analysed by UV spectrophotometer against blank prepared in the same concentration of α-CD in water so as to cancel any absorbance that may be exhibited by the α-CD.

2.2 Preparation of solid inclusion complex

Solid dispersion / Co- evaporated dispersion method

The solid inclusion complex of 4-dimethyl amino benzaldehyde with α-CD in 1:1 molar ratio were prepared by dissolving the drug in methanol and α-CD is dissolved in water separately (Jain, 2004). The α-CD solution is added to drug solution and stirred for about 48hours at room temperature to attain equilibrium. The resulting solution was evaporated to dryness [4].

2.2.1 Fourier Transform Infrared Spectroscopy

Infra–Red spectroscopy is used to estimate the interaction between cyclodextrin and the guest molecules in the solid state. FTIR spectra were obtained using JASCO FT 761 photometer at SIC-SFRC. The sample of pure drug 4-dimethyl amino benzaldehyde, α-CD and solid inclusion complexes were previously grounded and thoroughly mixed with KBr. The KBr disks were prepared by compressing the powder blend. The FTIR spectra were executed at a resolution of 1cm^{-1} (from 4000-400cm^{-1}).

3. Results and Discussion

3.1 Absorption Study

Table 1 and Fig.2 represents the absorption spectra of 4-dimethyl amino benzaldehyde with varying concentration of α-CD. A red shift with an increases in the absorbance is noticed for the absorption spectrum of the guest molecule 4-dimethylamino benzaldehyde (242.5nm to 245.5nm) by increasing the concentration of α-CD.

Table 1. Absorption maxima 4-dimethyl amino benzaldehyde at

different concentration of α-CD

α-CD concentration	λ_{max}(nm)	Absorbance
0	242.5	0.527
0.002	243.5	0.588
0.004	244.0	0.627
0.006	244.5	0.694
0.008	245.0	0.784
0.01	245.5	0.840
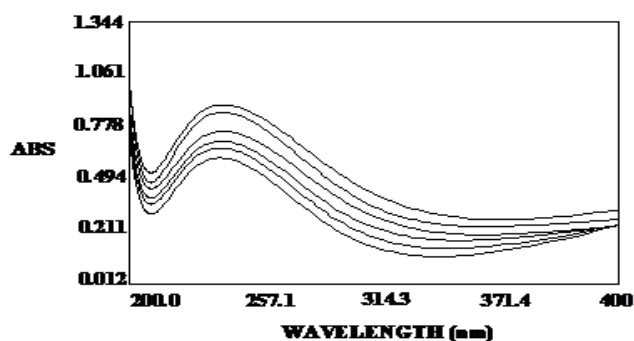
Fig 2. Absorption spectrum of DMAB with α-CD

3.2 Fluorescence Study

The inclusion complex formation generally leads to the change of excitation and emission wavelength of the drug[6]. Table 2 and Fig.3 represents the effect of α-CD on the fluorescence spectra of 4-dimethyl amino benzaldehyde. A red shift with an increase in the fluorescence intensity is noticed in the emission spectrum of 4-dimethyl amino benzaldehyde (360 nm to 377nm).These results show that 4-dimethyl amino benzaldehyde is entrapped in α-CD to form inclusion complexes.

Table 2. Fluorescence maxima of 4-dimethyl amino benzaldehyde at different concentration of α-CD

α-CD concentration	λ_{flu}(nm)	Intensity
0	360	113.397
0.002	368	137.206
0.004	372	149.111
0.006	374	153.398
0.008	376	155.063
0.01	377	161.016
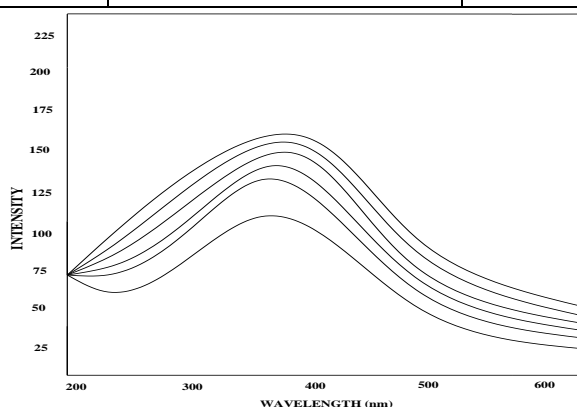
Fig 3. Emission spectra of DMAB with α-CD

The association constant (K) for the formation of inclusion complexes is determined from the changes in the absorption and fluorescence intensity of the guest molecule with increasing the concentration of α-CD using Benesi-Hildebrand equation[7]. The equation for 1:1 complexes are

Absorption

$$\frac{1}{A-A_0} = \frac{1}{A-A_0} + \frac{1}{K(A-A_0)[\alpha-CD]}$$

Fluorescence

$$\frac{1}{I-I_0} = \frac{1}{I-I_0} + \frac{1}{K(I-I_0)[\alpha-CD]}$$

In the above equation A_0/ I_0 is the intensity of absorbance / fluorescence of 4-dimethyl amino benzaldehyde without α-CD, A/I is the absorbance/ fluorescence intensity with a particular concentration of α-CD. A good linear correlation is obtained from the graph drawn between concentration of α-CD and intensity of absorbance/emission. The association constant for absorption and emission is calculated from the slope of the graph.

For absorption

$K = \dfrac{1}{Slope(A-A_0)} = 386$ for 4-dimethyl amino benzaldehyde : α-CD inclusion complexes.

For emission

$K = \dfrac{1}{Slope(I-I_0)} = 404$ for 4-dimethyl amino benzaldehyde : α-CD inclusion complexes.

This analysis reveals that the drug molecule 4-dimethyl amino benzaldehyde form 1:1 inclusion complexes with α-CD. The higher value of association constant for absorption and emission confirms that 4-dimethyl amino benzaldehyde include firmLy in the cavity of α-CD.

3.3 Phase solubility study

Fig.4 represents the phase solubility diagram of α-CD: 4-dimethyl amino benzaldehyde liquid inclusion complex. From the diagram it is observed that the drug solubility increases linearly by increasing α-CD concentration. The diagrams are considered as A_L type according to the model proposed by Higuchi and Carnors. The apparent stability constant (Ks) is found to be $307M^{-1}$ for α-CD:4-dimethyl amino benzaldehyde complex. The higher stability constant value confirms the higher solubilizing capacity of DMAB.
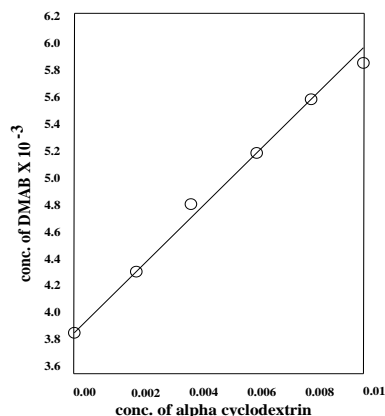
Fig 4. Phase solubility diagram of α-CD : DMAB

3.4 Fourier Transform Infrared (FTIR) Spectroscopic study

The FTIR spectrum of pure α-CD (Fig.5) shows characteristic peak at 3382.91cm^{-1} (O-H stretching vibration), 2925.81cm^{-1} (C-H), 1641.31 cm^{-1}(H-O-H bending), 1155.28 cm^{-1}(C-O) and 1029.92cm^{-1} (C-O-C).

The FTIR spectrum of 4-dimethyl amino benzaldehyde and solid inclusion complex are shown in the Fig. 6 and 7. The N-H stretching frequency appeared at 3317.56cm^{-1} in the original sample is appeared at 3379.29cm^{-1} in the solid inclusion complex. The C-H methyl stretching frequency appeared at 2900.94cm^{-1} and 2816.07cm^{-1} is shifted to 2924.09cm^{-1}and 2823.79cm^{-1} in the inclusion complex. The C=O stretching modes of aldehyde group observed at 1666.50cm^{-1} in the original sample is shifted to 1658.78 cm^{-1} in the inclusion complex whereas the C-H peak at 2731.20cm^{-1} in the original sample is appeared at same frequency in the inclusion complex. The intensity in the inclusion complex was significantly different from original sample. This indicates that the guest molecule DMAB are included in the cavity of α-CD.
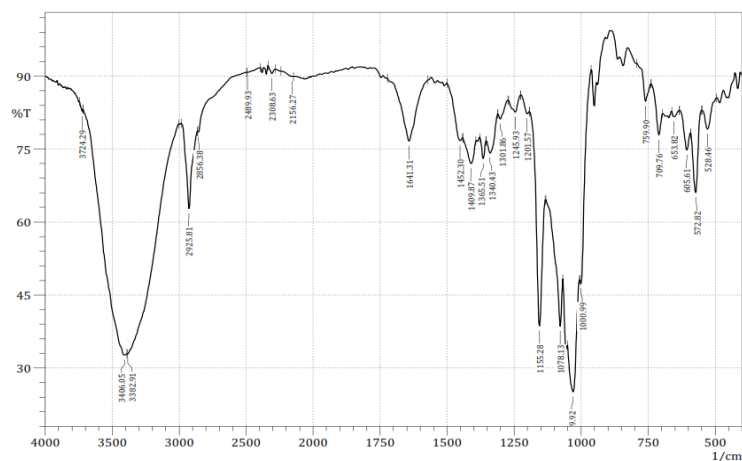
Fig 5. FTIR Spectrum of α-CD
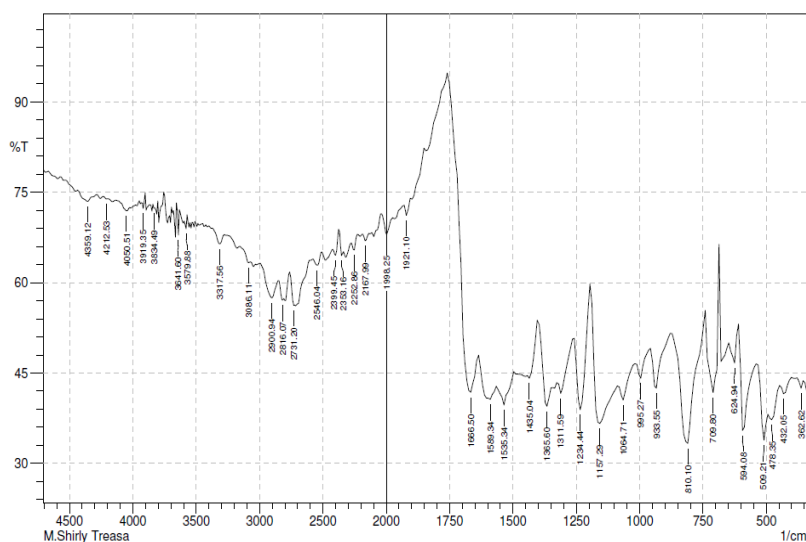
Fig 6. FTIR spectrum of DMAB
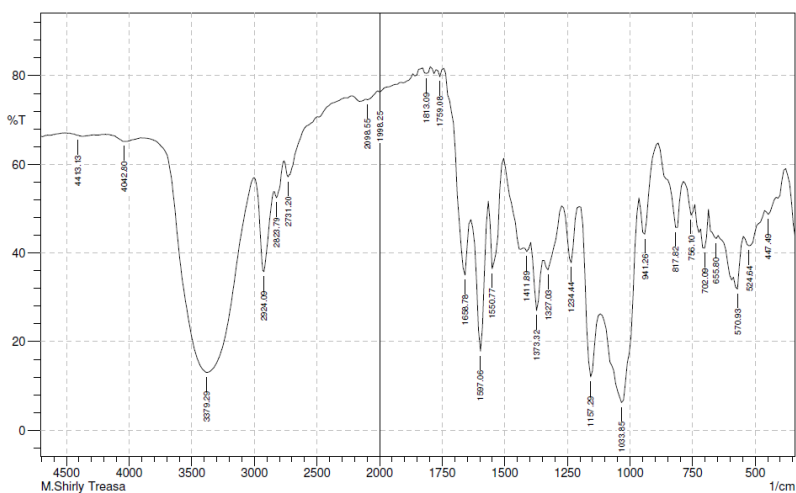
Fig 7. FTIR spectrum of α-CD:DMAB inclusion complex

4. Conclusion

From these observations it is concluded that the organic fluorophore 4-dimethyl amino benzaldehyde form 1:1 inclusion complex with α-CD. The phase solubility study proves the solubility of 4-dimethyl amino benzaldehyde enhanced by the addition of α-CD. The association constant and solubility constant of 4-dimethyl amino benzaldehyde inclusion complexes are higher. These results show that the organic fluorophore 4-dimethyl amino benzaldehyde is fully included in α-CD cavity.

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Perfect Mean Cordial Labeling of Ladder and Grid Graphs

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ABSTRACT

A vertex labeling is said to be $h: V(G) \to \{0, 1, 2, 3\}$ perfect mean cordial labeling of a graph G if it induces an edge labeling h^* defined as follows:

$h^*(uv) = \begin{cases} 1 \ if \ 2|h(u) + h(v)| \\ 0 \qquad otherwise \end{cases}$ *for all $uv \in E(G)$ with the condition that $|e_h(0) - e_h(1) \le 1|$ and $|v_h(\alpha) - v_h(\beta) \le 1|$ for all $\alpha, \beta \in \{0, 1, 2, 3\}$, where $e_h(\delta)$ is number of edges label with $\delta(= 0, 1)$ and $v_h(\lambda)$ denote the number of vertices labeled with $\lambda(= 0, 1, 2, 3)$. A graph G is said to be perfect mean cordial graph if it admits a perfect mean cordial labeling. In this paper, we prove that cartesian product of specific graphs namely ladder and grid graphs are perfect mean cordial graphs.*

Keywords*: perfect mean cordial graph, perfect mean cordial labeling.*

AMS Subject Classification: *05C78.*

1 Introduction

Graph labeling is one mainly rising areas of mathematics which related to integers, vertices, edges and both subject definite conditions. Perfect Mean Cordial labeling of graphs was introduced by Angel Jebitha [1]. Let $G = (V, E)$ be a graph of vertex set V and edge set E. A vertex labeling $h: V(G) \to \{0,1\}$ with the induced edge labeling $h^* : V(G) \to \{0,1\}$ given by $h^*(e) = |h(w) - h(z)|$ is called binary vertex labeling. A binary vertex labeling of a graph G is called cordial labeling if $|v_h(0) - v_h(1) \le 1|$ and $|e_h(0) - e_h(1) \le 1|$, where $v_h(i)$ the number of vertices labeled with i ($i = 0, 1$) and $e_h(j)$ the number of edges labeled with j ($j = 0, 1$). A graph G is cordial if it admits cordial labeling.

Definition 1.1. [1] A vertex labeling $h: V(G) \to \{0, 1, 2, 3\}$ with induced edge labeling $h^*: E(G) \to \{0, 1\}$ defined by

$$h^*(uv) = \begin{cases} 1 \ if \ 2|h(u) + h(v)| \\ 0 \qquad otherwise \end{cases} \ for \ all \ uv \in E(G)$$

is called perfect mean cordial labeling of G if $|e_h(0) - e_h(1) \le 1|$ *and* $|v_h(\alpha) - v_h(\beta) \le 1|$ *for all* $\alpha, \beta \in \{0, 1, 2, 3\}$, where $v_h(\lambda)$ is number of vertices labeled with $\lambda(= 0, 1, 2, 3)$ and $e_h(\delta)$ denote the number of edges labeled with $\delta(= 0, 1)$. A graph G is said to be perfect mean

cordial graph if it admits a perfect mean cordial labeling.

Definition 1.2. [2] The cartesian product $G_1 \times G_2$ of two graphs G_1 and G_2 is defined to be the graph with vertex set $V_1 \times V_2$ and two vertices $u = (u_1, u_2)$ and $v = (v_1, v_2)$ in $V = V_1 \times V_2$ are adjacent in $G_1 \times G_2$ if either $u_1 = v_1$ and u_2 is adjacent to v_2 or $u_2 = v_2$ and u_1 is adjacent to v_1.

The graphs $P_n \times K_2$ and $P_m \times P_n$ are known as ladder and planar grid respectively.

In this paper, we investigate perfect mean cordial labeling labeling of ladder and grid graphs. In [2, 3, 4], several authors discussed various cordial labeling of graph operations. Terms not defined are used in the sense of [5].

2 Main Results

Theorem2.1. Ladder $P_n \times K_2$ is a perfect mean cordial graph.

Proof. Let $V(P_n \times K_2) = \{w_i, z_i : 1 \leq i \leq n\}$

Let $E(P_n \times K_2) = \{w_i w_{i+1}, z_i z_{i+1} : 1 \leq i \leq n-1\} \cup \{w_i z_i : 1 \leq i \leq n\}$

We construct vertex labeling $h : V(P_n \times K_2) \to \{0,1,2,3\}$ $as\ follows$:

$$h(u_i) = \begin{cases} 3 & i \equiv 0 \pmod 4 \\ 0 & i \equiv 1 \pmod 4 \\ 3 & i \equiv 2 \pmod 4 \\ 1 & i \equiv 3 \pmod 4 \end{cases} \quad 1 \leq i \leq n$$

$$h(v_i) = \begin{cases} 2 & i \equiv 0 \pmod 4 \\ 2 & i \equiv 1 \pmod 4 \\ 1 & i \equiv 2 \pmod 4 \\ 0 & i \equiv 3 \pmod 4 \end{cases} \quad 1 \leq i \leq n$$

The induced edge labeling is,

$$h^*(uv) = \begin{cases} 1 & if\ 2 | h(u) + h(v) \\ 0 & otherwise \end{cases} \text{,for all } uv \in E(P_n \times K_2).$$

Examination of vertex and edge demands are illustrated below.

	Vertex condition	Edge condition
$n \equiv 0 \pmod 4$	$v_h(0) = v_h(1) = v_h(2) = v_h(3) = \dfrac{n}{2}$	$e_h(0) = e_h(1) = \dfrac{3n}{2} - 1$

$n \equiv 1(mod4)$	$v_h(0) = v_h(2) = \dfrac{n-1}{2} + 1$ $v_h(1) = v_h(3) = \frac{n-1}{2}$	$e_h(0) = \dfrac{3(n-1)}{2},$ $e_h(1) = \frac{3(n-1)}{2} + 1$
$n \equiv 2(mod4)$	$v_h(0) = v_h(1) = v_h(2) = v_h(3) = \dfrac{n-2}{2} + 1$	$e_h(0) = e_h(1) = \frac{3(n-2)}{2} + 2$
$n \equiv 3(mod4)$	$v_h(0) = v_h(1) = \dfrac{n-3}{2} + 2$ $v_h(2) = v_h(3) = \frac{n-3}{2} + 1$	$e_h(0) = \dfrac{3(n-3)}{2} + 4,$ $e_h(1) = \frac{3(n-3)}{2} + 3$

Table 2.1: Vertex and edge demands of $Pn \times K2$

Consequently, the graph $P_n \times K_2$ fulfills the demands $\mid e_h(0) - e_h(1) \mid \leq 1$ and $\mid v_h(\alpha) - v_h(\beta) \mid \leq 1 \, for \, all \; \alpha, \; \beta \in \{ 0,1,2,3\}$.

Accordingly, $P_n \times K_2$ is a perfect mean cordial graph.

Example2.2. Illustration of the perfect mean cordial graph $P_6 \times K_2$ is shown in the Figure 2.1
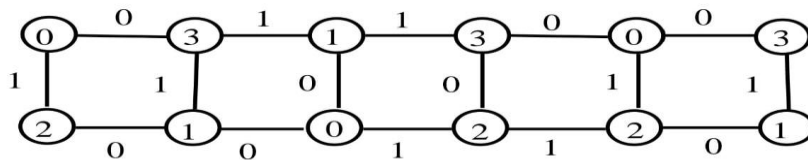
Figure 2.1. Perfect mean cordial labeling of $P_6 \times K_2$

Theorem. 2.3. Grid graph $P_n \times P_n$ is a perfect mean cordial graph.

Proof. Let $V(P_n \times P_n) = \{w_{ij} : 1 \leq i,j \leq n \}$

Let $E(P_n \times P_n) = \{w_{ij}w_{i(j+1)} : 1 \leq i \leq n , 1 \leq j \leq n-1\} \cup \{w_{ij}w_{(i+1)j} :$ $1 \leq i \leq n-1 , 1 \leq j \leq n$

We construct vertex labeling $h : V(P_n \times P_n) \rightarrow \{0,1,2,3\}$ as follows:

Case1: $i \equiv 0(mod4)$

$$h(w_{ij}) = \begin{cases} 1 & i \equiv 0(mod4) \\ 3 & i \equiv 1(mod4) \\ 2 & i \equiv 2(mod4) \\ 0 & i \equiv 3(mod4) \end{cases} \quad 1 \leq j \leq n$$

Case2: $i \equiv 1(mod4)$

$$h(w_{ij}) = \begin{cases} 2 & i \equiv 0(mod4) \\ 0 & i \equiv 1(mod4) \\ 3 & i \equiv 2(mod4) \\ 1 & i \equiv 3(mod4) \end{cases} \quad 1 \leq j \leq n$$

Case3: $i \equiv 2(mod4)$

$$h(w_{ij}) = \begin{cases} 0 & i \equiv 0(mod4) \\ 2 & i \equiv 1(mod4) \\ 1 & i \equiv 2(mod4) \\ 3 & i \equiv 3(mod4) \end{cases} \quad 1 \leq j \leq n$$

Case4: $i \equiv 3(mod4)$

$$h(w_{ij}) = \begin{cases} 3 & i \equiv 0(mod4) \\ 1 & i \equiv 1(mod4) \\ 0 & i \equiv 2(mod4) \\ 2 & i \equiv 3(mod4) \end{cases} \quad 1 \leq j \leq n$$

The induced edge labeling are,

$$h^*(uv) = \begin{cases} 1 & if \ \ 2|h(u) + h(v) \\ 0 & otherwise \end{cases} \text{for all } uv \in E(P_n \times P_n).$$

Examination of vertex and edge demands are illustrated below.

	Vertex condition	Edge condition
$n \equiv 0(mod4)$	$v_h(0) = v_h(1) = v_h(2) = v_h(3) = \dfrac{n^2}{4}$	$e_h(0) = e_h(1) = n^2 - n$
$n \equiv 1(mod4)$	$v_h(0) = \dfrac{n^2 - 1}{4} + 1$ $v_h(1) = v_h(2) = v_h(3) = \dfrac{n^2-1}{4}$	$e_h(0) = e_h(1) = n^2 - n$
$n \equiv 2(mod4)$	$v_h(0) = v_h(1) = v_h(2) = v_h(3) = \dfrac{n^2}{4}$	$e_h(0) = e_h(1) = n^2 - n$
$n \equiv 3(mod4)$	$v_h(0) = v_h(2) = v_h(3) = \dfrac{n^2-1}{2}$ $v_h(0) = \dfrac{n^2 - 1}{4} + 1$	$e_h(0) = e_h(1) = n^2 - n$

Table 2.2. Vertex and edge demand of $P_n \times P_n$

Consequently, the graph $P_n \times P_n$ fulfills the demands $\mid e_h(0) - e_h(1) \mid \leq 1$ and $\mid v_h(\alpha) - v_h(\beta) \mid \leq 1$ $for\ all\ \ \alpha,\ \beta \in \{\ 0,1\ ,2\ ,3\}$.

Accordingly, $P_n \times P_n$ is a perfect mean cordial graph.

Example2.4. Illustration of the perfect mean cordial graph $P_6 \times P_6$ is shown in the Figure2.2.
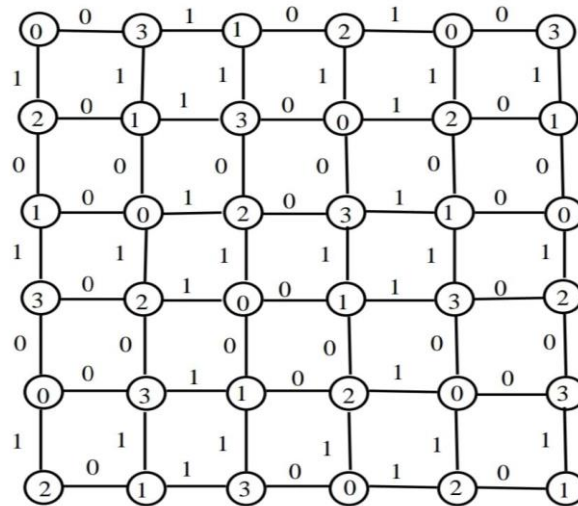
Figure 2.2. Perfect mean cordial labeling of $P_6 \times P_6$

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More Results on Adjacency Matrix and Energy of a T_2 Hypergraph

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ABSTRACT

A hyper graph $H = (X, D)$ is said to be a T_2 hyper graph if for any three distinct vertices u, v and w in X, there exist a hyper edge containing u, v butnot w and another hyper edge containing w but not u and v. In this article, the adjacency energy of a T_2 hyper graph is studied. It is shown that $AE\big(H \leq n\sqrt{n} + n - 4\big).$

***Keyword**s: T_2 hyper graph, adjacency matrix, adjacency energy.*

Subject Classification: 05C65

1 Introduction

The basic definitions and terminologies of a hyper graph are not given here and we refer it [1, 2]. The concept of hyper graph was introduced by Berge in 1967. Later the same concept was studied by Vitaly Voloshin and Alain Bretto [2, 3]. Seena and Raji Pilakkat were introduced Hausdorff hyper graph, T_0 hyper graph and T_1 hyper- graph. Based on [4, 5], we introduced a new class of hyper graph namely T_2 hyper graph and the parameter adjacency energy is studied for the same. Throughout this article H is a simple connected T_2 hyper graph with order n and size m. Here the order and size are the minimum number of vertices and edges used to define a T_2 hypergraph. In A(H), λ_1 is the largest eigen value and λ_n is the smallest eigen value. The following definitions and theorems are used in sequel.

Definition 1.1. [6] A hypergraph $H = (X, D)$ is said to be a Haussdorff hyper graph if for any two distinct vertices u, v of X there exists hyper edges D_1 and D_2 such that $u \in D_1, v \in D_2$ and $D_1 \cap D_2 = \emptyset$

Definition 1.2. [4] A hypergraph $H = (X, D)$ is said to be a T_0 hyper graph if for any two distinct vertices u, v of X there exists a hyper edge containing one of them but not the other.

Definition 1.3. [5] A hyper graph $H = (X, D)$ is said to be a T_1 hyper graph if for any two distinct vertices u, v of X there exists a hyper edge containing u but not v and another hyper edge containing v but not u.

Definition 1.4. [7] A hyper graph $H = (X, D)$ is said to be a T_2 hyper graph if for any three distinct vertices u, v and w of X there exist a hyper edge containing u, v but not w and another

hyper edge containing w but not u, v.

Definition 1.5. [8] The adjacency matrix is the square matrix which rows and columns are indexed by the vertices of H and where for all $u, v \in X, u \neq v, a_{uv} = |\{d \in D : u, v \in D\}|$ and $a_{uv} = 0$.

Definition 1.6. [9] The adjacency energy of a hypergraph is sum of the eigen values of its adjacency matrix.

Definition 1.7. [9] A graph G on n vertices is said to be hypo energetic if E(G)< n. Graphs for which E(G) $\geq n$ are said to be non – hypo energetic

Definition 1.8. [9] A graph G on n vertices is said to be hyper energetic if E(G) $> 2n$-2.

Definition 1.9. [10] A graph G on n vertices is said to be border energetic if

E(G) = 2n-2.

2 Adjacency matrix and energy of a T₂ hyper graph

In this section, we find the energy of a T_2 hyper graph using adjacency matrix. Considera T_2 hyper graph given in figure 1 with 10 vertices and 6 edges.
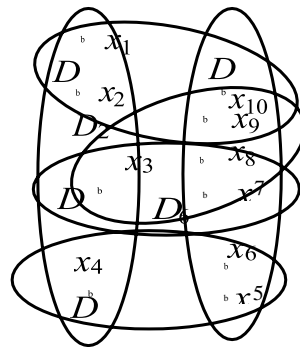
Figure 1. T ₂ Hyper graph

The Adjacency matrix of H = T₂ is given by

$$A\,(H) = \begin{pmatrix} 0 & 2 & 1 & 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 2 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 0 & 2 & 0 & 0 & 2 & 2 & 1 & 1 \\ 1 & 1 & 2 & 0 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 2 & 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 2 & 0 & 1 & 1 & 1 & 1 \\ 0 & 0 & 2 & 1 & 1 & 1 & 0 & 3 & 1 & 1 \\ 0 & 0 & 2 & 1 & 1 & 1 & 3 & 0 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 2 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 2 & 0 \end{pmatrix}$$

The eigen values of A (H) are

λ= 8.97, 2.9, 1.59, -0.4, -1.29, -2, -2, -2, -2.74, -3

Therefore, Adjacency energy AE (H) = $\sum_{I=1}^{n}|\lambda_i|$=26.88

Vertices	Energy	$n\sqrt{n} + n - 4$
4	8	8
5	8	12.18
6	12	16.69
7	15.73	21.52
8	18.84	26.62
9	25.61	32
10	26.88	37.62
11	31.32	43.48
12	40.95	49.56
13	44.21	55.87
14	143.97	62.38
15	46.38	69.09
16	61.97	76
17	69.32	83.09
18	67.28	90.36
19	78.91	97.81
20	100.36	105.44

Table 1. Adjacency energy of a T_2 hyper graph

Result 2.1. For a T$_2$ hyper graph AE (H)$\leq n\sqrt{n} + n - 4$. Equality holds only
 if n=4 in H

Proof. The above table gives the adjacency energy of a T$_2$ hyper graph of order n, where
$4\leq n \leq 20$.

Observation 2.2. From the above table,

(i) T$_2$ hyper graph is hyper energetic

(ii) T$_2$ hyper graph is border energetic in n=5

(iii) T$_2$ hyper graph is non-hyper energetic

Result 2.3. Let H be a T$_2$ hypergraph with $4\leq n \leq 20$ then

$\lambda_1 < \frac{3n}{2} + \sqrt{\frac{3}{2}}$ if $4\leq n \leq 19$

$|\lambda_1| < \left|\frac{3n}{2} + \sqrt{\frac{3}{2}}\right|$ if n=20

Proof. The result follows from the below table

vertices	largest eigen value(λ_1)	$\frac{3n}{2} + \frac{3}{2}$
4	3.9	7.22
5	3.4	8.72
6	4	10.22
7	4.7	11.72
8	6.13	13.22
9	7.84	14.72
10	8.97	37.62
11	9.52	16.22
12	10.20	19.22
13	10.91	20.72
14	14.16	22.22
15	18.52	23.72
16	14.65	25.22
17	17.84	26.72
18	18.67	28.22
19	20.46	29.72
20	31.28	31.22

Theorem 2.4. Let H be a T_2 hyper graph with $4 \le n \le 20$ then $AE(H) <$

$\dfrac{n(n-2)^2}{(detA(H))^{\frac{1}{n}}}$

Proof. From an arithmetic and geometric mean inequality,

$$\frac{\sum_{i=1}^{n}|\lambda_i|}{n} > \left(\prod_{i=1}^{n}\lambda_i\right)^{\frac{1}{n}}$$

We have $|\lambda_i| > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}}$ for all i=1,2,3,…,n

Therefore $|\lambda_1| > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}}$

$|\lambda_1|\sum_{i=1}^{n}|\lambda_i| > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}}\sum_{i=1}^{n}|\lambda_i|$
$|\lambda_1|\sum_{i=1}^{n}|\lambda_i| = |\lambda_n|(|\lambda_1| + |\lambda_2| + \cdots + |\lambda_n|)$
$|\lambda_1|\sum_{i=1}^{n}|\lambda_i| > n\lambda_1^2 > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}}\sum_{i=1}^{n}|\lambda_i|$
$n(n-2)^2 > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}}AE(H)$
$AE(H) < \dfrac{n(n-2)^2}{(detA(H))^{\frac{1}{n}}}$

Theorem 2.5. Let H be a T_2 hypergraph with $4 \le n \le 20$ then
$$A > \frac{n(n-2)}{n-1} \text{ where A} = \sum_{i=1}^{n}\sum_{j=1}^{n}a_{ij}^2.$$

Proof. We have $(\sum_{i=1}^{n}|\lambda_i|)^2) \leq (n-1)(\sum_{i=2}^{n}|\lambda_i^2|)$

$$(-\lambda_1^2) \leq (n\text{-}1)(\sum_{i=1}^{n}|\lambda_i^2| - \lambda_1^2)$$
$$= (n\text{-}1)(A\text{-}\lambda_1^2)$$
$$n\lambda_1^2 \leq (n-1)A$$
$$(n-1)A > n\lambda_1^2 = n(n\text{-}2)$$
$$A > \frac{n(n-2)}{n-1}$$

Theorem 2.6. Let H be a T_2 hypergraph with $4 \leq n \leq 20$ then

$$AE(H) < \begin{cases} \dfrac{4n}{(detA)^{\frac{1}{n}}} & if\ n = 4,5,6 \\[2ex] \dfrac{9n}{(detA)^{\frac{1}{n}}} & if\ n = 9\ to 12 \\[2ex] \dfrac{16n}{(detA)^{\frac{1}{n}}} f\ n = 16\ to\ 19 \\[2ex] \dfrac{25n}{(detA)^{\frac{1}{n}}} & if\ n = 20 \end{cases}$$

Proof. From an arithmetic and geometric mean inequality,

$$\frac{\sum_{i=1}^{n}|\lambda_i|}{n} > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}}$$

We have $|\lambda_i| > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}}$ $\forall i = 1,2,3,\ldots,n$

Therefore $|\lambda_n| > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}}$

$|\lambda_n|\sum_{i=1}^{n}|\lambda_i| > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}}\sum_{i=1}^{n}|\lambda_i|$
$|\lambda_n|\sum_{i=1}^{n}|\lambda_i| = |\lambda_n|(|\lambda_1| + |\lambda_2| + \cdots + |\lambda_n|)$
$|\lambda_n|\sum_{i=1}^{n}|\lambda_i| > n\lambda_n^2 > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}}\sum_{i=1}^{n}|\lambda_i| \ldots\ldots\ldots (1)$

Case 1: If n=4,5,6
Then the smallest eigen value $\lambda_n = 2$
From (1), $4n > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}} AE(H)$

$$\frac{4n}{(detA)^{\frac{1}{n}}} > AE(H)$$

Case 2: If n=9 to 12

Then the smallest eigen value $\lambda_n = -3$

From (1), $9n > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}} AE(H)$

$$\frac{9n}{(detA)^{\frac{1}{n}}} > AE(H)$$

Case 3: If n=16 to 19
Then the smallest eigen value $\lambda_n = --4$
From (1), $16n > (\prod_{i=1}^{n}\lambda_i)^{\frac{1}{n}} AE(H)$

$$\frac{16n}{(detA)^{\frac{1}{n}}} > AE(H)$$

Case 4: If n=20

Then the smallest eigen value $\lambda_n = -5$

From (1), $25n > (\prod_{i=1}^{n} \lambda_i)^{\frac{1}{n}}$ AE(H)

$$\frac{25n}{(detA)^{\frac{1}{n}}} > AE(H)$$

Theorem 2.7. Let H be a T_2 hypergraph with $4 \leq n \leq 20$ then

$$detA(H) > \begin{cases} -2^n \ if \ 4 \leq n \leq 6 \\ -3^n \ if \ 9 \leq n \leq 12 \\ -4^n \ if \ 16 \leq n \leq 19 \\ -5^n \ if \ n = 5 \end{cases}$$

Proof. In H, $\prod_{i=1}^{n} \lambda_i = \lambda_1 \lambda_2 \dots \lambda_n \ \forall i$

Since $\lambda_i > \lambda_n \ \forall i$

$> \lambda_n \lambda_n \dots \lambda_n$

$> \lambda_n{}^n$ ....(1)

Case 1: If $4 \leq n \leq 6$ then $\lambda_n = -2$

From (1), $detA(H) > -2^n$

Case 2: If $9 \leq n \leq 12$ then $\lambda_n = -3$

From (1), $detA(H) > -3^n$

Case 3: If $16 \leq n \leq 19$ then $\lambda_n = -4$

From (1), $detA(H) > -4^n$

Case 4: If $n = 20$ then $\lambda_n = -5$

From (1), $detA(H) > -5^n$

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On the Upper Monophonic Global Domination Number of a Graph

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ABSTRACT

A monophonic global dominating set M *of* G *is called a minimal monophonic global dominating set of* G *if no proper subset of* M *is a monophonic global dominating set of* G. *The maximum cardinality of a minimal monophonic global dominating set of* G *is the upper monophonic global dominating set of* G, *denoted by* $\bar{\gamma}_m^+(G)$. *This concept's general qualities are investigated. The upper monophonic global domination number of some family of graphs is determined. It is shown that for any positive integers* a *and* b *with* $2 \le a \le b$, *there exists a connected graph* G *such that* $\gamma_m(G) = a$ *and* $\bar{\gamma}_m^+(G) = b$. *where* $\gamma_m(G) = a$ *is the monophonic global domination number of* G.

Keywords: *Domination number, Global domination number, Monophonic number, Monophonic global domination number, Upper monophonic global domination number.*

AMS Subject Classification: *05C12,05C38.*

1. Introduction

A finite, undirected connected graph with no loops or many edges is referred to as a graph $G = (V, E)$ The letters n and m respectively, stand for the order and size of G. Basic graph theoretic terms are taken from [1]. If uv is an edge of G then two vertices u and v are said to be adjacent. If $uv \in E(G)$, then u is $v's$ neighbour and the set of $v's$ neighbours are denoted by $N(v)$ and degree of $v \in V$ has degree $\deg(v) = |N(v)|$. If $\deg(v) = n - 1$, a vertex v is referred to as a universal vertex. A vertex v is called an extreme vertex if $G[N(v)]$ is complete. The subgraph induced by a set S of vertices of a graph G is denoted by $G[S]$ with $V(G[S]) = s$ and $E(G[S]) = \{uv \in E(G): u, v \in S\}$. 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 an $u - v$ geodesic. A vertex x is said to lie on a $u - v$ geodesic P if x is a vertex of P including the vertices u and v.

A chord of a path P is an edge which connects two non-adjacent vertices of P. An $u - v$ path is called a monophonic path if it is a chordless path. The monophonic distance $d_m(u, v)$ from u to v is defined as the length of a longest $u - v$ monophonic path in G. An $u - v$

monophonic path of length $d_m(u,v)$ is called a $u - v$ monophonic. The monophonic eccentricity $e_m(v)$ of a vertex v in G is the maximum monophonic distance from v and a vertex of G, (i.e). $e_m(v) = max\{d_m(v,u) : u \in V\}$. The minimum monophonic eccentricity among the vertices of G is the monophonic radius, $rad_m G$ and the maximum monophonic eccentricity is its monophonic diameter, $diam_m G$. We denote $rad_m(G)$ by r_m and $diam_m G$ by d_m. Two vertices u and v of G are monophonic antipodal vertex if $d_m(u,v) = d_m$. A vertex v is called a monophonic peripheral vertex of G, if $e_m(v) = d_m$. The monophonic distance of a connected graph was studied by Santhakumaran [2]. For two vertices u and v, the closed interval $J[u,v]$ consists of all the vertices lying in a $u - v$ monophonic path including the vertices u and v. If u and v are adjacent, then $J[u,v] = \{u,v\}$. For a set M of vertices, let $J[M] = \cup_{u,v \in M} J[u,v]$. Then certainly $M \subseteq J[M]$. A set $M \subseteq V(G)$ is called a monophonic set of G if $J[M] = V$. The monophonic number $m(G)$ of G is the minimum order of its monophonic sets and any monophonic set of order $m(G)$ is called a m-set of G. The monophonic number of a graph was studied in [3,4,5,6].

A subset $S \subseteq V(G)$ is called a dominating set if every vertex $v \in V(G) \backslash S$ is adjacent to a vertex $u \in S$. The domination number, $\gamma(G)$, of a graph G denotes the minimum cardinality of such dominating sets of G. A minimum dominating set of a graph G is hence often called as a γ-set of G. The domination concept was studied by Haynes, Hedetniemi and Slater [7]. A subset $D \subseteq V$ is called a global dominating set in G if D is a dominating set of both G and $\bar{G}$. The global domination number $\bar{\gamma}(G)$ is the minimum cardinality of a global dominating sets in G. The concept of global domination in graph was introduced by Sampathkumar [8] and Vaidya and Pandit haave studies global domination and its properties [9, 10]. A set $M \subseteq V$ is said to be a monophonic global dominating set of G if M is both a monophonic set and a global dominating set of G. The minimum cardinality of a monophonic global dominating set of G is the monophonic global domination number of G and is denoted by $\bar{\gamma}_m(G)$. A monophonic global dominating set of cardinality $\bar{\gamma}_m(G)$ is called a $\bar{\gamma}_m$ -set of G. Throughout the paper, G denotes a connected graph at least two vertices. The following theorem is used in the sequel.

Theorem 1.1. [11] Each extreme vertex of a connected graph G belongs to every monophonic global dominating set of G.

2 The Upper Monophonic Global Domination Number of a Graph

Definition 2.1. A monophonic global dominating set of G is called a minimal monophonic

global dominating set of G if no proper subset of M is a monophonic global dominating set of G. The maximum cardinality of a minimal monophonic global dominating set of G is the upper monophonic global dominating set of G, denoted by $\bar{\gamma}_m^+(G)$.

Example 2.2. For the graph G given in Figure 2.1, $M_1 = \{v_1, v_2, v_3\}, M_2 = \{v_1, v_3, v_4\}$, $M_3 = \{v_1, v_3, v_5\}, M_4 = \{v_1, v_3, v_6\}, M_5 = \{v_1, v_5, v_6\}, M_6 = \{v_3, v_5, v_6\}$ and $M_7 = \{v_2, v_4, v_5, v_6\}$ are the only seven minimal monophonic global dominating sets of G so that $\bar{\gamma}_m^+(G) \geq 4$. It is easily verified that no 5-element subset of V is a minimal monophonic global dominating set of G, and thus $\bar{\gamma}_m^+(G) = 4$.
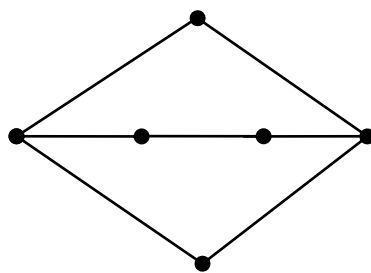
Figure 2.1

Observation 2.3. Let G be a connected graph of order $n \geq 2$. Then

(i) Each extreme vertex of a graph G belongs to every minimal monophonic global dominating set of G. In particular, each end-vertex of G belongs to every minimal monophonic global dominating set of G.

(ii) Each universal vertex of G belongs to every minimal monophonic global dominating set of G.

(iii) Let G be a connected graph and v a cut vertex of G. If M is a minimal monophonic global dominating set of G, then every component of $G - v$ contains an element of M.

(iv) For a connected graph G order $n \geq 2, 2 \leq \bar{\gamma}_m(G) \leq \bar{\gamma}_m^+(G) \leq n$.

(v) For a connected graph G order $n \geq 2, \bar{\gamma}_m(G) = n$ if and only if $\bar{\gamma}_m^+(G) = n$.

(vi) For the star $G = K_{1,n-1} (n \geq 3), \bar{\gamma}_m(G) = \bar{\gamma}_m^+(G) = n$.

(vii) For the complete graph $G = K_n, \bar{\gamma}_m(G) = \bar{\gamma}_m^+(G) = n$.

Theorem 2.4. Let G be a connected graph of order n $\geq$ 2. If $\bar{\gamma}_m^+(G) = n$, then $\bar{\gamma}_m(G) = n$.

Proof: This follows from observation 2.3 (iv) and (v).

Remark 2.5. The converse of Theorem 2.4 need not be true. For the graph G given in Figure 2.2, $M_1 = \{v_1, v_2, v_3\}$ is a $\bar{\gamma}_m$ - set of G and $M_2 = \{v_1, v_2, v_4, v_5\}$ is a minimal

monophonic global dominating set of G so that $\bar{\gamma}_m(G) = 3$ and $\bar{\gamma}_m^+(G) = 4$.
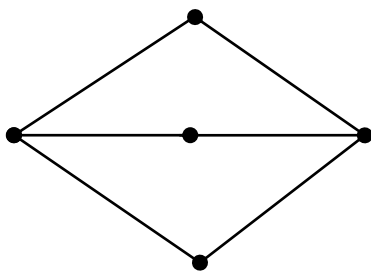
Figure 2.2

Theorem 2.6. For the path $G = P_n$, $(n \geq 4)$, $\bar{\gamma}_m^+(G) = \lceil\frac{n}{2}\rceil$.

Proof: Let $V(P_n) = \{v_1, v_2, .., v_n\}$ and $E(P_n) = \{v_i v_{i+1} / 1 \leq i \leq n - 1\}$. We prove this theorem by considering two cases.

Case 1: n is even.

Let $n = 2k$ ($k \geq 2$). Let $M = \{v_1, v_3, v_5, .., v_{2k-2}, v_{2k}\}$. Then M is a minimal monophonic global dominating set of G and so $\bar{\gamma}_m^+(G) \geq k = \frac{n}{2}$. We prove that $\bar{\gamma}_m^+(G) = \frac{n}{2}$. Suppose this is not the case. Then there exists a minimal monophonic global dominating set M' such that $|M'| \geq \frac{n}{2} + 1$. Hence there exists $v_l v_{l+1} \in M'$, where $1 \leq l \leq n - 1$. By Observation 2.3 (i), $v_1, v_n \in M'$. Without loss of generality, let us assume that $v_1 \neq v_l$ and $v_l \neq v_n$. Then $M' - \{v_l\}$ is a monophonic global dominating set of G, which is a contradiction to M' a minimal monophonic global dominating set of G. Therefore $\bar{\gamma}_m^+(G) = \lceil\frac{n}{2}\rceil$.

Case 2: n is odd.

Let $n = 2k + 1$. Let $M = \{v_1, v_3, v_5, .., v_{2k-1}, v_{2k+1}\}$ is a minimal monophonic global dominating set of G and so $\bar{\gamma}_m^+(G) \geq \lceil\frac{n}{2}\rceil$. Using similar argument as in Case (i), we prove that $\bar{\gamma}_m^+(G) = \lceil\frac{n}{2}\rceil$.

Theorem 2.7. For the cycle $G = C_n$ $(n \geq 4)$, $\bar{\gamma}_m^+(G) = \lceil\frac{n}{2}\rceil$.

Proof: The proof is similar to the proof of Theorem 2.6.

Theorem 2.8. For the fan graph $G = K_1 + P_{n-1}$ $(n \geq 4)$, $\bar{\gamma}_m^+(G) = 4$.

Proof: If $n = 4$, then the result follows from Observation 2.3 (i) and (ii). So, let $n \geq 5$. Let $V(K_1) = \{x\}$ and $V(P_{n-1}) = \{v_1, v_2, .., v_{n-1}\}$. Let $M = \{x, v_1, v_{n-1}, y\}$, where $y \in \{v_2, v_3, ..., v_{n-2}\}$. Then M is a minimal monophonic global dominating set of G and so $\bar{\gamma}_m^+(G) \geq 4$. We prove that $\bar{\gamma}_m^+(G) = 4$. Suppose this is not the case. Then there exists a minimal

monophonic global dominating set M' such that $|M'| \geq 5$. By Observation 2.3(i) and (ii) $x, v_1, v_{n-1} \in M'$. Hence it follows that $\subset M'$, which is a contradiction to M' a minimal monophonic global dominating set of G, Therefore $\bar{\gamma}_m^+(G) = 4$.

Theorem 2.9. For the complete bipartite G $= K_{r,s}$ $(1 \leq r \leq s)$,

$$\bar{\gamma}_m^+(G) = \begin{cases} r + s, & \text{if } r = 1,\ s \geq 1 \\ s + 1, & \text{otherwise} \end{cases}$$

Proof: Let $U = \{u_1, u_2, \ldots, u_r\}$ and $W = \{w_1, w_2, \ldots, w_s\}$ be the two bipartite sets of G.

Case 1: If $r = 1, s \geq 1$. This follows from Observation 2.3(i).

Case 2: $2 \leq r < s$.

Let $M = W \cup \{x\}$, where $x \in U$. Then M is a monophonic global dominating set of G. We prove that M is a minimal global dominating set of G. Suppose this is not the case. Then there exists a monophonic global dominating set M' such that $M' \subset M$.

Let v be a vertex of G such that $v \in M$ and $v \in M'$. If $v = x$, then M' is not a global dominating set of G. If $v = w_i$ for some i $(1 \leq i \leq s)$, then $v \notin J[M']$ and so M' is not a monophonic set of G, which is a contradiction. Therefore M is a minimal global dominating set of G and so $\bar{\gamma}_m^+(G) \geq s + 1$. Note that $M_1 = U \cup \{y\}$, where $y \in W$ and $M_{ijkl} = \{u_i, u_j, w_k, w_l\}$ $(1 \leq i \leq j \leq r)$ $(1 \leq k \leq l \leq s)$ are the minimal monophonic global dominating set of G. We prove that $\bar{\gamma}_m^+(G) = s + 1$. Suppose this is note the case. Then there exists a minimal monophonic global dominating set S such that $|S| \geq s + 2$. Then $S \subset U \cup W$. Since $|S| \geq s + 2$, either $M_1 \subset S$ or $M_{ijkl} \subset S$ for $(1 \leq i \leq j \leq r), (1 \leq k \leq l \leq s)$, which is a contradiction to S a minimal monophonic global dominating set of G. Therefore $\bar{\gamma}_m^+(G) = s + 1$.

Case 3: $r = s$. Using similar argument are as Case 2, we show that $\bar{\gamma}_m^+(G) = r$.

Theorem 2.10. For the wheel graph G $= K_1 + C_{n-1}$, $(n \geq 4)$, $\bar{\gamma}_m^+(G) = 4$.

Proof: Let $V(K_1) = \{x\}$ and $V(C_{n-1}) = \{v_1, v_2, \ldots, v_{n-1}\}$. Let $M = \{x, u, v, w\}$, where $u, v, w \in V(C_{n-1})$. Then M is a minimal monophonic global dominating set of G and so $\bar{\gamma}_m^+(G) \geq 4$. We prove that $\bar{\gamma}_m^+(G) = 4$. Suppose this is not the case. Then there exists a minimal monophonic global dominating set M' such that $|M'| \geq 5$. By Observation 2.3(ii), $x \in M'$. Since $M' - \{x\} \subset V(C_{n-1})$, We have $M \subset M'$, which is a contradiction to M' a minimal monophonic global dominating set of G. Therefore $\bar{\gamma}_m^+(G) = 4$.

Theorem 2.11. For any positive integers a and b with $2 \leq a \leq b$, there exists a connected graph G such that $\bar{\gamma}_m(G) = a$ and $\bar{\gamma}_m^+(G) = b$.

Proof: If $a = b$, let $G = K_{1,a-1}$. Then by Observation 2.3 (vi), $\bar{\gamma}_m(G) = \bar{\gamma}_m^+(G) = a$. So, let

$2 \leq a < b.$ Let $V(K_2) = \{x, y\}$ and $V(K_{b-a+1}) = \{u_1, u_2, \ldots, u_{b-a+1}\}.$ Let $H = K_{b-a+1} + K_2.$ Let G be the graph in Figure 2.3 obtained from H by adding $a-1$ new vertices $z_1, z_2, \ldots, z_{a-1}$ and joining each vertex z_i $(1 \leq i \leq a-1)$ with y. Let $Z = \{z_1, z_2, \ldots, z_{a-1}\}.$ By Observation 2.3 (i), Z is a subset of every monophonic global dominating set of G. Since $J[Z] \neq V$, Z is not a monophonic global dominating set of G and so $\bar{\gamma}_m(G) \geq a.$ Let $M = Z \cup \{x\}.$ Then M is a monophonic global dominating set of G so that $\bar{\gamma}_m(G) = a.$

Next, we prove that $\bar{\gamma}_m^+(G) = b.$ Let $T = Z \cup \{u_1, u_2, \ldots, u_{b-a+1}\}.$ Then T is is a monophonic global dominating set of G. We show that T is a minimal monophonic global dominating set of G. Let W be any proper subset of T. Then there exist at least one vertex say $v \in T$ such that $v \notin W$. By Observation 2.3 (i), $v \neq z_i$ for all i $(1 \leq i \leq a-1)$. Now, assume that $v = u_j$ for some j $(1 \leq j \leq b-a + 1)$. Then $u_i \notin J[W]$ and so W is not a monophonic global dominating set of G. Hence T is a minimal monophonic global dominating set of G so that $\bar{\gamma}_m^+(G) \geq b.$

Now, we show that there is no minimal monophonic global dominating set S of G with $|S| \geq b + 1$. Suppose that there exists a minimal monophonic global dominating set S of G such that $|S| \geq b + 1.$ Since $|V(G)| = b + 2$ and since M is a monophonic global dominating set of G, it follows that $|S| = b + 1.$ It is easily seen that, $y \notin S$ and so $S = V(G) - \{y\}.$ Since M is a monophonic global dominating set of G, it follows that S is not a minimal a monophonic global dominating set of G, which is a contradiction. Thus $\bar{\gamma}_m^+(G) = b.$
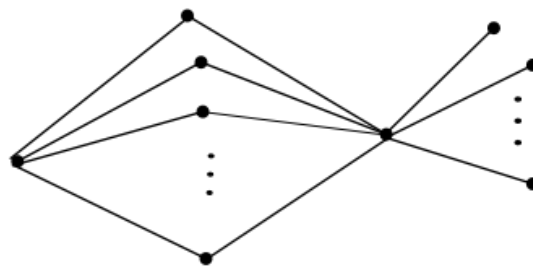
Figure 2.3

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On the Upper Geodetic Cototal Domination Number of a Graph

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ABSTRACT

A geodetic cototal dominating set D in a connected graph G is called a minimal geodetic cototal dominating set of G if no proper subset of D is a geodetic cototal dominating set of G. The maximum cardinality of a minimal geodetic cototal dominating set of G is the upper geodetic cototal domination number of G and is denoted by $\gamma^+{}_{gct}(G)$. It is shown that for every two positive integers a *and* b *of integers, with* $3 \leq a \leq b$, *there exists a connected graph* G *with* $\gamma_{gct}(G) = a$ *and* $\gamma^+{}_{gct}(G) = b$.

Keywords: *geodetic set, cototal domination, geodetic cototal domination, upper geodetic cototal domination.*
AMS Subject Classification: *05C12, 05C69.*

1 Introduction

Graphs are the mathematical structures used to model pairwise relations between objects or a pictorial representation of set of objects where a link connects some pairs of objects. The interacting objects are called points, vertices, or nodes and the relationships that connect the objects are called lines, edges or arcs. A graph $G = (V, E)$, consists of a finite nonempty set V = V(G) of vertices together with a set E = E(G) of un ordered pair e = {u, v} of distinct elements of V. The standard terminology and notations in this article are based on the book Graph theory and Distance in Graphs [1, 2]. In this article, we consider only a finite, undirected graph with no loops or multiple edges. For vertices u and v in a connected graph G, the distance $d(u, v)$ is the length of a shortest $u-v$ path in G. A $u-v$ path of length $d(u, v)$ is called a $u-v$ *geodesic*. The *eccentricity $e(v)$* of a vertex v in G is the maximum distance from v and a vertex of G. The minimum eccentricity among the vertices of G is the *radius*, $rad\ G$ or $r(G)$ and the maximum eccentricity is its *diameter*, $diam\ G$ of G. Let $x, y \in V$ and let $I[x, y]$ be the set of all vertices that lies in $x - y$ geodesic including x and y. Let $S \subseteq V(G)$ and $I[S] = \bigcup_{x,y \in S} I[x, y]$. Then S is said to be a *geodetic set* of G, if $I[S] = V$. The *geodetic number $g(G)$* of G is the minimum order of its geodetic sets and any geodetic set of order $g(G)$ is called a g-*set* of G. A set $S \subseteq V(G)$ is called a *dominating set* if every vertex in $V(G) - S$ is adjacent to at least one vertex of S. The *domination number*, $\gamma(G)$, of a graph

G denotes the minimum cardinality of such dominating sets of G. A minimum dominating set of a graph G is hence often called as a γ-set of G. For the fundamentals of domination concept refer [3]. A dominating set S of G is a *cototal dominating set* if every vertex $v \in V \setminus S$ is not an isolated vertex in the induced subgraph $\langle V \setminus S \rangle$. The cototal domination number $\gamma_{ct}(G)$ of G is the minimum cardinality of a cototal dominating set [4].   A set $S \subseteq V$ is said to be a geodetic cototal dominating set of G, If S is both geodetic set and cototal dominating set of G. The geodetic cototal domination number of G is the minimum cardinality among all geodetic cototal dominating sets in G and denoted by $\gamma_{gct}(G)$. A geodetic cototal dominating set of minimum cardinality is called the γ_{gct}-set of G [5]. The several concepts of geodetic cototal domination number of a graph were studied [6, 7]. The following theorem is used in the sequel.

Theorem 1.1. [6] Each extreme vertex of a connected graph belongs to every geodetic cototal dominating set of G.

2 The upper geodetic cototal domination number of a graph

Definition 2.1. A geodetic cototal dominating set $D \subset V$ is said to be a minimal geodetic cototal dominating set, if there does not exist a set $N \subset D$ that is a geodetic cototal dominating set of the graph G. The upper geodetic cototal dominating number $\gamma_{gct}^+(G)$ is the maximum size of a minimal geodetic cototal dominating set of G.

Example 2.2. For the graph G given in Figure .1, $S_1 = \{v_2, v_5\}, S_2 = \{v_2, v_4, v_6\}$ are the only two minimal geodetic cototal dominating sets of G and so $\gamma_{gct}^+(G) \geq 3$. Since there is no minimal geodetic cototal dominating set of G with cardinality four, $\gamma_{gct}^+(G) = 3$.
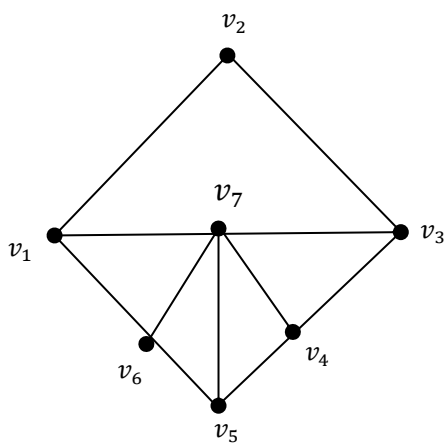
G
Fig 1.

Remark 2.3. Every minimum geodetic cototal dominating set of G is a minimal geodetic cototal dominating set of G, but the converse need not be true. For the graph G given in Fig.1, $S_2 = \{v_2, v_4, v_6\}$ is a minimal geodetic cototal dominating set of G but not a minimum geodetic cototal dominating set of G.

Theorem 2.4. Let G be a connected graph of order n. Then $2 \leq \gamma_{gct}(G) \leq \gamma_{gct}^+(G) \leq n$.

Proof: Since every geodetic cototal dominating set of G needs at least two vertices, $\gamma_{gct}(G) \geq 2$. . Since every minimum geodetic cototal dominating set of G is a minimal geodetic cototal dominating set of G, it follows that $\gamma_{gct}(G) \leq \gamma_{gct}^+(G)$. Also, since V(G) is a geodetic cototal dominating set of G, We have $\gamma_{gct}^+(G) \leq n$. Therefore $2 \leq \gamma_{gct}(G) \leq \gamma_{gct}^+(G) \leq n$.

Remark 2.5. The bounds in Theorem 2.4 are sharp. For the graph G = K_2, $\gamma_{gct}(G)$=2 = n and for the graph G = C_4, $\gamma_{gct}(G) = \gamma_{gct}^+(G) = 4$. For G = K_n, $\gamma_{gct}^+(G) = n$. Also, the bounds in Theorem 2.4 are strict. For the graph in Fig.1, $\gamma_{gct}(G) = 2$, $\gamma_{gct}^+(G) = 5$ and n = 7. Thus $2 < \gamma_{gct}(G) < \gamma_{gct}^+(G) < n$.

Observation 2.6. (i) For $G = K_n$ $(n \geq 2), \gamma_{gct}^+(G) = n$.

(ii) For $G = P_n$ $(n \geq 5), \gamma_{gct}^+(G) = \left\lceil \frac{n}{3} \right\rceil$.

(iii) For $G = C_n$ $(n \geq 6), \gamma_{gct}^+(G) = \left\lceil \frac{n}{3} \right\rceil$.

(iv) For $G = K_{1,n-1}$, $\gamma_{gct}^+(G) = $ n.

Theorem 2.7. For G=$K_{r,s}(G) = \begin{cases} r + s, & if\ 1 \leq r \leq 3 \\ 4, & if\ 4 \leq r \leq s \end{cases}$.

Proof: Let $U = \{u_1, u_2, \ldots, u_r\}$ and $W = \{w_1, w_2, \ldots, w_s\}$ be the two bipartite sets of G. Let S be a γ_{gct}-set of G. If $1 \leq r \leq 3$. Then $S = V(G)$ is the unique γ_{gct}-set of G. so that $\gamma_{gct}^+(G) = 3$. So, let $4 \leq r \leq s$. Let $S = \{u_1, u_2, w_1, w_2\}$. Then S is a minimal geodetic cototal dominating set of G and so $\gamma_{gct}^+(G) \geq 4$. We prove that S is a minimal geodetic cototal dominating set of G. Suppose this is not the case. Then there exists geodetic cototal dominating of S_1 such that $S_1 \subset S$. Then there exists a vertex $x \in S$ such that $x \notin S_1$. If $x = x_1$ or x_2, then w_1, w_2 do not belong to a geodesic joining a pair of vertices of S. If $x = w_1$ or w_2, then u_1, u_2 do not belong to a geodesic joining a pair of vertices of S. Therefore S_1 is not a geodetic cototal dominating set of G, which is a contradiction. Hence it follows that S is a minimal geodetic cototal dominating set of G and so that $\gamma_{gct}^+(G) \geq 4$. We prove that $\gamma_{gct}^+(G) = 4$. On the contrary suppose that $\gamma_{gct}^+(G) \geq 5$, Then there exists a minimal geodetic cototal dominating set S', such that $|S'| \geq 5$. Since $G[V - S']$ has no isolated vertices, $S' \subset U \cup W$ such that S' contains at least two vertices from U and at least two vertices from W. Hence it follows that

there exists a geodetic cototal dominating set M such that $M \subset S'$, which is a contradiction. Therefore $\gamma_{gct}^+(G) = 4$.

Definition 2.8. Let $V(\overline{K}_2) = \{x, y\}$ and $(\overline{K}_a) = \{v_1, v_2, \dots, v_a\}(a \geq 2)$. Let $H = \overline{K}_a + \overline{K}_2$. Let G_a be the graph in Fig. 2 obtained from H by adding a new vertex u and joining u with y.

Theorem 2.9. For the graph G_a, $\gamma_{gct}(G_a) = 2$.

Proof: Let $Z = \{u\}$ be the set of all end vertices of G. By Theorem 1.1, Z is a subset of every geodetic cototal dominating set of G. Let $S = Z \cup \{x\}$. Then S is a geodetic cototal dominating set of G so that $\gamma_{gct}(G_a) = 2$.
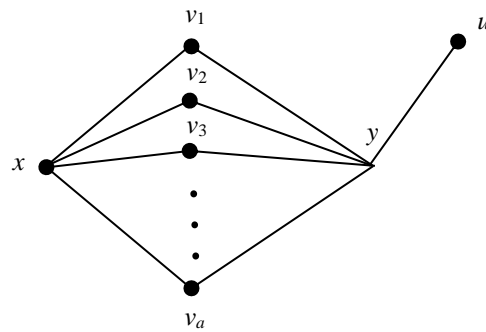
G
Fig 2.

Definition 2.10. Consider the paths $P_{2a+1}: x_1, x_2, \dots, x_{2a+1}$. Let $V(\overline{K}_2)) = \{x, y\}$. Obtain a graph H_a given in Fig. 3 from P_{2a+1} and $\overline{K}_2$ by introducing new vertices $y_1, y_2, \dots, y_{a-1}$ and edges xx_i $(1 \leq i \leq 2a + 1), yx_i$ $(1 \leq i \leq 2a + 1)$ and yy_i $(1 \leq i \leq a - 1)$.
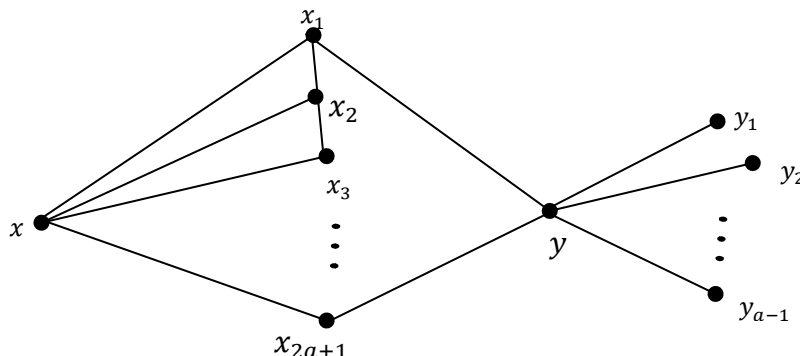
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Fig 3.

Theorem 2.11. For the graph H_a, $\gamma_{gct}(H_a) = a$ and $\gamma_{gct}^+(G) = 2a - 1$.

Proof: Let S be a $\gamma_{ct} - set$ of G and Y be the set of all pendant vertices of G. By Theorem 1.1, $Y\,S$. Hence $\gamma_{gct}(G) \geq a$. Since the vertex $x \notin I[Y]$. Y is not a geodetic cototal dominating set of G and so $\gamma_{gct}(G) \geq a$. Let $S = Y \cup \{x\}$. Then S is a geodetic cototal dominating set of G so that $\gamma_{gct}(G) = a$.

Next, we have to prove $\gamma_{gct}^+(G) = 2a - 1$. Let $S' = Y \cup \{x_1, x_3, \ldots, x_{2a+1}\}$. Then S is a geodetic cototal dominating set of G. We prove that S is a minimal geodetic cototal dominating set of G. Then $S_1 \subseteq S$, where S_1 is a geodetic cototal dominating set of G such that $S_1 \subset S$. Let x be a vertex of S such that $x \notin S_1$. By Theorem 1.1, $x \neq y_i$ $(1 \leq i \leq a - 1)$. If $h = x_i$ $(1 \leq i \leq 2a + 1)$ then $x_i \notin I[S_1]$, which is a contradiction. Therefore S is a minimal geodetic cototal dominating set of G so that $\gamma_{gct}^+(G) \geq 2a - 1$.

We prove that $\gamma_{gct}^+(G) = 2a - 1$. On the contrary, suppose that $\gamma_{gct}^+(G) \geq 2a - 1$. Then there exists a minimal geodetic cototal dominating set M such that $|M| \geq b + 1$. By Theorem 1.1, $Y \subset M$, which is a contradiction. Therefore $\gamma_{gct}^+(G) = 2a - 1$.

Theorem 2.12. For any connected graph G of order $n \geq 2$. Then $\gamma_{gct}(G) = n$ if and only if $\gamma_{gct}^+(G) = n$.

Proof: If $\gamma_{gct}(G) = n$. Then by Theorem 2.5, $\gamma_{gct}^+(G) = n$. Conversely let $\gamma_{gct}^+(G) = n$. Then $S = V(G)$ is the unique minimal geodetic cototal dominating set and so it is a minimum geodetic cototal dominating set of G. Hence $\gamma_{gct}(G) = n$.

Theorem 2.13. For every pair of a, b with $2 \leq a \leq b$ and $b \geq 2$, there exists a connected graph G such that $\gamma_{gct}(G) = a$ and $\gamma_{gct}^+(G) = b$.

Proof: Consider the paths $P : u_0, u_1, u_2$ and $Q : h_1, h_2, \ldots, h_{b-a+2}$. From P and Q obtain a new graph H by joining u_1 with h_1 and u_0 and u_2 with each h_i $(1 \leq i \leq b - a + 2)$. From H obtain a new graph G given in Fig.4. by introducing the vertices $z_1, z_2, \ldots, z_{a-2}$ and introducing the edge $u_i x_i$ $(1 \leq i \leq a - 2)$.

We prove that $\gamma_{gct}(G) = a$. The graph having set of pendent vertices $Z = \{z_1, z_2, \ldots, z_{a-2}\}$. Then by Theorem 1.1, Z is contained in every geodetic cototal dominating set of G. Since $I[Z] \neq V$ and $I[Z \cup \{x\}]$, where $x \notin Z$ is not a geodetic cototal dominating set of G and so $\gamma_{gct}(G) \geq a$. Now $S = Z \cup \{u_0, u_2\}$ is a geodetic cototal dominating set of G. Therefore $\gamma_{gct}(G) = a$.

Next, we have to prove $\gamma_{gct}^+(G) = b$. Consider $S = Z \cup \{h_1, h_2, \ldots, h_{b-a+2}\}$. Then S is a geodetic cototal dominating set of G. We prove that S is a minimal geodetic cototal

dominating set of G. Suppose this is not the case. Hence $S_1 \subset S$, where S_1 is a minimal geodetic cototal dominating set of G. Let x be a vertex of S such that $x \notin S_1$. By Theorem 1.1, $x \neq z_i$ $(1 \leq i \leq a + 2)$. If $x = h_i$ $(1 \leq i \leq b-a + 2)$ then $x \notin I[S_1]$, which is a contradiction. Therefore, S is a minimal geodetic cototal dominating of G so that $\gamma_{gct}^+(G) \geq b$. We prove that $\gamma_{gct}^+(G) = b$. On the contrary, suppose that $\gamma_{gct}^+(G) \geq b + 1$. Then there exists a geodetic cototal dominating set M such that $|M| \geq b + 1$. By Theorem 1.1, $Z \subset M$. Since S is a minimal geodetic cototal dominating set of G and $u_1 \notin M$, there does not exists a minimal geodetic cototal dominating with $|M| \geq b + 1$. Therefore $\gamma_{gct}^+(G) = b$.
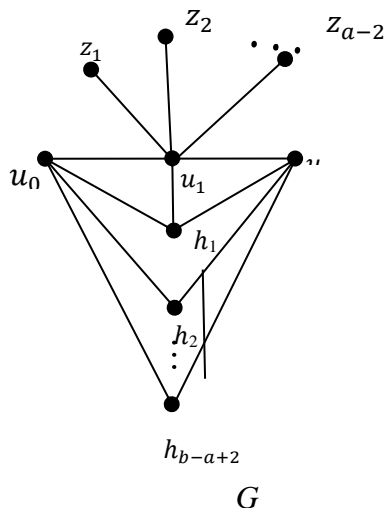
Fig 4.

Conclusion

In this paper the concept of upper geodetic cototal domination number of some standard graphs some general properties satisfied by this concept are studied. In future studies, the same concept will be applied for the other graph operations.

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Product Cordial Labeling of some Graphs

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ABSTRACT

Let $G(V, e)$ be a graph of vertex set V and edge set E. A graph G is said to be a product cordial graph if there exists a function $f: V \to \{0, 1\}$ with each edge assign the label $f(u)f(v)$ such that $|v_f(0) - v_f(1)| \le 1$ and $|e_f(0) - e_f(1)| \le 1$, where $v_f(i)$ and $e_f(i)$ denote the number of vertices and edges respectively labelled with $i(= 0, 1)$. In this paper, we find the product cordial labeling of Jewel graph, Jellyfish graph and Mongolian tent graph.

Keywords: Cordial labeling, Product cordial labeling, Product cordial graph

AMS Subject Classification (2010): 05C78

1 Introduction

Graph labeling is currently an emerging area in the research of graph theory. All graphs in this paper are finite, simple and connected graph. Basic definition of graphs is taken from [1, 2]. A bijection mapping that assigns natural number to vertices or edges or both subject to certain conditions is called a graph *labeling*. The cordial labeling of graph G is an injection $f: V \to \{0, 1\}$ such that each edge uv in G is assigned the label $|f(u) - f(v)|$ with the property that $|v_f(0) - v_f(1)| \le 1$ and $|e_f(0) - e_f(1)| \le 1$, where $v_f(i)$ and $e_f(i)$ denote the number of vertices and number of edges with label with $i(= 0, 1)$ respectively. The graph which admits cordial labeling is called the cordial graph. The concept of cordial labeling was introduced by Cahit [3] in which he investigated several results on this newly defined concept. Following the cordial labeling, several labeling such as prime cordial labeling, A-cordial labeling, H-cordial labeling and product cordial labeling are also introduced as variants of cordial labeling. The product cordial labeling was introduced by Sundaram et al. [4] and they have investigated several results on this newly defined concept. A graph G is said to be a *product cordial graph* if there exists a function $f: V \to \{0, 1\}$ with each edge set assigning the label $f(u)f(v)$ such that $|v_f(0) - v_f(1)| \le 1$ and $\left|e_f(0) - e_f(1)\right| \le 1$, where $v_f(i)$ and $e_f(i)$ is the number of vertices and edges respectively labelled with $i(= 0, 1)$.

The graphs obtained by joining apex vertices of k copies of stars, shells and wheels to a new vertex are proved to be product cordial by Vaidya and Dani [5] while some results on

product cordial labeling for cycle related graphs are reported in Vaidya and Kanani [6]. Vaidya and Barasara [7] have proved that the cycle with one chord, the cycle with twin chords, the friendship graph and the middle graph of path admit product cordial labeling. Vaidya and Vyas [8] have discussed product cordial labeling in the context of tensor product of some graphs while Vaidya and Barasara [9] have investigated some results on product cordial labeling in the context of some graph operations.

Definition 1.1. The cordial labeling of graph G is an injection $f: V \to \{0,1\}$ such that each edge uv in G is assigned the label $|f(u) - f(v)|$ with the property that $|v_f(0) - v_f(1)| \leq 1$ and $|e_f(0) - e_f(1)| \leq 1$, where $v_f(i)$ and $e_f(i)$ denote the number of vertices and number of edges with label i $(i = 0,1)$ respectively. The graph which admits cordial labeling is called the cordial graph.

Definition 1.2. A graph G is said to be a product cordial graph if there exists a function $f: V \to \{0,1\}$ with each edge assign the label $f(u)f(v)$, such that $|v_f(0) - v_f(1)| \leq 1$ and $|e_f(0) - e_f(1)| \leq 1$ where $v_f(i)$ and $e_f(i)$ denote the number of vertices and edges respectively labelled with i $(i = 0,1)$.

Definition 1.3. The jewel J_n is the graph with vertex set $V(J_n) = \{u, v, x, y, v_i : 1 \leq i \leq n\}$ and edge set $E(J_n) = \{ux, vx, uy, vy, uv_i, vv_i : 1 \leq i \leq n\}$

Definition 1.4. For integers $m, n \geq 0$, we consider the graph, Jelly Fish $J(m, n)$ with vertex set $V(J(m, n)) = \{u, v, x, y\} \cup \{v_1, v_2, \ldots, v_m, v_{m+1}, \ldots, v_{m+n}\}$ and the edge set $E(J(m, n)) = \{ux, uy, uv, vx, vy\} \cup \{v_i x : 1 \leq i \leq m\} \cup \{v_j y : m + 1 \leq i \leq m + n\}$

Definition 1.5. A Mongolian tent $M(m, n)$ is a graph obtained from $P_m \times P_n$ by adding one extra vertex above the grid and joining every other vertex of the top row of $P_m \times P_n$ to the new vertex.

2 Main Results

In this section, we find the product cordial labeling of Jewel graph, Jellyfish graph and Mongolian tent graph.

Theorem 2.1. The Jewel graph J_n is product cordial graph if n is odd and not product cordial graph if n is even.

Proof: Let J_n be the jewel graph with vertex set $V(J_n) = \{u, v, x, y, v_i : 1 \leq i \leq n\}$ and edge set $E(J_n) = \{ux, vx, uy, vy, uv_i, vv_i : 1 \leq i \leq n\}$

Here, $|V(J_n)| = n + 4 = p$ and $|E(J_n)| = 2n + 5 = q$

Case 1: n is odd

For $n = 1$,

Define a function $f: V \rightarrow \{0,1\}$ such that $f(u) = 1; f(v) = 0; f(x) = 1; f(y) = 1; f(v_1) = 0$

From the above labeling pattern, we have

$$v_f(1) = 3, v_f(0) = 2 \text{ and } e_f(1) = 3, e_f(0) = 4$$

Thus, $\left|v_f(0) - v_f(1)\right| = |2 - 3| = 1$ and $\left|e_f(0) - e_f(1)\right| = |4 - 3| = 1$

For $n > 1$,

Define a function $f: V \rightarrow \{0,1\}$ such that

$$f(u) = 1; f(v) = 1; f(x) = 1; f(y) = 1$$

$$f(v_i) = \begin{cases} 0 & \text{if } 1 \leq i \leq \left\lfloor \frac{p}{2} \right\rfloor \\ 1 & \text{otherwise} \end{cases}$$

From the above labeling pattern, we have

$$v_f(1) = \left\lfloor \frac{p}{2} \right\rfloor + 1, v_f(0) = \left\lfloor \frac{p}{2} \right\rfloor \text{ and } e_f(1) = \left\lfloor \frac{q}{2} \right\rfloor, e_f(0) = \left\lfloor \frac{q}{2} \right\rfloor + 1$$

Thus, $\left|v_f(0) - v_f(1)\right| = \left|\left\lfloor \frac{p}{2} \right\rfloor - \left\lfloor \frac{p}{2} \right\rfloor - 1\right| = 1$ and $\left|e_f(0) - e_f(1)\right| = \left|\left\lfloor \frac{q}{2} \right\rfloor + 1 - \left\lfloor \frac{q}{2} \right\rfloor\right| = 1$

Therefore, we have, $\left|v_f(0) - v_f(1)\right| \leq 1$ and $\left|e_f(0) - e_f(1)\right| \leq 1$

Hence, the Jewel graph admits product cordial labeling if n is odd.

Case 2: n is even

For $n = 2$,

Define a function $f: V \rightarrow \{0,1\}$ such that

$$f(u) = 1; f(v) = 0; f(x) = 1; f(y) = 1; f(v_1) = 0; \ f(v_2) = 0$$

From the above labeling pattern, we have

$$v_f(1) = 3, v_f(0) = 3 \text{ and } e_f(1) = 3, e_f(0) = 6$$

Thus, $\left|v_f(0) - v_f(1)\right| = |3 - 3| = 0$ and $\left|e_f(0) - e_f(1)\right| = |6 - 3| = 3$

For $n > 2$,

Define a function $f: V \rightarrow \{0,1\}$ such that

$$f(u) = 1; f(v) = 1; f(x) = 1; f(y) = 1$$

$$f(v_i) = \begin{cases} 0 & \text{if } 1 \leq i \leq \frac{p}{2} \\ 1 & \text{otherwise} \end{cases}$$

From the above labeling pattern, we have

$$v_f(1) = \frac{p}{2}, v_f(0) = \frac{p}{2} \text{ and } e_f(1) = \left\lfloor \frac{q}{2} \right\rfloor - 1, e_f(0) = \left\lfloor \frac{q}{2} \right\rfloor + 2$$

Thus, $\left|v_f(0) - v_f(1)\right| = \left|\frac{p}{2} - \frac{p}{2}\right| = 0$ and

$$\left| e_f(0) - e_f(1) \right| = \left| \left| \frac{q}{2} \right| + 2 - \left(\left| \frac{q}{2} \right| - 1 \right) \right| = \left| \left| \frac{q}{2} \right| + 2 - \left| \frac{q}{2} \right| + 1 \right| = 3$$

Therefore, in this case we have $\left| v_f(0) - v_f(1) \right| \le 1$ and $\left| e_f(0) - e_f(1) \right| > 1$

Hence, the Jewel graph does not admit product cordial labeling if n is even

Therefore, the jewel graph J_n is product cordial graph if n is odd and not product cordial graph if n is even.

The example of product cordial labeling of J_7 is shown in Figure 1.
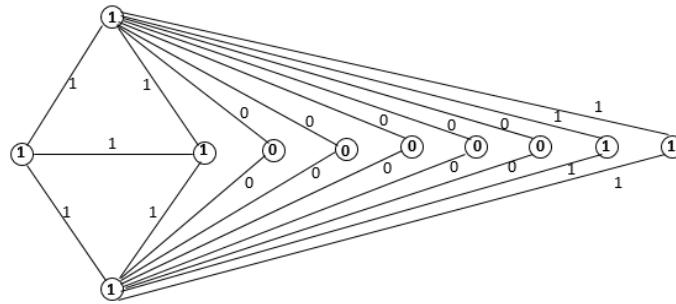
Figure 1.

The example of not product cordial labeling of J_8 is shown in Figure 2.
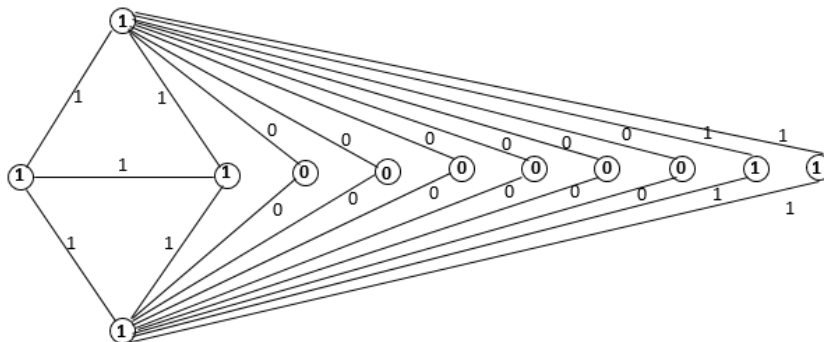
Figure 2.

Theorem 2.2. The Jellyfish graph $J(m, n)$ is product cordial graph for all $m + n \ge 1$

Proof: Let $J(m, n)$ be the jellyfish graph with vertex set

$V(J(m,n)) = \{u, v, x, y\} \cup \{v_1, v_2, \dots, v_m, v_{m+1}, \dots, v_{m+n}\}$ and the edge set

$E(J(m,n)) = \{ux, uy, uv, vx, vy\} \cup \{v_i x : 1 \le i \le m\} \cup \{v_j y : m + 1 \le j \le m + n\}$.

Here, $|V(J(m,n))| = m + n + 4 = p$ and $|E(J(m,n))| = m + n + 5 = q$

Case 1: $m + n = 1$

If $m = 0, n = 1$, we define a function $f: V \to \{0,1\}$ such that

$$f(u) = 1; f(v) = 1; f(x) = 0; f(y) = 1; f(v_1) = 0$$

From the above labeling pattern, we have $v_f(1) = 3, v_f(0) = 2$ and $e_f(1) = 3, e_f(0) = 3$

Thus, $\left| v_f(0) - v_f(1) \right| = |2 - 3| = 1$ and $\left| e_f(0) - e_f(1) \right| = |3 - 3| = 0$

If $m = 1, n = 0$, we define a function $f: V \to \{0,1\}$ such that

$$f(u) = 1; f(v) = 1; f(x) = 1; f(y) = 0; f(v_1) = 0$$

From the above labeling pattern, we have $v_f(1) = 3, v_f(0) = 2$ and $e_f(1) = 3, e_f(0) = 3$

Thus, $\left|v_f(0) - v_f(1)\right| = |2 - 3| = 1$ and $\left|e_f(0) - e_f(1)\right| = |3 - 3| = 0$

Therefore, in both the cases we have $\left|v_f(0) - v_f(1)\right| \leq 1$ and $\left|e_f(0) - e_f(1)\right| \leq 1$

Case 2: $m + n > 1$

Define a function $f: V \to \{0,1\}$ such that

$$f(u) = 1; f(v) = 1; f(x) = 0; f(y) = 1$$

$$f(v_i) = \begin{cases} 0 & if\ 1 \leq i \leq \left\lfloor \frac{p}{2} \right\rfloor - 1 \\ 1 & if\ \left\lfloor \frac{p}{2} \right\rfloor \leq i \leq m + n \end{cases}$$

From the above labeling pattern, we have following cases.

Subcase 2.1: $m + n = $ odd

$v_f(1) = \left\lfloor \frac{p}{2} \right\rfloor + 1, v_f(0) = \left\lfloor \frac{p}{2} \right\rfloor$ and

$e_f(1) = e_f(0) = \frac{q}{2}$

Thus, $\left|v_f(0) - v_f(1)\right| = \left|\left\lfloor \frac{p}{2} \right\rfloor - \left\lfloor \frac{p}{2} \right\rfloor - 1\right| = 1$ and $\left|e_f(0) - e_f(1)\right| = \left|\frac{q}{2} - \frac{q}{2}\right| = 0$

Subcase 2.2: $m + n = $ even

$v_f(1) = v_f(0) = \frac{p}{2}$ and

$e_f(1) = \left\lfloor \frac{q}{2} \right\rfloor, e_f(0) = \left\lfloor \frac{q}{2} \right\rfloor + 1$

Thus, $\left|v_f(0) - v_f(1)\right| = \left|\frac{p}{2} - \frac{p}{2}\right| = 0$ and $\left|e_f(0) - e_f(1)\right| = \left|\left\lfloor \frac{q}{2} \right\rfloor + 1 - \left\lfloor \frac{q}{2} \right\rfloor\right| = 1$

Therefore, in both the subcases we have, $\left|v_f(0) - v_f(1)\right| \leq 1$ and $\left|e_f(0) - e_f(1)\right| \leq 1$

Therefore, jellyfish graph admits the product cordial labeling if $m + n \geq 1$.

∴ The jellyfish graph $J(m, n)$ is product cordial graph if $m + n \geq 1$.

The examples of product cordial labeling of $J(3,2)$ and $J(4,2)$ are shown in Figure 3 and 4 respectively.
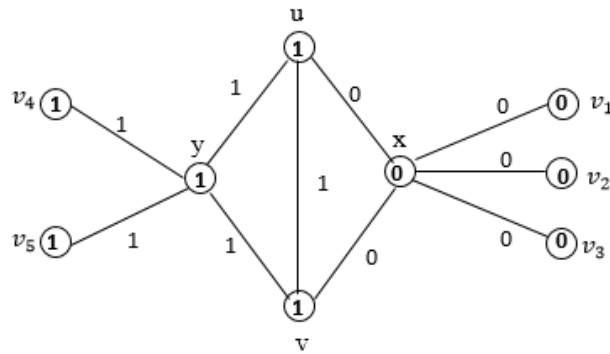
Figure 3.
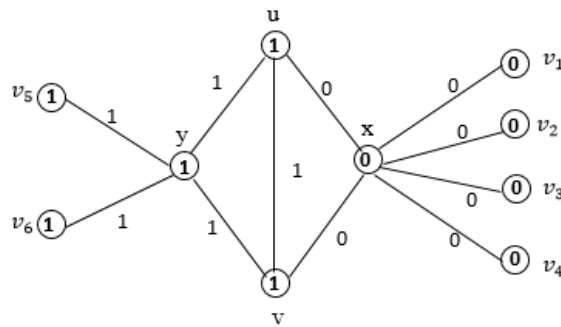
Figure 4.

Theorem 2.3. The Mongolian tent graph is product cordial graph except when both m and n are odd.

Proof: Let $M_{m,n}$ be the Mongolian tent graph with vertex set

$V(M_{m,n}) = \{\, v_{i,j} : 1 \leq i \leq m, 1 \leq j \leq n \} \cup \{v\}$ and edge set $E(M_{m,n}) = E_1 \cup E_2 \cup E_3$

where $E_1 = \{(\, v_{i,j}, v_{i,j+1}) : 1 \leq i \leq m, 1 \leq j \leq n-1\}$

$E_2 = \{(\, v_{i,j}, v_{i+1,j}) : 1 \leq i \leq m-1, 1 \leq j \leq n\}$, $E_3 = \{(\, v_{1,j}, v) : 1 \leq j \leq n\}$

Here, $\left|V(M_{m,n})\right| = mn + 1 = p$ and $|E(J_n)| = 2mn - m = q$

Case 1: m and n are even

Define a function $f : V \to \{0,1\}$ such that

$$f(v) = 1$$

$$f(v_{i,j}) = \begin{cases} 1 & \text{if } 1 \leq i \leq \frac{m}{2}, 1 \leq j \leq n \\ 0 & \text{if } \frac{m}{2} + 1 \leq i \leq m, 1 \leq j \leq n \end{cases}$$

From the above labeling pattern, we have

$v_f(1) = \left\lfloor \frac{p}{2} \right\rfloor + 1, v_f(0) = \left\lfloor \frac{p}{2} \right\rfloor$ and $e_f(1) = e_f(0) = \frac{q}{2}$

Thus, $\left|v_f(0) - v_f(1)\right| = \left|\left\lfloor \frac{p}{2} \right\rfloor - \left\lfloor \frac{p}{2} \right\rfloor - 1\right| = 1$ and $\left|e_f(0) - e_f(1)\right| = \left|\frac{q}{2} - \frac{q}{2}\right| = 0$

Therefore, we have, $\left|v_f(0) - v_f(1)\right| \leq 1$ and $\left|e_f(0) - e_f(1)\right| \leq 1$

Case 2: m is odd and n is even

Define a function $f:V \rightarrow \{0,1\}$ such that

$$f(v) = 1$$

$$f(v_{i,j}) = \begin{cases} 1 & if\ 1 \le i \le \left\lfloor \frac{m}{2} \right\rfloor, 1 \le j \le n \\ 0 & if\ \left\lfloor \frac{m}{2} \right\rfloor + 1 \le i \le m, 1 \le j \le n \end{cases}$$

And also

$$f(v_{i,j}) = \begin{cases} 1 & if\ i = \left\lceil \frac{m}{2} \right\rceil, 1 \le j \le \frac{n}{2} \\ 0 & if\ i = \left\lceil \frac{m}{2} \right\rceil, \frac{n}{2} + 1 \le j \le n \end{cases}$$

From the above labeling pattern, we have

$v_f(1) = \left\lfloor \frac{p}{2} \right\rfloor + 1, v_f(0) = \left\lfloor \frac{p}{2} \right\rfloor$ and $e_f(1) = \left\lfloor \frac{q}{2} \right\rfloor, e_f(0) = \left\lfloor \frac{q}{2} \right\rfloor + 1$

Thus, $\left| v_f(0) - v_f(1) \right| = \left| \left\lfloor \frac{p}{2} \right\rfloor - \left\lfloor \frac{p}{2} \right\rfloor - 1 \right| = 1$ and $\left| e_f(0) - e_f(1) \right| = \left| \left\lfloor \frac{q}{2} \right\rfloor + 1 - \left\lfloor \frac{q}{2} \right\rfloor \right| = 1$

Therefore, we have, $\left| v_f(0) - v_f(1) \right| \le 1$ and $\left| e_f(0) - e_f(1) \right| \le 1$

Case 3: m is even and n is odd

The proof is same as case (i).

Hence, the Mongolian tent graph admits product cordial labeling for the above three cases.

The condition $\left| v_f(0) - v_f(1) \right| \le 1$ and $\left| e_f(0) - e_f(1) \right| \le 1$ is not satisfied, if m and n are odd.

Therefore, the Mongolian tent graph $M_{m,n}$ is product cordial graph except when both m and n are odd.

The examples of product cordial labeling of $M_{3,4}$ and $M_{4,4}$ are shown in Figure 5 and 6 respectively.
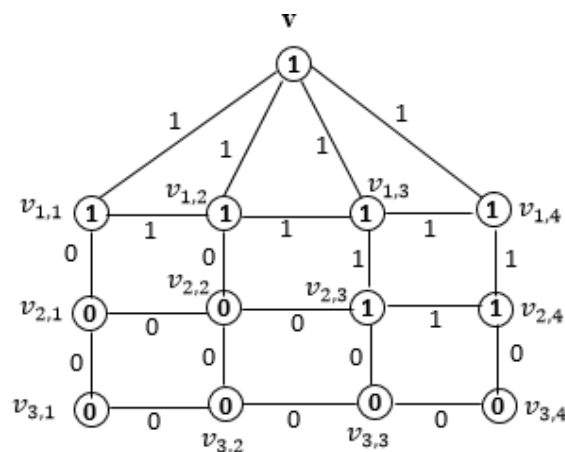
Figure 5.
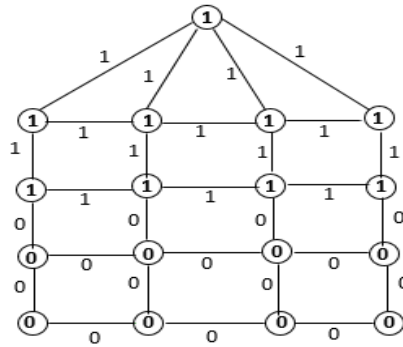
Figure 6.

Conclusion

In this paper, we have investigated product cordial labeling of jewel graph, jellyfish graph and Mongolian tent graph. It is very interesting to find graph or graph families which admits product cordial labeling. More exploration is possible for other graph families and similar results on other graph are an open area of research.

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Neutrosophic Transportation Problems with Interval Values

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ABSTRACT

In everyday life, transportation problems have uncertain and intemperate parameters as the transportation costs, supply, and demand are in fuzzy quantities. Therefore, neutrosophic sets have been introduced as a generalization of fuzzy sets to represent uncertainty, inconsistent and indeterminate information. The interval-valued neutrosophic fuzzy sets are characterized by an interval-valued membership grade, an interval-valued indeterminacy grade, and an interval-valued non-membership grade, which is a more naturalistic way of expressing the parameters in real-life problems. This paper, presents the ideal solution to an interval-valued neutrosophic transportation problem by using a triangular interval-valued neutrosophic number. The problem has been solved by estimating the proposed score function technique. Hence, the uncertainty in everyday life problems can be cleared up in an optimized way. The new method has been demonstrated with a numerical example.

Keywords: *Interval Valued Neutrosophic Transportation Problem, Triangular Interval Valued Neutrosophic Number.*

1. Introduction

A fuzzy set was introduced by Zadeh in 1965 [1] to encounter different types of uncertainties. It has been applied successfully in some fields [2,3]. Because the traditional fuzzy set represents the membership function of the fuzzy set with a single value $\mu_A(x) \in [0, 1]$, it cannot handle all cases. So, interval-valued fuzzy sets were introduced by Turksen [4]. In 1986, Atanassov introduced the intuitionistic fuzzy set [5], which deals with uncertain situations. Intuitionistic fuzzy sets are apt to handle problems with incomplete information and are characterized by their membership and non-membership grades. Intuitionistic fuzzy sets can hold incomplete information but not indeterminate information. F Smarandache [6] introduced the neutrosophic set in 1998, which was a generalization of classical sets, fuzzy sets, and Intuitionistic fuzzy sets. Neutrosophic sets can handle both incomplete and indeterminate information. In a neutrosophic set, indeterminacy is quantified clearly, and membership, indeterminacy, and non-membership are independent. Also, Wang, H., and Florentin Smarandache [7] introduced an interval-valued neutrosophic set. The interval-valued

neutrosophic fuzzy sets are determined by an interval-valued membership grade, an interval-valued indeterminacy grade, and an interval-valued non-membership grade. Hitchcock introduced the basic transportation model [8] in 1941, in which the transportation constraints were based on crisp values. But there are cases where the cost coefficients and supply and demand quantities of a transportation problem are uncertain due to some intemperate parameters. A fuzzy transportation problem is a problem in which the transportation costs, supply, and demand are in fuzzy quantities.

2 Preliminaries

Definition 2.1: A fuzzy set is defined by a domain membership grade mapping element, $A = \{(x, \mu_A(x)): x \in X\}$, where $\mu_A(x): X \to [0, 1]$. There is a mapping called the degree of membership grade of the fuzzy set A, and A (x) is called the membership grade of $x \in X$ in the fuzzy set A. These membership grades are represented by real numbers belonging to [0, 1].

Definition 2.2: A triangular fuzzy number can be represented by A (a_1, a_2, a_3) with membership grade $\mu_A(x)$ given by

$$\mu_A(x) = \begin{cases} \frac{x-a_1}{a_2-a_1}, & for\ a_1 \le x < a_2 \\ 1, & for\ a_2 = x \\ \frac{a_3-x}{a_3-a_2}, & for\ a_2 < x \le a_3 \\ 0, & otherwise \end{cases}$$

Definition 2.3: Let X be the universe. Neutrosophic set A in X is characterized by a membership grade T_A, indeterminacy grade I_A and non-membership grade F_A, where $T_A: X \to [0, 1]$, $I_A: X \to [0, 1]$, $F_A: X \to [0, 1]$. It can be written as A = $\{(x, T_A(x), I_A(x), F_A(x)) / x \in X\}$, satisfying $0 \le T_A(x) + I_A(x) + F_A(x) \le 3$.

Definition 2.4: [9, 10] Let X be a non-empty set that contains a point x. An interval valued neutrosophic set is denoted and defined as A in X and is characterized by an interval valued membership grade $T_A(x) = [T_A^L, T_A^U]$, interval valued indeterminacy grade $I_A(x) = [I_A^L, I_A^U]$ and interval valued non-membership grade $F_A(x) = [F_A^L, F_A^U]$. For every x in X, $T_A(x)$, $I_A(x)$, $F_A(x) \subseteq [0, 1]$.

Example: Let us assume that X = $[x_1, x_2, x_3]$. x_1 is competence, x_2 is hard work, x_3 is outcome. The values of x_1, x_2, x_3 belong to [0,1]. They are obtained from some domain experts. The result can be attained as a grade of "Yes," "grade of indeterminacy," or a grade of "No". Then the interval-valued neutrosophic set as $A_N = \{(x_1, [0.1, 0.5], [0.1, 0.9], [0.2, 0.4]) + (x_2, [0.3, 0.4], [0.3, 0.7], [0.1, 0.5]) + (x_3, [0.5, 0.6], [0.1, 0.2], [0.3, 0.6])\}$

Note: A triangular interval valued neutrosophic set $A_N = \{ (a_1, a_2, a_3); [T_A^L, T_A^U], [I_A^L, I_A^U],$

$[F_A^L, F_A^U]\}$, if $T_A^L = T_A^U$, $I_A^L = I_A^U$, $F_A^L = F_A^U$ will reduce to the triangular neutrosophic set .

Definition 2.5: [11] An interval-valued neutrosophic number A^N is a generalized form of the fuzzy set on R with the following membership, non-membership, and indeterminacy grades:

$$T_{A^L}(x) = \begin{cases} \frac{x-a_1+h_A(a_1-x),}{a_2-a_1}; a_1 \le x \le a_2 \\ \frac{a_3-x+h_A(x-a_3)}{a_3-a_2}; a_2 \le x \le a_3 \\ 0, \ otherwise \end{cases} ; T_{A^U}(x) = \begin{cases} \frac{x-a_1+h_A(a_1-x),}{a_2-a_1}; a_1 \le x \le a_2 \\ \frac{a_3-x+h_A(x-a_3)}{a_3-a_2}; a_2 \le x \le a_3 \\ 0, \ otherwise \end{cases}$$

Where $T_A(x) = [T_A^L(x), T_A^U(x)]$

$$F_{A^L}(x) = \begin{cases} \frac{a_2-x+f_A(x-a_2),}{a_2-a_1}; a_1 \le x \le a_2 \\ \frac{x-a_2+f_A(a_2-x)}{a_3-a_2}; a_2 \le x \le a_3 \\ 1, \ otherwise \end{cases} ; F_{A^U}(x) = \begin{cases} \frac{a_2-x+f_A(x-a_1),}{a_2-a_1}; a_1 \le x \le a_2 \\ \frac{x-a_2+f_A(a_3-x),}{a_3-a_2}; a_2 \le x \le a_3 \\ 1, \ otherwise \end{cases}$$

Where $F_A(x) = [F_A^L(x), F_A^U(x)]$

$$I_{A^L}(x) = \begin{cases} \frac{a_2-x+i_A(x-a_2),}{a_2-a_1}; \ a_1 \le x \le a_2 \\ \frac{x-a_2+i_A(a_2-x)}{a_3-a_2}; a_2 \le x \le a_3 \\ \delta, \ otherwise \end{cases} ; I_{A^U}(x) = \begin{cases} \frac{a_2-x+i_A(x-a_1),}{a_2-a_1}; \ a_1 \le x \le a_2 \\ \frac{x-a_2+i_A(a_3-x)}{a_3-a_2}; a_2 \le x \le a_3 \\ 1, \ otherwise \end{cases}$$

Where $I_A(x) = [I_A^L(x), I_A^U(x)]$; $h_A = T_A^U(x) - T_A^L(x)$.

Solutions to neutrosophic transportation problems with interval values [12]: Here, we use the proposed score function for interval-valued neutrosophic numbers. Also, for solving interval-valued neutrosophic transportation problems. A researcher can use triangular interval-valued neutrosophic numbers to solve interval-valued neutrosophic transportation problems. We need to maximise interval valued membership grade, minimise interval valued indeterminacy, and interval valued non-membership grade of information, and then the researcher can apply this technique when entering triangular neutrosophic numbers into the interval valued neutrosophic transportation problem method.

Conversion for the interval-valued neutrosophic transportation problem into its crisp transportation problem: We convert the interval-valued neutrosophic transportation problem into its crisp model by applying the following technique: Let $A_N = \{(a_1, a_2, a_3; [T_A^L, T_A^U], [I_A^L, I_A^U], [F_A^L, F_A^U]\}; a_1 \le a_2 \le a_3$ be a triangular interval valued neutrosophic number. Then the centre of gravity (COG) in R is

$$COG(R) = \begin{cases} a \ if \ a_1 = a_2 = a_3 \\ \left(\frac{1}{3}\right)[a_1 + a_2 + a_3], otherwise \end{cases}$$

Score function $S(A_N)$ = COG(R) x (1/4) [$2+ T^u + T^l - 2I^u - 2 I^l - F^u - F^l$]-----------(*)

Mathematical formulation of interval valued Neutrosophic transportation problem:

Minimum $z^N = \sum_{i=1}^{n} \sum_{j=1}^{m} X_{ij}^N C_{ij}^N$

Subject to $\sum_{i=1}^{n} X_{ij}^N = a_i^N$, i= 1,2 … n

$\sum_{j=1}^{m} X_{ij}^N = b_j^N$, j = 1,2 … m, For every $X_{ij}^N \geq 0$; for every i, j

If $\sum_{i=1}^{n} X_{ij}^N = a_i^N = \sum_{j=1}^{m} X_{ij}^N = b_j^N$; where i= 1,2 … n; j = 1,2 … m, then it a balanced neutrosophic transportation problem. If it is not balanced, use a dummy row or dummy column to bring it into balance. In a neutrosophic transportation problem, the aim is to minimise the cost of transporting product from source to destination with uncertain transported units. If transportation cost, demand, and supply are in interval values, it will be an interval-valued neutrosophic transportation problem.

Interval valued triangular neutrosophic transportation Table:

	D$_1$	D$_2$	D$_3$	D$_4$	Supply
S$_1$	(10,12,14); [0.5,0.4], [0.1,0.2], [0.2,0.3]	(3, 4, 5); [0.2,0.4], [0.5,0.7], [0.1,0.4]	(8, 9, 10); [0.5,0.8], [0.2,0.4], [0.3,0.4]	(1, 2, 3); [0.3,0.5], [0.1,0.3], [0.2,0.3]	26
S$_2$	(6,7,8); [0.5,0.6], [0.2,0.5], [0.1,0.8]	(10,11,12); [0.5,0.7], [0.1,0.2], [0.2,0.4]	(11,13,15); [0.6,0.8], [0.1,0.8], [0.4,0.9]	(9,10,11); [0.6,0.8], [0.1,0.2], [0.3,0.4]	28
S$_3$	(5,7, 9); [0.1,0.9], [0.4,0.5], [0.2,0.3]	(2, 4, 6); [0.2,0.4], [0.5,0.7], [0.1,0.4]	(4,6,8); [0.3,0.6], [0.1,0.8], [0.4,0.7]	(7, 8, 9); [0.6,0.7], [0,0.2], [0.4,0.5]	22
Demand	10	29	16	21	Balanced

Convert the interval-valued neutrosophic transportation problem into its crisp transportation problem by using (*)

Converted Crisp Transportation Table:

	D_1	D_2	D_3	D_4	Supply
S_1	5	2	7	1	26
S_2	2	6	1	5	28
S_3	2	3	0	4	22
Demand	10	29	16	21	Balanced

By correlating the systematic algorithm with the existing methods like NWCR, LCM, MRCM, and VAM, we get a better result when compared with other existing score function techniques. Also, find the best optimum solution.

Comparison: By comparing the proposed method with that of Saini, Rajesh Kumar, Atul Sangal, and Manisha Manisha in [13], we note that their model is only able to solve the problem with single-valued neutrosophic numbers, but by using the above proposed model in addition to handle interval-valued neutrosophic numbers, their model is more complex than the proposed model.

By comparing the proposed method with that of Dubey & Mehra in [14], we also found that they only consider membership grade and non-membership grade, while in our real-life circumstances, the researcher process has three forms: Yes, give up, and No. This limitation can be treated by the use of neutrosophic sets. In their model, the grades of membership and non-membership are considered a single valued number, while these grades are considered an interval number in the above proposed model. We can overcome the uncertainty in determining the membership and non-membership degrees. While you can handle incomplete information, using the above proposed method, you can handle not only incomplete information but also indeterminate and inconsistent information.

Conclusion

Interval-valued neutrosophic sets, being a generalization of neutrosophic sets, provide a chance to represent indeterminacy along with uncertainty. However, there are many transportation problems that have been studied with different types of values. We have discussed the solutions to transportation problems in an interval-valued neutrosophic environment.

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Further Results on Stolarsky-3 Mean Graphs

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ABSTRACT

Let G = (V, E) be a simple graph. G is said to be Stolarsky-3 Mean graph if each vertex $x \in V$ is assigned distinct labels f(x) from 1,2,....,q+1 and each edge e = uv is assigned with the labels f(e) $= \left\lceil \sqrt{\frac{[(f(u))^2+f(u)f(v)+(f(v))^2]}{3}} \right\rceil$ **(or)** $\left\lfloor \sqrt{\frac{[(f(u))^2+f(u)f(v)+(f(v))^2]}{3}} \right\rfloor$ *then the resulting edge labels are distinct and f is called a Stolarsky-3 Mean labeling of G. In this paper, we show the graphs $C_n @ P_m$, $L_n \odot \overline{K_2}$, $TL_n \odot K_1$, $(C_m \odot K_3) \cup L_n$, $C_m \cup T_n$ etc. are Stolarsky-3 mean graphs.*

Keywords: *Graph Labeling, Stolarsky-3 mean labeling, Dragon graph, Comb graph, Ladder graph, Triangular ladder graph and Triangular snake graph.*

1. Introduction

Let G be a finite, undirected and simple graph with p vertices and q edges. There are several types of labeling and a detailed survey was done by [1]. The standard terminology and notations in this article are based on the book Graph theory [2]. The concept of Mean labeling was introduced by Somasundaram et.al. in [3]. Motivated by the concept of [3], Kavitha et.al [4] introduced a new concept namely Stolarsky-3 mean graph and proved that the path graph, cycle graph, comb graph, ladder graph, star graph, triangular snake graph and quadrilateral graph are Stolarsky-3 mean graphs. Sandhya et.al. [5] proved that slanting Ladder, triangular ladder, H-graph, twig graph, middle graph and total graph are Stolarsky-3 mean graphs.

We provide the following definitions which are necessary for our main results.

Definition 1.1: A graph G with p vertices and q edges is said to be Stolarsky-3 Mean graph if each vertex $x \in V$ is assigned distinct labels f(x) from 1,2, ... ,q+1 and each edge e = uv is assigned with the labels f(e) = $\left\lceil \sqrt{\frac{[(f(u))^2+f(u)f(v)+(f(v))^2]}{3}} \right\rceil$ **(or)** $\left\lfloor \sqrt{\frac{[(f(u))^2+f(u)f(v)+(f(v))^2]}{3}} \right\rfloor$ then the resulting edge labels are distinct and f is called a Stolarsky-3 Mean labeling of G.

Definition 1.2. A walk in which all the vertices $u_1, u_2, ... , u_n$ are distinct is called a path. It is denoted by P_n.

Definition 1.3: A closed path is called a cycle. A cycle on n vertices is denoted by C_n.

Definition 1.4. The Corona $G_1 \odot G_2$ of two graphs G_1 and G_2 is defined as the graph G

obtained by taking one copy of G_1 (which has P_1 vertices) and P_1 copies of G_2 and then joining the ith vertex of G_1 to every vertex in the ith copy of G_2.

Definition 1.5. The Cartesian product $G_1 \times G_2$ of two graphs is defined to be the graph with vertex set $V_1 \times V_2$ and two vertices $U = (U_1, U_2)$ and $V = (V_1, V_2)$ are adjacent in $G_1 \times G_2$ if either $U_1 = V_1$ and U_2 is adjacent to V_2 and U_1 is adjacent to V_1.

Definition 1.6. The Union $G_1 \cup G_2$ of two graphs G_1 and G_2 is the graph with $V(G_1 \cup G_2) = V(G_1) \cup V(G_2)$ and $E(G_1 \cup G_2) = E(G_1) \cup E(G_2)$. The union of m copies of G is denoted by mG.

Definition 1.7. A Dragon is a graph obtained by joining an end vertex of a path P_m to a vertex of the cycle C_n. It is denoted by $C_n @ P_m$.

Definition 1.8. Comb $P_n \Theta K_1$ is a graph obtained by joining a single pendant edge to each vertex of a path.

Definition 1.9. The Ladder graph L_n ($n \geq 2$) is the product graph $P_2 \times P_n$ which contains 2n vertices and 3n-2 edges.

Definition 1.10. A Triangular ladder TL_n is a graph obtained from L_n by adding the edges $u_i v_{i+1}, 1 \leq i \leq n-1$, where u_i and v_i $1 \leq i \leq n$ are the vertices of L_n such that $u_1, u_2, ..., u_n$ and $v_1, v_2, ..., v_n$ are two paths of length n in the graph L_n.

Definition 1.11. A Triangular Snake T_n is obtained from a path $u_1, u_2, ..., u_n$ by joining u_i and u_{i+1} to a new vertex v_i for $1 \leq i \leq n-1$. That is, every edge of a path is replaced by a triangle C_3.

Definition 1.12. The graphs $\overline{K_p}$ are totally disconnected and are regular of degree 0.

2 Main Results

Theorem 2.1. Let P_n be the path and G be the graph obtained from P_n by attaching a pendant edge to both sides of each vertex of P_n. Then G is a Stolarsky-3 mean graph.

Proof: Let $u_1, u_2, ..., u_n$ be the vertices of the path P_n. Let G be a graph obtained from P_n by attaching a pendant edge to both sides of each vertex of P_n. Let $v_i, w_i, 1 \leq i \leq n$ be the new vertices of G.

Define a function f: $V(G) \rightarrow \{1, 2, ..., q+1\}$ by

$f(u_i) = 3i-1, 1 \leq i \leq n.$

$f(v_i) = 3i-2, 1 \leq i \leq n.$

$f(w_i) = 3i, 1 \leq i \leq n.$

Edge labeling's are

$f(u_i u_{i+1}) = 3$ i, $1 \le i \le n-1$.

$f(u_i v_i) = 3$ i -2, $1 \le i \le n$.

$f(u_i w_i) = 3$ i -1, $1 \le i \le n$. Here the edge labels are distinct. Hence G is Stolarsky-3 mean graph.

Example 2.2. The graph G obtained from P_5 is given below.
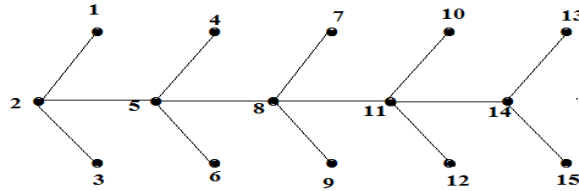
Figure 1

Theorem 2. 3. The graph obtained by attaching $K_{1,2}$ to each pendant vertex of a comb $P_n \boldsymbol{\Theta} K_1$ forms a Stolarsky-3 mean graph.

Proof: Let G be a graph obtained by attaching $K_{1,2}$ to each pendant vertex of a comb. Let u_i , v_i, x_i, y_i, $1 \le$ i $\le$ n be the vertices of G.

Define a function f: V(G)$\rightarrow$ {1,2, 3,…,q+1} by

$f(u_i) = 4i-3$, $1 \le i \le n$.

$f(v_i) = 4i-2$, $1 \le i \le n$.

$f(x_i) = 4i-1$, $1 \le i \le n$.

$f(y_i) = 4i$, $1 \le i \le n$.

The edges are labeled as

$f(u_i u_{i+1}) = 4i$, $1 \le$ i $\le$ n-1.

f $(u_i v_i) = 4i-3$, $1 \le i \le n$.

$f(x_i v_i) = 4i-2$, $1 \le i \le n$.

$f(x_i v_i) = 4i-1$, $1 \le i \le n$.

Then we get distinct edge labels. Hence G is Stolarsky-3 mean graph.

Example 2.4. The Stolarsky-3 mean labeling of $(P_4 \boldsymbol{\Theta} K_1) \boldsymbol{\Theta} K_{1,2}$
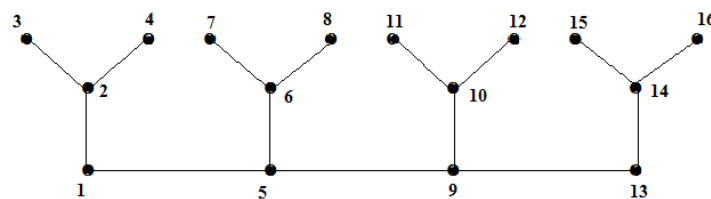
Figure 2

Theorem 2.5. The Dragon graph $C_n @ P_m$ is Stolarsky-3 mean graph.

Proof: Let $u_1, u_2, \dots, u_n$ be the vertices of the cycle C_n and $v_1, v_2, \dots, v_m$ be the vertices of the path P_m.

Here $u_n = v_1$. Define the function f: V $(C_n @ P_m) \rightarrow \{1, 2, \dots, q+1\}$ by

$f(u_i) = $ i, $1 \le i \le n$.

$f(v_1) = f(u_n)$.

$f(v_i) = $ (n-1) + i, $2 \le i \le m$. Then the edge labels are distinct.

Hence the Dragon graph $C_n @ P_m$ is Stolarsky-3 mean graph.

Example 2.6. The Stolarsky-3 mean labeling pattern of $C_5 @ P_5$ is shown below.
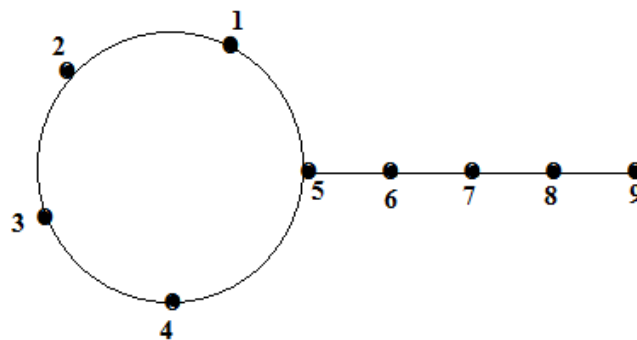
Figure 3

Theorem 2.7. Let G be the graph obtained from a path P_n by attaching C_3 in both end edges of P_n. Then G is a Stolarsky-3 mean graph.

Proof: Let $u_1, u_2, \dots, u_n$ be the vertices of the path P_n and $u_1 u_2 v_1$, $u_{n-1} u_n v_2$ be the triangles which are attached to the path at both ends.

Define a function   f: V(G)$\rightarrow \{1, 2, 3, \dots, q+1\}$ by

$f(u_1) = 1$.

$f(u_i) = $ (i-1)+2, $2 \le i \le n$-1.

$f(u_n) = $ n+3.

$f(v_1) = 2$.

$f(v_2) = $ n+2.

Then the edges are labeled as

$f(u_1 v_1) = 1$.

$f(u_2 v_1) = 3$.

$f(u_1 u_2) = 2$.

$f(u_iu_{i+1}) = i+2, 2 \le i \le n-2.$

$f(u_{n-1}u_n) = n+2.$

$f(u_{n-1}v_2) = n+1.$

$f(u_nv_2) = n+3.$ Then the edge labels are distinct.

Hence G is Stolarsky-3 mean graph.

Example 2.8. The Stolarsky-3 mean labeling of G obtained from P_7 is given below.
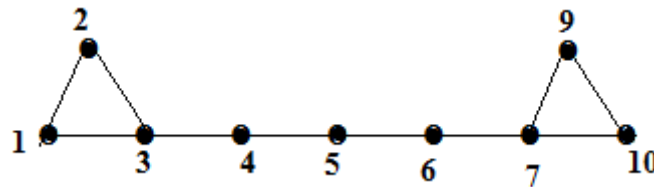
Figure 4

Theorem 2.9. The graph obtained by attaching K_3 to each pendant vertex of a comb $P_n \Theta K_1$ forms a Stolarsky-3 mean graph.

Proof: Let G be a graph obtained by attaching K_3 to each pendant vertex of a comb. Let u_i , v_i, x_i, y_i, $1 \le i \le n$ be the vertices of G.

Define a function f : V(G)→ {1,2,3,…, q+1} by

$f(u_i) = 5i\text{-}3, 1 \le i \le n.$

$f(v_i) = 5i\text{-}4, 1 \le i \le n.$

$f(x_i) = 5i\text{-}1, 1 \le i \le n.$

$f(y_i) = 5i, 1 \le i \le n.$

The edges are labeled as

$f(u_iu_{i+1}) = 5i, 1 \le i \le n\text{-}1.$

$f(u_iv_i) = 5i\text{-}4, 1 \le i \le n.$

$f(x_iv_i) = 5i\text{-}3, 1 \le i \le n.$

$f(y_iv_i) = 5i\text{-}2, 1 \le i \le n$

$f(x_iy_i) = 5i\text{-}1.$

Then the edge labels are distinct. Hence G is Stolarsky-3 mean graph.

Example 2.10. The Solarsky-3 mean labeling of $(P_4 \odot K_{1,2}) \odot K_3$
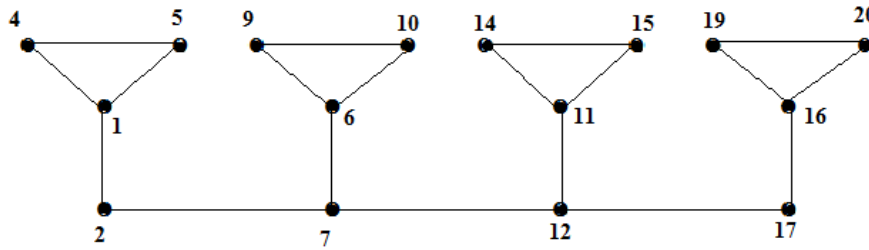
Figure 5

Theorem 2.11. The graph $L_n \odot \overline{K_2}$ is a Stolarsky-3 mean graph.

Proof: Let L_n be the Ladder graph with the vertices u_i, v_i, $1 \leq i \leq n$.

The graph $G = L_n \odot \overline{K_2}$ is obtained by joining u_i with two new vertices x_i, y_i, $1 \leq i \leq n$ and join v_i, with two new vertices s_i, t_i, $1 \leq i \leq n$ in L_n

Define a function f: $V(G) \rightarrow \{1,2,3,\ldots,q+1\}$ by

$f(u_i) = 7i\text{-}4$, $1 \leq i \leq n$.

$f(v_i) = 7i\text{-}5$, $1 \leq i \leq n$.

$f(x_i) = 7i\text{-}3$, $1 \leq i \leq n$.

$f(y_i) = 7i\text{-}1$, $1 \leq i \leq n$.

$f(s_i) = 7i\text{-}6$, $1 \leq i \leq n$.

$f(t_i) = 7i\text{-}2$, $1 \leq i \leq n$.

Then the edges are labeled as

$f(u_i u_{i+1}) = 7i$, $1 \leq i \leq n\text{-}1$.

$f(u_i v_i) = 7i\text{-}5$, $1 \leq i \leq n$.

$f(v_i v_{i+1}) = 7i$, $1 \leq i \leq n\text{-}1$.

$f(u_i x_i) = 7i\text{-}4$, $1 \leq i \leq n$.

$f(u_i y_i) = 7i\text{-}2$, $1 \leq i \leq n$.

$f(v_i s_i) = 7i\text{-}6$, $1 \leq i \leq n$.

$f(v_i t_i) = 7i\text{-}3$, $1 \leq i \leq n$. Thus, we get distinct edge labels.

Hence G is Stolarsky-3 mean graph.

Example 2.12. The Stolarsky-3 mean labeling of $L_4 \; \Theta \; \overline{K_2}$
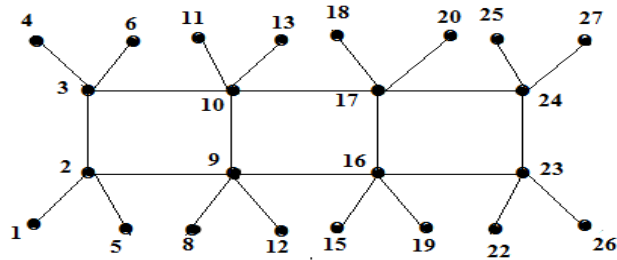
Figure 6

Theorem 2.13. $TL_n \; \Theta \; K_1$ is Stolarsky-3 mean graph.

Proof: Let TL_n be the Triangular ladder graph with the vertices $u_i, v_i, 1 \le i \le n$.

Let $G = TL_n \; \Theta \; K_1$ be a graph obtained by attaching x_i to u_i and y_i to v_i in TL_n.

Define a function $f\colon V(G) \to \{1,2,3,\ldots,q+1\}$ by

$f(u_i) = $ 6i-5, $1 \le i \le n$.

$f(v_i) = $ 6i-3, $1 \le i \le n$.

$f(x_i) = $ 6i-4, $1 \le i \le n$.

$f(y_i) = $ 6i-2, $1 \le i \le n$.

Then the edge labels are

$f(u_i u_{i+1}) = $ 6i, -2, $1 \le i \le$ n-1.

$f(v_i v_{i+1}) = $ 6i, $1 \le i \le$ n-1.

$f(u_i x_i) = $ 6i-5, $1 \le i \le n$, $f(u_i v_{i+1}) = $ 6i-1, $1 \le i \le n$.

$f(v_i y_i) = $6i-3, $1 \le i \le n$. Then the edge labels are distinct.

Hence G is Stolarsky-3 mean graph

Example 2.14. The Stolarsky-3 mean labeling of $TL_5 \; \Theta \; K_1$
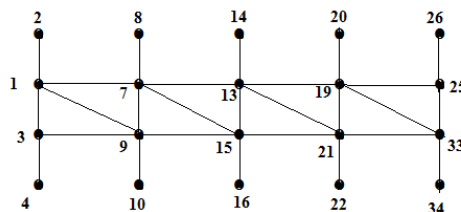
Figure 7

Theorem 2.15. $(C_m \; \Theta \; K_3) \cup L_n$ is Stolarsky-3 mean graph.

Proof: Let $u_1, u_2, \ldots, u_m$, u_1 be the vertices of the cycle C_m and let K_3 be the cycle with the

vertices $v_1, v_2, \ldots, v_m$, $w_1, w_2, \ldots, w_m$ which are attached to the vertices of the cycle C_m.

Let L_n be the Ladder graph with the vertices x_i and $y_i, 1 \le i \le$ n. Let $G = (C_m \; \Theta \; K_3) \cup L_n$.

Define a function   f: V(G) →{1,2,...., q+1} by

f(u_i) = 4i-2, 1≤ i ≤ m.

f(v_i) = 4i -3, 1≤ i ≤ m.

f(w_i) = 4i , 1≤ i ≤ m.

f(x_i) =4m+(3i-2) , 1≤ i ≤ n.

f(y_i) =4m+(3i-1), 1≤ i ≤ n . Then we obtain distinct edge labels.

Hence $(C_m \ominus K_{1,2}) \cup L_n$ is Stolarsky-3 mean graph.

Example 2.16. The Stolarsky-3 mean labeling of $(C_5 \ominus K_3) \cup L_5$ is given below
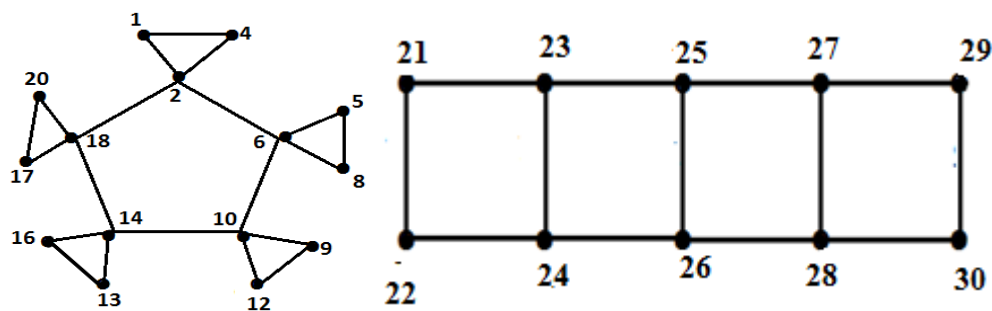
Figure 8

Theorem 2.17. $C_m \cup T_n$ is Stolarsky-3 mean graph.

Proof: Let $u_1, u_2, ..., u_m$,u_1 be the vertices of the cycle C_m and let T_n be the Triangular snake graph with the vertices $v_1, v_2, ..., v_n$ and $w_1, w_2, ..., w_{n-1}$. Let G = $C_m \cup T_n$. Define a function   f: V(G) →{1,2,…, q+1} by

f(u_i) =i, 1≤ i ≤ m.

f(v_i) = m+(3i-2), 1≤ i ≤ n.

f(w_i) = m+(3i-1), 1≤ i ≤ n − 1. Then we get distinct edge labels.

Hence $C_m \cup T_n$ is Stolarsky-3 mean graph.

Example 2.18. The Stolarsky-3 mean labeling of $C_5 \cup T_5$ is given below
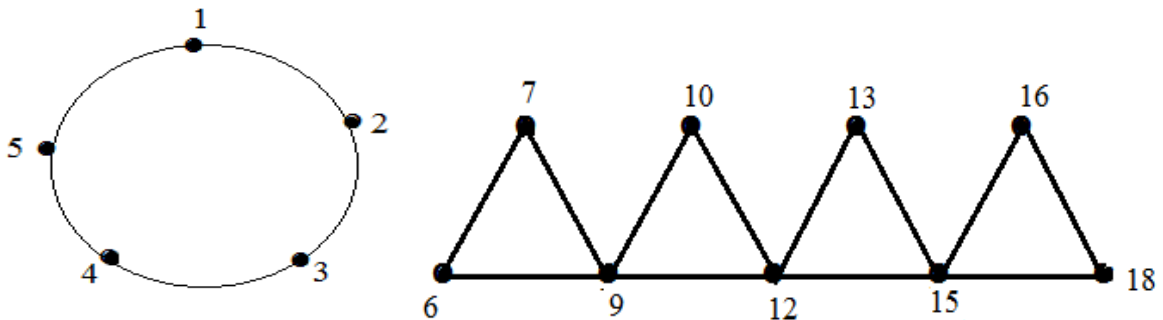
Figure 9

Conclusion

The Study of labeled graph is important due to its diversified applications. It is very interesting to investigate Stolarsky-3 mean labeling of some new graphs. The derived results are demonstrated by means of sufficient illustrations which provide better understanding. It is possible to investigate similar results for several other graphs.

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Super Cube Root Cube Mean Labeling of Snake Graphs

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ABSTRACT

Consider a graph G with | V(G) | = p and | E(G) | = q. A function f is called super cube root cube mean labeling if f : V(G) → {1,2,3,....,p+q} is injective and the induced function f* defined as f*(e) = $\left\lfloor \sqrt[3]{\frac{f(u)^3+f(v)^3}{2}} \right\rfloor$ or $\left\lceil \sqrt[3]{\frac{f(u)^3+f(v)^3}{2}} \right\rceil$ for all e = uv ϵ E(G) is bijective and the resulting edge labels are distinct. If such labeling exists, then G is called a super cube root cube mean graph. In this paper, we prove that triangular snake graph T_n, double triangular snake graph $D(T_n)$, quadrilateral snake graph Q_n, double quadrilateral snake graph $D(Q_n)$ are super cube root cube mean graphs.

Keywords: Triangular Snake Graph, Quadrilateral Snake Graph, Super Cube Root Cube Mean Labeling.

AMS Subject Classification (2010): 05C78

1. Introduction

In this paper, all graphs are simple, finite and undirected with $|V(G)|$ = p and $|E(G)|$ = q. Labeling of a graph is an assignment of integers to the vertices or edges or both subject to certain conditions. For an outstanding survey of graph labeling, refer to Gallian [1]. Various researchers in practice contributed many types of labeling [2, 3, 4, 5]. Ponraj and Somasundaram [6] introduced mean labelling. Let G be a graph with $| V(G) |$ = p and $| E(G) |$ = q. A mean labeling f is an injection from V to the set {0, 1, 2, …, q} such that every edge uv, is labelled with $\frac{[f(u)+f(v)]}{2}$ if [f(u) + f(v)] is even and $\frac{[f(u)+f(v)]+1}{2}$ if [f(u) + f(v)] is odd and the resulting edge labels are distinct. A graph that accepts a mean labeling is known as mean graph. The concept of cube root cube mean labeling was introduced and investigated by Kulandhai Therese and Romila [7]. A function f is called cube root cube mean labeling of a graph $G\ (V, E)$ with p vertices and q edges if $f: V(G) \rightarrow \{1,2, ... , q + 1\}$ is injective and the induced function f* defined as f*(uv) = $\left\lfloor \sqrt[3]{\frac{f(u)^3+f(v)^3}{2}} \right\rfloor$ for all $uv \in E(G)$, is bijective and the resulting edge labels are distinct. If such labeling exists, then G is called a cube root cube mean graph. Radhika and Vijayan have introduced the concept of super cube

root cube mean labeling [8]. A function f is called super cube root cube mean labeling if f : $V(G) \rightarrow \{1, 2, 3, \dots, p + q\}$ is injective and the induced function f^* defined as $f^*(e) =$ $\left\lceil \sqrt[3]{\dfrac{f(u)^3 + f(v)^3}{2}} \right\rceil$ or $\left\lfloor \sqrt[3]{\dfrac{f(u)^3 + f(v)^3}{2}} \right\rfloor$ for all e = uv ϵ E(G) is bijective and the resulting edge labels are distinct. If such labeling exists, then G is called a super cube root cube mean graph. In this paper triangular snake graph T_n, double triangular snake graph $D(T_n)$, quadrilateral snake graph Q_n, double quadrilateral snake graph $D(Q_n)$ are proved that super cube root cube mean graphs. In this paper, it is assumed that k is an integer and its value is ≥ 1.

Definition 1.1. The triangular snake graph T_n is obtained from a path P_n by replacing each edge of the path by a triangle C_3. That is a triangular snakegraph is obtained from a path $u_1, u_2, \dots, u_n$ by joining u_i and u_{i+1} to a new vertex v_i, $1 \leq i \leq n - 1$.

Definition 1.2. A double triangular snake graph $D(T_n)$ consists of two triangular snakes that have a common path.

Definition 1.3. A quadrilateral snake graph Q_n is obtained from a path P_n by replacing each edge of the path by a cycle C_4. That is a quadrilateral snake graph Q_n is obtained from a path $u_1, u_2, \dots, u_n$ by joining u_i, u_{i+1} to new vertices v_i and w_i respectively and adding edges $v_i w_i$ for i = 1, 2, …, n-1.

Definition 1.4. A double quadrilateral snake graph $D(Q_n)$ consists of two quadrilateral snakes that have a common path.

2 Main Results

Theorem 2.1. Any triangular snake graph T_n is a super cube root cube mean graph.

Proof. Let T_n be a triangular snake graph.

Let $V(T_n) = \{u_i, v_j, 1 \leq i \leq n \ \& \ 1 \leq j \leq n-1\}$ and

$E(T_n) = \{u_i u_{i+1}, u_i v_i, u_{i+1} v_i, 1 \leq i \leq n - 1\}$

Here p = 2n - 1 & q = 3n – 3 Hence p + q = 5n - 4.

Define a function f: $V(T_n) \rightarrow \{1, 2, 3, \dots, p + q\}$ by

$f(u_i) = 5i - 4, \ 1 \leq i \leq n$

$f(v_i) = 5i - 2, \ 1 \leq i \leq n - 1$.

Then, the edge labels of T_n are

$f^*(u_i v_i) = 5i - 3, \ 1 \leq i \leq n - 1$

$f^*(u_i u_{i+1}) = 5i - 1, \ 1 \leq i \leq n - 1$

$f^*(u_{i+1} v_i) = 5i, \ 1 \leq i \leq n - 1$.

Clearly $f(V(T_n)) \cup \{f^*(e): e \in E(T_n)\} = \{1, 2, 3, \dots, p + q\}$.

Hence Triangular snake graph T_n is a super cube root cube mean graph.

An example of super cube root cube mean labeling of T$_4$ is shown in Figure1.
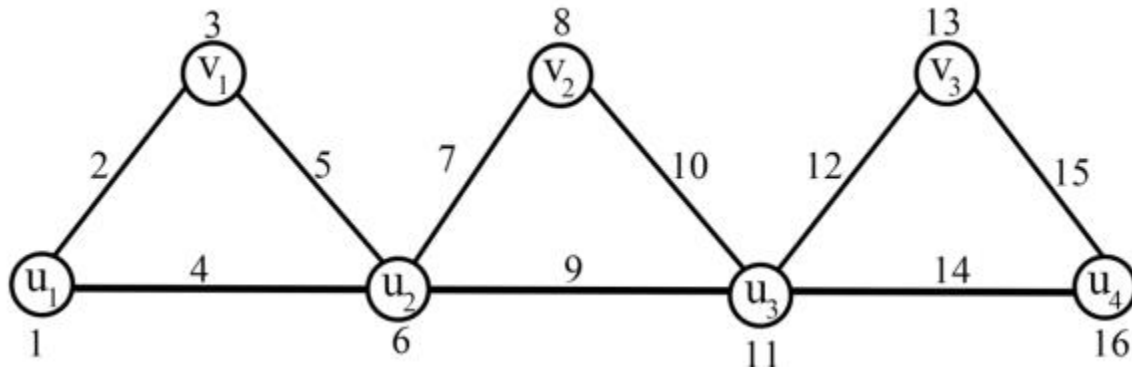
Figure 1.

Theorem 2.2. Any double triangular snake graph D(T$_n$) is a super cuberoot cube mean graph.

Proof. Let D(T$_n$) be a double triangular snake graph.

Let $V(D(T_n)) = \{u_i, v_j, w_j, 1 \leq i \leq n \ \& \ 1 \leq j \leq n\text{-}1\}$ and

$E(D(T_n)) = \{u_i u_{i+1}, u_i v_i, u_{i+1} v_i, u_i w_i, u_{i+1} w_i, 1 \leq i \leq n - 1\}$

Here p = 3n - 2 & q = 5n - 5 Hence p + q = 8n - 7.

Define a function f: $V(D(T_n)) \rightarrow \{1,2,3, \ldots, p + q\}$ by

$f(u_1) = 1, \ f(u_2) = 6$

$f(u_i) = 8i - 7, 3 \leq i \leq n$

$f(v_1) = 9$

$f(v_i) = 8i - 1, 2 \leq i \leq n \text{-}1$

$f(w_i) = 8i - 5, \ 1 \leq i \leq n\text{-}1.$

Then, the edge labels of D(T$_n$) are

$f^*(u_i u_{i+1}) = 8i - 3, 1 \leq i \leq n - 1.$

$f^*(u_1 v_1) = 7$

$f^*(u_i v_i) = 8i - 4, 2 \leq i \leq n - 1$

$f^*(u_{i+1} v_i) = 8i, 1 \leq i \leq n \text{-}1$

$f^*(u_i w_i) = 8i - 6, 1 \leq i \leq n \text{-}1$

$f^*(u_2 w_1) = 4$

$f^*(u_{i+1} w_i) = 8i - 2, 2 \leq i \leq n \text{-}1.$

Clearly $f[V(D(T_n))] \cup \{f^*(e): e \in E(D(T_n))\} = \{1,2,3, \ldots, p + q\}$.

Hence any double triangular snake graph D(T$_n$) is a super cube root cube mean graph.

An example of super cube root cube mean labeling of D(T$_4$) is shown in Figure 2.
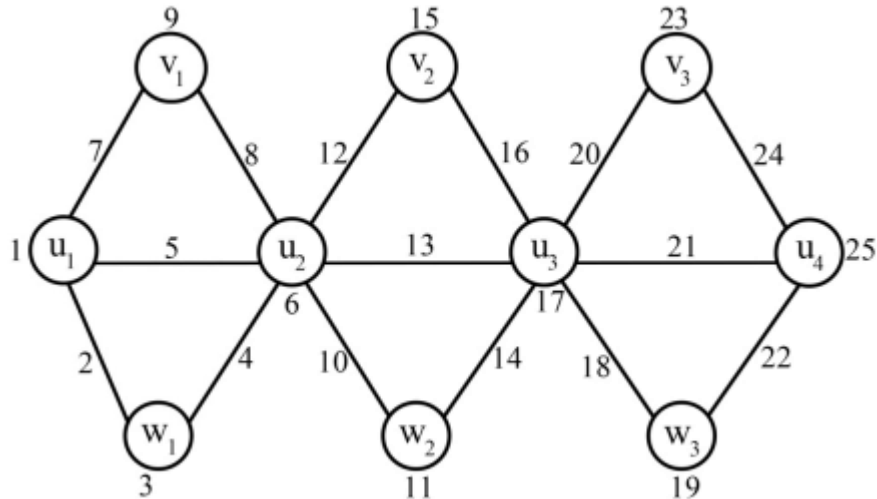
Figure 2.

Theorem 2.3. Any Quadrilateral snake graph Q_n is a super cube root cube mean graph.

Proof. Let Q_n be a quadrilateral snake graph.

Let $V(Q_n) = \{u_i, v_j, w_j, 1 \leq i \leq n \ \& \ 1 \leq j \leq n\text{-}1\}$ and

$E(Q_n) = \{u_i u_{i+1}, u_i v_i, v_i w_i, u_{i+1} w_i, 1 \leq i \leq n - 1\}$

Here $p = 3n - 2$ & $q = 4n - 4$ Hence $p + q = 7n - 6$.

Define a function f: $V(Q_n) \rightarrow \{1,2,3,\ldots, p + q\}$ by

$f(u_i) = 7i - 6, 1 \leq i \leq n$

$f(v_i) = 7i - 4, 1 \leq i \leq n - 1$

$f(w_1) = 5$

$f(w_i) = 7i - 1, 2 \leq i \leq n\text{ -}1.$

Then, the edge labels of Q_n are

$f^*(u_1 u_2) = 6$

$f^*(u_i u_{i+1}) = 7i - 2, 2 \leq i \leq n - 1$

$f^*(u_i v_i) = 7i - 5, 1 \leq i \leq n - 1$

$f^*(u_{i+1} w_i) = 7i, 1 \leq i \leq n - 1$

$f^*(v_i w_i) = 7i - 3, 1 \leq i \leq n - 1.$

Clearly $f[V(Q_n)] \cup \{f^*(e): e \in E(Q_n)\} = \{1,2,3,\ldots, p + q\}$.

Hence any Quadrilateral snake graph Q_n is a k-super cube root cube mean graph.

An example of Super cube root cube mean labeling of Q_4 is shown in Figure 3.
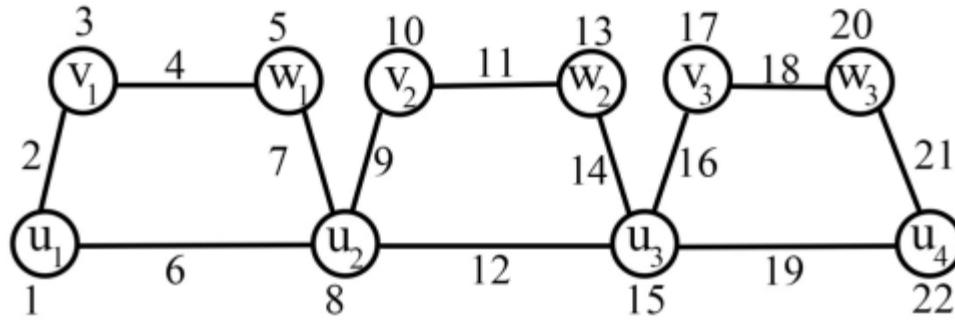
Figure 3.

Theorem 2.4. Any double quadrilateral snake graph $D(Q_n)$ is a supercube root cube mean graph.

Proof. Let $D(Q_n)$ be a double quadrilateral snake graph.

Let $V[D(Q_n)] = \{u_i, v_j, w_j, v'_j, w'_j, 1 \le i \le n\ \&\ 1 \le j \le n-1\ \}$ and

$E[D(Q_n)] = \{u_i u_{i+1}, u_i v_i, v_i w_i, u_{i+1} w_i, u_i v'_i, v'_i w'_i, u_{i+1} w'_i, 1 \le i \le n-1\}$

Here $p = 5n - 4\ \&\ q = 7n - 7$ Hence $p + q = 12n - 11$.

Define a function f: $V(D(Q_n)) \to \{1,2,3, \ldots, p + q\ \}$ by

$f(u_i) = 12i - 11, 1 \le i \le n$

$f(v_i) = 12i - 9, 1 \le i \le n - 1$

$f(w_i) = 12i - 5, 1 \le i \le n - 1$

$f(v'_i) = 12i - 6, 1 \le i \le n - 1$

$f(w'_i) = 9$

$f(w'_i) = 12i - 1, 2 \le i \le n - 1$.

Then, the edge labels of $D(Q_n)$ are

$f^*(u_1 u_2) = 11$

$f^*(u_i u_{i+1}) = 12i - 4, 2 \le i \le n - 1$

$f^*(u_i v_i) = 12i - 10, 1 \le i \le n - 1$

$f^*(u_{i+1} w_i) = 12i - 2, 1 \le i \le n - 1$

$f^*(v_i w_i) = 12i - 7, 1 \le i \le n - 1$

$f^*(u_i v'_i) = 12i - 8,\ \ 1 \le i \le n - 1$

$f^*(u_{i+1} w'_i) = 12i, 1 \le i \le n - 1$

$f^*(v'_1 w'_1) = 8$

$f^*(v'_i w'_i) = 12i - 3, 2 \le i \le n - 1$

Clearly $f[V(D(Q_n))] \cup \{f^*(e : e \in E(D(Q_n))\} = \{\ 1, 2, 3, \ldots,\ p + q\ \}$.

Hence any double quadrilateral snake graph $D(Q_n)$ is a super cube root

cube mean graph.

An example of Super cube root cube mean labeling of D(Q₄) is shown inFigure 4.
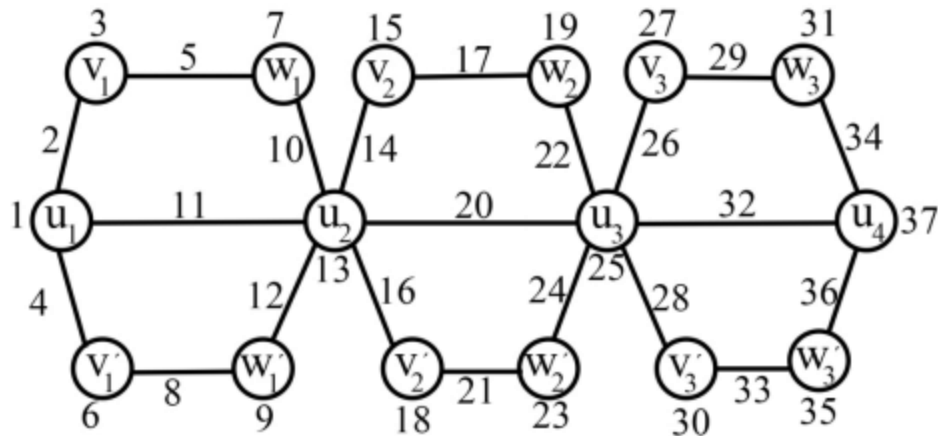
Figure 4.

Conclusion

From this paper, it could be concluded that the graphs such as triangular snake graph T_n, double triangular snake graph $D(T_n)$, quadrilateral snake graph Q_n, double quadrilateral snake graph $D(Q_n)$ are super cube root cube mean graphs. Further investigation shall be done for other graphs. There is a lot of scope for the researchers to apply Super Cube Root Cube Mean labeling to other graphs which are obtained from any other graph operations.

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Production and Optimization of Xylanase Enzyme from *Pseudomonas Sps.* under Solid State Fermentation

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ABSTRACT

Wheat bran was used as substrate for xylanase enzyme production from Pseudomonas sp. Optimization was done for the period of incubation, temperature, pH, carbon, and nitrogen sources for xylanase production. Xylanase production was found to be optimum at an incubation period of 96 hrs (105.4 U/mL), temperature 30°C (100.3U/mL), and pH 9.0 (100.5 U/mL). The results showed that the xylanase production was found to be higher in the presence of 4% carboxymethylcellulose (165.4 U/mL) and 4% dextrose (129.8 U/mL). It was also observed that 1% peptone (185.1 U/mL) and 1% beef extract (174.5 U/mL) supported maximum xylanase production. After purification of xylanase with ammonium sulphate precipitation and dialysis, the maximum activity was observed in the precipitate (489.3 U/ml). The enzyme was characterized and found to be active at pH 9 (772.2 U/mL) and temperature 60°C (919.0 U/mL). Further, the enzyme was immobilized with sodium alginate and calcium chloride.

Keywords: *Fermentation, Lignocellulose, Pseudomonas, Xylanase.*

Introduction

Enzymes are the important key for every biochemical reactions and they are considered as respective parameter of research. Enzymes possess specific role in the biological and biochemical reactions in most of the industrial applications. The most important constituent of the plant cell wall is lignocelluloses. The composition of lignin (15–20%), hemicellulose (25–30%) and of cellulose (40–50%) [1,2]. Xylanases are produced by various microorganisms like bacteria, fungi, actinomycetes, protozoans and molluscs[3,4].

The lignocellulosic substrates used for the production of xylanase enzyme involves agricultural waste materials like corn meal, corn cob, wheat bran, rice husk, rice straw, bagassae, sawdust, vegetable garbage etc. [5]. Nowadays, xylanase is used in animal feed, preparation of bread, preparation of drinks, manufacturing the textiles, bleaching of pulp etc. Xylanases also offer a great advantage for the generating fuels and chemicals [6]. Hence, the present investigation is carried out in producing the xylanase enzyme with a low cost material with optimization parameters.

Methodology

Isolation and Characterization of Microorganism

In the present study, the microorganism (*Pseudomonas sps.*) was isolated from the decaying wood, collected from Kanyakumari District. The scrapings of decaying wood are inoculated into nutrient agar medium and incubated at 37^0C for 24 hrs. After incubation period, the colonies obtained are characterized for its morphological characteristics and biochemical tests. Based on these observations, the bacteria was identified. Then, the bacterium was cultivated on Nutrient agar medium with 0.5 % birch wood xylan. The isolated organism was sub-cultured on Nutrient broth and stored at 4 °C.

Substrate Preparation

Wheat bran was collected from the Flour Mills in Kanyakumari District, Tamil Nadu, South India and used as substrate. The substrate wheat bran was washed for about 3- 4 times with distilled water and then heated for about 10 - 15 minutes. Finally, the substrate was dried and powdered. The powdered substrate was sieved using a 30μm mesh and stored at -20°C.

Xylanase Enzyme Production in a Solid-State Fermentation

5 g wheat bran was taken and added to 15 ml mineral basal salt solution (MBSS) medium with the substrate of moisture ratio 1 : 3. The production media contains (g/L) 30g NaCl, 0.75g KCl, 7g $MgSO_4$, 0.5g NH_4Cl, 7ml of 10% K_2HPO_4, 7.00 ml of 10% KH_2PO_4, 3 ml of trace metal solution (mg/L), that includes 2.83mg H_3BO_3, 1.80mg $MnCl_2.7H_2O$, 2.49mg $FeSO_4.7H_2O$, 1.77mg Na - K-Tartarate, 0.33mg $CuCl_2$, 0.02mg $ZnCl_2$, 0.04mg $CoCl_2$ and 0.02mg $Na_2MoO_4.2H_2O$. The medium and trace metal solutions were autoclaved separately. The flasks were cooled down to room temperature, and further sterilized trace elements were added. The flask was inoculated with 1 ml of inoculum and were mixed thoroughly and incubated for 24 hrs [2].

Optimization of Enzyme Production Parameters

The different parameters for producing xylanase enzyme, during fermentation were optimized. The incubation period on enzyme activity was examined at different time intervals 24, 48, 72, 96, 120, and 144 hrs, respectively, at the optimum temperature of (28 ± 2°C) and pH 7.0. The effect of temperature on enzyme activity was examined at 20°C, 25°C, 30°C, 35°C, and 40°C at pH 7.0 for 96 hours. Similarly, the effect of pH on enzyme activity was determined at various pH of 6, 7, 8, 9, and 10 respectively.

The effect of supplementation of additional carbon and nitrogen sources to wheat bran was analyzed by using different carbon sources of carboxymethylcellulose, dextrose, lactose, and sucrose (1%−5%). Similarly, the nitrogen sources analyzed were potassium nitrate (KNO_3),

ammonium sulphate [$(NH_4)_2SO_4$], beef extract and peptone (1%–5%). The optimum concentration of the carbon and nitrogen sources was also determined. The synergistic effect of different carbon and nitrogen sources, that possess high xylanase activity was also determined, inorder to find the best combination of carbon and nitrogen sources. The combined carbon and nitrogen sources include carboxymethylcellulose and peptone, carboxymethylcellulose and beef extract, dextrose and peptone, and dextrose and beef extract. The enzyme production was carried out with optimum temperature (30°C) and pH 9.0 for 96 hours [6].

Preparation of Enzymes

10 g of wheat bran and 30 ml of MBSS (pH 9.0), with carbon and nitrogen sources was prepared, sterilized, cooled and inoculated with 1 ml of the *Pseudomonas* sp in a nutrient broth. The flasks were incubated at 96 hours at room temperature, and the enzyme was extracted using Glycine-NaOH buffer.

Enzyme Assay

The xylanase activity was assayed using 1% birch wood xylan as the substrate. 1% xylan was dissolved in 50 mM Glycine-NaOH buffer (pH 9.0). The reaction mixture containing 40l of an appropriate dilution of the enzyme and 1 ml of the substrate was incubated for 10 min. The amount of reducing sugars liberated was determined by using 3,5-dinitrosalicylic acid method (DNS method). The absorbance of the reference samples (substrate solution incubated without enzyme and diluted enzyme solution in buffer) was recorded from the test sample values, and were measured by reading the optical density at 540 nm. The unit of xylanase activity was defined as the number of moles of reducing sugars formed per min under the assay conditions. Enzyme Activity = gm of maltose released / Volume of enzyme used x Time of assay X Total volume of assay (ml) / volume used in colorimetric determination [8].

Partial Purification by Ammonium Sulphate Precipitation

The contents were suspended in 100 ml of 50 mM Glycine-NaOH buffer (pH 9), vortexed thoroughly and centrifuged at 10,000 rpm for 10 min, at 4°C. All the proteins are precipitated by ammonium sulphate. 100 ml of bacterial culture was treated with 52.3 g of ammonium sulphate for the precipitation of protein. The precipitate was kept overnight without disturbance and further centrifugation was done at 10,000 rpm for 10 min. The precipitate was dissolved in phosphate buffer (50 mM, pH 8.0), and enzyme activity was determined in precipitate as well as supernatant. The precipitate maximum enzyme activity was used for further analysis [8].

Dialysis

The precipitate was dissolved in phosphate buffer (50 mM, pH 8.0), and the supernatant was dialysed against the buffer for 24 hours. Dialysis was carried out using cellulose tubing. The enzyme activity was determined in precipitate as well as supernatant. The precipitate possessing maximum enzyme activity was used for further analysis.

Enzyme Characterization - Temperature and Ph Profile

The optimal temperature for the purified xylanase was obtained by assaying the enzyme activity at different temperatures 50°C, 60°C, 70°C, 80°C, 90°C, and 100°C at pH 9.0. At each temperature, 40l of the enzyme along with 1 ml of birchwoodxylan substrate was incubated for about 40 mins, and the enzyme activity was measured at 540 nm. The xylanase activity using 1% (w/v) birchwoodxylan was determined with different pH of 4 to 11. Citrate buffer was used for pH 4 to 6, Phosphate buffer for pH 7 and 8, and glycine- NaOH buffer for pH 9 to 11. The enzyme, substrate and buffers, were incubated at 60°C for 3 hours. The enzyme activity was measured at 540 nm [9].

Effect of Metal Ion Concentration

The enzyme was incubated with 1 mM of $CaCl_2$, $MgCl_2$, $MgSO_4$, $HgCl_2$, $FeSO_4$, $CuCl_2$, $ZnCl_2$ and EDTA for 1 hour at (28 ± 2°C). The enzyme activity was measured at 540 nm.

Immobilization

The purified enzyme is entrapped and immobilized with sodium alginate and calcium chloride.

Results and Discussion

Isolation and Characterization of Microorganism

In the present investigation, from the collected sample, on the basis of morphological, cultural and biochemical characteristics, the isolated organism was *Pseudomonas* sps.

Optimization Parameters of Xylanase Enzyme Production

Effect of Incubation Period on Xylanase Activity

Wheat bran was used as the substrate for the experimental analysis. The microorganism is grown on the wheat bran and maximum enzyme production was observed was at 96 hrs (105.4 U/mL) for every 24 hours with 540 nm. Less amount of xylanase was produced in the first 24 hrs (7.1 U/mL) and later xylanase enzyme production increased rapidly at48 and 96 hrs (Graph 1). The fungi *Penicillium oxalicum* when cultured on wheat bran under solid state fermentation, showed maximum production of enzyme after 144 hrs, when observed with 540 nm [7].

Graph 1. Effect of incubation period on Xylanase activity

Effect of incubation period on xylanase activity

Enzyme Activity (U/ML)

Time (Days)	Value

6.9   7.1   42.7   59.3   105.4   100.2   98.9

Time (Days): 0   24   48   72   96   120   144
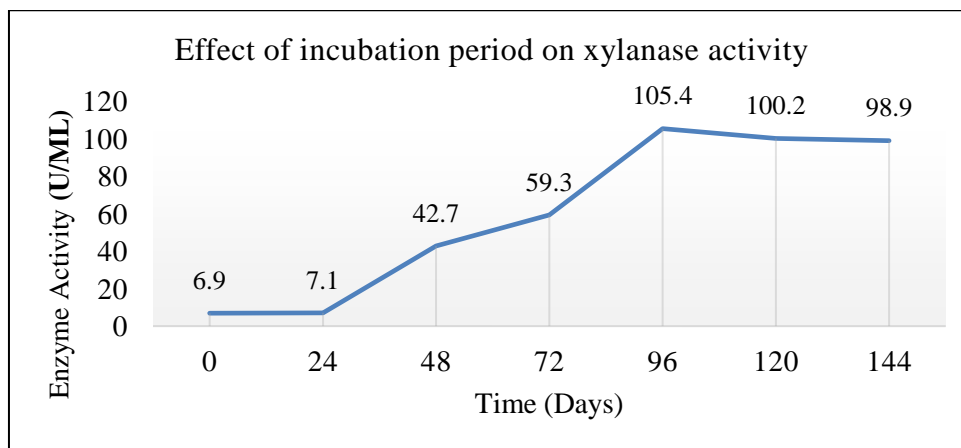
Effect of Temperature on Xylanase Activity

The optimum xylanase enzyme activity was found to be (100.3 U/mL) at 30°C. But, after 30°C, there is a sudden decrease in the production of enzyme. At 25°C (81.2 U/mL), the enzyme activity was lesswhen compared to that at 30°C. The minimum activity was observed at 20°C (36.2 U/mL) (Graph 2).

Graph 2. Effect of temperature on Xylanase activity

Effect of temperature on xylanase activity

Enzyme Activity (U/Ml)

40.5   42.8   44.6   43.9   36.2   81.2   100.3   55.8   52.3   50.9

Temperature: 0   5   10   15   20   25   30   35   40   45
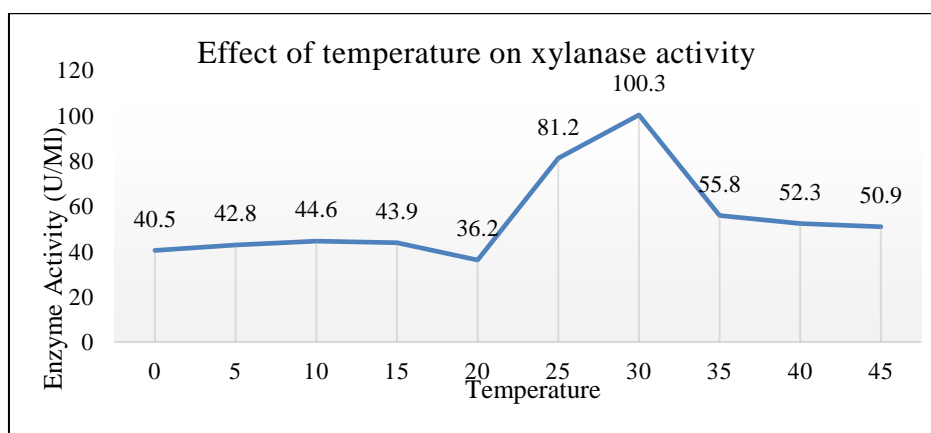
Effect of pH on Xylanase Activity

The highest enzyme activity was found to be optimum at pH 9 (100.5 U/mL) and minimum pH was observed at 6 (14.9 U/mL) (Graph 3). Xylanase enzyme with the pH value 7–9 is efficient for various reactions. Xylanase enzyme has potent effect at the pH value ranges from 7–9, and this ranges is essential for bioleaching industrial uses. The xylanase enzyme produced by *Bacillus* sp, showed maximal pH with respect to *Bacillus* Tar-1, C-125. *Bacillus* NCL-86-6-10 has potent activity at pH 8.0 [7]. Mostly, fungi producing xylanases also withstand the pH range in alkaline conditions. However, the present study reports are in accordance with the previous reports [8].

Graph 3. Effect of pH on Xylanase activity

Effect of pH on xylanase activity
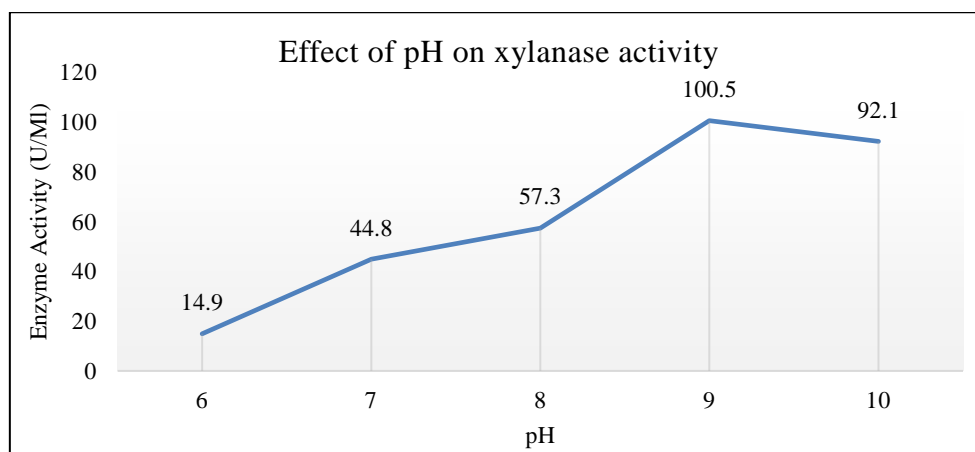
Effect of Carbon Sources on Xylanase Activity

The concentration on xylanase activity was studied at 1%–5%, with four different carbon sources. At 5%, all carbon sources found to be decreased in its xylanase ability. Among the four carbon sources, 4% of carboxymethylcellulose (165.4 U/mL) exhibit maximum enzymatic activity. 4% of dextrose (129.8 U/mL) also showed high enzymatic ability.The other two sources, sucrose and lactose showed very less enzymatic activity. Thus, 4% carboxymethylcellulose and dextrose are considered as the good sources for the producing xylanase enzyme (Graph 4).

The effect of carbon sources while producing xylanase enzyme by the bacteria *Pseudomonas oxalicum* exhibit maximum activity towards carboxymethylcellulose, when compared with other carbon sources like sucrose, lactose and glucose. This clearly emphasize that the present study findings are in great accordance when compared with earlier reports [9].

Graph 4. Effect of carbon sources on Xylanase activity

Effect of carbon sources on Xylanase activity
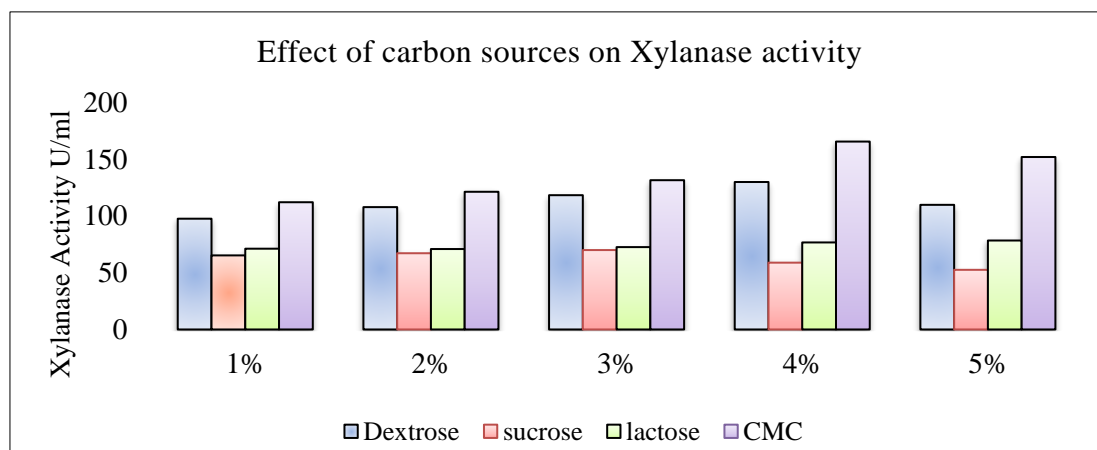
Ffect of Nitrogen Sources on Xylanase Activity

Among the four nitrogen sources tested, 1% peptone (185.1 U/mL) exhibited the maximum enzymatic activity. 1% beef extract (174.5 U/mL) also showed high enzymatic activity. Ammonium sulphate and ammonium nitrate showed very less activity. Thus, in the present investigation, 1% of peptone and beef extract are considered as good sources for producing xylanase enzyme (Graph 5). *Arthrobacter sps,* has the potency in producing more xylanase enzyme in the peptone and beef extract ratio of 1% [10].

Graph 5. Effect of nitrogen sources on Xylanase activity
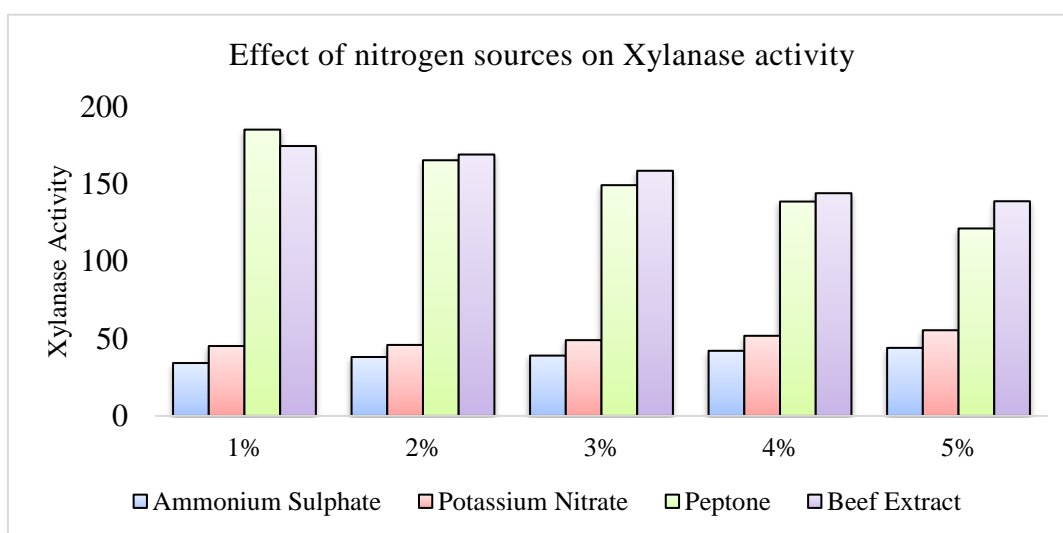
Graph 6. Effects of Various Carbon and Nitrogen Sources
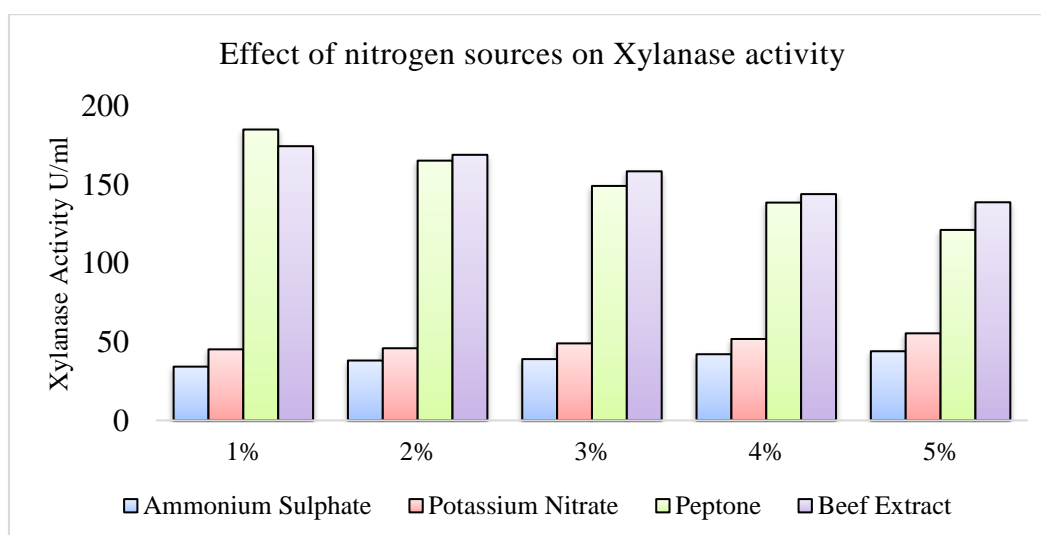
Effects of Various Carbon and Nitrogen Sources

Four different sources of two carbon (carboxymethylcellulose and dextrose) and nitrogen sources (peptone and beef extract) were selected to identify theparticularcombination that has the ability to exhibit the maximum enzyme activity. The two carbon sources that

exhibited the highest activity were 4% each of carboxymethylcellulose (182.1 U/mL) and dextrose (136.5 U/mL) and nitrogen sources 1% each of peptone (180.9 U/mL) and beef extract (175.4 U/mL). It was found that the combination of 4% dextrose and 1% peptone exhibited the maximum enzymatic activity (117.9 U/mL).

Purification of the Enzyme

The enzyme was isolated and partially purified by ammonium sulphate precipitation. After partial purification, centrifugation was done for precipitate separation. Later, the supernatants and precipitates were subjected to the cellulose tubing bag for dialysis. After dialysis, the enzyme assay was carried out for supernatant and precipitate. The precipitate (489.3 U/ml) showed maximum enzymatic activity, which indicates that the enzyme was present in the precipitate. Purification of xylanase enzyme with enzyme activity in precipitate (576.8 U/ml) and supernatant (624.9 U/ml) was achieved in *Bacillus sps* and this work correlates with that of current findings [11].

Characterization of Xylanase Enzyme

Temperature

The maximum enzymatic activity was observed at pH 9.0 (772.2 U/mL) after 3 hours of incubation. The enzyme activity was high at pH 10.0 (756.6 U/mL) but very less when compared to pH 9.0. The enzyme activity decreased gradually and reduce its activity in acidic pH after 3 hours (Graph 6).

Graph 6. Effect of pH on Xylanase activity
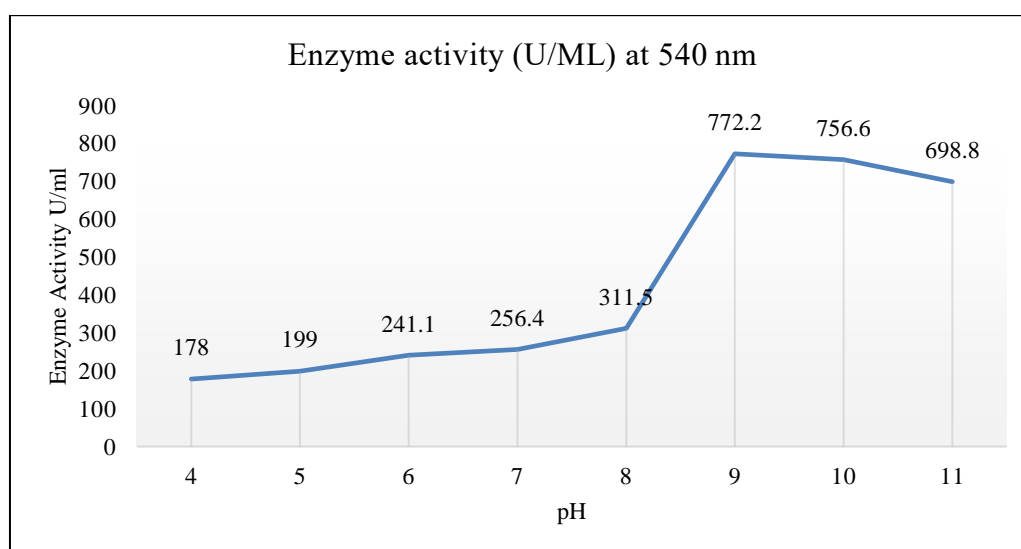
Graph 7. Effect of Temperature on Xylanase activity
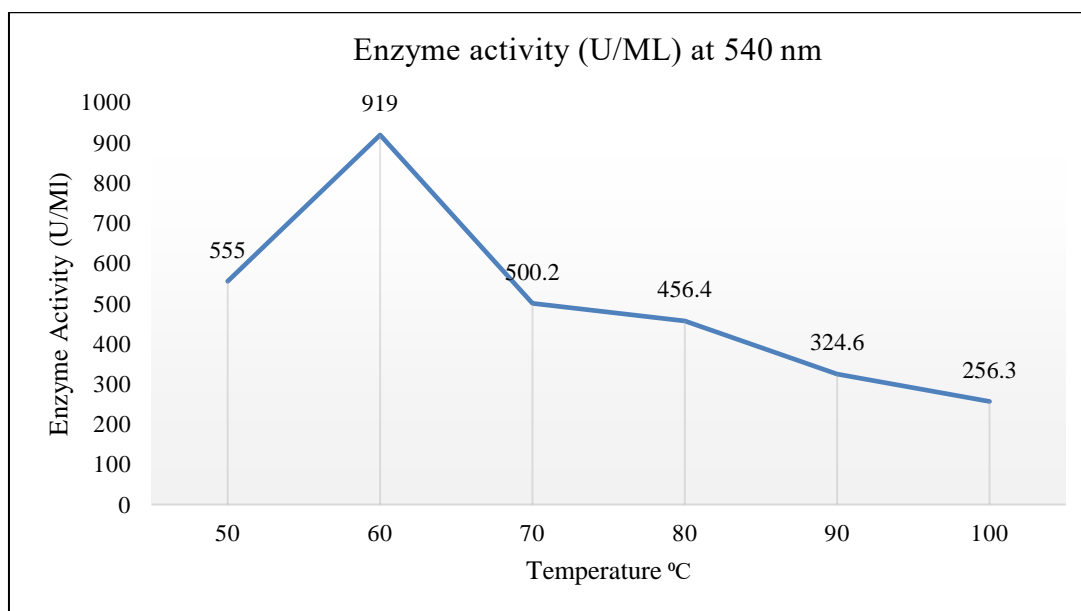
Maximum enzymatic activity was observed at the temperature range of 60°C (919.0 U/mL), after 40 min of incubation period. The enzyme activity was also very high at 50°C (555 U/mL) and 70°C (500.2 U/mL) (Graph 7).

Xylanase enzyme isolated from *Bacillus subtilis* was subjected to culture and grows on solid-state fermentation with the substrate oat spelt xylan. After fermentation, maximum enzyme activity was exhibited at pH 6.0. Xylanase enzyme isolated from *B. licheniformis* A99 showed the maximal pH at 7.0. Similarly, xylanase enzyme isolated from the bacterium *B. coagulans* BL69 cultured on the substrate soybean residues, exhibited optimum pH of 7.0 [12].

Effect of Metal Ion Concentration

Xylanase enzyme activity was analysed in the presence and absence of metal ions, and the metal chelator EDTA. Both Hg^{2+} (35.6 U/mL) and EDTA (11.8 U/mL) inhibited the xylanase enzyme activity. The xylanase activity was more by the addition of Zn^{2+}, Fe^{2+}, Cu^{2+}, Mg^{2+}, and Ca^{2+} ions (Graph 8). Nakamura *et al*. in 1993, studied about the effect of metal ions, which revealed that Hg^{2+} ions inhibited the activity of the enzyme [13]. Cesar and Mrsa in 1996 revealed that the bacterium *T. lanuginosus* showed that Ca^{2+} exhibit more enzyme activity [14]. Moreover, Mn^{2+} and Zn^{2+} ions also exhibit more response towards xylanase enzyme action. Ghanem *et al*. for *Aspergillus terreus* showed that Ca^{2+} enhanced xylanase activity [10]. Khandeparkar and Bhosle in 2005, reported that the bacterium *Enterobacter* sp. exhibited that EDTA has the capacity to inhibit the xylanase enzyme activity. The present work has similar results as in the earlier studies [12].

Graph 8. Effect of metal concentration on Xylanase activity

Enzyme Activity (U/ML) at 540 nm
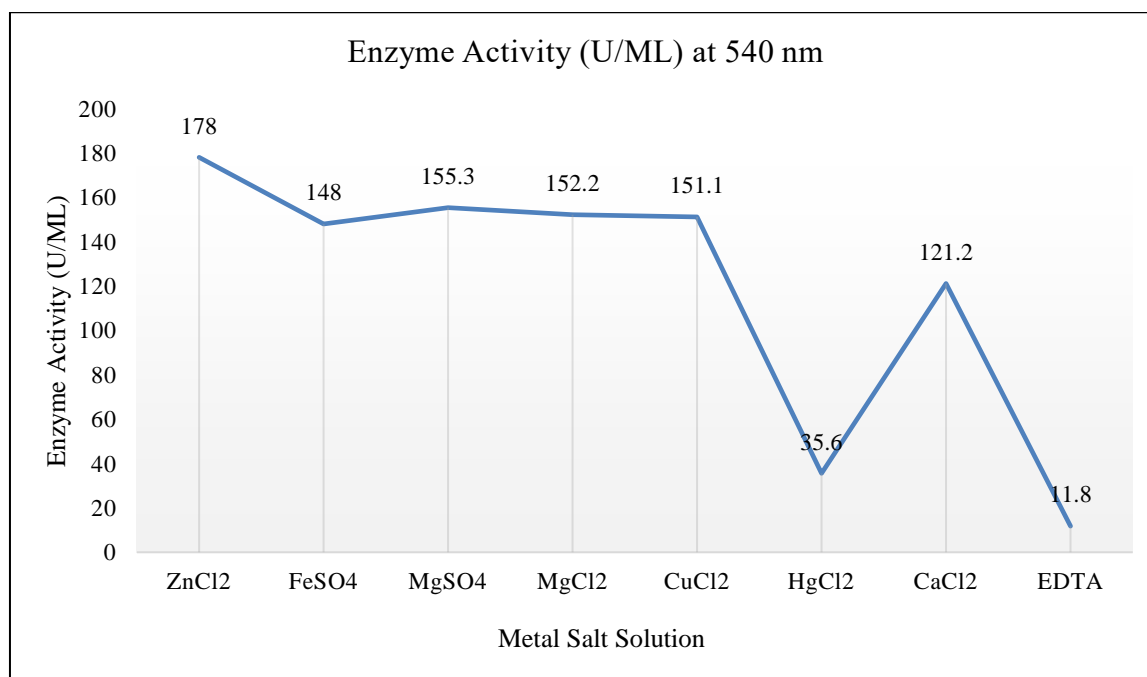
Immobilization

Immobilization was achieved successfully in the purified enzymes with the calcium chloride. In 2002, Couri *et al*. successfully immobilized the xylanase enzyme produced from *Bacillus sps.* with sodium alginate and calcium chloride [15].

Conclusion

The present study clearly emphasize that the usage of wheat bran substrate is really considered as a cheap and standard economical approach in producing xylanase enzyme with a low cost.

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Ethnobotanical Study of Medicinal Plants used by Kani Tribes of Mudavanpothai, Kanyakumari District, Tamil Nadu

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ABSTRACT

An ethnobotanical survey was carried out among the Kani tribes of Mudanvanpothai hill, Kanyakumari wildlife sanctuary, Tamil Nadu. The present study was done through structured questionnaire in consultation with the tribal ethno-medicinal practitioners and has resulted in the documentation of 71 medicinal plants belonging to 38 families. The most commonly represented families were Acanthaceae, Apocynaceae and Fabaceae. Decoction was the most common preparation used in herbal recipes. The medicines are mainly administered to women and children. The study shows a high degree of ethnobotanical novelty and the use of plants among the Kani tribes reflects the revival of interest in traditional folk medicine.

Keywords: Ethnobotany, Folk medicine, Kani Tribes.

Introduction

Plants have always been a major component of the traditional system of healing in developing countries and have also been an integral part of the history and cultural practices of local communities [1,2]. The World Health Organization has recognized that 80 % of the world's population, especially in developing countries, depends on the traditional medicines derived from plants [2 - 4]. These medicines are regarded to be safe and economical due to the dearth of healthcare facilities [2,5].

The term "Ethnobotany" was coined by J. W. Harshberger in 1895 to indicate plants used by the aboriginals: from "ethno"- study of people and "Botany"- study of plants. Ethnobotany deals with the study and evaluation of plant-human relations in all phases and the effect of plant environment on human society [2,6]. Plant-based medicines enjoy a respectable position today, especially in the developing countries, where modern health service is limited [7,8]. Throughout history plants have been used by humans for medicinal purposes and even in modern times, have formed the basis of many pharmaceuticals [9,10]. The investigation of therapeutic plants through qualitative survey methods has become important in recent decades [11-14]. The records of traditional knowledge on medicinal plants have been considered to support the discoveries of new drugs for the advantage of mankind [15].

India has a rich tradition in medicinal plant study, and is one of twelve mega

biodiversity centers [16,17]. Totally there are 427 tribe communities in India [17,18]. In Tamil Nadu there are 36 scheduled tribes [17,19]. Kani are a tribal community found in the southern parts of Kerala and Tamil Nadu states in India. They dwell in forest or near to forest in Thiruvananthapuram and Kollam in Kerala and Kanyakumari and Tirunelveli districts in Tamil Nadu [20].

The objective of this study was to analyze the richness of ethnomedicinal plants used by the Kani tribes of Mudavanpothai and their traditional medical practices. Documentation of the indigenous knowledge of ethnomedicinal plants is important for the conservation of biological resources as well as their sustainable utilization.

Study area

Tamil Nadu is the eleventh largest states in India with a geographical area of 13005 Sq. Kms and lies between 11° 00' to 12° 00' North latitudes and 77° 28' to 78° 50' East longitudes [17,21].

The study was conducted among the Kani tribes inhabiting Mudavanpothai of Pechipparai Reserve Forest (08° 26.945' N; 077° 18.501' E), situated in the foothills of Kanyakumari Wildlife Sanctuary. Mudavanpothai is a mountain which is located at a latitude of 8.40383 and the longitude 77.37235 with the GPS coordinates of 08° 24' 13.75'' N and 77° 22' 20.45'' E with an elevation of 697 meters above the sea level. South-west monsoon from June- September and north-east monsoon in October to December bring rain to this region. The annual rainfall varies from 100 cms to 300 cms. Major portion of the rainfall is received during southwest monsoon. Alluvial soil is predominant in the entire area. The temperature fluctuates due to the elevation. The minimum and maximum temperature is 20.5 and 33.6 $^{\circ}$C respectively. The vegetation of the area comprises of tropical evergreen forests, wet grasslands and moist teak forests.

Methodology

Kani tribal traditional medicinal experts have been interviewed and the data have been collected. The useful parts, mode of preparation of the medicine, mode of administration and types of ailments cured by the traditional medicines were noted. The surrounding forested areas and agricultural land of villagers were surveyed with local herbal healers and knowledgeable elders for the identification of various plant species and their traditional uses. Plant specimens were collected for taxonomic identification from different parts of the study area. All the specimens collected were identified with the help of Holy Cross College Herbarium and with Flora of Presidency of Madras [22]. The prepared database contains following details of the plant such as the botanical name, family, local name, habit and ethnomedicinal uses. The semi-

structured questionnaire was used to extract information on types of ailments treated by the use of medicinal plants and plant parts used in treating the respective ailments (Questionnaire 1).

Results and Discussion

Plants have been used as traditional medicine for several thousand years. Kani tribal are primarily a semi-nomandic community, one of the primitive people who have been originated from Kerala. They have slowly shifted to Tamil Nadu and have been settled in the forest of Kanyakumari and Tirunelveli region. Tribal botanical knowledge is a divine gift to humanity. Tribals, even today depend on wild plants and animals for their livelihood [17].

An exploration of ethnomedicinal plants in Kani tribes of Mudavanpothai documented 71 species distributed in 66 genera belonging to 38 families. The families of the species are arranged in chronological order. Botanical name, family, local name, parts used and ethnomedicinal uses are described in the table given below (Table 1). Among the documented plants, herbs are present in higher number followed by trees, shrub, climber, small tree and semi-erect shrub (Table 1). As in herbs, the harvesting of leaves can be done without much effort. The leaf is the most commonly used part for medicinal purposes (Table 1). Leaves are easy to get and the preparation or decoction is also easy with leaves than any part of the plant. The most commonly represented families are Acanthaceae, Apocynaceae and Fabaceae (Figure 1). Among these 71 species, *Hemionitis arifolia* is the only plant belonging to the class Pteridophyte (Plate 1). The images of the rare and endemic species are included (Plate 1).

The list of remedies described in the present study was remarkably different from those reported in the neighboring tribes like Didayi tribes of Malkangiri district, Orissa [23], Kani tribes of Kottor reserve forest, Thiruvananthapuram, Kerala [24] and Paliyar tribals of Theni district [25].

Similarly, the remedies described in this study are found to be the same with the medicinal practices of nearby tribals like Kani tribes of Thachamalai hill, Kanyakumari [26] and Kani tribes of Pechipparai hills [2]. The usage of plants for the treatment of diseases varies from place to place. About 37% of the medicines are taken in the form of decoction, followed by raw consumption (20%), plant extract (18%), oil (14%) and topical application (11%) (Figure 2). Decoctions are easy to prepare and will not lose its active ingredients. The present study reveals that, most of the plants, nearly 54% are used for the treatment of women and children related diseases and remaining 46% are used for the treatment of adults both male and female. It shows the vulnerability of women and children, when the chance of going to hospital is impossible (Figure 3).

Figure 1. Relative Abundance of Top 10 herbal plant families in the study area
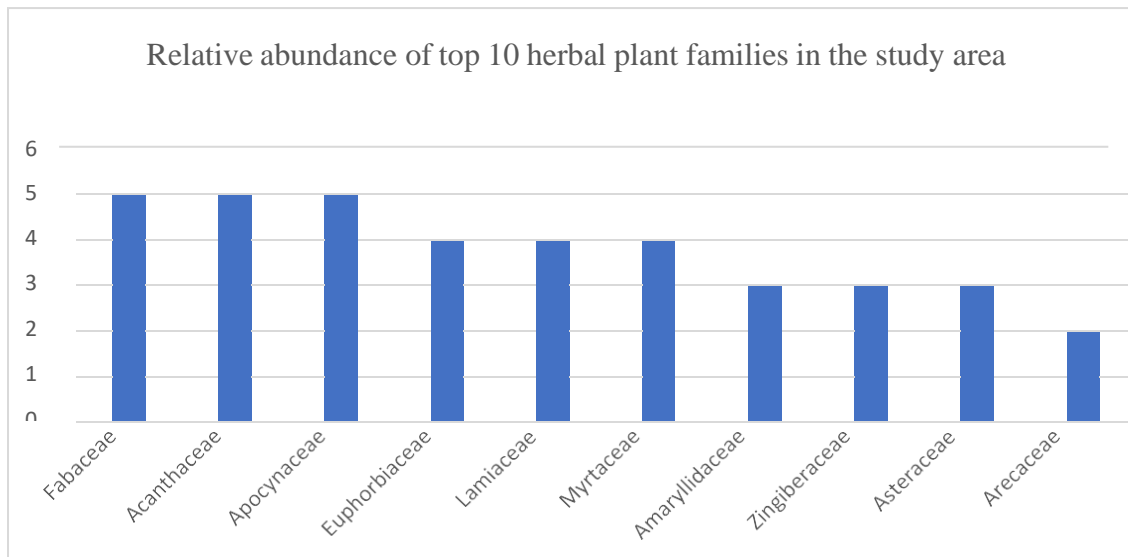
Figure 2. Mode of Application of Herbal Plants
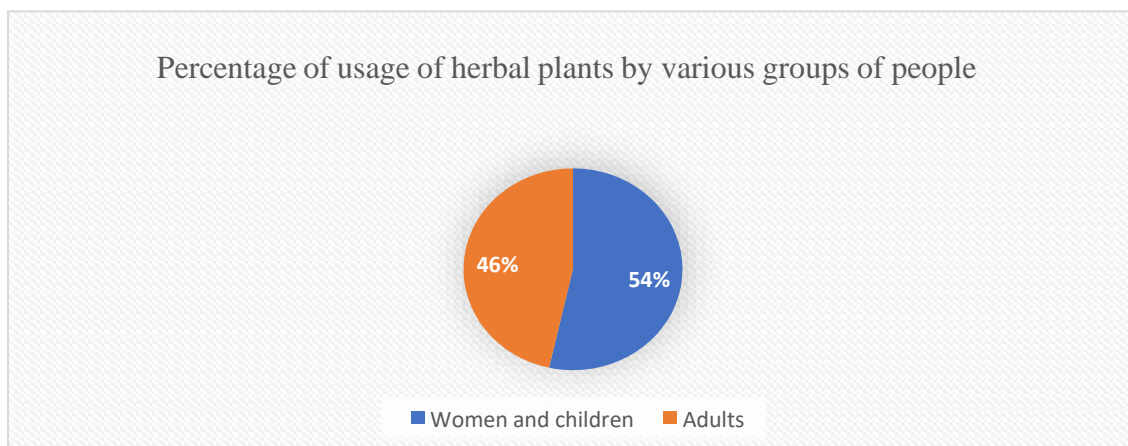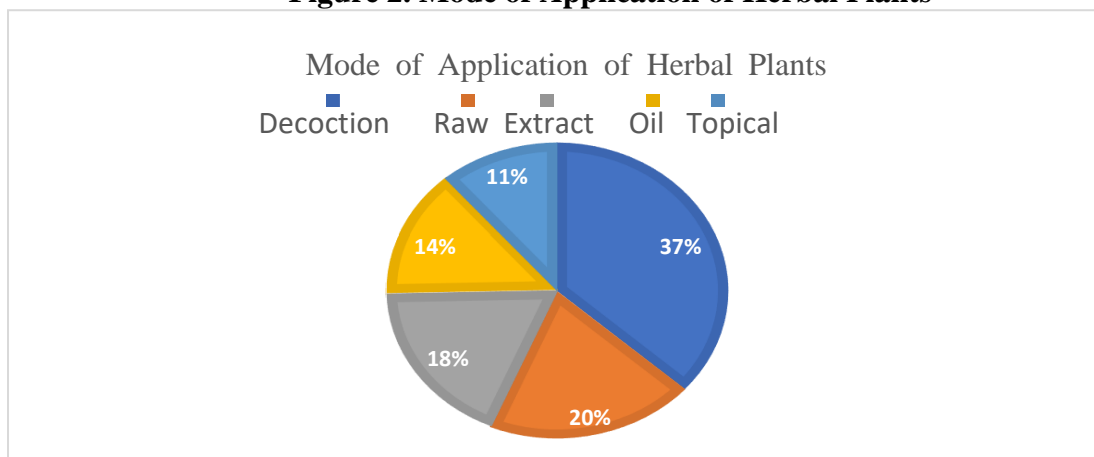
Figure 3. Percentage of usage of herbal plants by various groups of people

Questionnaire 1

1. Name the plant you use to treat the ailment?

2. What is the vernacular name of the plant?

3. How you have learned to recognize them?

4. Which plant part is used as medicine?

5. Can you explain the preparation in detail?

6. How long should the medicine be in-taken for recovery?

7. Internal or external administration?

8. How many times a day should the patient consume this medicine?

9. Whether they need to follow any diet plan?

10. To whom the medicine is administered? (Men/ women/children)

Table. 1 Medicinal plants and their uses

S. No	Botanical Name	Family	LocalName	Habit	Uses
1.	*Adathoda vasica* Nees.	Acanthaceae	Adhatoda	Shrub	The root decoction is used for the treatment of cold and fever.
2.	*Andrographis paniculata* (Burm.f.) Nees	Acanthaceae	Nilavembu	Herb	The decoctionmade from the whole plant is used for the treatment of fever and headache.
3.	*Justicia gendarussa* Burm.f	Acanthaceae	Karunochi	Shrub	The leaf is boiledwith water and people with rheumatism can take bath with thiswater to get relief from the disease.
4.	*Justicia glauca* Rottl.	Acanthaceae	Thavasi murungai	Herb	The decoction made from the whole plant is consumed for thetreatment of piles.
5.	*Strobilanthes alternata* (Burn.f.) Moylanex J.R.I. Wood	Acanthaceae	Karvi kurungi	Herb	The oil prepared by the addition of the leaves to coconut oil is applied topically to heal wounds.
6.	*Achyranthesaspera* L.	Amaranthaceae	Naayuruvi	Herb	The leaf decoction is used for the treatment offever.
7.	*Allium cepa* L.	Amaryllidaceae	Ulli	Herb	The raw onion is consumed after meal for the reduction of bad cholesterol.
8.	*Allium sativum* L.	Amaryllidaceae	Veluthulli	Herb	The raw garlic isconsumed for thetreatment of stomach issues and indigestion.
9.	*Centella asiatica* (L.) Urban	Apiaceae	Vallarai	Herb	The whole plantis added into coconut oil and this oil is used for the treatment of rashes and redness in infants.

10.	*Catharanthus roseus* (L.) G. Don	Apocynaceae	Sudukattu malligai	Herb	The decoction of the flower is consumed in the empty stomach for the treatment of ovarian cyst and other menstrual problems.
11.	*Hemidesmus indicus* (L.) R.Br.	Apocynaceae	Narnatti	Semi-erect shrub	The raw roots are consumed after removing the skin for the treatment of ulcer.
12.	*Pergularia daemia* (Forssk.) Chior.	Apocynaceae	Veliparuthi	Herb	The leaf extract is applied topically for the treatment of body pain for the pregnant women.
13.	*Rauvolfia serpentina* (L). Benth. ExKurz	Apocynaceae	Sarpagandha	Herb	The dried roots are boiled in water and consumed for the treatment of poisonous bites.
14.	*Tabernaemontana divaricata* R. Br.exRoem.& Schutt.	Apocynaceae	Nanthiyavatam	Shrub	The flower is crushed and the juice is dropped into the eyes for the treatment of eye disease.
15.	*Areca catechu* L.	Arecaceae	Paakku	Tree	The nut is powdered and it is consumed in the form of tea to expel intestinal worms.
16.	*Cocos nucifera* L.	Arecaceae	Tengku	Tree	The tea prepared from the dried and powdered shell is consumed in the empty stomach for the treatment of diabetes. The tender flower juice is consumed in the empty stomach for the treatment of kidney stone.
17.	*Asparagus racemosus* Willd.	Asparagaceae	Tannirvittan	Climber	The decoction prepared from the roots of this plant and leaves of *Centella asiatica* and *Ocimum sanctum* is used for the treatment of white discharge for both men and women.
18.	*Aloe vera* (L.) Burm.f	Aspholedelaceae	Kathalai	Herb	The jelly present in the leaf is consumed raw for the treatment of menstrual problems. It is also topically applied over the heat burns.
19.	*Elephantopus scaber* L.	Asteraceae	Anashovadi	Herb	The decoction made from the whole plant is used for the treatment of injuries and wounds.
20.	*Spagneticola trilobata* (L.) Pruski	Asteraceae	Karisalankanni	Herb	The juice of the stem is gargled for the treatment of toothache.

21.	*Tridax procumbens* L.	Asteraceae	Muriampac halai	Herb	The leaf extract is applied topically over the cut wounds.
22.	*Basella alba* (L.)	Basellaceae	Pasalakeera	Herb	The leaf decoction is used for the treatment of constipation.
23.	*Ehretia microphylla* Lam.	Boraginaceae	Kattu vellilai	Shrub	The decoction made from the leaf of this plant and *Piper betel* is used in the treatment of cholera.
24.	*Heliotropium indicum* L.	Boraginaceae	Thelkodukku	Herb	The decoction of the whole plant is used for the treatment of ulcer. The inflorescence paste is applied topically over the poisonous bites.
25.	*Carica papaya* L.	Caricaceae	Pappali	Tree	The tender leaf juice is consumed in empty stomach for the treatment of fever and to increase the blood count.
26.	*Terminalia chebula* Retz	Combretaceae	Kadukkai	Tree	The powdered seeds are consumed after meal for the treatment of constipation.
27.	*Momordia charantia* L.	Cucurbitaceae	Paagarkai	Climber	The decoction and juice made from the raw fruits are used for the treatment of diabetes.
28.	*Acalypha indica* L.	Euphorbiaceae	Kuppaimeni	Herb	The leaf extract is given to children for the treatment of cough. It is also mixed with leaf extract of *Vitex negundo* and breast milk and it is consumed for the removal of phlegm.
29.	*Croton tigilum* L.	Euphorbiaceae	Naervalam	Tree	The leaf decoction is used for the treatment of fever.
30.	*Euphoria hirta* L.	Euphorbiaceae	Amman pacharisi	Herb	Leaf juice is applied topically to heal wounds.
31.	*Jatropha curcus* L.	Euphorbiaceae	Kuruvetti	Shrub	The milk obtained from the plant is applied topically for the treatment of toothache.
32.	*Abrus precatorius* L.	Fabaceae	Athimaturam	Climber	The decoction of the root is consumed for the treatment of cold and cough.
33.	*Chamaecrista fasciculata* (Michx)Greene	Fabaceae	KaatuCassia	Herb	The decoction made from the leaves of this plant and *Ehretia microphylla* is used for the treatment of chicken pox and small pox.
34.	*Clitoria ternatea* L.	Fabaceae	Kannikkodi	Climber	The decoction made from the leaf is consumed for the treatment of ulcer.

35.	*Mimosa pudica* L.	Fabaceae	Thottac-curu ngi	Herb	The whole plant is added to coconut oil and it is applied topically for the treatment of eczema for infants.
36.	*Trigonella foenum-graecum* L.	Fabaceae	Venthayam	Herb	The decoction ofthe seeds are consumed for indigestion and it relieves heat from the body.
37.	*Curculigo orchioides* Gaertn	Hypoxidacee	Nilappannai	Herb	The grounded rhizome is applied over the breast for the treatment of breast milk accumulation.
38.	*Eleutherinebulbosa* (Mill) Urb.	Irridaceae	Kaatu ulli	Herb	The paste made from the bulb is mixed with the human urine and consumed for the treatment of snake bite.
39.	*Coleus aromatics* Benth.	Lamiaceae	Karpuravalli	Herb	The leaf extract is consumed forthe treatment of cold. It is also applied topicallyover the insect bites.
40.	*Ocimum sanctum* L.	Lamiaceae	Tulsi	Herb	Leaf juice is mixed with honey and consumed for the treatment of dry cough and cold.
41.	*Tectona grandis* L.f.	Lamiaceae	Thaekku	Tree	The tender leaf isadded to the coconut oil and this oil is applied topically for the treatment of rashes and itching.
42.	*Vitex negundo* L.	Lamiaceae	Vennochi	Shrub	The decoction prepared from the leaf is consumed for the treatment of head injuries.
43.	*Lawsonia inermis* L.	Lythraceae	Maruthani	Shrub	The leaf paste is used as the medicine for foot crack.
44.	*Punica granatum* L.	Lythraceae	Maathulai	Small tree	The dried and powdered peel is mixed with honey and consumed for stomachache. The ripe fruits are consumed toincrease the blood count.
45.	*Hibiscus rosa-sinensis* L.	Malvaceae	Sembarathi	Shrub	The leaf decoction is used as a natural shampoo and leaf paste is applied in the scalp for dandruff.
46.	*Azadirachta indica* A.Juss	Meliaceae	Veppai	Tree	The tender leaves are ground into a paste and consumed in empty stomach for the treatment of infertility and menstrual problems.
47.	*Moringa oleifera* Lam.	Moringaceae	Murungai	Tree	The tender leaf isconsumed raw for the treatment of blood cholesterol.

48.	*Musa paradisiaca* L.	Musaceae	Vaazha	Herb	The juice of thepseudostem is consumed in empty stomach for the treatment of kidney stone.
49.	*Eucalyptus globulus* Labill	Myrtaceae	Thailamaram	Tree	The leaf is added to the coconut oiland it is applied topically for the treatment of cold and headache.
50.	*Psidium guajava* L.	Myrtaceae	Koyyaa	Tree	The tender leaf isconsumed in the empty stomach for the treatment of indigestion. The leaf decoction is used for the treatment of diabetes.
51.	*Syzygium aromaticum*(L.)	Myrtaceae	Grambu	Tree	Clove oil is used for the treatment of toothache.
52.	*Syzygium cumini* (L.)	Myrtaceae	Naaval	Tree	The tea prepared from the powdered seeds are consumed in empty stomach for the treatment of diabetes.
53.	*Mirabilis jalapa* (L.)	Nyctaginaceae	Nalumani	Herb	The extract of the leaf is applied topically over the wounds and inflammation.
54.	*Biophytum sensitivum*(L.) DC.	Oxalidaceae	Mukkootti	Herb	The leaf is grinded with crystal salt and applied over the wasp sting area for the reduction of pain and inflammation.
55.	*Phyllanthus emblica* L.	Phyllanthaceae	Nelli	Tree	The fruit is mixed with honey and consumed in empty stomachfor increasing the appetite.
56.	*Phyllanthus niruri* L.	Phyllanthaceae	Keezhanelli	Herb	The whole plant is boiled in waterand it is consumed for the treatment offever.
57.	*Piper betel* (L.)	Piperaceae	Vettilai	Climber	The leaf decoction is consumed for thetreatment of whooping coughand asthma.
58.	*Piper nigrum* L.	Piperaceae	Kurumilagu	Shrub	The dry fruits are grounded with palm jaggery and consumed for thetreatment of cold.
59.	*Hemionitis arifoila* (Burm.f.) T.Moore	Pteridaceae	Kambi thamarai	Herb	The leaf is squeezed along with small onion and this extract is dipped in milk and a single drop is applied in the eyes for the treatment of eyeinfection.
60.	*Ixora coccinea* L.	Rubiaceae	Thetti	Shrub	The flowers of *Ixora coccinea* and whole plant of *Portulaca quadrifolia* is added to coconut oil and it is applied topicallyfor the treatmentof rashes, eczema

				and redness for children and adults.
61.	*Citrus limon* (L.) Osbeck Modernism	Rutaceae	Azhumichai	Small tree	Fruit juice is mixed with salt and consumed for the treatment of dysentery.
62.	*Murraya koenigii* (L.) Sprengel	Rutaceae	Curry veppilai	Small tree	The leaf paste isapplied over dog bite area in thebody.
63.	*Cardiospermum halicacabum* L.	Sapindaceae	Mutakkottan	Climber	The whole plant is made into a paste and applied all over the bodyto reduce the spasm and strain of pregnant women.
64.	*Scoparia dulcis* L.	Scrophulariaceae	Chirarita	Herb	The decoction made from the root is used for the treatment ofstomach ache.
65.	*Capsicum frutescens* L.	Solanaceae	Kanthari milagu	Herb	Fruit is consumed for the treatment of cholesterol. The fruit is mixed with palm jaggery for the treatment of fever and cold.
66.	*Solanum nigrum* L.	Solanaceae	Manathakkali	Herb	The decoction prepared from the whole plant is used for the treatment of ulcer.
67.	*Lantana camara* L.	Verbenaceae	Arasimala	Shrub	Leaf paste is mixed with lime and is applied topically over the wounds.
68.	*Cissus quadrangularis*L.	Vitaceae	Pirandai	Climber	The stem is added to coconut oil and it is applied topically for the treatment of body pain.
69.	*Alpinia galanga* (L.)Willd	Zingiberaceae	Paereeyarat hai	Herb	The rhizome of this plant and seed of *Areca catechu* is addedto coconut oil and it is applied topically for the treatment of heat burns.
70.	*Curcuma longa* L.	Zingiberaceae	Manjal	Herb	The powdered rhizome is mixed with honey and consumed for thetreatment of cold and for the removal of phlegm. The powder is also applied topically for insect bite.
71.	*Zingiber officinale* Roscoe.	Zingiberaceae	Inji	Herb	The decoction ofthe rhizome is used for the treatment of acidity and indigestion.

Plate 1. Rare and endemic medicinal plants of the study area

Hemionitis arifoila (Burm.f.) T. Moore

Hemidesmus indicus (L.) R.Br.

Eleutherine bulbosa (Mill) Urb.

Strobilanthes alternata (Burn.f.)
Moylan ex J.R.I. Wood

Curculigo orchioides Gaertn

Rauvolfia serpentina (L.) Benth. ex Kurz

Ehretia microphylla Lam.

Chamaecrista fasciculata (Michx) Greene

Biophytum sensitivum (L.) DC.

Elephantopus scaber L.

Justicia gendarussa Burm.f

Croton tigilum L.

Summary

Thus, the present study helped us to understand the ethno medicinal knowledge of Kani tribes of Mudavanpothai. The documentation is essential to preserve their botanical knowledge. Further, they have to be trained and awareness should be given for the conservation of the biodiversity of this area. Over exploitation and loss of natural habitat etc. is the major factors thatare responsible for the exploitation of the medicinal plants. Traditional uses of plants are declining as the younger generation is not interested in traditional practices. So, it is very important to protect the medicinal plants and valuable traditional practices.

Acknowledgement

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A Survey on Edible Plant Parts Available with Roadside Vendors of Kanyakumari District, Tamilnadu

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ABSTRACT

This study documents a total of 83 edible plants belonging 40 families utilized as a source of nutritional purposes by the people of Kanyakumari District. Information was gathered by interviewing with the roadside vendors and local people. Greens and fruits were most dominant. A detailed survey on the edible plants available with the roadside vendors of Kanyakumari District was carried out. This study focused on the identification and documentation of these plants with their usage and health benefits based on various literatures. Among the 83 species, products from trees were high in number, followed by that from herbs, climbers, shrubs, runners, creeper, under shrub and vine. Plant parts from Solanaceae was the is the dominant one . All the plants reported in the study are consumed by the people for its nutritive and medicinal properties. These edible plants provide significant health benefits because of their high vitamins, minerals, fibre, etc. The edible plants endure abundant bioactive compounds and significantly contribute to the nutritional security of mankind.

Keywords: Edibles, Kanyakumari District, Plant Parts

Introduction

Plants are an integral part of nature and the nature reflects the creativity of God. The plants are designed with a specific purpose. They are the life sustaining force on the earth [1]. Plants have formed the basis of traditional medicine and drug development. The human race started using plants and plant products successfully for treatment of diseases and injuries from the early days of civilization [2].

The primitive people are well acquainted with the properties and uses of plants of their surroundings [3]. Plants play an important role in the fulfilment of diet of local habitants. Edible plants are major part of balanced diet which acts as a supply of minerals and nutrients. The amount of nutrients required for a person varies with age, gender, physical activity etc. Indian population commonly rely on plants for all its basic nutritive benefits.

It is also recognized that indigenous foods and dietary diversity within an ecosystem can be powerful sources of nutrients and thus are conductive to good health. These vegetables are nutritionally rich and adapted to low-input agriculture. A sizable proportion of these underutilized leafy vegetables is not cultivated and is collected from the wild. Overwhelming epidemiological evidences indicates that diets rich in fruits and vegetable are associated with a lower risk of several degenerative diseases [4].

Green leafy vegetables are used as an important food source in all parts of the world and they are rich sources of bioactive compounds, minerals, and dietary fibres. However, leafy vegetables deteriorate very quickly after harvest due to their perishable nature and become unfit for consumption and furthermore, some of them are not available throughout the year. Fruits also play a vital role in all aspects of nutrition and medicinal benefits.

Apart from being a rich source of micronutrients and vitamins, the edible plants are also a good source of antioxidants, vitamins, minerals, etc. Present assessment is a novel come up to expose the edible plants sold by the roadside vendors consumed by the local people of Kanyakumari district, their potential and nutritional benefits.

Materials and Methods

Kanyakumari district is located in the southernmost part of the Indian peninsula. The district is around 1684 km^2. This is the second smallest district in Tamilnadu, has a varied topography with sea on three sides and the Western Ghats bordering the northern side. The entire district is bounded by Tirunelveli district on the north and east and by Gulf of Mannar on the south eastern part, the south and southwest are surrounded by the Indian ocean and the Arabian sea and the west and northwest by Kerala state. Hilly regions and plains almost comprise the landscape of the district. The study area enjoys warm and humid climate. It experiences two monsoons, Southwest monsoon during the month of June to September and northeast monsoon during October to November. The mean minimum temperature of the district ranges between 25°C to 32°C. The mean annual rainfall was 167.64mm. Kanyakumari district has varied ecosystems – forests, wetlands and freshwater resources. The district includes four taluks: Thovalai, Agastheeswaram, Kalkulam and Vilavancode.

The method of the present study was designed with the reason of providing base line information on the use of plant species in local system, through previous literature and field visits to various local markets of Kanykumari from January 2022 to June 2022. Ethnobotanical information on the use of edible plants was obtained through interviews and informal conversations.

Results and Discussion

During the study period a total of 83 plants were collected, recorded and tabulated. Life forms such as trees (31 species), followed by herbs (30 species), climbers (10 species), shrubs (7 species), runners (2 species) a creeper, under shrub and vine.

Fig 1. Life form distribution of edible plant parts
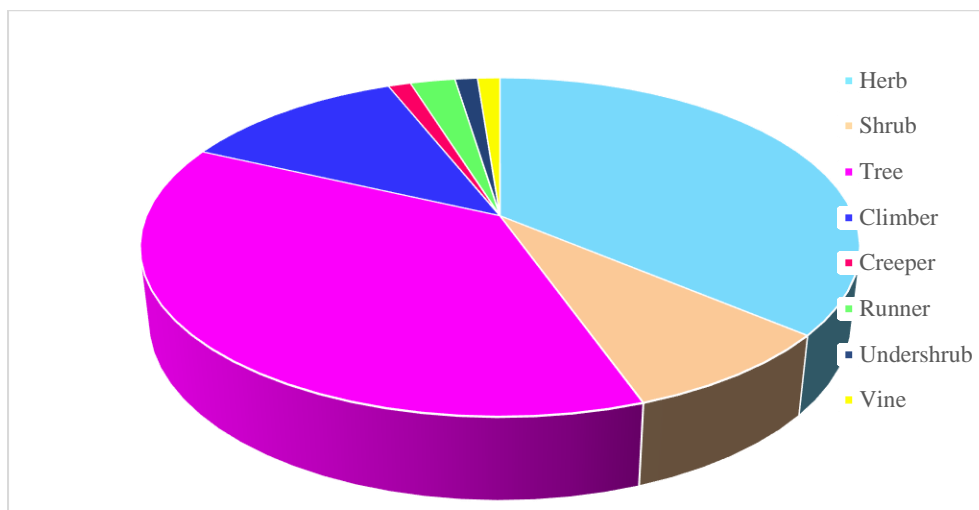
Among the 83 plants reported in the study Solanaceae consists of 8 species followed by Amaranthaceae and Fabaceae consists of 7 species, Apiaceae, Euphorbiaceae, Myrtaceae and Rutaceae consists of 4 species, Cucurbitaceae, Moraceae and Piperaceae consists of 3 species. Only two species were reported from Anacardiaceae, Annonaceae, Arecaceae, Caesalpiniceae, Palmaceae and Sapotaceae. Few families comprises only one species each.

Fig 2. Familywise distribution of edible plant parts
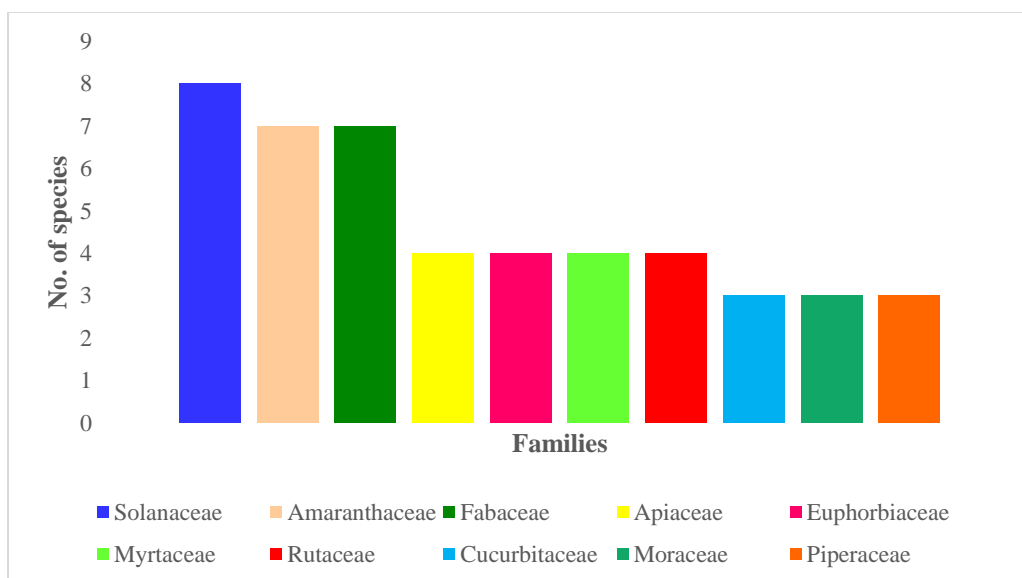
The various parts used as edibles were fruits, leaves, stem, flowers, flower buds, tubers, rhizome and bulbils. More number of fruits were consumed as compared with other useful parts. Leaves of 21 plants were used as edible plant. The tubers were eaten and in some cases. Few of the green leafy vegetables were consumed together with stem and leaves. *Zingiber officinalis* rhizome was consumed. Stem, fruits and flowers of *Musa paradisica* were eaten as vegetable.

Fig 3. Useful parts distribution of edible plant parts
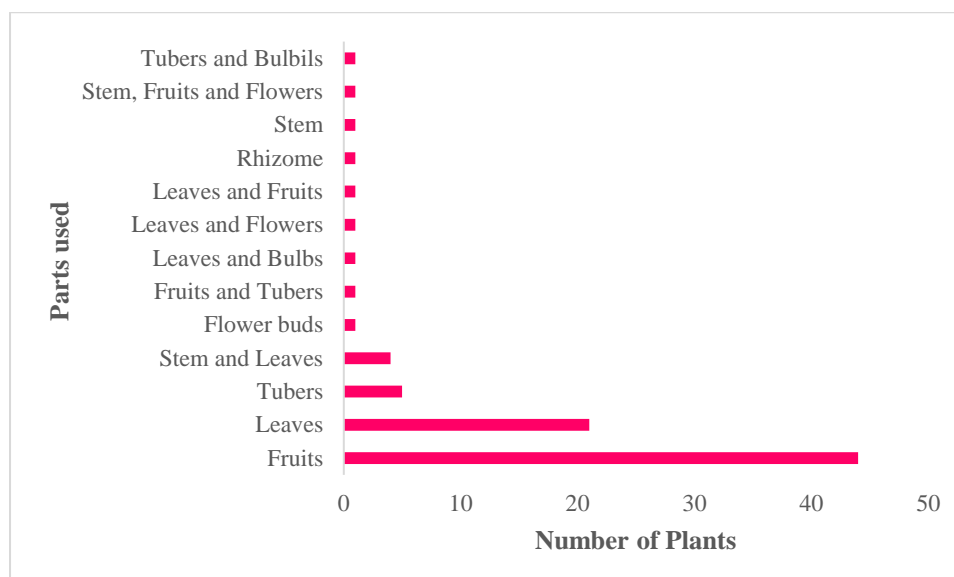
Although the overall health-promoting benefits of consuming a plant-based diet are well established. Most of the above-mentioned plants both cultivated and wild varieties are sold in these local markets in fresh forms, by poor and economically marginalised families, thereby generating an additional income to their household economy.

Early findings of [5] reported that the plant species are gathered from natural environments, particularly in the areas surrounding villages, field crops, gardens, forest, road side and fallow land. This survey was therefore important because it sought to understand the knowledge, attitude and use of dietary supplements to improve human health and prevent some of the chronic diseases.

Moringa oleifera L. flowers, fruits and leaves are used as vegetable. Leaves of *Solanum nigrum* was also cooked and used as vegetable [1].

In the present study the fruits of *Coccinia indica* are consumed as vegetable. Earlier reports of ripen fruits of *Coccinia indica* was consumed by the tribal peoples of Attappady, Southern Western Ghats [6].

All the *Amaranthus* species mentioned in the study are used a vegetable throughout in the district but the recipes differ from place to place. The whole plant of *Amaranthus gangeticus* is used as vegetable, *Dioscorea bulbifera* tubers and bulbils are edible, tender leaves of *Solanum nigrum* is eaten as leafy vegetable in Darrang district of Assam [7].

The finding of the study indicates the close relationship between health and food. Overlapping between foods and medicines is quite well known in traditional societies [8,9].

Few of the green leafy vegetables can be collected easily and it takes a crucial role in the daily intake of food. Earlier reports are also in corroboration with our results. This is due

to their easy availability and palatability [10]. Most of the local priority species recorded has multipurpose use that includes utilization as herbal medicine, food, aromatic, spices, vegetable, fruits etc. Due to the high nutritional benefits most of the plants surveyed in the study were used as vegetable and fruits. Species like *Phyllanthus emblica*, *Mangifera indica*, *Amaranthus* species, *Centella asiatica*, *Colacasia esculentum* and *Solanum nigrum* was reported as highly nutritive in Arunachal Pradesh [11].

Amaranthus spinosus, *Colacasia esculenta*, *Centella asiatica*, *Dioscorea bulbifera*, *Murraya koengii* and *Solanum torvum* are some of the edible plants used for various recipes around Kanyakumari district. Similarly traditional recipes of Tripura were also made by using the above-mentioned edible plants [12].

Most of the plants were found to be used for culinary purposes as well as in medicines. Previous authors also reported similar findings in their studies [7].

Evidence based studies suggest that the high intake of fresh fruits and vegetables have the ability to curtail a number of chronic debilitating diseases such as atherosclerosis and cancer [13][14]. People in Kanyakumari district extremely rely on fresh fruits, vegetables, greens etc uring in various seasons. During mango seasons certain native varieties of mangoes, jackfruits, tubers are also seen around the local markets of the district.

Hence continuing the consumption of edible plants in the diet, will help them to combat health problems linked with mineral insufficiency. The edible plants around the hilly regions are rich in minerals, vitamins and nutraceutical benefits. Micro minerals play a very vital role in the body such as iron needed for red blood cell production, zinc for healthy skin, reproductive and immune function, magnesium for nervous system health and calcium for strong healthy bones and teeth [15]. Calcium is important in blood clotting, muscles contraction and in certain enzymes in metabolic processes [16] and also essential for bone formulation and teeth development in children [17]. Magnesium is an essential micronutrient needed for nervous system health [15]. Iron plays an essential role in the respiratory pigments haemoglobin and myoglobin while calcium is firmly linked to many of the roles that vitamin D plays in the body [18]. Sodium is a vital mineral that act as the main monovalent ion of extracellular fluids constituting 93% of the ions (bases) found in the blood stream and helps prevention of muscular cramp [19]. Consumption of natural antioxidants from food supplements and traditional medicine is the best way to overcome this problem. Photochemical/ biomolecules present in aromatic, medicinal, spices, vegetable, fruits and other plants contain antioxidant properties [20]. These underutilized leafy vegetables can be obtained from different plant types: herbs, shrubs, trees or creepers. The parts most commonly consumed are leaves, but tender shoots,

buds, flowers, flower buds are also eaten. Therefore, the study shows edible plants has much importance in terms of nutritional and phytochemical sources.

Sl. No.	Botanical name	Family	Local name	Habit	Useful Part(s)	Uses
1.	*Abelmoschus esculentus* (L.) Moench	Malvaceae	Vendaikaai	Shrub	Fruits	Fruits are used as vegetable
2.	*Alangium salviifolium* (L.f.) Wangerin	Alangiaceae	Alinjil	Tree	Fruits	Fruits are eaten
3.	*Allium cepa* L.	Liliaceae	Vengayathalai	Herb	Leaves and Bulbs	Leaves and bulbs are used as vegetable
4.	*Alternanthera sessilis* (L.) R.Br. ex DC.	Amaranthaceae	Ponnaankanni keerai	Herb	Leaves	Leaves are used as vegetable
5.	*Amaranthus blitum* L.	Amranthaceae	Mulaikeerai	Herb	Leaves	Leaves are used as vegetable
6.	*Amaranthus gangeticus* L.	Amaranthaceae	Thandukeerai	Herb	Stem and Leaves	Stem and leaves are used as vegetable
7.	*Amaranthus spinosus* L.	Amaranthaceae	Mullukeerai	Herb	Stem and Leaves	Stem and leaves are used as vegetable
8.	*Amaranthus viridis* L.	Amaranthaceae	Kuppaikeerai	Herb	Stem and Leaves	Stem and leaves are used as vegetable
9.	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Arecaceae	Chaenaikilangu	Herb	Tubers	Tubers are cooked and eaten
10.	*Amaranthus dubius* Mart. Ex Thell.	Amaranthaceae	Araikeerai	Herb	Stem and Leaves	Stem and leaves are used as vegetable
11.	*Anacardium occidentale* L.	Anacardiaceae	Kollavumaram	Tree	Fruits	Fruits are eaten
12.	*Ananas comosus* (L.) Merr.	Bromeliaceae	Annasipazham	Herb	Fruits	Fruits are eaten
13.	*Annona muricata* L.	Annonaceae	Seemamundhiri	Tree	Fruits	Fruits are eaten
14.	*Annona squamosa* L.	Annonaceae	Seethapalam	Tree	Fruits	Fruits are eaten
15.	*Arachis hypogaea*	Fabaceae	Kadalai	Shrub	Fruits	Fruits are eaten
16.	*Areca catechu* L.	Palmaceae	Kamugu	Tree	Fruits	Fruits are eaten
17.	*Artocarpus altilis* (Parkinson) Fosberg	Moraceae	Seemapilaavu	Tree	Fruits	Fruits are cooked and eaten
18.	*Artocarpus heterophyllus* Lam.	Moraceae	Pilavu	Tree	Fruits	Fruits are eaten
19.	*Artocarpus hirsuta* Lam.	Moraceae	Cheenipala	Tree	Fruits	Fruits are eaten
20.	*Averrhoa bilimbi* L.	Geraniaceae	Pulichikaai	Tree	Fruits	Fruits are eaten raw
21.	*Averrhoa carambola* L.	Oxalidaceae	Star fruit	Tree	Fruits	Fruits are eaten

22.	*Basella alba* L.	Basellaceae	Pasalaikeerai	Climber	Leaves	Leaves are used as vegetable
23.	*Borassus flabellifer* L.	Arecaceae	Panai	Tree	Fruits and Tubers	Tender fruits are eaten raw, tubers are cooked and eaten
24.	*Cajanus cajan* (L.) Millsp	Fabaceae	Thuvarai	Shrub	Fruits	Dried fruits are eaten
25.	*Canavalia gladiata* (Jacq.) DC.	Fabaceae	Vetothikaai	Climber	Fruits	Fruits used as vegetable
26.	*Capsicum annuum* L.	Solanaceae	Pachaimilagu	Herb	Fruits	Fruits are eaten
27.	*Capsicum frutescens* L.	Solanaceae	Kaandhaarimilagu	Herb	Fruits	Fruits are used as vegetable
28.	*Cardiospermum halicacabum* L.	Sapindaceae	Mudakaruthaankerai	Climber	Leaves	Leaves are used as vegetable
29.	*Carica papaya* L.	Caricaceae	Papaali	Tree	Fruits	Fruits are eaten raw
30.	*Cassia tora* L.	Caesalpiniaceae	Thavaraillaikari	Herb	Leaves	Leaves are used as vegetable
31.	*Centella asiatica* (L.) Urban.	Apiaceae	Vallarai	Runner	Leaves	Leaves are used as vegetable
32.	*Cissus quadrangularis* L.	Vitaceae	Pirandai	Climber	Stem	Cooked as vegetable
33.	*Citrus limon* (L.) Burm. f.	Rutaceae	Elumitchai	Tree	Fruits	Fruits are eaten
34.	*Citrus maxima* (Burn) Merril.	Rutaceae	Bumblimaas	Tree	Fruits	Fruits are eaten
35.	*Citrus medica* L.	Rutaceae	Naarangaai	Tree	Fruits	Fruits are eaten
36.	*Coccinia grandis* (L.) Viogt	Cucurbitaceae	Kovaikaai	Climber	Fruits	Fruits are used as vegetable
37.	*Cocos nucifera* L.	Palmaceae	Thenaimaram	Tree	Fruits	Fruits are eaten
38.	*Colocasia esculenta* (L.) Schott	Araceae	Saembukilangu	Herb	Tubers	Tubers are cooked and eaten
39.	*Coriandrum sativum* L	Apiaceae	Kothamallithalai	Herb	Leaves	Leaves are used as vegetable
40.	*Cucumis sativus* L.	Cucurbitaceae	Vellarikaai	Creeper	Fruits	Fruits are used as vegetable
41.	*Cyamopsis tetragonoloba* (L.) Taub.	Fabaceae	Kothavarai	Herb	Fruits	Fruits are eaten
42.	*Cynodon dactylon* (L.) Pers.	Poaceae	Arugampul	Herb	Leaves	Leaves used to prepare juice
43.	*Dioscorea bulbifera* L.	Dioscoreaceae	Kaachalkilangu	Climber	Tubers and Bulbils	Tubers and bulbils are edible
44.	*Eclipta prostrata* (L.) L.	Asteraceae	Ponnaankanni	Herb	Leaves	Leaves used as vegetable
45.	*Eryngium foetidum* L.	Apiaceae	Rasakulai	Herb	Leaves	Leaves are used as vegetable
46.	*Ipomoea batatas* (L.) Lam.	Convolvulaceae	Cheenikilangu	Vine	Tubers	Tubers are cooked and eaten
47.	*Lycopersicon esculentum* Mill.	Solanaceae	Thakkaali	Herb	Fruits	Fruits are eaten

48.	*Mangifera indica* L.	Anacardiaceae	Maamaram	Tree	Fruits	Fruits are eaten raw
49.	*Manihot esculenta* Crantz	Euphorbiaceae	Marichinikilangu	Shrub	Tubers	Tubers are cooked and eaten
50.	*Manilkara zapota* (L.) P. Royen	Sapotaceae	Sapota	Tree	Fruits	Fruits are eaten
51.	*Maranta arundinacea* L.	Marantaceae	Koovaikilangu	Herb	Tubers	Tubers are cooked and eaten
52.	*Marsilea quadrifolia* L.	Marsiliaceae	Pulichakeerai	Runner	Leaves	Leaves used as vegetable
53.	*Mentha arvensis* L.	Lamiaceae	Pudhina	Herb	Leaves	Leaves are used as vegetable
54.	*Mimusops elengi* L.	Sapotaceae	Magilmaram	Tree	Fruits	Fruits are eaten
55.	*Momordica charantia* L.	Cucurbitaceae	Paagarkaai	Climber	Fruits	Fruits are eaten
56.	*Moringa oleifera* Lam.	Moringaceae	Murungaikeerai	Tree	Leaves and Flowers	Leaves and flowers are used as vegetable
57.	*Murraya koenigii* (L.) Sprenge	Rutaceae	Karuvaepillai	Tree	Leaves	Leaves are used as vegetable
58.	*Musa paradisiaca* L.	Musaceae	Banana	Herb	Stem, Fruits and Flowers	Inner stem is cooked as vegetable, ripen fruits are edible and flowers used as vegetable
59.	*Pandanus amaryllifolius* Roxb.	Pandanaceae	Rambaillai	Herb	Leaves	Leaves are used in cooking
60.	*Phyllanthus acidus* (L.) Skeels	Euphorbiaceae	Seemanelli	Tree	Fruits	Fruits are eaten
61.	*Phyllanthus emblica* L.	Euphorbiaceae	Nelli	Tree	Fruits	Fruits are eaten raw
62.	*Piper betle* L.	Piperaceae	Vetilai	Climber	Leaves	Leaves eaten
63.	*Piper longum* L.	Piperaceae	Thippili	Under shrub	Fruits	Dried fruits used as spices
64.	*Piper nigrum* L.	Piperaceae	Nallamilagu	Climber	Fruits	Dried fruits are used as spices
65.	*Pithecellobium dulce* (Roxb.) Benth.	Fabaceae	Kodukaapuli	Tree	Fruits	Fruits are eaten
66.	*Psidium gujava* L.	Myrtaceae	Koiyakaai	Tree	Fruits	Fruits are eaten
67.	*Punica granatum* L.	Lythraceae	Maadhulai	Tree	Fruits	Fruits are eaten
68.	*Sauropus androgynus* (L.) Merr.	Euphorbiaceae	Thavasumurungai	Herb	Leaves	Leaves are used as vegetable
69.	*Sesbania grandiflora* (L.) Poiret	Fabaceae	Agathikeerai	Tree	Leaves	Leaves are used as vegetable
70.	*Solanum melongena* L.	Solanaceae	Katharikaai	Shrub	Fruits	Fruits are used as vegetable
71.	*Solanum nigrum* L.	Solanaceae	Manathakkaalikeerai	Herb	Leaves and Fruits	Leaves and fruits are used as vegetable

72.	*Solanum torvum* Sw.	Solanaceae	Sundaikaai	Shrub	Fruits	Fruits are cooked as vegetable
73.	*Solanum trilobatum* L.	Solanaceae	Thoothuvalaikeer ai	Herb	Leaves	Leaves are used as vegetable
74.	*Solanum xanthocarpum* Schrad	Solanaceae	Kandankathari	Shrub	Fruits	Fruits are eaten
75.	*Spinacea oleracea* L.	Amaranthaceae	Paalakkeerai	Herb	Leaves	Leaves are used as vegetable
76.	*Syzygium caryophyllatum* (L.) Alston	Myrtaceae	Kiraambu	Tree	Flower buds	Flower buds are used as spices
77.	*Syzygium cumini* (L.) Skeels	Myrtaceae	Naval	Tree	Fruits	Fruits are eaten
78.	*Syzygium jambos* (L.) Alston	Myrtaceae	Jambakaai	Tree	Fruits	Ripen fruits are eaten raw
79.	*Talinum cunefolium* L.	Portulacaceae	Paruppukeerai	Herb	Leaves	Leaves are used as vegetable
80.	*Tamarindus indica* L.	Ceasalpineaceae	Puli	Tree	Fruits	Fruits are used in cooking
81.	*Trigonella foenum-graceum* L.	Apiaceae	Vendhayakeerai	Herb	Leaves	Leaves are used as vegetable
82.	*Vigna unguiculata* (L.) Walp.	Fabaceae	Payaru	Climber	Fruits	Fruits are used as vegetable
	Zingiber officinale Roscoe	Zingiberaceae	Inji	Herb	Rhizome	Rhizome is used as vegetable

Table 1. Summary of edible plants available in kanyakumari district

Conclusion

The present study provides a baseline data on the edible plants available with roadside vendors of Kanyakumari district. It gives idea on the edible plants and their useful parts. Further investigation is required to collect more nutraceutical and phytochemical benefits of the edible plants.

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Antibacterial activity of an endangered medicinal plant
Anaphyllum wightii Schott. Leaves

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ABSTRACT

This study was designed to examine the efficacy of various organic extracts derived from the leaves of Anaphyllum wightii schott. (Araceae) for antibacterial potential against bacterial pathogens like Staphylococcus aureus, Streptococcus mutans, Bacillus subtilis, Klebsiella pneumoniae, Proteus vulgaris and Escherichia coli. Different solvents selected for the study include four polar and one non - polar solvent. Streptomycin was the control used in the study. The present study revealed that, positive control showed a maximum zone of inhibition against all pathogenic bacteria screened when compared to the all-other solvent extracts. Among the tested solvent extracts, Acetone, ethanol and methanolic leaf extracts showed a remarkable antibacterial activity against bacterial pathogens. Least or no activity was observed in the diethyl ether and ethyl acetate extracts. Acetone extract showed a maximum zone of inhibition against Staphylococcus aureus (16mm), Klebsiella pneumonia (15mm) and Proteus vulgaris (16mm) respectively. Ethanol extract exhibits maximum zone of inhibition against Streptococcus mutans (16mm) and Escherichia coli (13mm) respectively. Methanolic extract showed a remarkable zone of inhibition against Bacillus subtilis (12mm). Diethyl ether exhibits no zone of inhibition against all the clinical pathogens except Streptococcus mutans (11mm). Ethyl acetate extract exhibits no zone of inhibition against all the bacterial pathogens except Klebsiella pneumonia (8mm) and Escherichia coli (13mm).

Keywords: Antibacterial activity, Anaphyllum wightii Schott., Solvents, Streptomycin

Introduction

Infectious diseases have been recognized as one of the major intimidations to human health throughout the world. Most of them are caused by microorganisms such as bacteria, viruses, rickettsia, and fungi [1]. The search for substances with high antimicrobial activity has been one of the most intensive fields of research to minimize the risk of infectious diseases [2]. Plant extracts are major sources of many therapeutic agents including antimicrobial agents for the treatment of infectious diseases**.** Natural products contain a range of lead compounds which may enable the development of novel antimicrobial agents as conventional antimicrobial drugs become ineffective due to emergence of resistance. The secondary metabolites present in a medicinal plant may have different modes of antimicrobial action which helps to combat the emergence of resistance [3]. With the rising prevalence of microorganism showing resistance

to antibiotics, there is an urgency to develop new antimicrobial compounds. Since antiquity, plants have been used to treat common infectious diseases. The healing potential of many plants have been utilized by Indian traditional medicines like Siddha, Ayurvedha and Unani. Being nontoxic and easily affordable, there has been a resurgence in the consumption and demand for medicinal plants [4].

Pathogenic organisms are getting stronger and resistant to multi antimicrobial agents. This is the one of the reasons, why the research has to be continued to discover new antimicrobial compounds. The world is filled with numerous plants from which we can find many antimicrobial compounds which microbes are not exposed to. The present study was carried out to find the anti-bacterial activity of *Anaphyllum wightii* Schott. (Araceae), a rare medicinal plants leaves using disc diffusion method.

Materials and Methods

The leaves of *Anaphyllum wightii* was collected from Ponmudi, Kerala. Fresh leaves were washed thoroughly 2-3 times with running tap water and then with sterile water. Then it was shade dried, powdered and used for extraction.

Preparation of solvent extractions

The leaves were washed with clean water and air dried for five days. Then the leaves were powdered and stored in the airtight containers. 20gm of the leaves powder were suspended in 120ml of 98% ethanol and left for 2 hours. Therefore, the suspensions were filtered into sterile containers separately using Whatmann No.1 filter paper. The extracts were allowed to dry at a temperature of 40° C into powder. The powder of the extracts obtained were stored in sealed bottles and kept in a refrigerator at 4 °C until further use as per the method followed by [5].

Test Organisms:

The test microorganisms used for antibacterial analysis *Staphylococcus aureus Streptococcus mutans, Bacillus subtilis, Klebsiella pneumoniae, Proteus vulgaris* and *Escherichia coli* were purchased from Microbial Type Culture Collection and Gene Bank (*MTCC*) Chandigarh. The bacterial strains were maintained on Nutrient Agar medium (NA).

Nutrient Broth Preparation

Pure culture from the plate were inoculated into nutrient agar plate and sub cultured at 37ºC for 24 h. Inoculum was prepared by aseptically adding the fresh culture into 2 ml of sterile 0.145 mol/L saline tube and the cell density was adjusted to 0.5 McFarland turbidity standard to yield a bacterial suspension of 1.5×10^8 cfu/ml. Standardized inoculum Used for Antimicrobial test.

Antimicrobial Test

Antibacterial activity is determined using the disc diffusion method. The medium was prepared by dissolving 38 g of Muller Hinton Agar Medium (Hi Media) in 1000 ml of distilled water. The dissolved medium was autoclaved at 15 Lbs pressure at $121^{0}C$ for 15 min (pH 7.3). The autoclaved medium was mixed well and evenly distributed in petriplates (25 ml/plate) before solidifying. Then the plates were swabbed with Pathogenic Bacteria culture viz. *Staphylococcus aureus, Streptococcus mutans, Bacillus subtilis, Klebsiella pneumonia, Proteus vulgaris* and *Escherichia coli*. The sample loaded disc was then placed on the surface of Mullar-Hinton medium and the plates were kept for incubation at 37°C for 24 hours. At the end of incubation, inhibition zones were examined around the disc and measured with transparent ruler in millimeters. The size of the zone of inhibition (including disc) was measured in millimeters. The absence of zone inhibition was interpreted as the absence of activity [6]. The activities are expressed as resistant, if the zone of inhibition was less than 7 mm, intermediate (8-10 mm) and sensitive if more than 11 mm [7].

Results and Discussion

Natural products contain a range of lead compounds which may enable the development of novel antimicrobial agents as conventional antimicrobial drugs become ineffective due to emergence of resistance. The secondary metabolites present in a medicinal plant may have different modes of antimicrobial action which help combat the emergence of resistance [3].

The antimicrobial activity of various plants belonging to family Araceae has been reported by many researchers [8-11]. In the present study, antibacterial activity of leaves from *Anaphyllum wightii* was investigated against various bacterial pathogens like *Staphylococcus aureus Streptococcus mutans, Bacillus subtilis, Klebsiella pneumoniae, Proteus vulgaris* and *Escherichia coli*. The different solvents selected for the study were 4 polar and 1 non-polar solvent. Diethyl ether was the non-polar solvent, while acetone and ethyl acetate were the aprotic polar solvents and ethanol and methanol were protic polar solvents used in this investigation. In this study, *streptomycin* was used as a control. Antibacterial effect was determined on the basis of zone of inhibition. Antibacterial activity of *Anaphyllum wightii* leaves are shown in (Table. I); (Plate. I).

The present study revealed that, negative control had no antibacterial effect against the clinical isolates. Moreover the positive control showed maximum zone of inhibition against all pathogenic bacteria when compared to the all other leaf extracts.

Among the tested solvent extracts, acetone extract showed remarkable antibacterial

activity against *Staphylococcus aureus* cultures producing an inhibition zone of 16mm followed by methanol (13 mm) and ethanol (10 mm) extracts. Against *Staphylococcus aureus* diethyl ether and ethyl acetate extract exhibited no activity. Ethanolic extracts showed a significant zone of inhibition against *Streptococcus mutans* (16 mm) followed by methanol, diethyl ether and acetone extracts. Ethyl acetate extract exhibited no zone of inhibition against *Streptococcus mutans*. Previous findings stated that methanolic extracts of *Lawsonia inermis, Azadirachta indica* and *Achyranthes aspera* leaves exhibited antimicrobial activity against selected bacterial isolates [12]. Methanolic extract showed a maximum zone of inhibition against *Bacillus subtilis* (12 mm) cultures followed by ethanol and acetone extracts. There was no zone of inhibition produced by diethyl ether and ethyl acetate extract against *Bacillus subtilis*. *Klebsiella pneumoniae* showed a maximum zone of inhibition (15mm) in acetone extract and a lowest inhibition zone of (8 mm) in ethyl acetate extract (Plate. I). Diethyl ether extract exhibited no zone of inhibition against *Klebsiella pneumoniae.* Acetone extract showed a maximum inhibition zone of (16 mm) against *Proteus vulgaris* cultures, while no activity was noticed against *Proteus vulgaris* in diethyl ether and ethyl acetate extract. Ethanol and ethyl acetate extracts of leaves showed remarkable inhibitory zone (13mm) against *Escherichia coli*. No activity was noticed against *Escherichia coli* in the diethyl ether extract (Plate. I). Extracts with no antibacterial activity may have antibacterial properties against other bacteria that were not tested [13]. According to [14] negative results do not indicate the absence of bioactive constituents nor that the plant is inactive. Active compounds may be present in insufficient quantities in the crude extracts to show activity at the dose levels employed. Therefore, a lack of activity can only be proven at high doses [15]. Alternatively, if the active principle is present in high enough quantities, there could be other constituents exerting antagonistic effects or negating the positive effects of the bioactive agents [16].

Based on the previous literature, among the water-miscible solvents (acetone, methanol and ethanol) ethanol was the most effective solvent showed wide spectrum of antimicrobial activity against Gram +ve, Gram -ve bacteria [17]. Another study reported that the most active extracts were obtained, when methanol was used as solvent [18]. The present study further reports that acetone, ethanol and methanol extracts of *Anaphyllum wightii* (leaves) showed the remarkable antibacterial activity against the clinical isolates, while diethyl ether and ethyl acetate showed poor activity.

Table 1. Antibacterial activity of *Anaphyllum wightii* leaves

Sample Code	Bacteria Strains Name					
	Staphylococcus aureus (G+)	*Streptococcus mutans* (G+)	*Bacillus subtilis* (G+)	*Klebsiella pneumoniae* (G-)	*Proteus vulgaris* (G-)	*Escheric hia coli* (G-)
L.M	13 mm	11 mm	12 mm	10 mm	12 mm	11 mm
L.E	10 mm	16 mm	11 mm	14 mm	10 mm	13 mm
L.DE	-	11 mm	-	-	-	-
L.EA	-	-	-	8 mm	-	13 mm
L.A	16 mm	10 mm	11 mm	15 mm	16 mm	12 mm
PC	20 mm	20 mm	14 mm	17 mm	20 mm	15 mm
NC	-	-	-	-	-	-

*LM- Leaf Methanol, L.E Leaf Ethanol, L.DE- Leaf Diethyl Ether, L.A- Leaf Acetone, PC-

Positive Control and NC- Negative Control

Plates 1. Antibacterial activity of *Anaphyllum wightii* (leaves)

Staphylococcus aureus (G+)

Streptococcus mutans (G+)

Bacillus subtilis (G+)

Klebsiella pneumoniae(G-)

Proteus vulgaris **(G-)**
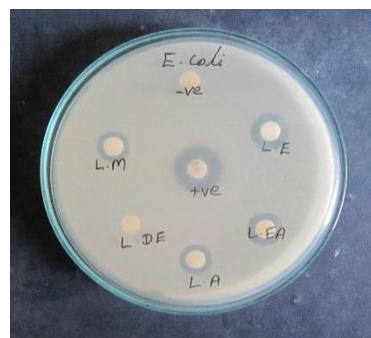
Eschorichea coli **(G-)**

The phytochemical constituents are responsible for the bioactivity of plant extracts. The type solvents has an important role in the process of extraction. The solvents used in the extraction procedure were found to have pronounced effect on the solubility of the antibacterial compounds.

Conclusion

The present study revealed that Acetone, Ethanol, and Methanolic extracts of leaves showed remarkable antibacterial activity against bacterial pathogens. The present results will form the basis for selection of this plant species for further investigation in the potential discovery of novel natural bioactive compounds.

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Morphological Differences and Medicinal Applications of three *Sansevieria* Species found in the Holy Cross College Campus, Nagercoil

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ABSTRACT

Sansevieria is a cosmopolitan genus that occurs in Africa, the Middle East, and the Asian subcontinent. The diversity in form is rather astonishing, ranging from tiny little plants, some with stout, spiky leaves and others with thin, flat ones, to formidable shrubs 2-4 m in height. This group of plants together within the genus Sansevieria are the similar flowers and seeds, but some believe that the flowers and seeds aren't so unique to exclude larger. Many species have water-resistant leaf fibres that are sometimes used in the manufacture of ropes and for bowstrings, and several are grown as ornamentals for their attractive foliage. This study aimed to describe the variations of Sansevieria species - Sansevieria trifasciata, Sansevieria cylindrica and Sansevieria roxburghiana based on morphological character.

Keywords: Sansevieria trifasciata, Sansevieria cylindrica and Sansevieria roxburghiana, Morphological character

Introduction

Morphological variation is the study of the physical form and external structure of plants. Morphological variation in plants is generally a feedback for the changing climatic conditions and reflects the adaptive evolution [1-3] while the soil factor has apparently shown to be a driving force to determine the morphological traits of plants [4,5].

Sansevieria is a genus of xerophytic perennial herbs occurring in dry tropical and subtropical parts of the world. It consists of about 70 species with a distribution ranging from Africa through Asia to Burma and the islands of the Indian Ocean [6,7].The habitats of *Sansevieria* are often described as open, sunny places, but frequently with subsurface soil availability. It also include termite mounds, river banks and rocky outcrops [8]. Some habitats mentioned by [9], such as sandy areas near seashore and uplifted coral plateaus.

Sansevieria is known variously as bow-string hemp, snake plant, zebra lily, mother in law's tongue, cow tongue, leopard lily, devil's tongue, good luck plant, etc. [10,11]. Members of *Sansevieria* are of great economic importance as ornamentals, as a source of fibre and as medicine for curing different ailments. *Sansevieria* species are among major foliage ornamentals mainly due to the variegated and mottled leaves [12] and the interesting wide variation in leaf shape. *Sansevieria trifasciata* Prain. is the most common species found

cultivated in gardens or pots, particularly *S. trifasciata* var *laurentii* (De Wild.) N.E.Br. The mottled, erect and stiff leaves of *Sansevieria* are used a great deal in artistic flower arrangements.

Sansevieria are a source of white strong elastic fibre commonly used in the manufacture of rope, fishing lines, cordage, fine matting, bowstring, and clothing [8]. In addition, [13-15] stated the use of *Sansevieria* fibre in making fine paper. *Sansevieria* species have horticultural value, *S. cylindrica*, *S. roxburghiana*, *S. zeylanica* are grown as ornamental plants. *Sansevieria* species are slow growing plants using the Crassulaceae Acid Metabolism (CAM) pathway. *Sansevieria* species are also used for a variety of medicinal purposes throughout the genus' geographical range.

Materials and methods

Plant materials:

The plants were collected from Holy Cross College (Autonomous), Nagercoil campus. They were sampled for study.

Sansevieria roxburghiana Schult

Sansevieria trifasciata Prain

Sansevieria cylindrica Bojer ex Hook

Morphological Variation and Medicinal importance:

Taxonomical Hierarchy of *Sansevieria trifasciata* Prain

Kingdom   : Plantae

Phylum   : Tracheophyta

Class   : Liliopsida

Order   : Asparagales

Family   : Asparagaceae

Genus   : *Sansevieria*

Species   : *trifasciata*

Distinguishing Features

Sansevieria trifasciata, commonly called snake plant or mother-in-law's tongue, is native to tropical western Africa. It is a stemless evergreen perennial that, with proper care, will last for many years. In its native habitat, plant foliage may rise to as much as 4' tall, but is often smaller (to 2' tall) on indoor plants. Erect, fleshy, sharply-pointed, sword-shaped leaves are deep green with light gray-green horizontal stripes. Leaves rise stiffly in a rosette from a thick rhizome. Small, fragrant, greenish-white flowers bloom on mature plants in spring, followed by orange berries. Flowers and fruit rarely appear on indoor plants. Leaves in each plant 2-6, much broader than thick, fleshy to rigidly coriaceous, dark green, with numerous very conspicuous, light or greyish-green, irregularly confined transverse bonds, in the normal form with a narrow dark green margin**;** large leaves linear-lanceolate, 40-175 cm × 2.5-9 cm, base channelled, margins entire, apex acute. Raceme erect, 40-75 cm long (peduncle included); flower-fascicles scattered or arranged group-wise; pedicel 6-8 mm long, articulated at about the middle; perianth 2.5-3 cm long, greenish-white, scented, divided just below the middle; lobes narrowly linear, broadening towards the greenish tip; stamens 7-8 mm long; style 15-18 mm long. Berry globose, 7-9 mm in diameter, orange, 1-2-seeded. Seed globular-ellipsoid, 6-7 mm × 5 mm, cream-brown. Rhizome sympodial, robust, yellowish-red.

Medicinal Uses:

The plant parts are used for the treatment of ear pain, swellings, boils, fever, ulcer, jaundice, pharyngitis, skin itches, urinary diseases, bronchitis, asthma and food poisoning. The plant is used to treat ringworm and fungal diseases. The leaf sap is applied directly on infected sores, cuts and grazes, it is also used to treat fungal and scabies infections [16].

It is also used for management of hypertension [17], anti-inflammatory treatment [18], thrombolytic activity [19], protection against carbon tetrachloride induced liver injury [20], anti-oxidant activities [21], antifungal properties [22], antiulcerative activity [23], analgesic and antipyretic activities [24], antidiabetic activity [25], treatment of corns [26], anthelmintic activity [27], antiallergic, anti-anaphylactic activity [28], antibacterial activities [29] and antimutagenic activities [30].

Taxonomical Hierarchy of *Sansevieria roxburghiana* Schult.

Kingdom	: Plantae
Phylum	: Tracheophyta
Class	: Liliopsida
Order	: Asparagales
Family	: Asparagaceae
Genus	: *Sansevieria*
Species	: *roxburghiana*

Distinguishing Features

Sansevieria roxburghiana Schult commonly called as Indian Bowstring Hemp, Bowstring Hemp. Found on rocky slopes, scrub jungles and hedges from plains to 1400m. It is a stemless evergreen perennial plant, producing fleshy, erect, rigid leaves 45- 75 cm or longer, and 2.5 cm wide, arising from a rhizome, leaves 6-24 over the life cycle, those of juvenile plants and the outer ones of a tuft spreading, others usually ascending; blade stiff, linear-oblong, 20-60 cm × 1-2.5 cm, deeply concave channelled down the face, rounded or slightly keeled on the back, margins entire and with age becoming narrowly whitish, apex tapering to a soft point, green, with transverse darker green rather regular bars on both sides and with 6-11 longitudinal dark green lines on the undersurface and often 1-3 on the upper. A fibre is obtained from the leaves. Raceme spike-like, 30-75 cm long (peduncle included), lower part with 4-5 erect acuminate sheaths 1-2 cm long; flowers 3-5 in a cluster; pedicel up to 8 mm long, jointed near the middle; tube 6-7 mm long; lobes linear, 8-9 mm long, greenish tinged with purple; stamens about 7 mm long, anthers dorsifixed; flower stalks 6 – 9 cm long, joined, ovary obovoid, 1.5 mm long, stigma simple, obscurely lobed. Berry globose, up to 6 mm in diameter.

Medicinal Uses

It has various traditional uses and recently various pharmacological uses are pursuing. Traditionally it is used as a cardiotonic, expectorant, febrifuge, purgative, tonic in glandular enlargement and rheumatism etc. The plant is known to possess antitumor, antibacterial, antidiabetic, antimicrobial, anticancer, antioxidant and analgesic activity.

The medicinal uses of *S. roxburghiana* Schult include treatment for abdominal pains, earache, diarrhoea and hemorrhoids traditionally, in treating ear aches and hemorrhoids, the leaf of this plant is heated and the warm juice is squeezed onto the affected area. The roasted leaves of *S. roxburghiana* Schult are used as an emollient. Root stocks are used as cough medicine in India. Juice of tender shoot is administered to children to clear their throats to clear

phlegm, as a febrifuge, tonic and purgative. In India, tender roots and rhizome are used as expectorant and in bone setting [31]. In viral diseases associated with nasal discharge, slightly warmed leaf juice is used as nasal drops [21].

Taxonomical Hierarchy of *Sansevieria cylindrica*

Kingdom	: Plantae
Phylum	: Tracheophyta
Class	: Liliopsida
Order	: Asparagales
Family	: Asparagaceae
Genus	: *Sansevieria*
Species	: *cylindrica*

Distinguishing Features

Sansevieria cylindrica, commonly called bowstring hemp, is a rhizomatous, succulent perennial native to tropical southern Africa. Mature clumps will reach up to 6' tall and spread to fill a 2' area. Will slowly form dense colonies from underground, spreading rhizomes. The grey-green leaves have variable, horizontal, dark green stripes and are cylindrical in shape, narrowing to a point at their tips. The leaves emerge from a fan-shaped rosette and can reach up to 6' tall and 1" wide. An upright, spike-like inflorescence will emerge from the center of the rosettes rarely if grown indoors or seasonally if grown in the ground outdoors. The inflorescences can reach up to 3' tall with 1" long, tubular, white blooms. Plants are sometimes grown in braided forms.

Medicinal Uses

The plant is effective against treatment for caries, small pox, snake bite, stomach cancer, inflammatory conditions, influenza, cough, ear pain, swellings, diarrhea, boils and fever and also this plant possess antihelmintic, antirheumatic, diuretic, laxative, vermifuge, antibacterial activity [32], antitrypanosomal activity [33], antioxidant and antidiabetic activities [34,35], antimutagenic effect [30], cytotoxic activity [36].

4. Other Benefits

1. Air-Purifiers

NASA recommended the *Sansevieria* species as air-purifiers. They clean the air from toxic substances, particularly benzene, formaldehyde, xylene and trichloroethylene. While cleaning the air, it also provides high levels of humidity and oxygen to the room. These properties of snake plants keep the surroundings clean and fresh.

2. Home Decor

The architectural and tall shaped leaves of these plant make it perfect for corners of the home and office. There are various kinds of snake plants; smaller ones like cylindrical or bird's nests are appropriate for an office desk or darker areas of the house.

3. Drought Tolerant

These plants require very less water. Overwatering is the major cause of its death. It is a high drought-resilient plant, even in summers. They are ideal to have, even if you are facing scarcity of water or in offices where regular watering can be difficult.

4. Grows in a Wide Range of Humid Conditions:

Sansevieria species can grow in a wide range of humid conditions. They do well in humid climates such as bathrooms and drier ones in the office. When placed in a humid environment, waterless and have extra drainage to reduce stagnant water. In dry areas, water deeply and more but only between soil drying.

5. Easy to Propagate

Every species of snake plant is easy to propagate. There are two ways of propagating the plant: leaf cut/rhizome cut. Cut the rhizomes (offset) as close to the stem as possible. Leave them in a glass jar with water to develop bigger roots, and then plant them in a pot with good drainage. Similarly, you can place the leaf-cutting in the glass jar to develop roots and then plant it or plant the leaf directly in the pot.

6. Symbolic of Good Virtues

It is believed that the first plant from this species was cultivated in China and was greatly treasured by the nurturers for its symbolism. The one who cares for the plant is granted eight virtues of longevity, prosperity, intelligence, beauty, art, health and strength.

7. Effective for Allergies

It absorb carbon dioxide and toxin particles from the air while releasing oxygen into the air. When you breathe fresh air, there are fewer chances of developing allergies and airborne diseases. Thus snake plant naturally decreases the onset of allergies.

8. Low-Maintenance

These plants are low-maintenance plants. They can thrive without water and sunlight. They are the best low-maintenance plants you could nurture. Place them in any condition, and it would bless you with its rare beauty and air-purifying properties.

9. Absorbs CO₂ at Night

It reduce CO_2 levels at night by absorbing it. It is because of Crassulacean Acid Metabolism (CAM), the capability to perform a certain type of photosynthesis that drought-tolerant, succulent plants like *Sansevieria trifasciata* perform.

10. Anti-Cancer plant

As you have come to know that plants from *Sanseviera* species clean the environments of cancer-causing agents like toluene, xylene, benzene, formaldehyde make it an effective anti-cancer plant

Conclusion

The morphological variation gives the comparitive physical form and external structure of plant. Morphological variation is commonly influenced by genetic variation, environmental variation, or the interactions between them. The present study depicts that there is a variability in terms of morphology among the three species. The primary causes of this variation is may be due to positional effects, environmental effects, and juvenility.

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Ethnobotanical uses of *Mukia madraspatana* (L.) Roem Leaves

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ABSTRACT

Mukia madraspatana (L.) Roem, belonging to the family Cucurbitaceae and has been used as a traditional medicine and also as wild edible greens. Leaves, stem, fruits and roots were reported to be used as a functional vegetable and to treat various diseases among various communities. It is an important medicinal plant for its numerous medicinal values in the field of Ayurveda, Siddha, Naturopathy and Folkloric traditional medicines in India as well as the Indigenous medical systems of the Sub-Saharan African, Asian and Australian communities. This plant is locally known as Musumusukkai, it is an annual monoecious, prostrate climber with tendrils and is densely covered with hairs. The present study gives information about the ethnobotanical uses of M. maderaspatana leaves.

Keywords: Ethnobotany, Mukia maderaspatana (L.) Roem, Herbal medicine

Introduction

Plants are one of the most important sources of medicines. *Mukia maderaspatana* is a popular herb used in the Siddha and Ayurveda medicines. It is commonly found on the road sides, railway lines in and around Tamil Nadu. *M. maderaspatana* is an annual monoecious, mostly prevalent in south India, belonging to the family Cucurbitaceae. *M. maderaspatana* is one of the important herb used by the ancestors that repel monsoon diseases. It is also found in tropical Africa, tropical Australia and tropical Asia[1].

Synonyms: *Cucumis maderaspatanus* (L.), *Melothria maderaspatana* (L.)Cogn., *Melothria altaeoides* (Ser.), *Mukia althaeoides* (Ser.) (M.Roem.), *Mukia rottleri* (M.Roem.), *Mukia scabrella* (L.) (Arn.), *Trichosanthes dioica* (Wall.), *Bryonia althaeoides* (Ser.), *Bryonia callosa* (Rottler.), *Bryonia gracilis* (Wall.), *Bryonia hispida* (Salisb.), *Bryonia maderaspatana* (L.), (Lam.), *Bryonia micrantha* Hochst (Cogn.), *Bryonia micropoda* (E.mey.), *Bryonia rottleri* (Spreng.), *Bryonia scabra* (Rottler.), *Bryonia scabrella* (L.)

Vernacular Names:

English	: Madras pea pumpkin
Tamil	: Musumusukkai
Malayalam	: Mushumushka
Telugu	: Musumusukaya
Kannada	: Chitrati

Marathi	: Bilavi
Urdu	: Musmusa

Collection of plant

Mukia maderaspatana (L.) M. Roem was collected from Marthandam, Kanyakunari district of Tamil Nadu, India. The leaves were separated, washed thoroughly and shade dried. Herbariums were prepared and deposited in the Botany Department Herbarium, Holy Cross College (Autonomous), Nagercoil, Kanyakumari District Tamil Nadu.

Description of the plant

The plant is prostrate or climbing in habitat. Leaves are symmetrical, ovate, angularly shallow to deeply 3-5 lobed, and 3-9 cm long. Flowers are pale to bright-yellow, male and female are in same axil, male flowers are pedicellate, female flowers are sessile. Fruit is berry, round shaped, hairless, and smooth. Pea-sized fruits are green, turning to orange and then red, as they mature. Seeds are grey or light black, ovoid-oblong, compressed, somewhat wrinkled, and scrobiculate. Flowering and fruiting period is from July to October.

Botanical Classification

Kingdom	: Plantae
Division	: Spermatophyta
Sub-division	: Angiospermae
Class	: Dioctyledonae
Sub-Class	: Polypetalae
Series	: Calyciflorae
Order	: Passiflorales
Family	: Cucurbitaceae
Genus	: *Mukia*
Species	: *maderaspatana*

Geographical distribution of *Mukia maderaspatana*

It is globally distributed throughout the tropics and subtropics. It was found in India at hilly region and in Sri Lanka, mainly in Maharashtra, Kerala, Karnataka, and Tamil Nadu. It is in deciduous forests.

Ethnomedical uses of leaf of *Mukia maderaspatana*

Leaves, stem, fruits and roots are reported to be used as a functional vegetable among various communities[2]. In Kanyakumari district, the leaves are abundantly used as greens, when compared to the usage of other parts as medicine it is consumed in the form of decoction. Leaf-extract is consumed internally to cure piles [3,4] and consumed orally to get relief from

cold and cough [5]. Leaf decoction is consumed orally to treat piles by the Irula tribal community in Walayar valley of Coimbatore district, Southern Western Ghats, India. For the treatment of piles, the Irula healers prepared the herbal medicine by mixing *Curcuma aromatica* and Coconut oil with *M. maderaspatan* [6].

   M. maderaspatana leaves are rich in protein, fiber, iron, calcium and vitamin C. Plant could be used as a diuretic, anti-anaemic, anti-oxidant etc., to the patients is due to the presence of a significant number of minerals present in them, like calcium (5.13%), magnesium (3.19%), flavonoids (2.56 mg/kg) and manganese (14.20 ppm) [7]. It is a boon for those suffering from tuberculosis, if taken continuously the disease will be cured. It can also cure respiratory related diseases. According to Siddha literature, the root and leaf powder is used to treat fever, dyspnea, abdominal disorders, hepatic disorders, cough and vomiting. The leaf decoction is given to hypertension and nasobronchial diseases [8]. *M. maderaspatana* leaves are pounded and the juice was mixed with ghee and used as scalp oil before head bath. It is one of the important ingredient in the preparation of hair oil. The active ingredient of Siddha preparation Kaphamarunthu is also *Mukia* leaves [9].

   The Ayurveda medical system prescribes the leaves and root of *M. maderaspatana* for asthma, cough, burning sensation, dyspepsia, flatulence, colic, constipation, ulcer, neuralgia, nostalgia, odontalgia and vertigo [10]. The leaves of *M. maderaspatana* are also known to remove phlegm, cure cough, indigestion and common cold. Leaves, stem, fruits and roots of *M. maderaspatana* are reported to be used as a functional vegetable among various communities [11,12,13]. *M. maderaspatana* leaves mixed with Tulsi leaves is used to prepare juice and given orally 3-4 tsp, 4-5 day in water to adults and one tsp for children for a week for the treatment of fever, cough, vomiting, common cold, throat infection, respiratory disorders in Bidar district of Maharashtra [14]. The extract of the leaves and bark of *M. maderaspatana*, is reported to be a good decongestant and a very good remedy for cough, cold and flu [15]. It is very useful for people with respiratory related disorders. As reported in Ayurvedic literatures various illness like toothache or flatulence, can be treated with *Mukia madaraspatana* as an expectorant and a sudorific. Certain traditional medical practitioners also use the tea of this plant leaves for alleviation of jaundice. In Manipur, the local Maibas, consume shoot, leaves and seeds to treat jaundice, vertigo and biliousness and also to treat dog bite [16,17].

   Paliyar tribals of Theni district in Tamil Nadu consume internally the leaf juice of *M. maderaspatana* to cure flatulence [18]. Similarly leaf juice is consumed by Kani Tribes in Agasthiayamalai to treat Giddiness [19]. The leaf juice of this plant is mixed with gingelly oil and applied topically on the head before taking bath to cure asthma [20]. Asthma and allergy

are cured using the leaf extracts by the local people of Villupuram district [21].

In traditional medical practice of Tanganyika in Africa the leaf-sap is used as a wound-dressing; leaves in poultice for burns and the sap is given to younger children to treat amoebiasis. Dried and powdered leaves are reported to be dusted over scabies and the plant-ash mixed with castor oil, is rubbed over scarification and the temples to relieve headache [22,23].

In Gujarat, the local tribes use the leaf paste on ulcers [24]. In Andhra Pradesh, the leaf-paste is applied to head before the bath twice or thrice a week to control dandruff [25]. Paniya, Kuruma and Kattunaikka tribes of Wayanad District in Kerala, use leaves and young fruit to treat ulcer and urinary complaints [26]. In Tamil Nadu the leaf powder of this plant is mixed with boiled rice and taken orally to treat cold and cough by traditional healers of Kanchepuram district [27].   Fresh, ground leaf-paste is applied externally to treat scabies and ringworm infection by Malayali tribe of Vattal Hills, Dharmapuri District [28]. Leaf extract is used against pitha disease and also the leaf juice, mixed with food is given for body stimulation by villagers of Dharapuram Taluk [29].

Conclusion

The herbal medicine reflects the revival of interest in traditional folk medicine. Different parts of the plant have been used traditionally to cure many illnesses. The medicinal potential of *M. maderaspatana* leaves was very high. The medicinal knowledge of the plant points to a great potential for research and the discovery of new drugs to fight diseases, obtaining new foods and other new uses. So, further scientific evaluation of this plant at the phytochemical, molecular and clinical studies is however needed.

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Natural Dyes for Colouring Cotton and Silk Fabrics

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ABSTRACT

Application   of dyes or pigments on textile materials   such   as fibers, yarns,   and wool with the goal of achieving color with desired color fastness is one of the oldest technique man has discovered,   however synthetic dyes have found its way in the present day. . Dyes from plants are one of the most unique uses of the plants. In the present study   various ranges of dyes extracted from the flowers of plants like, Hibiscus rosa-sinensis L., Impatiens balsamina L. rhizome of Curcuma longa L., leaves of Lawsonia inermis L., and fruits of Rivina humilis L., were used for coloring cotton and silk fabrics. Results showed that cotton fabric exhibited   good natural dye retaining capacity when compared to silk fabric.

Keywords: Cotton, Dye, Extract, Fastness, Mordant, Silk

1. Introduction

Nature has gifted us with many dye yielding plants. Use of natural dyes has been growing rapidly due to the harmful effects of synthetic dyes. Moreover, many countries already have imposed rigorous environmental rules over these dyes.   Germany has banned the azo dyes (synthetic dye) [1]. In this situation, a higher demand is put towards the greener alternatives or agricultural residues [2]. Using natural dyes in the coloration process in textile industry can be a step towards a new era of less polluting processing of fabrics [3]. Vegetable products were used in dye extraction such as onion –outer shell, red beetroot, orange rind, pomegranate rind, banana peel used by the people of South American, African and Asian countries [4,5,6]. Above all, they are eco friendly and can be recycled after use. The objectives of the present study are i) to extract dye from local plants. ii) to study the dye ability of silk and cotton using different mordants. iii) to study the fastness properties of these dyes on silk and cotton fabrics.

2. Materials and Methods

2.1. Collection of plant material

The flowers of *Hibiscus rosa-sinensis* L., *Impatiens balsamina* L. rhizome of *Curcuma longa* L., leaves of *Lawsonia inermis* L., fruits of *Rivina humilis* L. wereused to extract dye. The plant specimens were identified with the help of local and regional floras [7,8]. Inorder to check the spelling, eliminate the use of older synonyms and ensure uniform nomenclature all plant names were verified using [9].

2.3. Dye Extraction

The collected plant materials used for extraction of dye. The cleaned samples (50g) were crushed and then boiled with 100 ml of water for 30 mins in a hot water bath for quick extraction of dyes. At the end of 30 minutes, the total color was extracted. The hot solution was filtered and a clear solution was obtained which is used for dyeing cotton and silk fabric. [10]

2.4. Dyeing materials

Cotton and silk fabrics were used to test the dyeing ability of plants dyes.

2.5. Preparation of Mordant

2.5.1. Alum

0.748g of Alum and 0.187g of washing soda were mixed in 100ml of water and was stored for further use.

2.5.2. Vinegar

50 ml of 5% acetic acid is mixed with 100ml of water. From this, 25ml was taken and mixed with 100ml of distilled water.

2.5.3. Salt

5 g of Sodium chloride was mixed in 100ml of distilled water and was used as a mordant and stored for further use.

2.6. Premordant Dyeing

Sodium chloride, vinegar and alum were used as mordants. The extracts obtained were filtered and used for dyeing fabric material. The fabric materials used for dyeing were first washed with clean water. Then the fabric materials were transferred to fixative (mordants)- 100ml salt/ 125 ml vinegar/100 ml alum and allowed to boil for one hour at 100° C. The fabric material was simmed in the fixative for at least an hour. The fixed fabric was immersed in the extracted plant dye. It was then boiled and simmed until the fabric takes up the dye at least for an hour. After an hour, the fabric is carefully pulled out from the simmering fixative and is squeezed out completely. The fabric is then placed on the newspaper or tile to dry. The shade dried fabric were further evaluated for its light, rub and wash fastness. Wash fastness was tested by washing with soapy water (Jihad, 2014). [11]

2.7. Evaluation of Colour Fastness

Colour fastness of the dyed fabric samples was determined as per ISO: 105-A02 – 1995 method using a launder-O-meter following IsO-3 wash fastness method. The wash fastness rating was assessed using grey scale as per ISO-105-A02 (loss of shade depth) and ISO-105-AO3 extent of staining. Colour fastness to rubbing (dry and wet) was assessed by hand rubbing the fabric one sample ten times and grey scale as per ISO-105-AO3 extent of staining.

3. Results and Discussion

In the present study, the plant dyes yield bright colour shades when dyed in silk and cotton fabrics. The flowers of *Hibiscus rosa-sinensis* produced red colour extract and on dyeing, it produced an orange red to violet shades on different textile material studied. Among the mordants used, the best colour developed was in alum which gave dark violet colour in cotton. The salt and alum treated dyes were tolerant to washing and showed good light and rub fastness. The red-colored dye extracted from *Impatiens balsamin*a flowers gave different shades of pink and brown colors on the selected fabrics. Vinegar and alum treated fabrics showed good washing, rubbing and light fastness than the mordant salt.

Table 1. Plants that yielded substantive dyes

Sl. No	Binomial name	Family	Dye yielding plant part
1	*Curcuma longa* L.	Zingiberaceae	Rhizome
2	*Hibiscus rosa-sinensis* L.	Malvaceae	Flowers
3	*Impatiens balsamina* L.	Balsaminaceae	Flowers
4	*Lawsonia inermis* L.	Lythraceae	Leaves
5	*Rivina humilis* L.	Phytolaccaceae	Fruits

The *Rivinia humilis* fruits yield a light red color dye. Various shades of brown were observed in both cotton and silk materials. The leaves of *Lawsonia inermis* yielded a brown colored dye. Various shades of brown color were imparted in cotton and silk fabrics, but there is no color developed in silk treated with salt and vinegar except alum treated cotton cloth exhibited coffee brown shade. Good fastness observed in cotton treated with alum. Similar findings were recorded by [12]. The process is economically viable as the raw materials are available at low cost and so cost of production is also very low. Similar findings were reported in marigold, China rose and *bixa* flower [13].

Tabl 2. Plant synthesized color dyes using different mordants

Sl. No	Binomial name	Family	Dye yielding plant part	Fabric material	Vinegar	Sodium chloride	Alum
1	*Curcuma longa* L.	Zingiberaceae	Rhizome	Cotton	Dark yellow	Yellow	Yellow
				Silk	yellow	Shining yellow	Shining yellow
2	*Hibiscus ros a-sinensis* L.	Malvaceae	Flowers	Cotton	Red	Red	Dark blue
				Silk	Light red	Shining red	Light blue

3	*Impatiens bal samina* L.	Balsaminaceae	Flowers	Cotton	Pink	Pink	Light pink
				Silk	Light pink	Light pink	Pale pink
4	*Lawsonia ine rmis* L.	Lythraceae	Leaves	Cotton	Greenish brown	orange	brown
				Silk	Pale greenish	Light orange	Light brown
5	*Rivina humili s* L.	Phytolaccace ae	Fruits	Cotton	Pink	Dark pink	Pinkish yellow
				Silk	Light pink	Shining pink	Pale yellow

Based on the results an observation made that the cotton fabric material developed good colours with alum, vinegar and sodium chloride mordants when compared to silk fabric material [14]. These mordants when added to the dye gave different shades of color and thus enable us to make different types of shades from one plant using the mordant. The mordants alum and cream of tartar is directly added to the dye, whereas, in case of vinegar and salt the cloth is treated with those mordants and then it is immersed into the dye. This gives better results than directly adding the mordant into the dye. Some plants may have more than one color dependent upon which part of the plant one uses. Dyes don't combine directly with the substance they are intended to color. A mordant is required to make the color hold. Mordants are materials that cause the natural dyes to bond chemically with the cloth, preventing the color from either fading with exposure to light or washing out [15]. Mordant dyes are acid dyes having chelating sites to form stable coordination complex with metal ions from metal salts (mordants). Dyes can form chelates with different mordants to develop various shades with superior wash fastness [16].

3.1. Fastness results

Wash, light and rub fastness tests were conducted to determine whether the identified dyes would withstand washing and drying when used to color everyday clothes. Color Fastness is one of the important tests for fabric material as proper dyeing will impart good wash, rub and light fastness properties [17].

Table 3. Colour fastness of dyed fabrics using Nacl as mordant

Sl. No	Binomial name		Fastness											
			Wash fastness				Light fastness				Rub fastness			
			1	2	3	4	1	2	3	4	1	2	3	4
1	*Curcuma longa* L.	Cotton				✓				✓				✓
		Silk				✓				✓				✓

Sl. No	Binomial name		Wash fastness				Light fastness				Rub fastness			
			1	2	3	4	1	2	3	4	1	2	3	4
2	*Hibiscus rosa-sinensis* L.	Cotton			✓					✓				✓
		Silk			✓					✓				✓
3	*Impatiens balsamina* L.	Cotton		✓					✓					✓
		Silk		✓					✓					✓
4	*Lawsonia inermis* L.	Cotton		✓					✓					✓
		Silk		✓					✓					
5	*Rivina humilis* L.	Cotton	✓						✓					✓
		Silk	✓						✓					✓

Table 4. Colour fastness of dyed fabrics using vinegar as mordant

Sl. No	Binomial name		Fastness											
			Wash fastness				Light fastness				Rub fastness			
			1	2	3	4	1	2	3	4	1	2	3	4
1	*Curcuma longa* L.	Cotton				✓				✓				✓
		Silk				✓				✓				✓
2	*Hibiscus r osa-sinensis* L.	Cotton			✓					✓				✓
		Silk			✓					✓				✓
3	*Impatiens balsamina* L.	Cotton		✓					✓					✓
		Silk		✓					✓					✓
4	*Lawsonia inermis* L.	Cotton		✓					✓					✓
		Silk		✓					✓					✓
5	*Rivina hu milis* L.	Cotton	✓						✓					✓
		Silk	✓						✓					✓

Table 5. Colour fastness of dyed fabrics using alum as mordant.

Sl. No	Binomial name		Fastness											
			Wash fastness				Light fastness				Rub fastness			
			1	2	3	4	1	2	3	4	1	2	3	4
1	*Curcuma longa* L.	Cotton				✓				✓				✓
		Silk				✓				✓				✓
2	*Hibiscus rosa-sinensis* L.	Cotton			✓					✓				✓
		Silk			✓					✓				✓
3	*Impatiens b alsamina* L.	Cotton		✓					✓					✓
		Silk		✓					✓					✓
4	*Lawsonia i nermis* L.	Cotton			✓				✓					✓
		Silk			✓										✓
5	*Rivina hum ilis* L.	Cotton	✓						✓					✓
		Silk	✓						✓					✓

3.2. Washing fastness

Most natural colors were found to show market acceptable wash fastness. It was however observed that fading was more or greater for the fabrics with the solid detergents probably due to the presence of bleaching agents in the detergents and the selectively higher pH of the solutions of the solid detergents. More importantly, fixing the dyes with detergents gave us an insight regarding the dye-detergent relationship. That is an intense shade was developed after the fabric was brought to the fastness testing. This may be due to the instability of the dye molecules, which resulted in a change of shade and colour strength on the fabrics once the dyes were exposed to the conditions used in the fastness testing [18]. The results of washing and light fastness of the dyed fabrics are shown in table 3.Variable color shades were formed on both silk and cotton fabrics after fastness tests. *Curcuma longa* gave excellent(4) wash fastness in all the mordants *Hibiscus rosa-sinensis* recorded a good(3) wash fastness on both cotton and silk in the selected mordants. *Impatiens balsamina* gave a weak(2) result in vinegar, sodium chloride and alum mordants. *Lawsonia inermis* exhibited a good (3) wash fastness result in alum and weak (2) result in sodium chloride and vinegar. *Rivina humilis* recorded a poor (1) wash fastness result in all the mordants

3.3. Light fastness

The mordants vinegar and alum mordanted samples dyed with *Curcuma longa* and *Hibiscus rosa-sinensis* showed excellent (4) light fastness on both cotton and silk fabrics. *Impatiens balsamina*, *Lawsonia inermis* and *Rivina humilis* showed good (3) light fastness results in the three mordants. The salt, alum and vinegar treated dyes were tolerant to washing and showed good washing fastness. It also had a good light and rub fastness.

3.4. Rub fastness

In dyed and printed textile materials the unfixed dye particles are mechanically held on the surface and these particles are rubbed off easily on the wearer skin or any other cloth of contact. So it is necessary to determine the rubbing fastness of dyed or printed textile materials.

In the present study, dyed fabrics from all the plant materials *Curcuma longa, Hibiscus rosa-sinensis*, *Impatiens balsamina*, *Lawsonia inermis* and *Rivina humilis* recorded good (3) and excellent(4) results with all the three mordants in rub fastness test. All the mordants showed moderate washing, rubbing and light fastness except the silk treated with vinegar showed poor fastness. *Curcuma longa* and *Hibiscus rosa –sinensis* dyes show no change in colour after wash fastness test, indicating their ability to withstand laundering. This suggests their viability as dyes for colouring everyday clothes. Findings of [19] too are concordant with those of the present study. Fastness test has been observed that the washing

conditions also cause shade changes on dyed fabrics [20].

4. Conclusion

In the present study of various ranges of dyes extracted from ten plant materials. *Curcuma longa*, *Hibiscus rosa-sinensis*, *Impatiens balsamina*, *Lawsonia inermis* and *Rivina humilis* were the plants used for the extraction of dyes. Nacl, vinegar and alum are mordants used as fixatives of dyes. Plant parts like bract, flower, peel rhizome and leaf were used for extracting dyes. Fabrics like cotton and silk were used for dyeing. *Curcuma longa* and *Hibiscus rosa –sinensis* dyes show no change in colour after wash fastness test.   In the present study, the peel of The leaves of *Lawsonia inermis* yield a brown colored dye. Various shades of brown color were observed in cotton and Silk fabrics, but there is no color developed in silk treated with salt and vinegar except alum treated cotton cloth exhibited coffee brown shade .Good rubbing, light and wash fastness observed in all the three mordants. Dark yellow colour shades were obtained from a yellow dye extracted *Curcuma longa*. All the ten plants dyes show excellent results in rub fastness test. Cotton fabric shows good retaining capacity of natural dye when compared to silk fabric. Colour yields were found to be influenced by the addition of mordants. Alum and vinegar treated fabrics shows good retaining capacity and shows bright colours in the dyed cloths. This study is a key of searching the alternative to satisfy the consumers growing demand of eco-friendly products and progress has been made with this study in use of plant dyes. Thus on the basis of the results, it can said that plant dyes used in the present study for dyeing have good scope for application on cotton and silk fabrics.

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Herbal Cosmetics for Self-Beautification

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ABSTRACT

Beauty is the desire of every individual to give pleasure to the sense. Herbal cosmetics allow every individual to feel beautiful, healthy, charming and young about them. The isolated compounds from the herbal plants like Coconut, Aloe-vera, Lemon, Shikakai, Henna, Gooseberry, Soap nut, Coffee, Sugarcane, Rice, Ginger, Pepper, Cucumber, Castor, Beetroot and Rice were studied for their skin and hair care effects and mild adverse reaction such as itching is observed when using Aloe vera gel. The results obtained from the study, proved that herbal cosmetics are safe, highly effective with moisturizing effects and free from side effects, due to the presence of rich source of vitamins and minerals. They have anti-aging, anti-fungal, anti-dandruff, anti-bacterial, anti-septic, anti-inflammatory, anti-oxidant, insect repellent, wound healing, skin protection, revitalizing and rejuvenating agent. The present study revealed that herbal cosmetics are very safe and does not produce any toxic effect compared to synthetic cosmetics products. So, this study suggests that herbal cosmetics can be used regularly to avoid skin and hair problems.

Keywords: *Herbal cosmetics, herbs, skin care, hair care.*

1. Introduction

Natural beauty is blessing and cosmetics help in presenting and increasing the beauty and personality aspects of human beings. Cosmetics are the substances is to be applied to the human body for cleansing, beautifying, promoting attractiveness, and altering the appearance without affecting the body's structure or functions. The word cosmetic was derived from the Greek word "komatiks" meaning having the power, arrange, skill in decorating. Various synthetic compounds, chemicals, dye are proved to cause various skin diseases having numerous side effects [1].

Currently, a popular trend is back to the nature and using herbs as the main ingredient of skin care formulations due to natural ingredients are more bio compatible to the body than synthetic materials. Plants as one of the natural sources of cosmetics ingredient can be used to synthesize some useful inorganic materials that is usually called as green synthesis [2]. In India, the use of cosmetics comes from the earliest times in the medical arts and cosmetics in India. Indian women have long used herbs such as sandal wood and turmeric for skin care and henna to treat hair loss, saffron, use of rose water, attar sandals were common in the early

period. The use of betel leaves to darken the lips, vermilion and other colors with crayons for their caste face appointments, attach almonds to the whole body instead of gift and the use of perfumes and aromatics in all religious and social times has been very common since ancient times [3].

In present situation, the uses of herbal products and cosmetics have increased significantly. Society is reverting back towards natural products for food, medicine or cosmetics. Above 30% of the worlds sales of drugs are based on natural products. Herbal cosmetics are made by herbs which are easily available from nature; they are free from all the harmful synthetic chemicals. Although herbal cosmetics prepared by naturally available plant parts and plant extracts, they may as effective as synthetic product. Herbs do not produce instant cures. They offer a way to put the body in proper tune with nature [4].

2. Materials and Methods

2.1. Collection of Cosmetic Material

For the preparation of various herbal cosmetics, plant materials are collected from their natural habitats and a few from local herbal merchants. The collected plants are authentically identified using '*The Flora of Presidency of Madras*' [5]. Among the collected plants, some plant parts are used after drying and some plant parts extracted for preparation.

2.2. Preparation of *Aloe vera* gel: Take a fresh leaf of *Aloe vera* and wash it thoroughly. Keep it stand for 10-20 minutes until the yellow fluid is released. After this process, rinse is thoroughly. Scoop the gel from the leaf, and put it in a blender. Blend thoroughly until the gel becomes smooth. Add some lemon juice and oil of vitamin E capsule to preserve the gel. Aloe vera gel is ready to use.

2.3. Preparation of henna hair dye: Mix two tablespoon of dried powdered henna and one tablespoon of shikakai powder, soap nuts powder and amla powder. While applying, add a sufficient amount of water to make a paste. Let this paste stand overnight and in next morning, add one egg and a tablespoon of curd. Apply this mixture all over the hair and scalp and wash it off with lukewarm water after 40-45 minutes.

2.4. Preparation of face scrub Take ½ cup of fresh coffee powder and add ½ cup of coconut oil and mix it well. Now gently scrub the mixture over the face and leave it for 5-10 minutes. Then rinse it thoroughly. Then scrub apply on the face and gentle massage is recommended.2.5. Preparation of face spray: Take ¼ cups of rice grains. Wash it well with water. After washing, transfer it to another utensil. Add 1 cup of water. Take a lemon and remove the peel alone. Add it to the utensil containing rice. Cook on low medium heat for about 10 minutes. After 10 minutes, let it cool down and strain.

2.6. Preparation of *Aloe vera* oil: Take a fresh leaf of *Aloe vera* and wash it well. Keep it stand until the yellow comes out. Then scoop the gel from the leaf and put it on a blender along with this and add ginger. Blend it to a fine paste. In a heavy kadai, pour this mixture along with coconut oil and boil well. Meanwhile, add pepper to the hot boiling mixture. After boiling, filter the mixture. Now *Aloe vera* gel is ready to use. Then apply your face, skin and hair.

2.7. Preparation of cucumber cream: Grate the cucumber well. Extract the juice from the grated cucumber. Take 2 scoops of aloe vera gel and mix the juice with the gel well. Then add coconut oil with this mixture and melt it with double boiler method. Keep this mix aside to get cooled. Finally, add vitamin E capsule oil and mix well. Scratch it. Mix ghee with this residue. Kajal is ready.

2.8. Preparation of kajal: Earthen lamps are lighted using castor oil. A vessel is kept upside down at the top of the lamp. Keep it for some hours. Ashes of the lamp are obtained. Scratch it. Mix ghee with this residue.

2.9. Preparation of lip tint: Take some coconut oil in a little bottle. Add 1 tsp of glycerine to it. Mix it well.Add a little beetroot powder to this mixture and stir well.

1.10. Preparation of hair serum: Take 1 cup of rice in a bowl. Add 2 cups of water to it. Allow to settle for 24 hours. Strain the water and keep it separately. Add natural *Aloe vera* to the rice water and mix well.

2.11. Preparation of beetroot night gel: Grate the beetroots and extract juice from it. Boil the juice well to get a concentrated juice of it. To this, add a drop of glycerin to it and mix well. Then add aloe vera gel and vitamin E capsule to it and mix well. Apply this cream on face before sleeping.

Table 1. Formulations of Herbal cosmetics

Botanical Name	Family	Common Name	Local Name	Quantity
1. *ALOE VERA* GEL				
Aloe vera	Asphodelaceae	Aloe gel	Chottukatali	1 no.
Citrus limon	Rutaceae	Lemon	Elumichai	1 no.
2. HENNA HAIR DYE				
Acacia concinna	Fabaceae	Hair fruit	Shikakai	25 gm
Lawsonia inermis	Lythraceae	Henna	Maruthani	50 gm
Phyllanthus emblica	Phyllanthaceae	Gooseberry	Nellikai	25 gm
Sapindus emarginatus	Sapindaceae	Soap nuts	Soapukai	25gm
3. FACE SCRUB				
Cocos nucifera	Arecaceae	Coconut Oil	Thengai	¼ cup
Coffea arabica	Rubiaceae	Coffee	Coffee	¼ cup
Saccharum Officinarum	Poaceae	Sugarcane	Karumbu	¼ cup
4. FACE SPRAY				
Oryza sativa	Poaceae	Rice	Nel	1 cup
Citrus limon	Rutaceae	Lemon	Elimichai	1no.
5. ALOE VERA OIL				
Aloe vera	Asphodelaceae	Aloe	Chottukatralai	1-2 no.
Zingiber officinale	Zingiberaceae	Ginger	Inji	1-2 no.
Piper nigrum	Solanaceae	Pepper	Nallamilagu	10-15 no.
Cocos nucifera	Arecaceae	Coconut	Thengai	50ml
6. CUCUMBER CREAM				
Cucumis sativus	Cucurbitaceae	Cucumber	Vellarikai	1no.
Aloe vera	Asphodelaceae	Aloe	Chottukatali	3 tsp
Cocos nucifera	Arecaceae	Coconut	Thengai	2 tsp
7. KAJAL				
Ricinus communis	Euphorbiaceae	Castor	Amanaku	2 tbsp
Ghee				
8. LIP TINT				
Cocos nucifera	Arecaceae	Coconut	Thengai	3 tsp
Beta vulgaris	Amaranthaceae	Beetroot	Chenkilangu	1no.
9. HAIR SERUM				
Oryza sativa	Poaceae	Rice	Nel	1 cup
Aloe vera	Asphodelaceae	Aloe	Chottukatali	1No.
10. BEETROOT NIGHT GEL				
Beta vulgaris	Amaranthaceae	Beetroot	Chenkilangu	1no.
Aloe vera	Asphodelaceae	Aloe	Chottukatali	3 tsp

Results and Discussion

Herbal cosmetics are the preparations used to enhance and improve the human appearance. The aim of this research is to prepare cosmetics which are good for our skin and hair. Compared to synthetic products, herbal products are safe to use. Herbal ingredients are preferred over chemical substances because of their easy availability and least side effects. The beginning of 21st century has seen significant progress in the herbal industry. Natural beauty is a boon and cosmetics help enhance the aesthetic and personality aspects of human beings [6]. There is an increasing number of consumers concerned more about natural products with natural ingredients, free from harmful chemicals. Much awareness iscreated about the herbal cosmetics amongst the customers of health,beauty, fresh appearance, looking young and glowing of face [7].

In the present study, the herbal cosmetic products formulation containing the plant materials are leaves of aloe and henna, rhizomes of ginger, beetroot, fruits of cucumber and lemon, coffee, rose, seeds of rice grains, pepper, coconut oil and vitamin E capsule and the herbal cosmetic products are herbal cream, lip tint, face scrub, face spray, serums, Kajal, *Aloe vera* hair oil, *Aloe vera* gel etc. [8]. The gel of *Aloe vera*, henna leaves, coconut oil, vitamin E capsule have been used as herbal cosmetics for skin and hair.

Aloe vera gel is an ingredient in many cosmetics because it heals moisturizes, softens skin and wound healing property [9]. *It* contains amino acids like leucine, isoleucine, saponin, glycosides that provide cleansing action, vitamins A, C, E, B, choline, B12 and folic acid and provide antioxidant activity [10,11].

Aloe vera hair oil is one such product used for hair care. Hair oils are applied for cure of hair disorders such as baldness, graying of hairs, hairfall and dryness of hairs [12]. In the present findings of herbal hair oil contains herbal drugs such as *Aloe vera, Zingiber officinalis, Piper nigrum, Cocos nucifera.* The similar findings in the different herbal formulation containing *Aloe vera*, pepper, ginger, coconut oil stimulates hair growth, maintain the hair roots and strength, promotes the darkening of hair colour, reduces dandruff and lice, increases anti-oxidant, anti-inflammatory and anti-microbial activity[13-16]. Coconut oil contains a high percentage of glycerides and acts as a skin moisturizer and skin softener [17].

Lime juice and its oil are very beneficial for skin when consumed orally or applied externally. It rejuvenates the skin, keeps it shining, protects it from infections and reduces body odor due to presence of a large amount of vitamin-C and Flavonoids and acts as anti-oxidants, anti-biotic and disinfectants. When applied externally on skin, its acids scrub out the dead cells, cures dandruff, rashes, bruises etc [18].

Studies have shown that ginger extract can improves the structure and function of the skin and ginger and curcumin extract may reduce the formation of non-healing wounds in at-risk skin. Gingerol helps new blood vessel formation in inflamed and damaged skin [19].

Amla is rich in vitamin c, tannins and minerals such as phosporous, iron and calcium which provides nutrition to hair and also causes darkening of hair and prevents premature graying of hair [20]. Shikakai remove oil and dirt from hair very effectively [21]. Reetha powder is used as hair and body purifier in India [22].

Face creams are used as cosmetics for softening and cleansing action. The ayurvedic system of medicine was one of the most important systems that use herbal plant and extract of the treatment of various diseases [23]. Cucumber is believed that they promote refreshing, cooling, healing, soothing, emollient and anti-itching effect to the irritated skin [24]. *Cucumis sativus* extracts, was investigated for their anti-oxidant, antimicrobial potential and its cosmetic value in treatment of acne [25]. Facial cream can also assist in the prevention of the development of photoaging and inflammatory skin disorders [26,27,28]. In recent days increasing attention has been given to the protective properties against UV rays originating from sunlight [29]. In the present study, sugar, coconut oil is used for face scrub. Similar studies conducted by [30,31].

Eye cosmetics are old as vanity. For thousands of years, the people of ancient civilizations decorated their eyes with colourful substances in order to their facial appearance (Hardy *et al*., 1998). The role of kajal in eye products cannot be ignored, as it is one of those products. Kajal is worn for many reasons, including tradition, beautification, or to ward off the evil eye [32].

Colorants or coloring agents are mainly used to impart a distinctive appearance to the Cosmetic products [24-26]. Color has been used in cosmetics since early times. Basically, a desire to buy a cosmetic product is controlled by three senses namely sight, touch and smell. As such as, color is an important ingredient of cosmetic formulations [18].Lip tint formulations are most widely used to enhance the beauty of lips and addglamour touch to the makeup along all the cosmetic products [33,34]. Kadu *et al*. (2005) also reported that beetroot is the most important ingredient to prepare natural lip tint. Beetroot cream makes our skin fair and fresh [35].

The herbal cosmetic products are the best option to reduce skin problems such as hyper pigmentation, skin wrinkling, skin aging and rough skin texture etc. The demand of herbal cosmetic is rapidly expanding. The advantages of herbal cosmetics are lower cost, side effects free, ecofriendly, safe to use etc. Also has a great future ahead as compared to the synthetic

cosmetics. An estimate of WHO demonstrates about 80% of world population depends on natural products for their healthcare, because of side effects inflicted and rising cost of modern medicine. The synthetic beauty products can irritate your skin, and cause pimples. They might block your pores and make your skin dry or oily. The natural ingredients used assure no side effects [36].

Conclusion

The knowledge of medicinal plants used by the people is a part of the tradition and culture. Now a days skin problem are very common and natural remedies are more acceptable for a remedy for skin diseases without side effects using herbs compared to the synthetic ones. In the present study we have identified s e v e r a l plants used by the people to cure dermatological disorders without harmful effects. In the present scenario, it is a belief that herbals are much potential, safer and are used as curative medicines. Some of the plants were found to have dual use, both as curative and as cosmetics. The growing interest in herbs is a part of the movement towards change in life styles. Further extensive ethnobotanical and ethnopharmacological study, proper regulation and standardization of herbs, quality control test will lead to tremendous and significant growth in herbal cosmetics field as it is assumed to be much safer for longer use.

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Immunostimulant Effect of *Acorus Calamus* and *Allium Sativum* on Tinfoil Fish

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ABSTRACT

Fishes not only play an important role in the demand of food for humans but they have also emerged as major model organisms for different biomedical researches. Diseases in fish caused by bacteria are most widespread. Antibiotics are frequently used to control fish diseases caused by bacteria, but there is an increasing risk of developing antibiotic resistant strains of bacteria. The medicinal plants can act as immune stimulants, conferring early activation to the non-specific defense mechanisms of fish and elevating the specific immune response. The herbs contain many immunologically active components such as polysaccharides, organic acids, alkaloids, glycosides and volatile oils, which can enhance immune functions. Recently, there has been increased interest in the immune stimulating function of some herbs in aquaculture. The non-specific immune functions such as bacteriolytic activity of fish have been improved by some herbs. Henceforth, this article elucidates certain herbs (Acorus calamus, Allium sativum) which have been shown experimentally as well as clinically to possess immunostimulant effects in Tinfoil fish against Staphylococcus aureus. The selected herbal extracts reduced the effects of bacterial infections such as reduction in the external leisons and increased the survival rate and new scales were seen appearing after the 20th day of herbal supplement treatment.

***Keywords**: Allium sativum, Acorus calamus, Staphylococcus aureus, Tinfoil fish*

1. Introduction

Aquaculture has become a key component of the animal health industry, due to the continued expansion of cultured fish and shellfish species [1]. Aquaculture is therefore an emerging industrial sector which requires continued research with scientific, technical developments, and innovations [2]. Bacterial diseases are responsible for heavy mortalities in both culture and wild fishes throughout the world and most of the causative microorganisms are naturally occurring opportunist pathogens which invade the tissue of a fish host, thereby rendered such susceptible to infection [3].

Acorus calamus Linn. (Acoraceae) also known as Vasambu, is a mid-term, perennial, fragrant herb which is practiced in the Ayurvedic (Indian traditional) and the Chinese system of medicine. The plant's rhizomes are brown in color, twisted, cylindrical, curved, and shortly nodded. Several reports ascertained a wide range of biological activities involving its myriad of active phytoconstituents. In this sense, the intent of this review is to assemble and summarize the geographical distribution, ethnopharmacology and phytochemistry, mechanism of action

of *A. calamus* along with preclinical and clinical claims that are relevant to manage neurological and metabolic disorders [4].

Garlic (Allium sativum) is a medicinal plant known as an immunostimulant. Garlic in fish farming can stimulate a response to eating so that it encourages growth and boosts the immune system. The effect of garlic is associated with the presence of organosulfur compounds, such as allicin [5].

Preparation of herbal extract is feed with ornamental fish like Tinfoil. The fish was injected by the pathogen *Staphylococcus auerus* and the leisons occurred. By phytotheraphy of herbal extract lesions cured and new scales were formed. To investigate the immune response of Tinfoil fish through infection, taking into account and the nature of the pathogen. To analysis the extracellular lesion and diameter of the fish were calculated.

2.   Materials & Methods

2.1. Collection of Plant Material

The fresh rhizome of *A. calamus and A. sativum* are widely distributed in tropical and warm temperate regions. These plants are commonly used in folk medicine to treat dermatitis, gastric ulcer, abrasion, lesions and inflammation.

2.2 Preparation of Plant Extract

The fresh rhizome of *A. calamus and A. staivum* were collected in Enayam, Kanyakumari district and washed under running tap water for 5 minutes. The small hairs of the rhizome were removed, and the parts of the plants were chopped and shade dried for a week to achieve weight constancy. The dried parts were finely powdered in an electric blender and stored in air tight bottles. To obtain herbal residue the powders were extracted with 90% w/w ethanol using a orbital shaker. The ethanol was removed under pressure using a rotary evaporator. The dried crude herbal residues were stored in a dark airtight bottle 4ºC for further studies.

2.3 Microorganism

The bacterial strain *Staphylococcus aureus* was purchased from the Vivek laboratory (Nagercoil, Kanyakumari district), and maintained in the laboratory under standard conditions. Subcultures were maintained on Nutrient broth for 18 hrs at30ºC and routinely tested for pathogenesis by inoculation in to fishes.

2.4 Collection of experimental Fish

The test fish Tin foil *Barbonymus schwanenfeldii* were acclimatized in tanks to the laboratory condition for at least 7 days and fed of almost same size were collected alive in

healthy conditions from local fish aquarium, Kanyakumari, Tamil Nadu .The fishes were transported from the reservoir in oxygenated bags to the Laboratory and immediately some control fishes transferred into the glass aquaria of 50Liters capacity containing well aerated, unchlorinated ground water for 7 days acclimatization. The other fishes with the active movement were only used for the experimentation. The fishes were screened for any physical damage, disease and mortality. The immobilized, injured, abnormal and dead fishes were discarded immediately.

2.5 Experimental Design

A total of 6 fishes were divided into two groups of 3 each in triplicate as follows: Group a) injected pathogen fish Group b) Control. Measured the length and weight of the fish were recorded.

2.6 Induction of Infection

The pathogen (2.7×10^3 in 0.2ml of sterile distilled water) were administered intramuscularly (0.1 ml) using 20-gauge needle. The control fish were injected with plain distilled water. During the entire experimental period that lasted 25 days the fishes were examined daily in the morning and evening to observe the gross pathological changes in the lesion size, formation of epidermis and fresh scales.

3. Results and Discussion

3.1 Physical and Morphological Changes in Tinfoil fish

The effects pathogenic infection on various haematological parameters of Tinfoil fish studies and result are included here. In the treated groups all the fish survived has during the entire experiments period of 20 days. However, in the infected untreated group about 20% started succumb daily from 20±2.00 days onwards with a 50%cumulative mortality on 20 day. Weight (2.8±0.11cm, 3.2±0.21cm, 3.9±0.32cm, 4.3±0.32cm, 4.6±4.1cm) in Tin foil fish.Length (1.0±0.00 cm, 1.3±0.12 cm,1.6±0.6 cm,cm,2.1±0.13 cm,), Weight (0.6±0.11 cm, 0.82±0.21 cm, 1.2±0.32 cm, 1.6±0.32 cm, 1.9±0.41 cm) were measured in 0 days. The inoculated fishes showed clinical signs of *S.aureus* infection; in the infected untreated group of lesion size grew from healing on the fifth day to scale formation from the 0 day; in the treated groups the lesion gradually decreased in size (1.67±0.12 cm, 0.92±0.09 cm, 0.87±0.04 cm, 0.42±0.32 cm, 0.00±0.00 cm) with the formation of epidermis and scales.

Plate 1. Healing of Lesion in Tin foil Fish

Injection of pathogen (*S. aureus*)   Lesion occured

Healing of Lesions in Tinfoil Treated with Herbal Feed to Determine the Potent
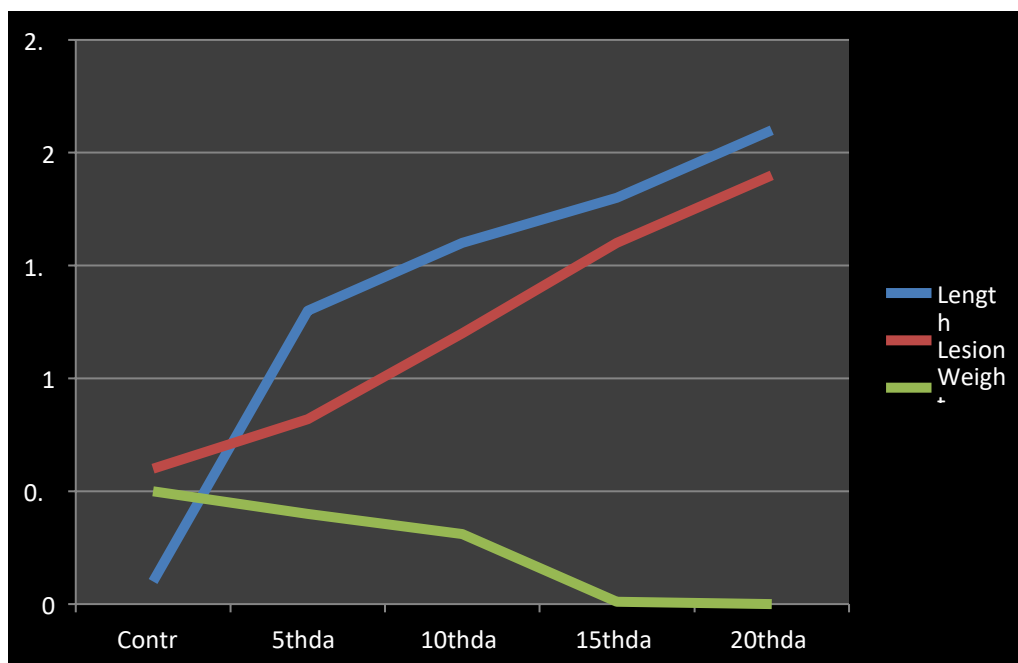
In the present study, two different extracts of the two herbs effectively controlled the pathogen *Staphylococcus aureus.* This was supported by [6], who extracted the plants *Terminalia bellerica, Ocimum sanctum, Daemia extensa, Andrographis paniculata* and *Myristica fragrans* and tested the extracts against the *S. aureus* and found them to have strong antimicrobial activity. Methanolic plant extracts from Eucalyptus globules, *Punica granatum, Artemisia mozicana,* and *Bovvania arborea* posses strong in vitro antibacterial activity against the *Staphylococcus aureus, E. coli, Pseudomonas sp.,* and *Candida sp* [7]. The

survival and other immune parameters were significantly improved compared to the control group. An Artemia-enriched herbal diet for *Penaeus monodon* with the combination of five herbs, which significantly increased growth and survival during stress conditions [8]. Also, feeding with *W. somnifera, Ferula asafoetida,* and *Mucuna pruriens* remarkably accelerated the spawning rate, fecundity, and larval quality in hatcheries of *P. monodon* [9,10]. Several herbal principles have been tested for their growth-promoting activity in aquatic animals.

3. Conculsion

The herbal feed *A. calamus* and *A. sativum* treated tinfoil fish group showed no mortality, diameter and weight gain. The effectiveness of herbal supplementation in fish feed to manage fish diseases and produce healthy fish. The outcomes of the studies suggest the use of herbs and herbal products feed supplements for healthy fishes in culture. Conclusively, the herbal feed supplements promote growth, minimizes stress, improves immunity and prevents infections in fishes against *S. aureus* that will help to produce new scales healthy fishes for human consumption.

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Traditional Knowledge of Medicinal Plants used by the Rural people of Southwest Coast of Kanyakumari District, Tamilnadu, India

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ABSTRACT

The present research work intends to study the medicinal plants used by the rural people of southwest coast of Kanyakumari district. It becomes too essential to analyses the medicinal plants and evaluating the economic importance of the plants present in village. The ethnobotanical survey was conducted from August 2018 to January 2019 by field visits in the study period. A total of 97 plant species belonging to 42 families were recorded in Keezhkulam village. Out of 42 families, 6 were monocotyledonous and 36 were dicototyledonous. Of the total plant species observed, based on the habit, herbs represented by 35%, 34% of trees, 17% of climbers, followed by shrubs 14%. This study would provide some basic clues of medicinal properties of plants used by villagers Keezhkulam, Kanyakumari district of Tamilnadu.

***Keywords**: Biodiversity, Conservation, Keezhkulam, Medicinal plants*

1. Introduction

Ethnobotany being a multidisplinary study, Anthropologists look at the role of plants lives from a broad cultural basis including symbolic [1], folk classification [2], resource utilization etc. Botanists are involved in investigation of folk classification, plant medicine [3,4,5] and the ecological interaction of people and plants [6]. The World Health Organization (WHO) estimated that perhaps 80% of the World's population relies on herbs for its primary healthcare needs [7]. There are some medicinal practices, viz. Ayurveda and Siddha in India, Chinese medicine in china, Unani medicine in Islamic countries, etc. Although in India several workers have investigated local medicinal uses of plants where herbal medicine is widely used for therapeutics [8]. Traditional medicine is used worldwide and having great economic value in the 21st century in both developed and developing countries. The plants are rich in active ingredients. Thus knowledge on plant diversity of an area and knowledge on medicinal uses of those plants by local people is of prime importance for development of these species considered effective in the treatment of various ailments [9]. The present work was undertaken and to evaluate traditional knowledge of Keezhkulam village people of Kanyakumari district, Tamilnadu with quantitative ethnobotanical point view to study the ethnobotanical investigation.

2. Materials and Methods

Keezhkulam is a large village located in Vilavancode of Kanniyakumari district, Tamilnadu with total 2745 families residing. Ethnobotanical survey was carried out during August 2018 to January 2019. Totally six field visits were carried out in the study area which includes six to ten days per visit knowledgeable traditional healers were identified based on their experience on herbal medicine with frequent field visits in the study area and interview were carried out with the identified local people and traditional healers. The documented medicinal plants were collected and preserved for preparation of herbarium specimens using standard methodologies. The plant materials were identified based on the recorded morphological, flowering and fruiting characters which were noted during the field visits. The binomials of preserved herbarium specimens were identified using 'The Flora of Tamilnadu Carnatic' [10] and 'The Flora of Presidency of Madras' [11]. Citations of the plants were obtained from the database the plant list (IPNI) (http://www.ipni.org). The identified plant specimens were labelled on herbarium sheets and deposited in the herbarium of Scott Christian College, Nagercoil, for future reference.

3. Results and Discussion

The present investigation comprises 97 taxa (Table .1) used by the villagers as medicinal uses. The medicinal plants distributed in 86 genera belonging to 42 families (Table. 2). Out of the documented medicinal plants 46 belong to Polypetalae, 23 belonging to Gamopetalae, 15 belonging to Monochlamydeae, 6 belonging to monocotyledons.

Table 2. Distribution pattern of medicinal plant species of the study area

Floristic Group	Family	Genus	Species
Angiosperm	42	86	97
Dicotyledons	36	74	84
Polypetalae	22	44	46
Gamopetalae	7	19	23
Monochlamydeae	7	11	15
Monocotyledons	6	12	13

A total of 42 families were recorded Solanceae was a dominant family with 7 taxa the co-dominant position was occupied by Apiaceae, Asclepiadaceae, Liliaceae each with 5 taxa. Caesalpinaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Lamiaceae and Rutaceae (4 taxa each), Annonaceae, Malvaceae, Moraceae, Papilionaceae and Zingiberaceae (3 taxa each), Acanthaceae, Amaranthaceae, Arecaceae, Asteraceae, Lauraceae, Myrtaceae, Oleaceae, Piperaceae and Vitaceae (2 taxa each), Anacardiaceae, Apocynaceae, Bromeliaceae, Cariacaceae, Clusiaceae, Combretaceae, Leguminosae, Lythraceae, Meliaceae, Mimosaceae,

Moringaceae, Myristiaceae, Musaceae, Poaceae, Punicaceae, Rhamnaceae, Rosaceae and Santalaceae were monospecific. Of the total species observed, based on the habit, herbs represented by 35%, 34% of tree, climber 17% followed by14% of shrubs (Fig. 1). The frequent use of herbs among the indigenous communities is a result of wealth of herbaceous plants in their environs [12].
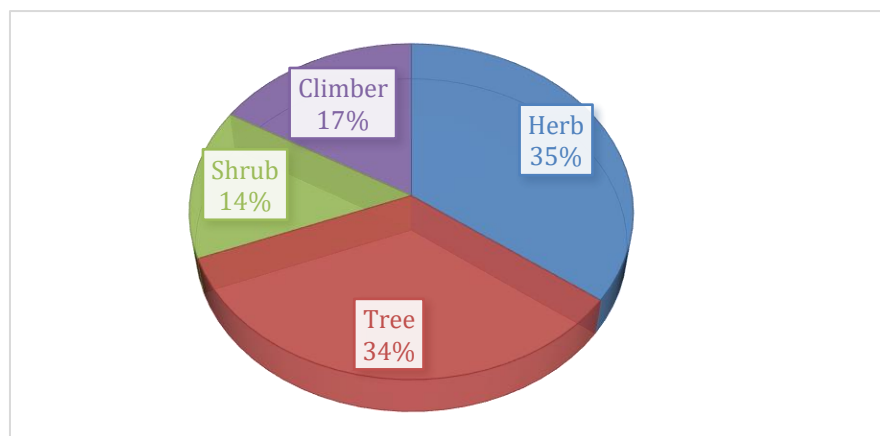
Fig 1. Habitwise distribution of medicinal plants of the study area

In the present study the various plant parts used as medicines were leaves (35 taxa), Fruit (24 taxa), Flower (5 taxa), Rhizome (2 taxa), Bark (2 taxa), Seed (12 taxa) and Bulb (2 taxa). The leaves are the predominant part utilized in the treatment of human diseases (Fig .2). It is evident from the recent ethnobotanical studies which confirmed that leaves are the major portion of the plant used in the treatment of diseases [13, 14]. Similar results were also reported in ethnobotanical studies in Bangladesh [15] and in other ethnomedicinal studies in tropical Asia [16].
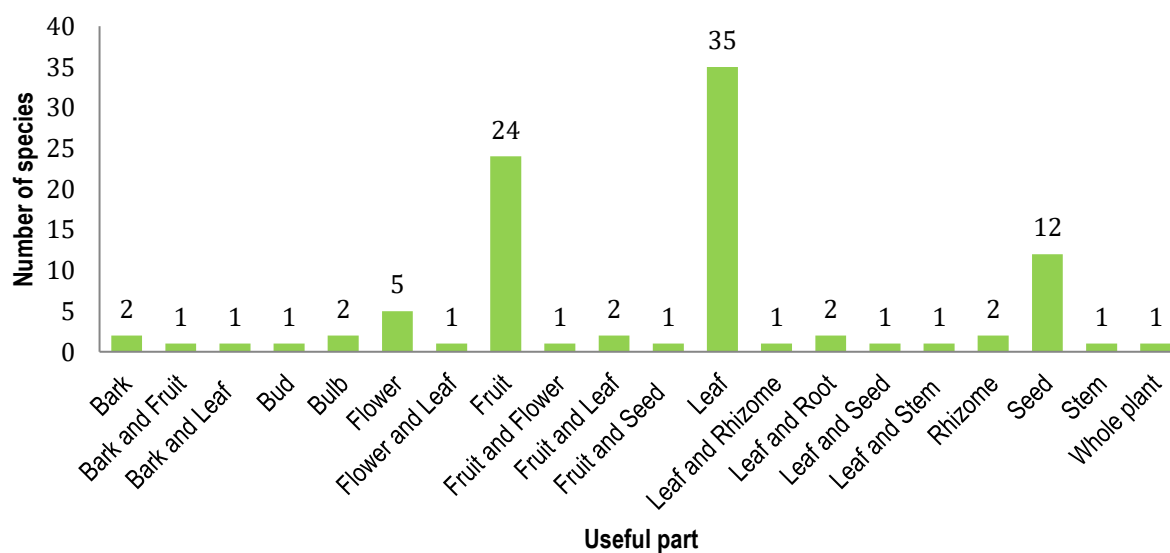
Fig 2. Plant parts used in medicinal plants of the study area

Decoction, paste, powder, infusion, oil, Juice and raw are the common methods employed for the preparation of medicinal plants. Among these majority of the plant remedies were repared by paste (22%) followed by decoction (20%), powder (19%), juice (17%), raw (3%), infusion (7%), oil and chewed (1% each) (Fig.3).
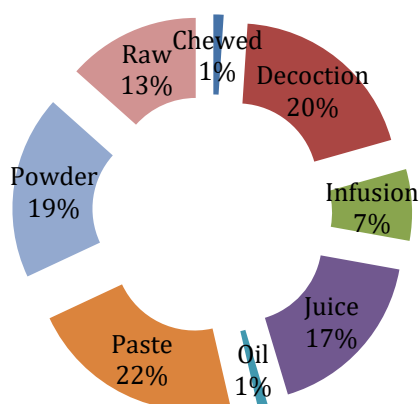
Fig 3. Mode of preparation of medicinal taxa of the study area

Plant medicine is mostly administrated to the livestock in the oral form (74 taxa: 76%) followed by topical application (23 taxa: 24%) (Fig 4.). Oral intake predominates over topical application which was also cited in the earlier studies [17, 18]. Medicinal plants are generally used to treat fever, coughs, cuts and wounds, cold ailments, teeth ache, hair loss, skin diseases, joint pain, dysentery and diarrhea. Similar results were found by [19].
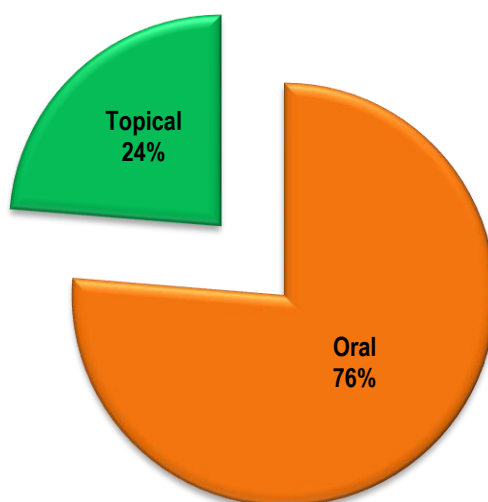
Fig 4. Mode of application of medicinal taxa of the study area

Table 1. List of commonly used medicinal plants by village people.

Sl. No.	Botanical Name	Family	Local Name	Comman Name	Useful Part	Habit	Preparation	Mode of Application
1	*Abelmoschus esculentus* (L.) Moench	Malvaceae	Vendai	Lady's finger	Fruit	Herb	Infusion	Oral
2	*Acalypha indica* L.	Euphorbiaceae	Kuppaimaeni	Indian mellow	Leaf	Herb	Paste	Topical
3	*Achyranthes aspera* L.	Amaranthaceae	Nayuruvi	Chaff-flower	Leaf and seed	Herb	Powder	Oral
4	*Aegle marmelos* (L.) correa	Rutaceae	Vilvam	Bael	Fruit	Tree	Decoction	Oral
5	*Allium cepa* L.	Lilaceae	Vengayam	Onion	Bulb	Herb	Paste	Topical
6	*Allium sativum*L.	Lilaceae	Vilaipuindu	Garlic	Bulb	Herb	Raw	Oral
7	*Aloe vera* (L.) Burm.f.	Liliaceae	Chotukatalai	Aloe	Leaf	Herb	Paste	Topical
8	*Alternanthera sessilis* L.	Amarantheceae	Poinnakani keerai	Sessile Joyweed	Leaf	Herb	Raw	Oral
9	*Ananas comosus* (L.) Merr.	Bromeliaceae	Annasi	Pineapple	Fruit	Herb	Raw	Oral
10	*Andrographis paniculata* (Burm. F.) Nees	Acanthaceae	Nelavembu	King of bitter	Leaf	Herb	Juice	Oral
11	*Anethum graveolens* L.	Apiaceae	Satakkuppi	Dill	Fruit	Shrub	Decoction	Oral
12	*Annona muricata* L.	Annonaceae	Muliumundiri	Guanapanaa	Fruit	Tree	Raw	Oral
13	*Annona squamosa* L.	Annonaceae	Sithapazham	Custard apple	Seed	Tree	Powder	Topical
14	*Artocarpus heterophyllus* Lam.	Moraceae	Pala	Jack fruit	Leaf	Tree	Juice	Oral
15	*Azadirachta indica* A. Juss.	Meliaceae	Veppamaram	Neem	Leaf and Stem	Tree	Paste	Topical
16	*Borassus flabellifer* L.	Arecaceae	Panaimaram	Palmyra palm	Seed	Tree	Decoction	Oral
17	*Bunium bulbocastanum* L.	Apiaceae	Karunshiragam	Cumin	Seed	Herb	Powder	Oral
18	*Caesalpinia bonduc* (L.) Roxb.	Caesalpiniaceae	Kalaitekkai	Grey Nicker	Fruit	Shrub	Raw	Oral
19	*Calophyllum inophyllum* L.	Clusiaceae	Punnaikkai	Beauty leaf	Leaf	Tree	Paste	Topical
20	*Calotropis gigantean* (L.) Dryand.	Asclepiadaceae	Erukku	Madar	Leaf	Shrub	Powder	Topical
21	*Capsicum frutescens* L.	Solanaceae	Kautharimilagu	Chilli	Fruit	Herb	Infusion	Oral

22	*Carica papaya* L.	Caricaceae	Papali	Melon like fruit	Fruit	Tree	Raw	Oral
23	*Cassia fistula* L.	Caesalpinaceae	Sarakoinataki	Amaltas	Leaf	Tree	Decoction	Oral
24	*Catharanthus roseus* (L.) G.Don	Apocynaceae	Nithiyakalyani	Madagascasperi winkle	Whole plant	Herb	Decoction	Oral
25	*Centella asiatica* (L.) Urb.	Apiaceae	Vallaria	Asiatic pennywort	Leaf	Herb	Powder	Oral
26	*Cinnamomum iners* Reinw. ex Blume	Lauraceae	Therali	Wild Cinnamon	Flower	Tree	Paste	Topical
27	*Cinnamomum verum* J. Presl	Lauraceae	Lavangam	Cinnamon	Flower	Tree	Paste	Oral
28	*Cissus quadrangularis* L.	Vitaceae	Perandai	Hadjora	Leaf	Climber	Decoction	Oral
29	*Citrus limon* (L.) Osbeck	Rutaceae	Elumitchai	Lime fruit	Fruit	Tree	Juice	Oral
30	*Citrus reticulate* Blanco	Rutaceae	Kamala orange	Mandarin orange	Fruit	Tree	Juice	Oral
31	*Coccinia grandis* (L.) Voigt	Cucurbitaceae	Kovaikkai	Hort	Fruit	Climber	Raw	Oral
32	*Cocos nucifera* L.	Arecaceae	Thengu	Coconut tree	Fruit and Flower	Tree	Oil	Topical
33	*Coriandrum sativum* L.	Apiaceae	Kothamalli	Coriander	Seed	Herb	Decoction	Oral
34	*Crotalaria retusa* L.	Fabaceae	Kilukiluppai	Rattleweed	Leaf	Herb	Decoction	Oral
35	*Cucumis sativus* L.	Cucurbitaceae	Vellarikkai	Cucumber	Fruit	Climber	Infusion	Oral
36	*Cucurbita pepo* L.	Cucurbitaceae	Poosani	Pumpkin	Fruit	Climber	Juice	Oral
37	*Curcuma longa* L.	Zingiberaceae	Manjal	Turmeric	Rhizome	Herb	Powder	Oral
38	*Cynodon dactylon* (L.) Pers.	Poaceae	Arugampul	Bermuda grass	Leaf and Root	Herb	Powder	Topical
39	*Datura innoxia* Mill.	Solanaceae	Oomattai	Thorn-apple	Leaf	Shrub	Decoction	Oral
40	*Daucus carota* L.	Apiaceae	Carrotkizhangu	Carrot	Fruit	Herb	Juice	Oral
41	*Eclipta prostrata* L.	Asteraceae	Karisalangani	False daisy	Leaf	Herb	Powder	Oral
42	*Elettaria cardamomum* (L.) Maton	Zingiberaceae	Yelakkai	Cardamom	Seed	Shrub	Powder	Oral
43	*Ficus benghalensis* L.	Moraceae	Aalamaram	Banyan tree	Bark	Tree	Decoction	Oral
44	*Ficus racemose* L.	Moraceae	Aththimaram	Fig	Fruit	Tree	Juice	Oral

45	*Gloriosa superba* L.	Liliaceae	Kalapiakilangu	Climbing lilly	Rhizome	Climber	Paste	Topical
46	*Glycyrrhiza glabra* L.	Leguminosae	Athimadhuram	Liquorice	Leaf	Shrub	Paste	Topical
47	*Gossypium arboretum* L.	Malvaceae	Paruthi	Cotton	Leaf	Shrub	Decoction	Oral
48	*Gymne masylvestre* (Retz.) R. Br. ex Sm.	Asclepiadaceae	Serukurujan	Periploca of the wood	Leaf	Shrub	Raw	Oral
49	*Hemidesmus indicus* (L.) R.Br. ex Schult.	Asclepiadaceae	Nannari	Indian sarasaparilla	Leaf and Rhizome	Climber	Powder	Oral
50	*Hibiscus rosa-sinensis* L.	Malvaceae	Chemparuthi	Hibiscus	Flower and Leaf	Shrub	Paste	Oral
51	*Indigo feratinctoria* L.	Papilionaceae	Aauri	Black Henna	Leaf	Climber	Decoction	Oral
52	*Jasminum grandiflorum* L.	Oleaceae	Pichi	Jasmin	Leaf	Climber	Paste	Topical
53	*Jasminum sambac* (L.) Aiton	Oleaceae	Malikai	Jasmin	Flower	Climber	Paste	Topical
54	*Justicia adhatoda* L.	Acanthaceae	Adhathodai	Malabarnut	Leaf	Shrub	Powder	Oral
55	*Lablab purpureus*(L.) Sweet	Papilionaceae	Avarai	Hyacinth bean	Leaf	Climber	Juice	Oral
56	*Lawsonia inermis* L.	Lythraceae	Maruthani	Henna	Leaf	Shrub	Paste	Topical
57	*Leucas aspera* (Willd.) Link	Lamiaceae	Thumbai	Cheppilai	Leaf	Herb	Paste	Topical
58	*Lycopersicon esculentum* L.	Solanaceae	Takkali	Tomato	Fruit	Herb	Juice	Oral
59	*Mangifera indica* L.	Anacardiaceae	Makai	Mango	Fruit and Leaf	Tree	Raw	Oral
60	*Mentha longifolia*(L.) L.	Lamiaceae	Pudinakeerai	Horse mint	Leaf	Herb	Juice	Oral
61	*Mimosa pudica* L.	Mimosaceae	Thottalchurunkai	Touch me not	Leaf	Herb	Paste	Oral
62	*Momordica charantia* L.	Curcurbitaceae	Pagarkkai	Bitter gourd	Fruit	Climber	Infusion	Oral
63	*Moringa oleifera* Lam.	Moringaceae	Murungai	Drumpstick	Bark and Leaf	Tree	Decoction	Oral
64	*Murraya koenigii* L.	Rutaceae	Karivapilai	Curry leaf	Leaf	Tree	Juice	Oral
65	*Musa paradisiaca* L.	Musaceae	Valai	Banan tree	Flower	Herb	Infusion	Oral
66	*Myristica fragrans* Houtt.	Myristiaceae	Jathikai	Nut meg tree	Fruit	Tree	Powder	Oral
67	*Ocimum tenuiflorum* L.	Lamiaceae	Thulasi	Holybasil	Leaf	Herb	Juice	Oral

68	*Pergularia daemia* (Forssk.) Chiov.	Asclepiadaceae	Veliparuthi	Pergularia	Leaf	Climber	Paste	Topical
69	*Phyllanthus emblica* L.	Euphorbiaceae	Nellikai	Amala	Fruit and Seed	Tree	Raw	Oral
70	*Phyllanthus niruri* L.	Euphorbiaceae	Keelaneli	Stone breaker	Leaf and Root	Herb	Juice	Oral
71	*Piper betle* L.	Piperaceae	Vettilai	Betal leaf	Leaf	Climber	Decoction	Oral
72	*Piper nigrum* L.	Piperaceae	Nallamilagu	Black pepper	Seed	Climber	Powder	Oral
73	*Plectranthus amboinicus* (Lour.) Spreng.	Lamiaceae	Navarapacchilai	Indian Borage	Leaf	Herb	Chewed	Oral
74	*Polyalthia longifolia* (Sonn.) Thwaites	Annonaceae	Asoka	Polyathia	Seed	Tree	Powder	Oral
75	*Pongamia pinnata* (L.) Pierre	Fabaceae	Pongumarum	Indian beech	Root	Tree	Powder	Topical
76	*Prosopis cineraria* (L.) Druce	Fabaceae	Vannimaram	Loong Tree	Seed	Tree	Decoction	Oral
77	*Prunus avium* L.	Rosaceae	Cherry	Sweet cherry	Fruit	Shrub	Juice	Oral
78	*Psidium guajava* L.	Myrtaceae	Koyya	Guava	Leaf	Tree	Decoction	Oral
79	*Punica granatum* L.	Punicaceae	Madulai	Crown flower	Bark and Fruit	Tree	Raw	Oral
80	*Ricinus communis* L.	Euphorbiaceae	Amanakku	Castor oil plant	Seed	Tree	Decoction	Oral
81	*Sansevieria roxburghiana* Schult. &Schult.f.	Liliaceae	Marual	Indian Bowstring hemp	Leaf	Herb	Paste	Topical
82	*Santalum album* L.	Santalaceae	Santhanam	Santal Wood	Bark	Tree	Paste	Topical
83	*Senna auriculata* (L.) Roxb.	Caesalpinaceae	Avaraum	Avarai	Flower	Herb	Infusion	Oral
84	*Sesbania grandiflora* (L.) Pers.	Fabaceae	Agatikeerai	Agati	Leaf	Tree	Raw	Oral
85	*Solanum americanum* Mill.	Solanaceae	Manathakkali	Black night shade	Fruit	Herb	Decoction	Oral
86	*Solanum melongena* L.	Solanaceae	Kathirikkai	Brinjal	Fruit	Shrub	Juice	Oral
87	*Solanum torvum* L.	Solanaceae	Chuntaikkai	Turkey Beery	Root	Shrub	Powder	Oral
88	*Solanum trilobatum* L.	Solanaceae	Thuthuvalai	Climbing brinjal	Leaf	Herb	Juice	Oral
89	*Syzygium aromaticum* (L.)	Myrtaceae	Kirambu	Clove	Bud	Tree	Powder	Oral

	Merr. &L.M.Perry							
90	*Tamarindus indica* L.	Caesalpiniaceae	Puzhi	Tamarind	Fruit and Leaf	Tree	Paste	Topical
91	*Terminalia chebula* Retz.	Combretaceae	Kadukkai	Chebulicmyr obalan	Fruit	Tree	Raw	Oral
92	*Tridax procumbents* (L.) L.	Asteraceae	Muriampacchi lai	Tridase Daisy	Leaf	Herb	Paste	Topical
93	*Trigonella foenum-graecum* L.	Papilionaceae	Venthayam	Fenugreek	Seed	Herb	Paste	Topical
94	*Tylophora indica* (Burm. f.) Merr.	Asclepiadeceae	Nanjaruppaan	Indian lpecac	Leaf	Climber	Powder	Oral
95	*Vitis vinifera* L.	Vitaceae	Thiratchai	Graps	Fruit	Climber	Juice	Oral
96	*Zingiber officinale* Roscoe	Zingiberaceae	Inji	Zinger	Stem	Herb	Decoction	Oral
97	*Ziziphus jujube* Mill.	Rhamnaceae	Illanthai	Chinese Date	Fruit	Tree	Infusion	Oral

4. Conclusion

Traditional knowledge of plants in many rural communities is changing because of rapid socio economic and cultural changes. Documentation of this knowledge is valuable for the communities and their future generations and for scientific consideration of wider uses of traditional knowledge. This study would provide some basic clues of medicinal properties of plants used by villagers Keezhkulam Kanyakumari district of Tamilnadu. Ethnomedicinal studies clearly defined that the knowledge of medicinal plants is important not just for *the villagers themselves* but for the entire world.

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Antibacterial efficacy of the leaves of the medicinal plant *Bacopa monnieri*

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ABSTRACT

Bacopa monnieri also known as "Neer-Brahmi" has been considered an important medicinal plant in Ayurvedic systems for centuries. The present study was carried out to evaluate the antimicrobial potential of the aqueous leaf extract of B. monnieri (L.). Four different concentrations (25, 50, 75 and 100 µl/ml) of leaf extract of B. monnieri (L.) were tested for antibacterial activity against Gram-positive Staphylococcus aureus and Gram-negative Klebsiella pneumoniae bacterial strains. The sensitivity of plant fractions was tested using the disc diffusion method.The minimum inhibitory concentration (MIC) of leaf extract was evaluated against each bacterium. Leaf extract demonstrated effective activity against the tested bacteria, with inhibition zone diameters ranging from 6.08-17.83 mm and their efficacy in terms of MICs ranged from 1.56 to 6.25 µl/ml. In conclusion, the results indicate that the B. monnieri leaf extract contains essential metabolites in the search for new effective antibacterial agents.

Keywords: Bacopa monnieri, Antibacterial Activity, Disc Diffusion Assay, Minimum Inhibitory Concentration

1. Introduction

Infectious diseases have been recognized as one of the major intimidations to human health throughout the world. Most of them are caused by microorganisms such as bacteria, viruses, and fungi [1]. It is reported that bacteria are attributed to approximately 30% of all diseases, leading to millions of deaths every year [2]. The development of bacterial resistance against available antibiotics has necessitated the need to search for new antibacterial agents.

Active compounds with antibacterial activity have been identified in plants so far to develop new promising drugs. Compared with synthetic drugs, plant-based antibiotics are considered to be safer due to their natural origin. Plants can produce a variety of organic chemicals of high structural diversity, called secondary metabolites, such as alkaloids, terpenoids, flavonoids, and tannins, which have antimicrobial properties *in vitro* [3]. The most important advantages claimed for the use of herbal plants in various diseases are their safety, in addition to being economical, effective, and easily available [4].

Bacopa monnieri (L.) commonly known as Neer-Brahmi, belonging to the family Scrophulariaceae is a creeping small prostrate annual herb growing widely in tropical regions of Asia [5]. It is mostly used in Ayurvedic medicine for treating various diseases like ulcers, tumors, ascites, indigestion, enlarged spleen, leprosy, inflammations, anemia, and biliousness. Therefore, the purpose of the present study was to screen the antibacterial activity of *Bacopa*

monnieri leaf extract against *Staphylococcus aureus* and *Klebsiella pneumoniae*.

2. Materials and Methods

Sample Collection: The leaves of *Bacopa monnieri* were collected from the Western Ghats, approximately located at 10°10′N 77°04′E in Tamil Nadu, India. Fresh leaves were cleaned several times with distilled water and dried at room temperature in the open air for further analysis.

Sample Preparation and Extraction: The leaves were air-dried at room temperature, ground to powder with a mechanical grinder to obtain a fine powder and stored in an air-tight container for further use. 2.5 g of *Bacopa monnieri* leaves powder is mixed with 50 ml of distilled water and kept in a water bath for 30 minutes. The colour change in the mixture from light green to brownish colour implied that the extraction has occurred. The extract was filtered through Whatmann No.1 to remove any undissolved materials. The obtained solution was stored in clean containers at 4°C for further analysis.

Bacterial culture: The test microorganisms *Staphylococcus aureus* (MTCC 916) and *Klebsiella pneumoniae* (MTCC 503) were purchased from Microbial Type Culture Collection and Gene Bank (MTCC) Chandigarh. The bacterial strains were maintained on Nutrient Agar (NA).

Antibacterial activity

Disc diffusion method: For the disc diffusion assay, the plates were swabbed with pathogenic bacterial culture viz. *Staphylococcus aureus* and *Klebsiella pneumoniae* was evenly swabbed on a solidified 25 ml MHA. Discs (6 mm in diameter) were punched from a sheet of Whatmann filter paper, sterilized, and impregnated with different concentrations of leaf extract (25 µl, 50 µl, 75 µl, and 100 µl). Thereafter, the discs were placed on the surface of inoculated MHA plates and then incubated at 37°C for 24 h to observe the formation of inhibition zones around the discs. The size of the zone of inhibition (including the disc) was measured in millimeters.

Determination of minimum inhibitory concentration (MIC): Minimum inhibitory concentration (MIC) is the lowest concentration of the drug which will inhibit growth as measured by observed turbidity in the test tube [6]. The broth micro dilution method was used to determine the MIC. *B. monnieri* leaf extract was dissolved in 10% DMSO and diluted to a higher concentration. Then, serial ½ dilutions of leaf extract were prepared directly in a microtiter plate containing Mueller Hinton broth to obtain concentrations from 0.78 to 50 µl/ml. The bacterial inoculum was added to give a final concentration of 5×10^5 CFU/mL in each well. The positive control was used containing Gentamicin as the standard drug at final concentrations from 0.125 to128 µl/ml. The plate was covered with a sterile sealer and

incubated for 24 h at 37°C.

Statistical Analysis: The experimental results were expressed as mean ± standard deviation (SD) of three replicates. Where applicable, the data were subjected to one-way analysis of variance (ANOVA) and differences between samples were determined by post hoc tukey test. P values less than 0.05 were considered statistically significant. Microsoft Excel 2010 statistical package was used for all analyses.

3. Results

In the present study, the antibacterial efficacy of *B. monnieri* leaf extract was evaluated against two bacterial species *Staphylococcus aureus* and *Klebsiella pneumoniae* by disc diffusion method. By employing the Kirby Bauer well diffusion technique antibacterial activity of different concentrations of leaf extract viz. 25 µl, 50 µl, 75 µl, 100 µl, plain disc and Streptomycin is corroborated to perform a comparative study and obtained results are given in Table 1. Fig.1 confers the Zone of inhibition (in mm).

The antibacterial activity was clearly expressed in terms of a clear zone of inhibition of the leaf extract. *Bacopa monnieri* leaf extract showed inhibition zones in all the concentrations against the two bacterial strains. The zone of inhibition increases as the concentrations of extract increase in both the tested bacterial strains.

Aqueous extract of *B. monnieri* leaf extract recorded the lowest antibacterial activity against *S. aureus* with an inhibition zone of 6.08 mm at the concentration of 25 µl while the highest activity was observed at the concentration of 100 µl against *K. pneumoniae* with 17.83 mm inhibition. The highest level of inhibitory effect was seen at the concentration of 100 µl for *S. aureus* and *K. pneumoniae* showing 12.9 mm and 17.83 mm antibacterial activity. When compared statistically, the difference in mean zone of inhibition between *S. aureus* and *K. pneumoniae* was nonsignificant (p value- 0.13 > 0.05).

The results of the present study revealed that the inhibitory effect of *B. monnieri* against *K. pneumoniae* was near to the standard drug Streptomycin. While comparing the inhibitory rates of both the tested organisms, the growth of Gram-negative *K. pneumoniae* was more effectively inhibited than the Gram-positive *S. aureus*.

Table 1. Inhibitory activity of *B. monnieri* leaf extract on bacteria

Concentration (µl/ml)	Zone of inhibition (mm)		
	Staphylococcvus aureus (G+)	*Klebsiella pneumoniae* (G-)	Streptomycin (Control)
25 µl	6.08±0.62	8.82±0.27	9.59±0.91
50 µl	8.01±0.49	12.5±0.5	14.59±0.5

75 µl	10.33±0.63	15.4±0.61	18.09±0.15
100 µl	12.9±0.13	17.83±0.25	19.94±0.78

Fig 1. Antibacterial activities of *B. monnieri* leaf extract at different concentrations and Streptomycin as standard

The effectiveness of the extracts on tested bacterial strains was determined by measuring the minimum inhibitory concentration (MIC) (Table 2). The minimum inhibitory concentration (MIC) was studied on *B. monnieri* leaf extract using different concentrations against *S. aureus* and *K. pneumoniae* bacteria.The results showed that leaf extracts could inhibit the growth of the two tested bacteria but with different sensitivities. MIC values of *B. monnieri* leaf extract were 6.25 µl/ml against *S. aureus* and 1.56 µl/ml against *K. pneumoniae*. The MIC of streptomycin against both the tested bacteria was 0.78 µl/ml.

Table 2. Antimicrobial activity expressed as Minimum Inhibitory Concentration (MIC µl/ml) of the *B. monnieri* leaf extract

Bacterial name	MIC
Staphylococcus aureus	6.25 µl/ml
Klebsiella pneumoniae	1.56 µl/ml
Streptomycin (Control)	0.78 µl/ml

4. Discussion

Increasing the number of multi-drug resistance pathogenic microbes in humans and animals as well as unwanted side effects of certain antibiotics has encouraged enormous

interest to search for new antimicrobial drugs of plant origin [7]. The prime objective of ethnopharmacology is to identify plants of medicinal importance with minimal side effects. Additionally, active compounds from the plant extracts with antibacterial activity can be transformed into possible medication. Research to develop efficient and accessible medication from active plant compounds in the interest of public health is a need of the present world.

The present investigation was carried out to analyze the antibacterial efficacy of *B. monnieri* leaf extract against G+ve *S. aureus* and G-ve *K. pneumoniae*. From the results, it was clear that as the concentration increased, the zone of inhibition also increased in both bacterial species. *S. aureus* was less affected by *B. monnieri* leaf extract compared with *Klebsiella pneumoniae* even in high concentrations. Streptomycin has shown higher efficacy against *K. pneumoniae* as compared to *S. aureus*.

B. monnieri leaf extract showed different levels of inhibition depending upon the Gram-positive and Gram-negative bacteria. This might be due to the high antibiotic resistance of Gram-negative bacteria. Most Gram-positive bacteria such as *S. aureus* are surrounded by a coarse peptidoglycan cell wall. This structure, although mechanically strong, appears to offer little resistance to the diffusion of small molecules such as antibiotics [8]. *K. pneumoniae*, in contrast, as Gram-negative bacteria, surround themselves with a second membrane, the outer membrane, which functions as an effective barrier.

Minimum inhibitory concentration (MIC) is the lowest concentration of an antimicrobial agent that inhibits the growth of a microorganism after 18–24 h. It was observed that against *S. aureus* and *K. pneumoniae*, *B. monnieri* leaf extract exhibited the minimum inhibitory values of 6.25 and 1.56 µl/ml as MIC respectively, which is a demonstration of a strong antimicrobial activity against both organisms. This result indicates that at a lower concentration, aqueous *B. monnieri* leaf extract is more effective against gram-negative bacteria than against gram-positive bacteria. This could be due to the complete solubility of the bioactive components of the plant in the extraction solvent and the inability of the cell membrane to exhibit a permeability barrier [9,10].

5. Conclusion

In this study, the aqueous leaf extract of *B. monnieri* was assessed for its antibacterial activity against *S. aureus* and *K. pneumoniae*. The results indicated that the leaf extract of *B. monnieri* had demonstrated significant antibacterial effects on bacterial strains tested, especially *K. pneumoniae*. This was confirmed by the determination of both diameters of inhibition zones and minimal inhibitory concentrations. This indicated that the *B. monnieri* plant has potent antibacterial properties and could be used in the development of novel antibacterial agents.

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In Vitro Evaluation of Antimicrobial Activity of *Justicia Adhatoda* Aqueous Leaf Extract

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ABSTRACT

Justicia adhatoda is a well-known medicinal plant in Ayurvedic and Unani medicine. Cough, whooping cough, cold, and clinging phlegm in the mouth, throat, and chest have been traditionally treated using J. adhatoda leaves. The present study aimed to evaluate antimicrobial activity and Minimum Inhibitory Concnetrations of J. adhatoda leaf extract against Gram-positive and Gram-negative bacterial strains such as Staphylococcus aureus and Pseudomonas aeruginosa. Based on the data presented here in, the largest zone of inhibition was found to be against P. aeruginosa (23mm) and the lowest inhibition zone was observed for S. aureus (13mm) at 100 µl/ml. The MIC values recorded for P. aeruginosa (6.25 µl/ml) and S. aureus was 12.5 µl/ml. As a result, the current method may be effective in identifying a new bioactive compound for the development of novel medications. Thus, it may be used as a strong antimicrobial agent against P. aeruginosa pathogens.

Keywords: Pseudomonas aeruginosa, Staphylococcus aureus, Justicia adhatoda

1. Introduction

The global prevalence of infectious diseases caused by bacteria is a major public health problem [1-2]. The bacterial agents including *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, and *Proteus vulgaris* cause several human infections [3]. The recent emergence of antibiotic resistance and related toxicity issues limit the use of antimicrobial agents [4] and are prompting a revival in research on the antimicrobial role of plants against resistant strains due to comparable safety and efficacy [5].

Plants are the prospective source of antimicrobial agents in different countries [6]. About 60 to 90% of the population in developing countries uses plant-derived medicine. Traditionally, crude plant extracts are used as herbal medicine for the treatment of human infectious diseases [7]. Plants are rich in a variety of phytochemicals including tannins, terpenoids, alkaloids, and flavonoids which have been found to have antimicrobial properties [8]. Although the mechanism of action and efficacy of these herbal extracts in most cases is still needed to be validated scientifically, these preparations mediate important host responses [9].

In India, *Justicia adhatoda* is familiar as a medicinal herb finding its major place in various medical practice types such as Siddha, Ayurveda, Unani, homeopathy, and also other

ancient medicine [10]. Adhatoda parts, i.e., leaf, root, stem, and flower, are employed in many medicinal drug preparations. Especially the leaves are used in herbal remedies for diseases like chronic bronchitis, whooping cough, fever, cold, cough, jaundice, and asthma as a sedative expectorant, diarrhea, dysentery, and painful rheumatic inflammatory swellings.

Thus the present study investigated the activity of *Justicia adhatoda* leaf extract against human pathogenic bacteria such as *Pseudomonas aeruginosa* and *Staphylococcus aureus*.

2. Materials and Methods

The leaves of *Justicia adhatoda* were collected from Holy Cross College, Nagercoil (8.1560° N, 77.4151° E) and were brought to the laboratory. Leaves were washed three times with double distilled water and air-dried for 20 days. The dried leaves were ground to get a fine powder and stored in airtight container for further analyses.

Plant Collection and Preparation of the plant extract: 10 gm of the dried leaf sample was weighed, added to 100 ml of distilled water, and boiled at 80°C for 60 min. The extract was collected by simple filtration using Whatman no. 1 filter paper, and the extract was stored in a refrigerator at 4°C.

Antibacterial Activity: *Staphylococcus aureus* (Gram-positive) and *Pseudomonas aeruginosa* (Gram-negative) were used for examining the bactericidal activity of plant extract. The inoculum was prepared aseptically by adding the fresh culture into 2 ml of sterile 0.145 mol/L saline tubes, and the cell density was adjusted to 0.5 McFarland turbidity standard to yield a bacterial suspension of 1.5×108 cfu/ml. Nutrient agar served as a medium for bacterial growth. Plant extract at concentrations of 25 μl, 50 μl, 75 μl, and 100 μl was tested against bacterial strains and compared with Streptomycin as a positive control. The plates were incubated at 37°C for 24 h, and the zone of incubation around the disc was observed. Three replicates were carried out for each extract against each of the test organisms. Data were expressed as mean ± standard deviation.

Determination of the Minimum Inhibitory Concentration (MIC)

The broth microdilution method was used to determine the MIC according to the European Committee on Antimicrobial Susceptibility Testing (EUCAST). The tested extracts were dissolved in 10% DMSO and diluted to a higher concentration. Then, serial ½ dilutions of extracts were prepared directly in a microtiter plate containing Mueller Hinton broth to obtain concentrations from 0.125 to 100 mg/mL. The bacterial inoculum was added to give a final concentration of 5×10^5 CFU/mL in each well. The positive control was used containing Streptomycin as the standard drug at final concentrations from 0.125 to 100 μl/ ml. The plate was covered with a sterile sealer and incubated for 24 h at 37°C.

Statistical analysis

The inhibition zones were calculated as means ± SD. The significance was evaluated by analysis of variance (ANOVA) using Microsoft Excel program. Significant differences in the data were established at the 5% level of significance. *P* values less than 0.05 were considered statistically significant.

3. Results

Antibacterial activity

Evaluation of the antibacterial activity of aqueous leaf extract of *J. adhatoda* plant was determined by the disc diffusion method against selected human pathogens bacteria such as *Pseudomonas aeruginosa, and Staphylococcus aureus.*

Table 1. Antibacterial activities of aqueous leaf extract of *J. adhatoda* and standard drug

Concentration	*S. aureus*	*P. aeruginosa*	Streptomycin
25 µl	6±0.0	10±0.2	12±0.2
50 µl	9±0.1	15±0.5	18±0.6
75 µl	11±0.2	17±0.5	21±0.9
100 µl	13±0.3	23±1.0	26±1.9

The results showed better growth of inhibition against the tested bacterial strains based on the gradual increase of concentrations of 25 µl, 50µl, 75 µl and 100 µl extracts compared with the control. The diameters of inhibition zones are shown in Table 1 and Plate 1. The zone of inhibition formed by the leaf extracts was compared with that of the standard antibiotic Streptomycin. The aqueous leaf extract of *J. adhatoda* presented strong activity against *P. aeruginosa* with a diameter of inhibition zone of 23.0 mm and low activity against *S. aureus* (13.0 mm diameter) at a concentration of 100 µl. As the concentration of extracts was reduced the antibacterial activity was equally reduced. The inhibition zones of leaf extract obtained in this study indicated that leaf extracts have the efficiency to kill both Gram-negative and Gram-positive bacteria. There is no significant different between the means of the *P. aeruginosa* and *S. aureus* (p value - 0.059 < 0.05).

Plate 1. Plates showing antibacterial activity of aqueous leaf extract
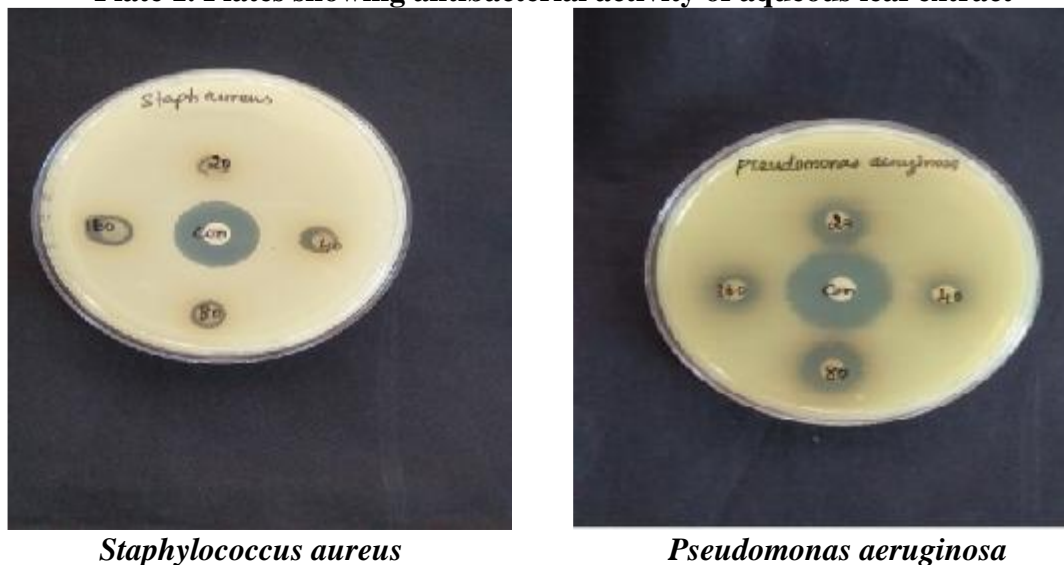
Staphylococcus aureus   *Pseudomonas aeruginosa*

Minimum Inhibitory Concentrations

The effectiveness of the extracts on tested bacterial strains was determined by measuring the minimum inhibitory concentration (MIC). The samples of *J. adhatoda* leaf extract against Gram-positive and Gram-negative bacteria were tested for MIC using different concentrations from 0.125 to 100 µl/ml.

Table 2. Minimum inhibitory concentration (MIC) of aqueous leaf extracts of *J. adhatoda*

Bacterial Strains	MIC values
S. aureus	12.5 µl
P. aeruginosa	6.25 µl

The MIC value of *J. adhatoda* leaf extracts is shown in Table 4.2. *J. adhatoda* leaf extract showed the lowest MIC values against *P. aeruginosa* (6.25 µl/ml) followed by *S. aureus* (12.5 µl/ml).

4. Discussion

The MIC was considered the lowest concentration of the extract that completely inhibits bacterial growth. The lower the MIC the higher is the activity of the extract. Medicine plants contain a wide range of elements that can be used to treat chronic as well as infectious diseases. The most important advantage of herbal medicine is the relatively low cost compared to synthetic medicines as well as low-level side effects [11]. Antimicrobial resistance has been a major concern in the healthcare system globally [12]. Moreover, the wide usage of antibiotics

in the treatment of infectious diseases, and multiple drug resistance against pathogenic microorganisms have developed in recent years [13 -16]. Therefore, there is a need to develop alternative antimicrobial drugs to treat infectious diseases from various sources including plants [17-18]. The use of *J. adhatoda* plant extracts to test for antimicrobial activity has been brought forward as one of the ways of achieving this goal. This study evaluated the use of aqueous leaf extracts in treating selected bacterial pathogens (*S. aureus*, and *P. aeruginosa*).

The antimicrobial activity of leaf extract at different concentrations (25, 50, 75 and 100 µl/ml) was dictated by the zone of inhibition against the development of microorganisms. The most elevated antibacterial action was seen against *P. aeruginosa* (23.00±1.15) and afterward *S. aureus* (13.00 ± 0.64). It has been reported previously that the water extract of different plants usually yields significantly higher amounts compared to ethanolic extracts of the same plants [19]. Liu *et al.* [20] demonstrated that the antimicrobial properties of thyme are owing to its content of thymol that could bind to membrane proteins by hydrophobic bonding and hydrogen bonding, and thus changing the permeability of the membranes.

The antibacterial activity of the produced leaf extract against Gram-negative bacteria was higher than that against Gram-positive bacteria, which could have been possible due to the difference in the thickness of the peptidoglycan layer of their cell wall [21]. These activity variations can be attributed to the different properties that each bacterial strain constitutes its mechanism of inhibition [20]. Particularly, the cell wall composition of Gram-positive bacteria is seen to possess a thick layer of polysaccharide which is hard to be penetrated by leaf extracts, while the opposite is true with Gram-negative bacteria [22].

Mostafa *et al*. [23] that the difference in MIC of plant extracts is due to variations in their chemical constituents and the volatile nature of their components. The data revealed variability in the MIC of *J. adhatoda* extract, with the lowest MIC values of *P. aeruginosa* (6.25 µl/ml) and highest MIC values for S. aureus (12.5 µl/ml). Moreover, it has been reported that a large number of different chemical compounds such as (phenolic compounds and their derivative compounds, the esters of weak acid, fatty acid, terpenes, and others) are presented in ethanolic extracts of spice, and thus these chemical components can affect multiple target sites against the bacterial cells [24-25]. These findings indicate that the plant extracts tested in this study could be used to naturally eliminate or control the growth of pathogenic microorganisms.

5. Conclusion

It was concluded that *J. adhatoda* showed potential antibacterial activity against human pathogens such as *Pseudomonas aeruginosa* and *Staphylococcus aureus*. Further phytochemical analysis of these plants will be helpful for the elucidation of lead molecules.

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Efficacy of *Calophyllum Inophyllum* and *Cassia Fistula* Acetone Solvent Extracts against *Oryctes Rhinoceros* (Linn.)

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ABSTRACT

Oryctes rhinoceros Linn. is one of the serious pests of the coconut palm, Cocos nucifera L. Adult O. rhinoceros and has an important status in economic entomology. Decaying organic matter and cow dung are the breeding sites of the adult beetle. Treatment of breeding sites with insecticides is a common method to control this pest. Applications of chemical pesticides result in the development of resistance by the grubs and have a negative effect on the environment. Plant extracts can cause antifeedancy, repellency, growth regulation, fecundity suppression, sterilization, ovipositional changes, and changes in biological fitness such as reduced life span, loss of flying ability, low nutrient absorption, high mortality, immuno depression, enzyme inhibition, and disruption of biology of insects. Calophyllum inophyllum, which belongs to the Guttiferae family, and Cassia fistula, which belongs to the Caesalpiniaceae family, are the chemically richest plants, and different solvent extracts of these plants exhibit pesticidal activites. Thus the current study was undertaken to test the insecticidal properties of C. inophyllum and C. fistula with a view to control the coconut pest O. rhinoceros.

Key words: *Calophyllum inophyllum, Cassia fistula, Oryctes rhinoceros,* pest management.

1. Introduction

One of the major pests that affect the coconut palm *Cocos nucifera* L. is *Oryctes rhinoceros* Linn. Adult *O. rhinoceros* digs into and attacks the deeper, softer areas of the crown of coconut trees, which stunts plant growth, reduces nut output, and resulting in low yield, which causes severe economic loss to the farmers. Because of this, economic entomology accords this pest important status [1]. Adult beetles breed in decomposing organic waste including cow dung. Controlling this pest usually involves treating the breeding areas with pesticides. Chemical pesticide applications cause the ecology to suffer and lead to grubs developing a tolerance to them. Because they are efficient and target the insect in question, botanical products are important instruments in pest management programmes [2]. Plant extracts have the power to affect insects in a variety of ways, including antifeedancy, growth regulation, fecundity suppression, sterilisation, ovipositional changes, repellency, and changes to their biological fitness, including shorter lifespans, a loss of their ability to fly, poor nutrient absorption, high mortality, immuno depression, enzyme inhibition, and disruption of biological synthesis [3]. Different forms of abnormalities also can be induced in insects by phytochemicals, making them a safe insect pest management tool. [4]. *Calophyllum inophyllum*, belongs to the

Guttiferae family and *Cassia fistula* belongs to the Caesalpiniaceae family are chemically richest plant. Different solvent extracts of both plants demonstrate larvicidal, ovicidal and repellent activities against *Aedes aegypti* [5]. In order to suppress the coconut pest *O. rhinoceros*, the current study was conducted to evaluate the insecticidal potential of *C. inophyllum* and *C. fistula*.

2. Material and Methods

Collection and extraction of plants

The leaves of *Calophyllum inophyllum* and *Cassia fistula* were collected from the Vizhunthayambalam of Kanniyakumari District. The fresh leaves collected were shade dried being grounded using an electric blender. 50 g of powdered leaves were extracted with 300 ml of acetone using a soxhlet apparatus for 8 hours. The extract was reduced under pressure using a rotary evaporator and stored at 4 °C for further analysis.

Preliminary Phytochemical analysis:

The acetone extracts of *C. inophyllum,* and *C. fistula* were subjected to qualitative chemical screening for the identification of various classes of active chemical constituents such as alkaloids, carbohydrates, glycosides, flavonoids, phenol, amino acids, tannins, terpenoids, and phlobatannins [6] (Table1).

Table 1. Preliminary Phytochemical analysis of C. *inophyllum* and C. *fistula*

Experiments	Observation
Plant extract + Wagner's reagent	Reddish brown precipitate indicates presence of alkaloid.
Plant extract + Benedict's reagent	Reddish brown precipitate reveals the presence of carbohydrate.
Plant extract + Glacial acetic acid and Ferric chloride solution +Sulphuric acid.	Appearance of violet or a greenish ring indicates the presence of glycosides.
Plant extract + Sodium hydroxide solution	Appearance of intense yellow colour and colourless solution on addition of dilute hydrochloric acid reveals the presence of flavonoids
Plant extract + Ferric chloride	Appearance of deep blue or black colour indicates the presence of phenol.
Plant extract + Ninhydrin solution	Purple colour reveals the presence of protein and amino acid.
Plant extract + Ferric chloride solution.	Appearance of blue or greenish color indicates the presence of tannins.
Plant extract + Water. The mixture was shaken vigorously	Formation of persistent foam indicates the presence of saponins
Plant extract + Hydrochloric acid.	Appearance of Red precipitate indicates the presence of phlobatannins.
Plant extracts + Chloroform + Sulphuric acid	Appearance of Reddish brown precipitate indicates the presence of terpenoids.

Collection and rearing of grub

Oryctes rhinoceros egg masses were collected from cow dung manure pits and incubated in a 500 gram plant pot containing 300 gram of culture medium made by combining sterile dried cow dung and paddy straw in a 2:1 ratio. After hatching, the larvae were separated and reared in a culture medium at the rate of 3 larvae per plant pot.

The third instar larva of *O. rhinoceros* was selected for the bioassay experiment, and the grub with same weight was treated as one category. Its size varying from 96 ± 0.903 cm length and 3.0 ± 0.2 cm width and weight $10:83 \pm 0.9$ gm. The grubs are reared in a medium containing varying concentrations (10, 20, 30, 40, and 50 g) of acetone extract weight, which were treated as one category. The grubs are reared in a medium containing varying concentrations of acetone extract until the emergence of adults. If any mortality was observed in the control, then data was subjected to Abbot's formula [7] in order to find out the corrected percent mortality using the following formula:

$$\text{Percentage mortality} = \frac{\text{Number of dead larvae} \times 100}{\text{Number of larvae introduced}}$$

$$\text{Correct percentage mortality} = \frac{1 - \text{Number in T after treatment} \times 100}{\text{Number in C after treatment}}$$

Where,   T- experimental Category and

C- Control Category.

The lower and upper fiducial limits (LC_{30}) and median lethal concentration (LC_{50}) were calculated using probit analysis in Excel 2007 [8].

Table 2. The ratio of mixture of cow dung, Paddy straw and plant powder

	Treatment	Concentration (%)				
	Percent	3.33%	6.66%	10%	13.33%	16.66%
1	Acetone extract (gm)	10	20	30	40	50
2	Cow dung	193g	187g	180g	174g	167g
3	Paddy Straw	97g	93g	90g	86g	83g

Total Haemocyte Count (THC) and Differential Haemocyte Count (DHC)

Five 3rd instar larvae of *O. rhinocerous* from the stock culture was reared separately in 300 gms culture medium containing 1:1, 1:3 and 1:5 dilution of LC_{50} concentration of acetone solvent extracts of *C. inophyllum* and *C. fistula*. After 72 hours of exposure the haemolymph was collected by amputating the prologs. Oozing haemolymph was collected in a prechilled

eppendorf tube having few crystals of phenyl thiourea. Total haemocyte was counted in treated and control groups [9]. fusing haemocytometer [10]. Differential haemocyte count (DHC) was estimated by counting different haemocytes from the population of 200 cells, based on the morphological features as described by [11]. THC and DHC were determined in at least 10 larvae both in control and experimental animal separately.

Data Analysis

The data collected were represented as mean $\pm$ SD. The mortality (%) was corrected by Abbott's formula and subjected to probit analysis to derive 50% mortality (LC_{50}). Analysis of Variance (ANOVA) was carried out to understand the impact of treatment with the two leaf extracts on *O. rhinoceros* larvae over different period of exposure.

3. Results and Discussion

Phytochemical analysis

The results of the preliminary phytochemical analysis of acetone, solvent extracts were shown in the table 3. The results showed the presence of alkaloid, phenol, tannins and terpenoids, glycosides, flavonoids, protein, saponins, Phlobatannins. Alkaloids, flavonoids, saponins, terpenoids and phenols were present in higher concentration in the acetone solvent extracts of *C. inophyllum* whereas less number of compounds were reported in *C. fistula* solvent extracts.

Table 3. Preliminary phytochemical analysis of Acetone extracts of selected plants

Secondary metabolites	*C. inophyllum*	*C. fistula*
Alkaloid	++	+
Carbohydrate	-	-
Glycosides	+	-
Flavonides	++	-
Phenol	+	+
Protein and amino acid	+	-
Tannins	+	+
Saponins	++	-
Phlobatannins	++	-
Terpenoids	-	+

Figure 1. Lethal concentration of *C. inophyllum* (CI) and *C. fistula* (CF) extracts at different hour of exposure to third instar grub *O. rhinoceros*
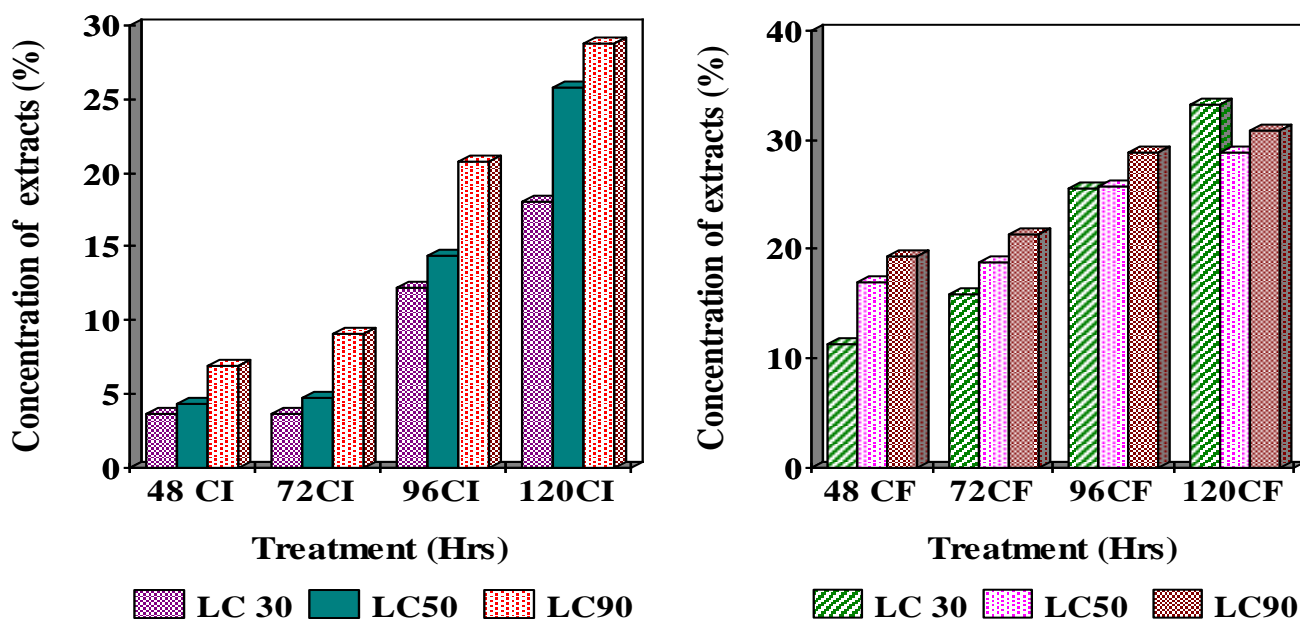
Figure 1 depicts the results of acetone solvent extracts of *C. fistula* and *C. inophyllum*. The mortality of the exposed larvae was noted at 48, 72, 96, and 120 hours in order to evaluate the toxicity of the plant extracts. Increased plant extract concentration is required for longer exposure times. For instance, 4.4% and 16.9% of *C. inophyllum* and *C. fistula* produce 50% of the damage at 48 hours of exposure, whereas at 120 hours of exposure, solvent extracts are required at 25.7% and 28.9%. Death rates are also dose-dependent). Plant based products had the highest percentage of larval death because of its insecticidal and antifeedent capabilities against insects. [12] studied the pathogenicity of neem against red palm weevil, *Rhynchophorus ferrugineus* and founded that highest mortality rates attained in prepupae at higher concentration. [13] reported neem based product showed the lowest medial lethal concentration (1.13 ml/l) against white grub than to others, this finding greatly supports our result. This result is upholding our research finding of larvicidal capability of *C. inophyllum* and *C. fistula* leaves against *O. rhinoceros* grubs. A dose-dependent mortality observed is attributed to their primary and secondary metabolite compositions of selected plants. Plant derivatives reduce the survival rates of larva and pupae as well as adult emergence [14]. The leaves of *C. fistula* showed the highest phenolic, flavonoid and proanthocyanidin contents [15] These compounds are responsible for antifeedant, repellent and larvicidal activity *C. fistula* and *C. inophyllum* [16]. Mortality was caused by inhibition of feeding activity or poisoning of hormone-producing

organs that regulate insect development process. In addition to hormonal disorders, physiological disorders can also inhibit the growth of larvae such as protease and invertase enzymes that can interfere with the food digestion of insects [17].

Figure 2. Differential hemocytes of *O. rhinocerous* treated with 1:1; 1:3; 1:5 dilution of LC$_{50}$ concentration of Acetone solvent extracts of selected plants.

C. inophyllum

C. fistula
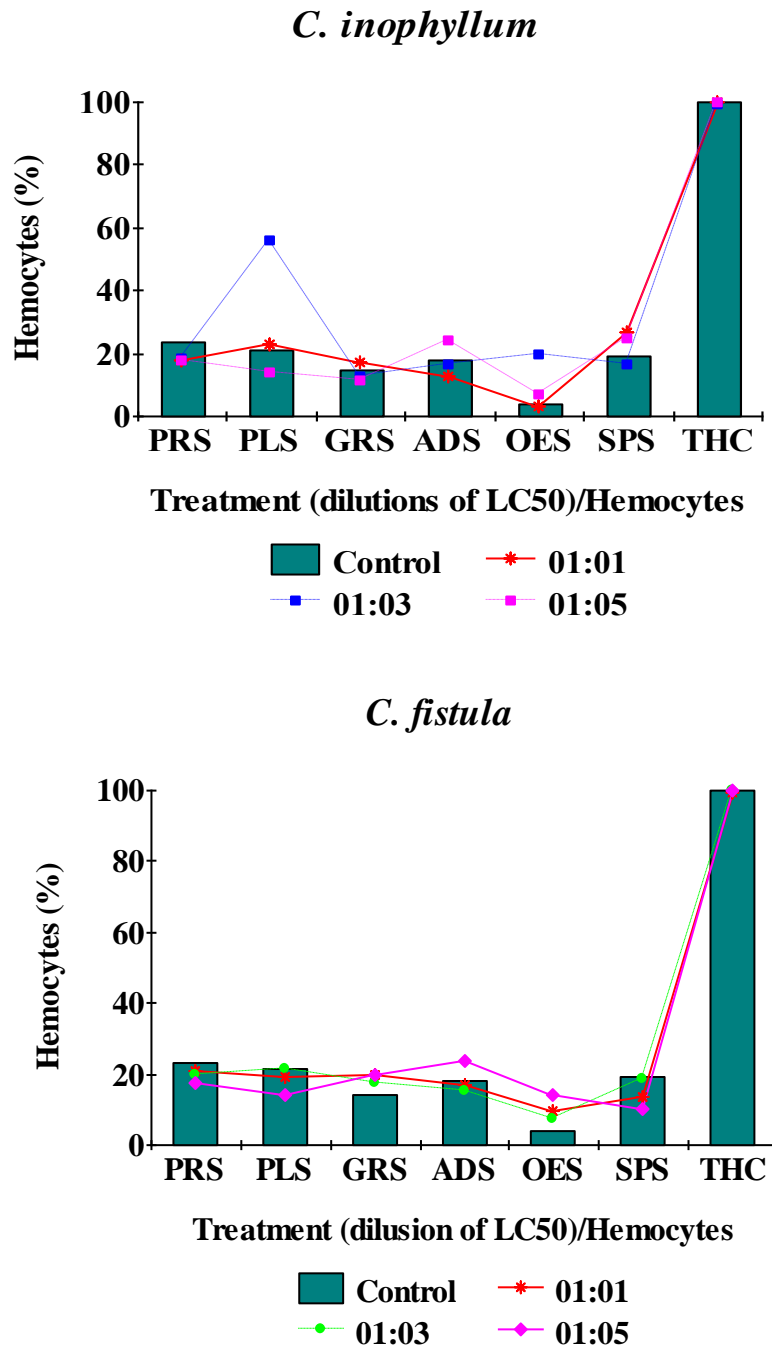
Six different types of hemocytes, prohemocytes (PRs), plasmatocytes (PLs), adipocytes (ADs), granulocytes (GRs), oenocytoids (OEs) and spherulocytes (SPs) were observed in both experimental and control categories of *O. rhinoceros*. In control categories maximum percent

of haemocytes were observed in the order PR (23.28%) >PL (21.23%)>SP (19.17%) > AD (17.80%) > GR (14.38%) > OE (4.14%), changes in this order of percent of cells were observed in all experimental categories. For instance in 1:1 dilution of *C. inophyllum* acetone treated categories the maximum number of cells were found among the SP (26.58%) instead PR in control groups. The number of cells were found in the order of PL (23.04 %) >PR (17.57%) >GR (17.18%)>AD (12.50%) >OE (3.12%). Compared to control in all experimental categories a decreasing trend was observed in Plasmatocytes, Granulocytes, Sperulocytes and Prohemocyte where as an increasing trend was observed in adipocytes and oenocytes. The production, multiplication and differentiation of hemocytes were controlled by the hormone [18] and it is assumed the disturbed hormonal regulation affects the production of cells. Reduction of PR number is attributed either to the inhibition of mitotic division, conversion of other types of cells or the inhibitory activity on hematopoietic organs. Plasmatocytes and Granulocytes are phagocytosis in function may be attracted to other compounds which enter the body. Oenocytes are resisting the penetration of plant metabolites thus remain unaffected [19].

The Total Haemocyte Count (THC) count in all experimental categories was declined compared to control (100%). The decrease in number of hemocytes is about 99.51 and 99.52 in 1:1 dilution of *C. fistula* and *C. inophyllum* respectively. Reduction in THC in the experimental categories substantiates the finding of other workers, who worked on neem based formulations [20,18]. The reduction may be due to toxic effects of secondary metabolites or inhibitory effects of the extracts on endocrine glands and their secretion [21,18]

4. Conclusion

We hereby summarize that the two chosen plant *C. fistula* and *C. inophyllum* has pronounced effect on the mortality in life of the III instar grub at different hours of exposure. The grubs were exhibiting increasing sensitivity with increasing hours of exposure. The larvicidal effect of the plant extracts may be due to its inhibitory effect on the hormone producing organ which leads to the absence of regulatory mechanism. The plant extracts also alter the immune function by increasing or decreasing the number of immunocytes either inhibiting its proliferation or inducing phagocytic activity of immune cells. Thus from the work it is conclude that *C. fistula* and *C. inophyllum* showed varying degree of toxicity to *O. rhinoceros* larvae and can be used in the Integrated Pest Management (IPM) to reduce the use of hazardous chemical insecticides.

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Screening of hemolymph of marine crab *Tumidodromia dromia* for its antibacterial and hemagglutination property

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ABSTRACT

Marine crabs, which survive in a stressful environment, have developed modalities to overcome stress and pathogens by the production of innate immune molecules. These humoral factors have been tapped as an alternative source of natural drugs. This study is aimed to assess the antimicrobial properties and screen for the presence of agglutinins in the hemolymph of the marine crab Tumidodromia dromia through disc diffusion method and hemagglutination assay. In-vitro antibacterial activity of the hemolymph against Bacillus cereus, Bacillus subtilis, Klebsiella pneumonia, Enterobacter aerogenes, Proteus mirabilis and Escherichia coli was carried out following disc diffusion method. The highest antibacterial activity of the crab's hemolymph over Bacillus cereus, Enterobacter aerogenes and Bacillus subtilis was observed in a dose response manner. Since the hemolymph exhibited antimicrobial properties, it was hypothesized that agglutinins could be a factor influencing antimicrobial activity. To test this hypothesis, the hemagglutination activity of the hemolymph was carried out with the erythrocyte derived from cow, goat, buffalo, pig, mice, guinea pig, rabbit, rat and chick. The agglutination reaction was seen maximum with erythrocytes derived from buffalo, mice and guinea pig. The result of the study revealed that the hemolymph of Tumidodromia dromia has hemagglutination properties. Purified form of antimicrobial molecule and hemagglutinin from the hemolymph of the crab can be used as natural drugs against microbes and cancer.

Keywords: *Antimicrobial activity, Crab lectin, Hemagglutination, Hemolymph.*

1. Introduction

Microorganisms have developed resistance against drugs and it is primarily due to misuse and overuse of drugs. Antimicrobials are designed to fight against the pathogenic microbes but these microbes restrict access to the antibiotics by preventing their entry through the cell wall by either pumping mechanism or degrading with the help of enzymes and proteins [1]. Isolation of antimicrobial substances from natural substances has found to be an alternative option [2]. According to recent studies the solution lies within the marine environment and the developing countries have now turned their spotlights towards marine life. Ocean is a host of diverse organisms and is constantly under the threat of pathogenic microbes and other stress

factors. To combat the stress, various peptides, alkaloids, polyketides and terpenes are produced by the microbes which in turn have been found to exert antimicrobial activity [3]. Invertebrates and vertebrate animals have two kinds of defence against microorganisms: cellular and humoral mechanisms. The crustacean humoral immunity is characterized by antimicrobial factors like clotting factors, lipopolysaccharides, peptides, complements and lectins which are found in the circulating hemolymph. The marine crab which can be used as a source of natural antibiotics has a hard cuticle as the first defence mechanism. Complex interactions of innate humoral and cellular immune response are observed in tissues and hemocoel, which leads to elimination of pathogens. Clear understanding of the biological activity can help immensely in the formalization of new drugs with specific action [4]. The crab hemolymph is a source of antimicrobial molecules such as cathelicidins, protegrins, lectins etc. [5]. Lectin provides a role of blockade of invasion, infection, inhibition of growth, microbial cell adhesion and migration.

Antimicrobial properties of hemolymph of crab has been documented from marine crabs *Charybdis lucifera* [6, 7], *Carcinus maenas* [8, 9], *Calinectes sapidus* [10, 11], *Liagore rubromaculata*[12], *Ocypode macrocera* [13] and *Atergatis integerrimus* [14]. Hemagglutination has been observed in crabs *Scylla serrata* [15], *Atergatis integerrimus* [16], *Travancoriana charu* [17], *Grapsus tenuicrustatus* [18]. Since marine crabs have been found to be a rich source of biomolecules that can specifically target clinical pathogens, the present investigation was carried out to screen for the antimicrobial property and to find out the presence of agglutinins which could be a potential molecule to target microbes. The hemolymph of the marine crab *Tumidromia dromia*, was selected and the experiment was carried out with the following objectives.

- To evaluate in vitro antibacterial activities against *Escherichia coli, Proteus mirabilis, Klebsiella pneumonia, Enterobacter aerogenes, Streptococcus pyogenes, Bacillus subtilis* and *Bacillus cereus*.

- To screen for the presence of agglutinins in the hemolymph.

2. Materials and Methods

Collection of Hemolymph

The crab *Tumidromia dromia*, were collected from the coastal area of Kela Manakudi, Kanniyakumari, Tamil Nadu, India (Latitude: 8.1161°N, Longitude: 77.4883°E). The hemolymph was collected by cutting the third walking leg of the crab in a centrifuge tube. The crab was then safely let back into the sea.

Bacterial Strains

Gram positive bacteria such as *Bacillus subtilis* (MTCC 5981), *Bacillus cereus* (MTCC 430); Gram negative bacteria such as *Klebsiella pneumonia* (MTCC 530), *Enterobacter aerogenes* (MTCC 111), *Proteus mirabilis* (MTCC 1429), *Escherichia coli* (MTCC 443) were collected from Scudder labs, Nagercoil and maintained at 4°C.

Antibacterial Assay

In vitro antibacterial assay was carried out by disc diffusion technique [20]. Whatmann No 1 filter paper disc with 6 mm diameter was impregnated with different concentrations of hemolymph (25 µl, 50 µl, 75 µl, 100 µl). The discs along with positive control (Standard antibiotic disc) were kept at the centre of Muller Hinton Agar (MHA) plates seeded with bacterial culture. After incubation at room temperature for 24 hours, antibacterial activity expressed in terms of diameter (mm) of zone of inhibition was calibrated and recorded.

Collection of Erythrocytes

Cow, goat, buffalo, pig and chick blood samples were collected from slaughter houses and blood of other animals were collected from veterinary hospitals by ear (rabbit) and heart puncture (rat, guinea pig, mice). Blood samples were collected directly in sterile modified Alseivier's medium pH 6.1 (30 mM sodium citrate, 77 mM sodium chloride, 114 mM glucose, 100 mg neomycin sulphate and 330 mg chloramphenicol). Blood samples were suspended and washed three times with ten volumes of Tris-buffered saline TBS, pH 7.5 (Tris-HCl 50 mM, NaCl 100 mM, $CaCl_2$ 10 mM) and resuspended in the same as 1.5% suspension.

HA Assay

Hemagglutination assay was performed in 96 well, 'U' bottomed microtiter plates (Tarson, India) as described by Ravindranath and Paulson [19]. The hemolymph (25 µl) was serially diluted with TBS (25 µl, pH 7.5) and mixed with 25 µl of 1.5% erythrocyte suspension and incubated for 1 hour at room temperature (30±2°C). HA titre was reported as the reciprocal of the highest dilution of hemolymph giving complete agglutination after 1 hour.

3. Results

Antibacterial Property

Bacterial strains *Bacillus cereus, Bacillus subtilis*, *Klebsiella pneumonia, Enterobacter aerogenes, Proteus mirabilis* and *Escherichia coli* were screened for antibacterial activity against hemolymph. Different concentrations of hemolymph (25 µl, 50 µl, 75 µl and 100 µl) were tested for all the strains and amikacin was used as control. The bacterial strains were sensitive to the hemolymph with an inhibitory zone ranging from 9 mm to 16 mm. The results

showed that the pathogens were sensitive to the hemolymph in a dose dependent manner (Fig. 1 & plate 1).

Fig 1. The antibacterial activity of crab hemolymph

Bacterial Strains (mm)
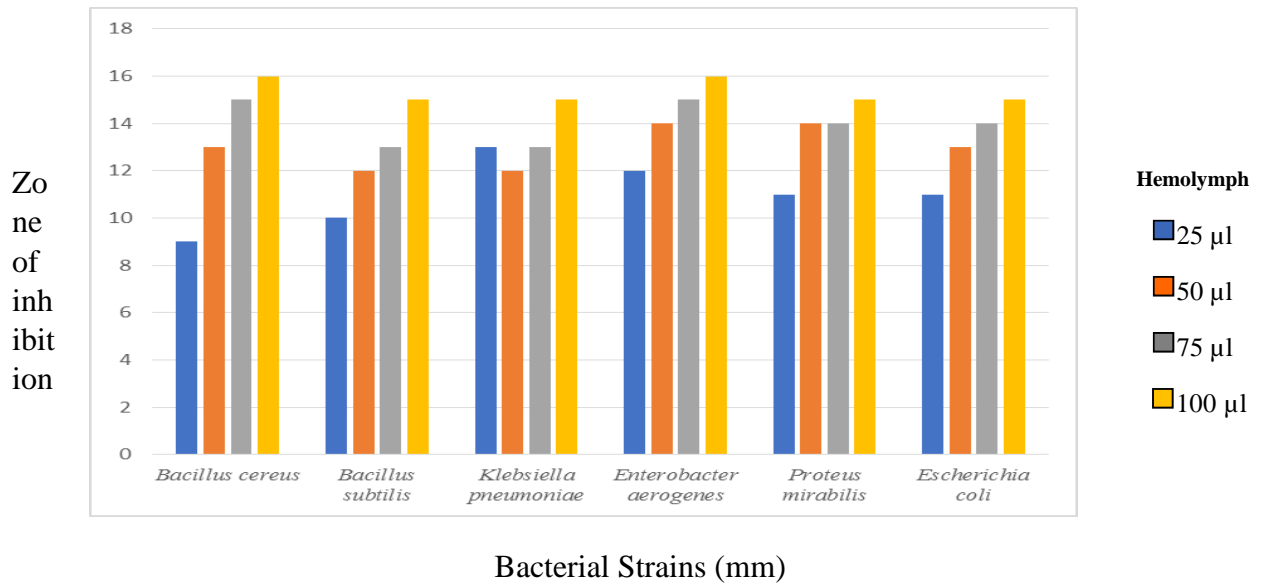
Plate 1. Antibacterial activity of hemolymph against *Bacterial strains*

Bacillus cereus   *Bacillus subtilis*

Proteus mirabilis   *Klebsiella pneumonia*
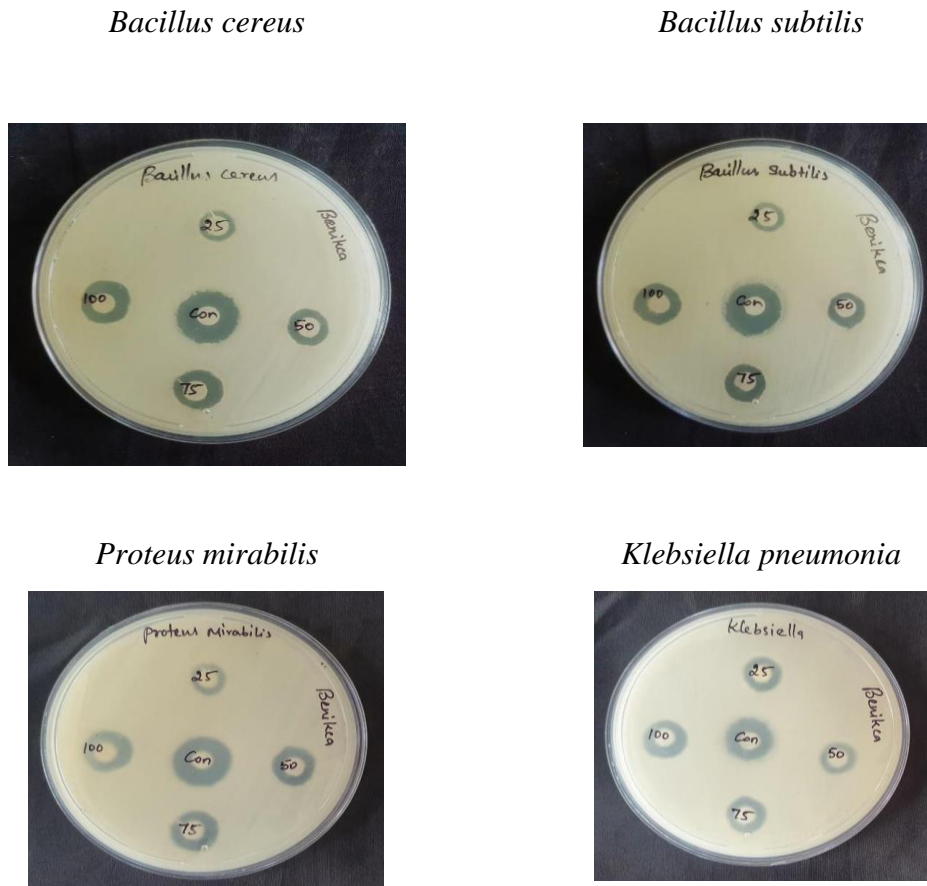
Enterobacter aerogens   *Escherichia coli*

Hemagglutination Property

In order to know whether agglutinins could have contributed to antimicrobial activity HA assay was carried out. Hemagglutination studies revealed the presence of agglutinins as evident by its capacity to agglutinate mammalian erythrocytes. Buffalo, guinea pig and mice erythrocytes showed considerable hemagglutination with the crab's hemolymph (Table 1) when compared to other erythrocytes.

Table 1. Hemagglutinin activity of the hemolymph of the marine crab,

Tumidromia dromia

Erythrocytes	Cow	Goat	Buffalo	Pig	Mice	Guinea pig	Rabbit	Rat	Chick
HA Titer	2	16	64-128	0	256	64	2	0	2

4. Discussion

Nature always has, still and will serve as the best source of medicines and antimicrobials. With the rise in marine and arthropodan research, effective bioactive compounds are isolated [21] and applied for diagnosis and treatment of diseases. Hence, a marine crab *Tumidodromia dromia* was selected and the hemolymph was collected and tested for antimicrobial activity. The activity was noted for Gram positive, as well as Gram negative bacteria. In the present study, a slight increase in activity was seen against Gram positive *Bacillus cereus* and *Bacillus subtilis;* and also, Gram negative *Klebsiella pneumonia, Enterobacter aerogenes, Proteus mirabilis* and *Escherichia coli*. Antimicrobial activity has been documented from the hemolymph of *P. pelagicus* against Gram-positive *Bacillus pumilus, S. aureus, and E. faecalis*, and Gram-negative *Morganella morganii, P. vulgaris, and P. aeruginosa*, as well as the fungus *Candida albicans* at 150 µg/mL [22]. The density charge,

structure of lipopolysaccharides and lipid composition of the cytoplasmic membrane in Gram negative and Gram-positive bacteria might be the cause [23]. The crude hemolymph of *Carinoscorpius rotundicauda* has a disruptive effect on the peptidoglycan layer of Gram-positive bacteria which destructs the defence mechanism of bacteria [24].

Maximum zone of inhibition of 16 mm and 14.7 mm has been reported against *Enterobacter sp*. and *S. entrica* from male hemolymph and protein precipitated from hemolymph respectively of *Portunus segnis* [25]. The report of Sundaramurthy et al [26] revealed that the hemolymph of the male crab *Uca triangularis* shows an inclined level of antibacterial peptide, than that of female hemolymph. Hemagglutinin assay showed that the hemolymph has affinity towards the erythrocytes tested at varied capacities with HA titer ranging from 2 to 256. The agglutination against buffalo erythrocytes is due to the presence of the receptor component NeuGc, a sialic acid on the glycocalyx of buffalo erythrocytes [27, 16]. The purified antimicrobial peptide and lectin may have greater potential towards pharma chemicals [28]. Since the presence of agglutinins is observed it may be speculated that lectin could be a factor complementing the antimicrobial activity. Thus, the present study paves a way to further isolate the lectin and assess its antimicrobial potential on clinical pathogens.

5. Conclusion

The hemolymph of the marine crab *Tumidromia dromia* has shown antibacterial activity against Gram positive bacteria such as *Bacillus cereus, Enterobacter aerogenes* and *Bacillus subtilis*. Hemagglutination assay showed the presence of agglutinin, which agglutinated buffalo, mice and guinea pig erythrocytes. Upon purification this can lead to a new discovery of antibacterial drugs.

Acknowledgement

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The Contribution of Pallavas Towards Saivism in Kanchipuram

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ABSTRACT

Pallavas played vital role for the development of Saivism in Kanchipuram.They established their capital at Kanchipuram.They were laid strong foundation for construction of temples with granite stones in Kanchipuram as well as other parts of Tamil country.The most of the Pallava rulers were devotees of lord Siva.They developed cultural activities towards Saivism.The Saiva Nayanmars had maintained good relationship with the Pallavarulers.Thecontributions of Pallava rulers paved the way for Kanchipuram as became the holy centre of saivism.

Keywords: *Siva Kanchi, Kachchi, Ekambam, Nayanmars, Mattavilasaprahasana, Pasupatas, Kalamuka,Tondaimandalam.*

Introduction

The pre historic period the Dravidians worshipped a number of deities like Korravai, Murugan, Varunan, Etc. At the same time they belief in the existence of one supreme. The worship of Shiva was originally Dravidian. In various Neolithic settlements in south India have been found lingams, this is an ample evidence of the worship of siva in the form of a linga existed in stone age.

The Agastya said that he learned Tamil language of south from siva this it may be Inferred that siva was a Dravidian deity.

Aims of the study

- To know about the architectural style of Pallavas.
- To appraise the contributions of Pallavas.
- To explore the growth of savism during the Pallava period.

Kanchipuram

Kanchipuram is one of the most ancient cities in India. Once it was the capital of Tondaimandalam which had twenty four kottams. It has been variously called as Kanchipedu, Kanchi, Kachi and conjeevaram. The first name among the others is the oldest and the most original is Kachchi but Kanchi is the more popular. The Kanchi and Kachchi, both find Place in Tamil works composed by Appar and sambandar in the middle of the 7th century A. D. In the Talgunda inscription of the KandantaKakushtavarman was mentioned Kanchi is called

Pallavandrapuri. Kanchipuram later divided into big Kanchi known as Siva Kanchi, Vishnu Kanchi was known as small Kanchi and JainaKanchi. The Shiva temples were mostly established in Siva Kanchi.

Pallavas rule

The Pallavas ruled Tondainadu from 250 AD to 900 AD. The Pallava rule has been divided into the period of the pallavas of prakrit charters, The period of pallavas of Sanskrit charters, Pallavas of simha Vishnu line and pallavas of Nandivarman – II pallavamalla line. The simhavishnu also known as the lion of the earth is considered to be the virtual founder of the pallavas. The Mahendravarman - I, Narasimhavarman – I, Parameswaravarman – I, Narasimhavarman – II, Parameswaravarman – II, Nandivarman – II, Dandivarman, Nandivarman – III, were important rules of pallava dynasty. Kanchipuram has been regarded as one of the holiest and most important cities even before pallavas, their rule added further glory to the town as they embellished the city with gigantic temples and shrines. The literature and religion received fair patronage which promoted the religious and cultural life of the people. Many Nayanmars were lived during pallavaregime that was extended royal patronage in propagating their ideas and morals. The royal emblem of the pallavas was Nandi (Bull).

The Aiyadigalkadavarkon who has been identified as pallavasimhavarman III, the father of simhavishnu, is regarded as one of the saints. The work kshetravanba of this royal saint who was an erudite scholar both in Tamil and Sanskrit describes the 22 places which he visited on his pilgrimage, Ekambam or Ekambaranatha temple was one among the places on which he has sung.Some of the pallava kings like sivaskandavarman, skandasishyanandivarmanetc bear names which suggest their association with saivism. Even their Bull emblem and the khativanga a weapon of siva on the royal flag may be taken as denoting their allegiance to saivism.

Kanchi was the strong hold of saivism at the time of mayurasarman. Pallavas were staunch saivites and consequently their capital was the strong hold of saivism. Therefore mayurasaraman came for study. The mattavilasaprahasana of mahendravarman – I and the hymns of Appar contain reference to kapalikas, kalamukhas and pasupatas in the pallava period the sculptural representations and inscriptional references to these sects in places around kanchi.

Temples and Sculptures

The closing years of the 6th century and advent of the 7th century A. D. witnessed a period of greate renaissance as far as the Tamil country and kanchi which was the capital of pallavas of simhavishnu period.

The nayanmars, the avowed devotees of Siva were spread saivism in Tamil country. The soul stirring songs popularly known as Tevaram inspired and influenced the masses. This Influence gradually culminated in hatred and autogonism towards the other religions like Jainism and Buddhism which of course were soon totally dethrohed from the minds of the people by the indefatigable efforts of these saints. The absolute political control which the pallavas wielded over the Tamil country made the spread of saivism quicker and more rapid.

Mahendravarman and his contemporary saint Appar joined hands to promoting and accelerating to spread of saivism while mahendravarman was building everlasting edifices on stone for siva, Appar carved out a place for saivism in the minds of the people by his sweet verses. The Ekambaranatha temple also received its share from the hands of this benevolent pallava monarch who built a mandapa in that temple complex.

It was mahendravarman – I who caused to be made a temple, probably the first for Ganesa at vallam in the Tamil country, he can be regarded as a pioneer who introduced the Ganesa cult in the Tamil country.The poet mayura contemporary of pallavas who composed a poem of hundred verses in Sanskrit on sun god called as surya – sataka and by singing which in the shrine of surya in the temple of kanchapesvara at kanchi, he got cured of leprosy. According to reliable tradition there existed in the past 108 siva temples in kanchi. The important siva temples are Ekambaranatha, Kailasanatha, Kachapesvara, Onakanthan, Satyavaratesvara, Iravattanesvara, Piravetianeswara, Mukkeswara, Svarchareswara, Kayarohanesvara, Brahmapurisvara etc.

The Narasimhavarman – II's inscription traces the mythical genealogy of the pallavas and mentions his building of Rajasimhasvara. The kamakshi temple inscription of his queen Lokamahadevi states that she was affected by a brahmarakshasa. Another queen Rangapataka is stated to have founded a small shrine in the Rajasimhesvara temple. The Kailasanatha inscription said that mahendra III son of Rajasimha built a siva shrine in front of the Rajasimhesvara's shrine.

The Ekambaranatha temple is one of the largest temples of south India the temple deity sriEkambranatha was known as prithivilinga means linga of earth it is first among the other panchabhutakshetras. In the prakaram round the mango tree is an idol of lingam which is the composite of 108 lingas. There is another one of 1008 small lingas. The ideals of 63 Nayanmars are found near the sanctum. There is a sculptural panel depicting siva destroying manmatha. There are several inscriptions on walls and pillars of the temple which belongs to different pallavas rulers.

The pallava ruler Narasimhavarman – II built kailasanatha temple who ruled between

700 – 728 AD. He was an illustrious ruler of pallava dynasty who initiated to the construction of structural temples in stone in large numbers. There are seven sub – shrines in a row near the entrance facing east which were constructed by some of the queens of Rajasimha. Some of the sculptures found inside the temple were Ardhanareeswara, sage vyasa and sankaracharya.

The Kacchapeswara temple is another important temple of kanchi. The sacredness of this temple is attributed to Vishnu in the form of a kacchapa (Tortoise) worshipped siva here. The linga got the name kacchapeswara.

The Iravataneswara temple belongs to the time of Rajasimha it is dedicated to siva and originally consisted of a dvitalavimana with square sikhara and griva. The Brahma, Vishnu, Dakshinamurthi, Ravaniungrahamurthi, urdevatandava, Chandesaanugraha, Ganga dhara sculptures were found in temple.

The Piravataneswara temple was built during the reign of pallavaNandivarman – II. The temple faces west and it is dedicated to siva. The somaskandar, Brahma, Vishnu, Durga, Lingodbhava, Nrithyamurthi, Gajalakshmi and other sculptures were placed.

The mukteswara temple also known as Dharmahadeviisvaram after the name of the queen of Nandivarman – II.The sculptures depicting Ravana lifting Kailas, Bhikchatana, Gangadhara, Chandesanugrahasurya, Karthikeya, Durga, etc.

The kausikesvara temple, Jwarahareswara temple, Karuneeswara temple, Kayarohaneswara temple, Satyavraksvara temple, Visweshwara temple, Ramanathesvara temple, Mangaleswara temple are other noted siva temples in Kanchipuram.

Music

The songs of Appar, Sambandar and Sundaramurti flourished in this period are filled with music. Appar sang that the shadow of siva's feet is as soothing as the pure music of the Vina, The regular singing of devarams in siva temples, a practice still observed in many of the temples of south india began as early as the days of the pallava kings. The mahendravarman – I also known as "Sankirnajati" because he was also a master of Tala and Wellversed to play musical instruments.Mahendravarman's grandson Rajasimha was also an accomplished musician as known from his surnames. He praised as srivadyavidyadharah, Sri Atodyatumbura, Sri Vinanaradah. The music inscription of kudumiyamalai is all india interest. It is a great historical value. The author of the inscription is mahendravarman – I, a pallava ruler.

Dance

The art of dancing may be traced to a remote antiquity in the Tamil country. Kuttus referred in the early Tamil works were the indigenous dances of the Tamil land. Kuttus has several subdivisions. They were kuravai, Kalinadan, Kudakkuttu, Karanam, Nokku and

Torpavai. The Nandivarman – II pallavamalla period dancing girls were attached in the temple at KanchipuramDuringRajasimha's reign his queen Rangapataka has been expert in Bharatanatya. She was associated in the construction of a pallava shrine in the kailasanatha temple.

The dancing girls were called Risabhataliyar, devaradiyal, talicheri – pendugal. There were seven divisions among the women dancers. Namely duttai, vikrutai, prattiyaiBhaktai, Hrdai, Alangarai and Rudrakanikai. The Nayanmars praised these dancers in their hymns relating to different shrines in the pallava kingdom. The muktesvara temple at kanchi and the Tiruvorriyur temple maintained a large number of dancing women for the performance of singing and dancing at the time of divine worship and services during festivals. The pallava king mahendravarman – I in mattavilasaprahasand refers to siva as kapali and his dance Tandava comprising the course of the three worlds. The contemporary hymns of the Devaram and Nalayiradivyaprabhandam contain descriptions of siva as a Nrittamurti. The dancing mode of siva was placed in the kailasanatha temple at kanchi. The Iravathaneswara temple at kanchi contains a culture of siva depicting him in the Lalathatilaka mode of dance. The wonderful art of dancing must have been greatly popularized and stimulated in the south by the pallava kings.

Painting

The pallava court played an important part in the development of the art of painting. The Mahendravarman – I was called as vicitracitta, citrakarapuli and Daksinachitra, he was probably the author of south Indian painting. The Ardhanarisvara paintings in Mamallapuram was painted by Mahendravarman – I.

The Svastika, Trisula, Lotus, Bull, Durga ornaments, Mountain were painted in various pallava temples. The Talasampotitapose painted in the Talapurisvara temple at panamalai, Somaskanda panels also painted in various temples at Tondaimandalam. The parvati and dancing siva paintings were found in kailasanatha temple at kanchi. The siva paintings were found in malai cave temple at malaiyadipatti were the contributions of pallavas.

Conclusion

The pallavas were patronizing and contributing to the development of saivism through the Temples, Sculpture, Painting, Musing, Dance, Drama, etc. The pallavas were conducted festivals and pujas in their temples. They also conducted different Yajnas, Rituals and Ceremonies. The various activities of pallavas laid the strong foundation for the upliftment of saivism in Tamil country which later reflected in to all over the world.

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Historical Perspectives of Arthasastra – A Study

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ABSTRACT

The Arthasastra is the most comprehensive treatise on the political science. It deals with the state – affairs in the internal as well as the external sphere. The aim of the Arthasastra is thoroughly practical, to show how a state should be governed. The Arthasastra has been rightly regarded as the standard work on politics and administration. Arthasastra the diplomatic history of Mauryas was written by Kautilya. It is divided into 15 Adhikarams with 180 prakaranas. This work is a combination of sutra and Bhashya. Sutra probably applies to the headings of prakaranas and the rest, Bhashya is a commentary on it with a certain mixture of verses. The Arthasastra is in prose as well as verse. A number of slokas are borrowed by Kautilya from earlier sources on polity. Even then many of them are composed by Kautilya the author himself.

Keywords: *Arthasastra – prakaranas – Mauryas – polity – composition - administration – kautilya – instructional.*

Aims

The major aims of this article are to explore the hidden facts of Arthasastra, to analyse and praise the structure, narration of facts, chapteraisation and authenticity of materialization. It explains the nature of government, law, civil and criminal court systems, ethics, economics markets and trade, the methods of screening ministers, diplomacy, theories on war, and nature of peace, duties and the obligations of a mauriyan king. So it is a master piece of knowledge of ancient India.

Introduction

The Arthasastra is principally instructional in character. It is intended to teach a ruler how he should conduct himself in the various situations that are likely to arise in the course of his rule. There is little the arising, hardly any sustained discussion of theoretical problems about the origin the state and functions of the state and soon. No doubt, the Arthasastra is instructional in character. But there is nothing to show that the instructions are addressed to any particular king. It provides general instructions on matters of state – craft and administration and it is intended that the instructions should be and could be followed by any state or king who cares for an efficient administration for ensuring the prosperity and well – being of his subjects.

The teachings and the instructions in the Arthasastra cannot be claimed to be as a whole an authentic creation of Kautilya. The text of the Arthasastra is composed by bringing together the teaching of all earlier works on polity and administration which were regarded as authoritative in the days of Kautilya probably there were already the works of thirteen individual writers, on the science of polity.

Arthasastra and Mauriyan Empire

The mauriyan age that the whole of India was politically united for the first time under one head and rule. The Mauriyan rulers established political and cultural contact with other civilized monarch like selucus of Syria, Ptolemy of Egypt, Artigonos ruler of Nepal. The Mauriyan Age that India enjoyed blessings of continued peace, and consequently trade and commerce, Science literature and art flourished well in the country. It was the age of cultural brilliance. K.A. Nilkanta Sastri observes "Viewed from any angle, the age of Mauriya Empire was an age of great endeavor and noble achievement. Politically, India became one and the cultural unity in the midst of diversity that has always characterized her civilization became marked than ever in this period. India was in the van of human progress, and one of her greatest emperors set forth into the world the message of universal peace and love.

One of the main sources of the cultural history of the Mauriyan Age is Kautilya's Arthasastra. It deserves some explanation. Kautilya (or) Vishnugupta, also stayed Chanakya was a learned Brahman of Taxila in the north – western region now in Pakistan. He was present there when Alexander invaded the north – western region. He helped Chandragupta Maurya to overthrow the last ruler of the Nanda dynasty of Magadha in fourth century B.C. He became the Prime – Minister of Chandragupta Maurya and guided him in administration.

Period of the Composition of the Arthasastra

Indian tradition is unanimous in holding the Arthasastra as the work or the Vishnugupta Kautilya (or) Chanakya. He destroyed the power of the Nandas and placed Chandragupta Maurya on the throne of Magadha. As Chandragupta is known to have come to throne in 321 B.C or there about, the date of the composition of the Arthasastra by Kautilya conforms to the end of the fourth century B.C. This traditional view is opposed by few scholars who hold the opinion that the Arthasastra is a later work. They regard it even of much later date. According to them the Arthasastra is based on the teachings of learned Brahman Scholar Kautilya and it cannot be a work by his own hand. They place the composition of the Arthasastra in the fourth Century A.D. Hildebrandt ascribes the composition of the Arthasastra to a school of Kautilya's disciples, and Keith ascribes it to some followers of Kautilya. Thus some sscholars put the Arthasastra to the third or fourth century A.D. While others prefer a date three or four centuries

earlier. The whole question has been very critically examined by Indian scholars and they conclude that kautilya flourished in the reign of Chandragupta maurya and he composed the Arthasastra in the closing years of the fourth century B.C.

Arthasastra – A vast literagative source of Knowledge

The Arthasastra contains 15 Adhikarnas with 180 prokaranas (Sections). It is also divided by another device, perhaps a later one, into 150 adhyayas (Chapters) separated from one another by the insertion of verses, summarizing the subject of each Adhyaya Kautilya not only based his tex on the available knowledge, but also on his personal observation and study of political phenomena and institutions.

i) Book One: This preliminary part of the Arthasastra dealks with the education and discipline of Princes and kings. According to Kautilya, a king must know metaphysics, the four Vedas, pastoral persuits, trade, industry and the science of state-craft and administration. He must control vices like, passions, lust, anger, greed, vanity, jealousy, etc. He must pay heed to all the departments of the government and administer justice impartially. Kautilya discusses the appointment of ministers and other offcers of the State and the daily routine to be followed by the ruler. He sets a daily time-table of the duties of the king.

ii) Book Two: It principally describes the duties of the various executive- officers of the state. It gives a fairly full picture of State activity in various fields. It deals with the bureaucratic system of government. It discusses significant questions of land, administration and fortification of towns, industrial establishments, laying out the capital, regulations of imports, prostitution, adulteration etc. The concluding portion of the book discusses critically the government of the cities, the multifarious duties of the city-mayor etc.

iii) Book Three: It gives knowledge about law and its administration. It reproduces complete Code of Law. It discusses many cases of civil law like marriage, remarriage of widows and males, dowry, inheritance, partition, contracts, debts, deposits, pledges, partnership, revocation of sale and purchase, etc.

iv) Book Four: It mentions about suppression of crime. It explains the removal of dangerous elements like deceitful and fraudulent artisans and merchants, traders committing fraud in weights and measures, etc. It shows how to track and punish thieves, murderers, dacoits and other criminals. It provides penalty for the counterfeit coins and remedies against natural calamities like flood, epidemic and famine. It enlists measures for the protection of people from suspects and oppression of government – servants, death-penalty with or without torture, punishment for transgression on social obligations, etc.

v) Book Five: It is miscellaneous in character. It deals with various topics like secret measures against seditious persons and ministers, salaries for the different categories of State servants, measures to fill the treasury of the king, etc. It also explains how a candidate for a high office in the State should endeavor to secure and retain it. Finally, it gives advice to the Prime-minister on ensuring continuity of rule on the demise of the ruling monarch. Kautilya favors the hereditary monarchy.

vi) Book Six: It enumerates the qualities which make each of the seven Prakritis or constituents of State ideal. Six political expedients like peace, war with another and alliance with others are also described. It also explains the Raja mandala or circle of kings as a preliminary to discussion on the State's relations with its neighbors. It is the shortest among all the book chapters.

vii) Book Seven: It contains an exhaustive discussion on the way in which each of the six Gunas (six political expedients in the field of diplomacy) may be used in the various situations that are likely to arise. In case of conquest. Kautilya describes the various ways in which rivals may be outwitted by stratagem or overcome by force. In case the king is weak he should sue for peace.

viii) Book Eight: It is clearly narrates the calamities such as flood, fires, etc., and shortcomings and weaknesses affecting the various Prakrits. It is necessary to overcome these calamities and drawbacks before any aggressive activity can be undertaken. Kautilya advises a king to avert financial troubles in the interest of his people and property.

ix) Book Nine: It contains information and guidance before launching an expedition. It deals with preparations for war and describes the kinds of troops that should be mobilized for an expedition, precautions to be taken and the dangers to be guarded before starting and expedition. The king must take to be guarded before starting an the expedition, march of the army, possible trouble in the rear, loss of men and money, ultimate gain expected and internal and external dangers that are likely to arise as a result of invasion. Kautilya explains the strategic measures for averting many kinds of political dangers.

x) Book Ten: It is explained with fighting, defense of the capital camping of the army, its march, use of the services of the non-combatants for making roads, bridges, wells, various modes of fighting types of battle – array, secret measures to destroy the enemy, and other topics.

Conclusion

Thus Arthasastra has proven it is the prime source material which reveals the history of Mauryas. It is considered as one of the primary source to reconstruct the history of mauryas.

It clearly explained the foundation of Mauryan Empire by Chandragupta Maurya, its rulers and its diplomatic history. Moreover it gives first hand informations about Pataliputra, the capital city of Mauryas. It clearly pictured about the municipal administration of Pataliputra and its autonomy. The material evidence of Arthasastra is unavoidable and more precious.

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அணைக்கரை கருணை இல்லம் - ஒரு மீள் பார்வை

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ஆய்வுச்சுருக்கம்

"சிரிக்கத் தெரிந்தவனே கவலைகளை மறக்கத் தெரிந்தவன்

சிந்திக்கத் தெரிந்தவனே சாதிக்கத் தெரிந்தவன்

சாதிக்கத் தெரிந்தவனே சரித்திரம் படைக்கத் தெரிந்தவன்"

என்ற பொன்மொழிக்கேற்ப அணைக்கரையின் அகல்விளக்காய் திகழ்ந்து கொண்டிருப்பதே திருஇருதய கன்னியர் சபையின் கருணை இல்லம். இறைத்திட்டத்தைத் தனதாக்க எண்ணி முட்காடுகளும், மணல் திட்டுகளும் புடைசூழ, அக்கினி வெயிலும், மழைச்சாரலும், கோலமிட வாழ்விழந்து, வண்ணம் இழந்து, வாடி நின்ற இயலாக் குழந்தைகள், பெற்றோர்களாலே ஏற்றுக்கொள்ள முடியாமல் தூக்கி வீசப்பட்ட குழந்தைகள் இவர்களின் துயர் நீக்கி, கண்ணீர் துடைத்து, தாயாய் விளங்கியவர் அன்னை ஸ்கொலாஸ்டிக்காள். அவரது அயராத உழைப்பாலும் முயற்சியாலும் உருவாக்கப்பட்டதே இக்கருணை இல்லம். நலிந்தோர் நலம் காக்க, விழியிழந்தோர் விழியாக கருணை மனம் கொண்ட அன்னையால் 1982-ஆம் ஆண்டில் உருவாகி இன்றும் செயல்பட்டு வருவது தான் அணைக்கரை கருணை இல்லம். இவ்வில்லத்தின் வழியாக வாழ்வு பெற்ற இயலாக் குழந்தைகள் ஏராளம். இயேசுவின் திருஇருதய அன்பின் சாராம்சத்தை வாழ்வில் எண்பிக்க சிறகொடிந்து வாழும் இவ்வியலாக் குழந்தைகளுக்கு சிறகாக அனைத்திலும் அனைத்துமாய் இருந்து வழிகாட்டுவதும், வாழ்வளிப்பதும் இவ்வில்லத்தின் உயரிய நோக்கமாகும். இந்நோக்கத்தின் அடிப்படையிலேயே பெற்றோரால் புறம் தள்ளப்பட்டு, உடன்பிறப்புகளால் ஏளனத்துக்குள்ளாக்கப்பட்டு வாழ்வில் நம்பிக்கையிழந்து, உலகில் வாழ்வதே வீண் என உழன்ற குழந்தைகளின் விழிகளின் விழிநீரைத் துடைத்து, அன்புக்காய் ஏங்கும் ஏழை, எளியவர் தம் சோகங்களைத் தன் சொத்தாக்கி அவர் தம் துயர் துடைத்து மனித மாண்புயர உழைத்து, அன்னவர் ஏக்கம் போக்கி, அனைத்துவித தேவையிலும் உடனிருந்து அன்னையாய் அரவணைத்தவர் தாம் இயேசுவின் திருஇருதய சபை நிறுவனர் அன்னை ஸ்கொலாஸ்டிக்கா மற்றும் அருட் சகோதரிகள். "சேவை செய் சிகரம் காண்பாய்" என்பதற்கேற்ப இன்றும் தொடர்கிறது இவர்களின் சேவை. இவ்வில்லம் பலருக்கும் குறிப்பாக ஜாதி, மதம், இனம், மொழி, வேறுபாடின்றி சமதர்ம சமுதாயத்திற்கு வித்திட சமத்துவ தென்றலாய் வலம் வந்து கொண்டிருக்கிறது. அன்பும், அமைதியும், மகிழ்ச்சியும், நீதியும், சமத்துவமும், சகோதரத்துவமும் நிறைந்து விளங்கும் இந்த மனித சமூகத்திற்கு பகிர்தலே மிக முக்கியமானது என்பதை முன்னிறுத்தி செயல்பட்டு வருகிறது இக்கருணை இல்லம்.

முன்னுரை

உலகில் பிறக்கின்ற ஒவ்வொரு உயிரினத்தின் பிறப்பிற்கும் ஒரு நோக்கம் அல்லது ஓர் இலக்கு அல்லது இலட்சியம் இருக்கின்றது. அது போலவே இவ்வுலகில் இருக்கின்ற ஒவ்வொரு நிறுவனங்கள், அமைப்புக்கள், சபைகள் அனைத்தும் அதனதன் நோக்கங்களைக் கண்முன் கொண்டே செயல்பட்டு வருகின்றன. இப்படிப்பட்ட உயரிய நோக்கங்களுடன் செயல்படுவதே இயேசுவின் திருஇருதய மாற்று திறன் படைத்த மற்றும் இயலாக் குழந்தைகள் இல்லமாகும். 1895-ஆம் ஆண்டில் புனித அகஸ்டின் கானொனேசெஸ் என்ற துறவற சபையைச் சார்ந்த மரிய லூயிஸ் என்ற அருட்சகோதரி முளகுமூட்டில் அருட்தந்தையர்களால் நடத்தப்பட்ட குழந்தைகள் காப்பகத்திலுள்ள குழந்தைகளைக் கவனிக்கும் விதமாக பெல்ஜியத்திலிருந்து வர வழைக்கப்பட்டார்கள்.[1] சில ஆண்டுகளுக்குப்பின் கானொனேசெஸின் மறைபோதகர்கள் என்ற பெயரில் முளகுமூட்டினைத் தாயகமாக கொண்டு இல்லத்தில் வளர்ந்த பிள்ளைகளை இணைத்து புதிய சபையாக இதை மாற்றினார்கள். பெல்ஜியத்திலிருந்து வந்த மறைபோதக அருட்சகோதரிகள் போதுமான படிப்பும் அதற்கேற்ற சான்றிதழ்களும் கொண்டிருந்தார்கள். ஆனால், இங்கிருந்து தேர்ந்தெடுக்கப்பட்ட சகோதரிகளோ போதுமான படிப்பும் அதற்கேற்ற சான்றிதழ்களும் பெறாதவர்கள்.

இதனால், இவர்கள் பணிசெய்யும் துணைச்சகோதரிகளாகவே கருதப்பட்டார்கள். அவர்களில் ஒருவராக இச்சபையில் சேர்ந்தவர்கள் தான் இயேசுவின் மீது அதிகமான பாசமும், பற்றுதியும் கொண்ட ஏசுவடியாள் என்ற பெயர் கொண்ட அன்னை ஸ்கொலாஸ்டிக்கா. என்றுமே இயேசுவுக்கு ஒரு அடிமையாக இருக்கவேண்டும் என்ற எளிய மனநிலையைக் கொண்டவர்கள் அன்னையவர்கள். ஒன்பதாம் வகுப்பு வரை படித்து முடித்து தமிழ் ஆசிரியராக பணியாற்றியவர்கள். முளகுமூட்டில் மறைபோதக அருட்சகோதரிகள் என்ற சபையில் இணைந்து 1941-இல் தனது முதல் வார்த்தைப்பாட்டினைப் பெற்று துணை சகோதரியாக இருந்தார்கள். 1951-ஆம் ஆண்டு பன்னிரண்டாம் பத்திநாதர் என்ற பாப்பரசர் ஒரு சபையில் இரண்டு விதமாக சகோதரிகள் இருக்கக் கூடாது என்ற ஆணையின் பேரில் பயிற்சியில் இருந்த படிப்பை முடிக்காத சகோதரிகளைத் திரும்ப அவர்களது வீடுகளுக்கு அனுப்புவது அல்லது வேறு கன்னியர் சபையில் சேர அனுமதி கொடுப்பது என்று முடிவெடுக்கப்பட்டது.[2] இதனால், சரிவர படிப்பை முடிக்காத இளம் உள்ளங்களுக்கு கலக்கமும், வேதனையும், கவலையும் ஏற்பட்டு அழுது புலம்பினர். இந்த செய்தி கன்னியாகுமரி அகஸ்டின் சபை கன்னியர் இல்லத்தில் ஆண்டு தியானம் செய்து கொண்டிருந்த ஸ்கொலாஸ்டிக்கா அருட்சகோதரியின் உள்ளத்திலும் ஒருவிதமான கலக்கத்தையும், மனவருத்தத்தையும் ஏற்படுத்தியது. இந்நேரத்தில் தூய ஆவியானவரின் தூண்டுதலால் வீட்டிற்கு அனுப்பப்படும் இந்த சகோதரிகளைக் கொண்டு இயேசுவின் பெயரால் புதிய சபை தொடங்கலாமே! என்ற எண்ணம் அருட்சகோதரி ஸ்கொலாஸ்டிக்காவுக்கு ஏற்பட்டது. இந்த எண்ணம் அவர்களின் ஏக்கமாக மாற பலரிடமும் ஆலோசனைகளைப் பெற்றுக் கொண்டார்கள்.[3]

மரியாய் என்ற பெயர் கொண்ட இவர்களது தங்கை, அன்னாள் சபையைச் சேர்ந்த

அருட்சகோதரி பெனடிட் மற்றும் அவர்களின் பங்கு தந்தையாக இருந்த அருட்தந்தை நவமணி ஆகியோர் தூத்துக்குடி ஆயர் ரோச் ஆண்டகையிடம் மதிப்பும், மரியாதையும் பெற்றிருந்ததால், இயேசுவின் சிறிய சகோதரிகள் என்ற பெயரில் அழகப்பப்புரத்தில் சபை தொடங்க வாய்மொழி வழியாக அனுமதி பெற்றுக் கொண்டார்கள். இந்த வாய்மொழி அனுமதியைக் கொண்டு 1952-ஆம் ஆண்டு ஜுன் 21-ஆம் நாள் அகஸ்டின் சபையில் விருப்ப நிலையில் இருந்த அருட்சகோதரி ரோஸ், அருட்சகோதரி ராஜம், அருட்சகோதரி வெரோணிக்காள், அருட்சகோதரி மார்கிரட், அருட்சகோதரி ஆக்னஸ் இவர்களைக் கொண்டு புதிய சபைக்கான விதை அழகப்பப்புரத்தில் ஊன்றப்பட்டு இன்று வரை செழிப்புற்று வளர்ந்து வருகிறது.[4] பிறகு பத்து ஆண்டுகள் இயேசுவின் திருஇருதய அருட்சகோதரிகளுக்கு பல்வேறு துன்பங்களும் துயரங்களும் அழகப்பப்புரம் பங்கு மக்களாலும், அருட்தந்தையர்களாலும் மறைமாவட்ட நிர்வாக அருட்தந்தையர்களாலும் ஏற்பட்டது. பின்னர் 1964-ஆம் ஆண்டில் இயேசுவின் திருஇருதய சபை வளர்ச்சிக்காக சொந்த நிலம் தேவை என்பதை உணர்ந்த பெரியவர்கள் மற்றும் வழிகாட்டிகள், பல நல்ல உள்ளங்களின் உதவியோடு அணைக்கரை ஊரில் நூறு ஏக்கர் நிலம் வாங்கி சபை இல்லத்தை இடமாற்றம் செய்தனர். அதிலிருந்து சபை மீண்டும் தளிர்க்கவும், வளரவும் துவங்கியது.

இயேசுவின் திருஇருதய சபையின் ஆன்மீகம்

"ஆன்மீகம் என்பது உன்னத அன்பின் அடிநாதம்" இயேசுவின் திருஇருதயத்தின் ஆன்மீகம் என்பது இயேசுவின் மூலம் வெளிப்படுத்தப்பட்ட கடவுளின் இரக்கமுள்ள அன்பை அனுபவிக்கும் வழியை எடுத்துக்காட்டுகிறது. இயேசுவின் திருஇருதய சபை நிறுவனர் அன்னை ஸ்கொலாஸ்டிக்கா அவர்கள் கிறிஸ்துவின் அன்பை நிபந்தனையின்றி அனுபவித்து அதை எந்தவித எதிர்பார்ப்பும் இல்லாமல் ஏழைகளோடு பகிர்ந்து கொண்டார்.[5] ஒருவரையொருவர் அன்பு செய்வதன் மூலமும் கடவுளின் படைப்புகள் அனைத்திலும், குறிப்பாக கைவிடப்பட்ட பெண்கள், ஏழைகள் மற்றும் மாற்றுதிறனாளிகளை மரியாதையோடும், அக்கறையோடும், அன்போடும், தாழ்ச்சி நிறைந்த உள்ளத்தோடும் வழிநடத்தி தமது அன்பைப் பகிர்ந்துகொள்ள அனைவருக்கும்

அழைப்பு விடுத்தார்கள். இதனால், இயேசுவின் திருஇருதயத்தின் பக்தியை எல்லா சூழ்நிலைகளிலும் குறிப்பாக துன்ப துயரங்களின் போது "இயேசுவின் திரு இருதயதயமே என் நம்பிக்கையெல்லாம் உமது பெயரில் வைக்கின்றேன்" என்ற ஜெபத்தின் மூலம் அவர்கள் எல்லா பிரச்சனைகளிலும் அமைதியையும் வெற்றியையும் அடைந்தார்கள்.[6] பங்கிலுள்ள எல்லா வீடுகளிலும் இயேசுவின் திருஇருதய படங்களை நிறுவுவதன் மூலம் திருஇருதய பக்தியைப் பரப்பினர். அதைத் தொடர்ந்து இயேசுவின் திருஇருதய ஜெபங்கள், திருஇருதய நண்பர்கள் இயக்கம் போன்றவற்றின் மூலம் சிறப்பு முயற்சிகளை மேற்கொண்டார்கள்.

அணைக்கரை கருணை இல்ல வரலாறு

"சின்னஞ்சிறிய சகோதர சகோதரிகளுக்கு எவற்றை செய்வீர்களோ அவற்றை எனக்கே செய்தீர்கள்" என்ற இறைவார்த்தைக்கேற்ப இயேசுவின் திருஇருதய சபை சகோதரிகள் மூலம் அனைவருக்கும் வாழ்வு வழங்க வேண்டும் என்ற நோக்கத்தோடு முட்காடுகளை வெட்டி சீர்செய்து, அணைக்காயில் 1964 -ஆம் ஆண்டு கருணை இல்லத்திற்கு அடித்தளமிட்டார்கள். அவர்களுக்கு உதவி செய்தவர்கள் அவர்களது தங்கை அருட்சகோதரி மார்கிரேட்டும் மற்றொரு தங்கையாகிய மரிய ஆரோக்கியமும் அவரது துணைவர் திரு.அந்தோணி முதுதமாகும். இவர்களோடு இணைந்து பல பொதுநிலையினரும் உழைத்தார்கள். விளைவு 1964 -ஆம் ஆண்டு அணைக்கரையில் நூறு ஏக்கர் நிலம் வாங்கப்பட்டு 1982 -ஆம் ஆண்டு ஏப்ரல் 17- இல் நான்கு ஊனமுற்ற மற்றும் மாற்றுத்திறன் குழந்தைகளோடு கருணை இல்லம் தொடங்கப்பட்டது.[7] ஆரம்பத்தில் இவர்களைப் பராமரிக்க இரண்டு அருட்சகோதரிகள் மட்டுமே இருந்தனர். இப்போது அது வளர்ச்சி பெற்று போதுமான கட்டிட வசதிகளுடன் நூறு பிள்ளைகளுக்கு வாழ்வாதாரமாகத் திகழ்கின்றது. இவர்களில் முப்பது பிள்ளைகள் இயேசுவின் திருஇருதய இயலாக் குழந்தைகளுக்கான பள்ளியில் கல்வி கற்று வருகின்றனர். மேலும் இங்குள்ள பிள்ளைகளை கவனிக்க கருணை உள்ளம் கொண்ட பணியாளர்களும் அவர்களோடு ஆறு அருட்சகோதரிகளும் இருந்து வருகின்றார்கள்.[8]

இல்லத்தின் செயல்பாடுகள்

உடல் மற்றும் மனவளர்ச்சி குன்றிய குழந்தைகளுக்கு அவரவர் திறமைக்கேற்ப

ஆசிரியர்கள் மற்றும் அருட்சகோதரிகள் மூலம் கல்வி பெறும் வாய்ப்பினை கொடுத்து வருகின்றார்கள். மேலும், குழந்தைகளுக்கு அன்றாட கடமைகளைச் செய்வதற்கும், கைத்தொழில் செய்வதற்கும் பயிற்சி அளித்து வருகின்றார்கள். உடல் வளம்பெற உடற்பயிற்சியும், யோகாபயிற்சியும் மருத்துவ ஆய்வுக்கு உட்படுத்தி மருத்துவ வசதியும் அளித்து குழந்தைகளின் உடல் நலன்களைப் பாதுகாத்து வருகின்றார்கள்.[9] உதவி செய்யும் உபகாரிகளுக்காக தினமும் அருட்சகோதரிகளும், பிள்ளைகளும் நற்கருணை ஆராதனைச் செய்து வருகின்றார்கள்.[10] மட்டுமல்ல குழந்தைகளின் திறனுக்கேற்ப பாடல், நடனம், பொழுதுபோக்கிற்கான விளையாட்டுக்கள், கிறிஸ்துமஸ் வாழ்த்து அட்டை செய்தல், தோட்டவேலை செய்யவைப்பது எழுத்துக்கள் எழுத என்று பல பயிற்சிகள் கொடுத்து வருகின்றார்கள்.[11] இப் பிள்ளைகளின் ஜெபத்தினால் பலர் குழந்தைப்பேறு இல்லாதவர்களுக்கு குழந்தைப்பாக்கியமும், உடல்நலம் குன்றியவர்களுக்கு உடல்நலமும் பெற்று வருகிறார்கள். அவர்கள் குழந்தைகளுக்கு நன்றி கூறும் விதமாக உணவுகள், உடைகள், பரிசுப்பொருட்கள் கொடுத்து மகிழ்கின்றார்கள். மேலும் உடல்நலம் இல்லாத இயலாக் குழந்தைகளை நாகர்கோவில் ஆசாரிப்பள்ளம் அரசு மருத்துவர்களின் உதவியுடன் சிறப்பு சிகிட்சை அளித்து வருகின்றார்கள். மனநலம் சார்ந்த மருத்துவர்களையும் அழைத்து சிறப்பு சிகிட்சையும அளித்து வருகின்றார்கள். பிள்ளைகள் மகிழ்ச்சியாக வாழ்வதேற்கேற்ற சூழல்களை அமைத்துள்ளனர்.[12]

தொடக்கக்கால பணிகளும் வாழ்க்கை முறையும்

"பணிவிடை செய்வது பரமனுக்கே பணிபுரிவது போன்றது" என்பதற்கேற்ப சுமார் நான்கு பிள்ளைகளாகிய ஜார்ஜ் மேரி, கீதா, செல்வி, ஜெபா ஆகிய பிள்ளைகளுடன் ஆரம்பித்த

இக்கருணைஇல்லம் படிப்படியாக வளர்ந்தது. தொடக்கக் காலத்தில் பொருளாதார நெருக்கடிக்கு மத்தியில் பிள்ளைகளின் நல்வாழ்வுக்காக இயலாக் குழந்தைகளின் உதவியோடு கைத்தொழில்கள் செய்ய திட்டமிடப்பட்டது. முண்டாசு கவி பாரதியின்,

> "கைத்தொழில் ஒன்றைக் கற்றுக் கொள்
> கவலை உனக்கில்லை ஒத்துக்கொள்
> எத்தொழில் எதுவும் செய்யாமல்
> இருந்திடல் உனக்கே சரியாமோ?

ஏன்ற வாக்கினை மனதில் கொண்டு திருஇருதய சபை நிறுவனர் அன்னை ஸ்கொலாஸ்டிக்கா அவர்கள் வறுமையினாலும் மனதினாலும் பாதிக்கப்பட்டவர்கள் வாழ்வு உயர அனைவருக்கும் வேலைவாய்ப்பை வழங்கும் நோக்கில் கைத்தொழில்கள் கற்றுக்கொடுக்க வழிவகுத்தார்கள். இயற்கையாக கிடைக்கக்கூடிய பொருட்களைக் கொண்டு பிறர்க்கு பயன் தரும் வகையில் மகிழ்ச்சியும் கவர்ச்சியும் ஏற்படுமளவில் பல வகையான கைவினைப் பொருட்களைச் செய்ய கற்றுக் கொடுத்தார்கள். ஊதாரணமாக மரவள்ளிப்புட்டு, பூக்கள், கற்றாழை நார் கூடை, மீன் செதில், கடல் சங்கு, துண்டு துணிகள் போன்றவற்றைக் கொண்டு கண்காட்சி பொருட்கள் செய்தல், ஓய்வு நேரங்களில் பூ சரம் செய்தல், துணிகளைக் கொண்டு பூ செய்தல், மெழுகுவர்த்தி செய்தல் போன்ற கைத்தொழில்கள் செய்து வந்தார்கள். இதன் மூலம் கிடைத்த வருவாயே தொடக்கக்காலத்தில் அனைவரின் சாப்பாட்டுக்கும் உதவியது. அதன் பின் பணிக்காக பதினெட்டு கிளை பணித்தளங்கள் தொடங்கப்பட்டன. பணியின் பொருட்டு ஊர்களுக்கு செல்லும் போது போக்குவரத்து வசதிகளின்றி எல்லா இடங்களுக்கும் நடந்தே சென்று வருவார்கள். இவ்வாறு நான்கு ஊனமுற்ற குழந்தைகளுடன் மலர்ந்த அணைக்கரை இயேசுவின் திருஇருதய மாற்றுத்திறன் படைத்த குழந்தைகள் காப்பகமானது படிப்படியாக வளர்ந்து இப்போது நாற்பது ஆண்டுகளை கடந்து விட்டது. இன்று இங்கு நூறு உடல் மற்றும் மனநலம் பாதிக்கப்பட்ட பிள்ளைகளைக் காணப்படுகின்றனர்.[13] இவ்வில்லத்தில் வளர்ந்த எட்டு பிள்ளைகளுக்கு திருமணம் நடத்தப்பட்டு அவர்கள் சிறப்பாக உள்ளார்கள். கைத்தொழில் செய்வதில் தேர்ச்சிபெற்றவர்கள். வெளியூர்களில் சென்றும் வேலைபார்த்து வருகிறார்கள். மேலும் இவ்வில்லத்தில் வளர்ந்த பிள்ளைகளில் அருள்மேரி என்னும் பெண் பி.காம் பட்டத்துடன் கணிணி படிப்பையும் முடித்து கூடங்குளத்தில் அரசு ஊதியத்தில் வேலைபார்த்து வருகிறார். சங்கீதா என்ற மற்றுமொரு பெண் பி.காம் படிப்பை முடித்து இப்போது வேலைக்காகக் காத்திருக்கிறார்கள். இவர்கள் இருவருமே அரசுத்தேர்வில் முதல் மதிப்பென் பெற்றவர்களாவர்.[14]

வளர்ச்சி பாதையில் பயணித்த அருட்சகோதரிகள், அருட்தந்தையர்கள் மற்றும் பொது நிலையினர்

- 1989-ஆம் ஆண்டு அருட்சகோதரி அல்போன்ஸ் அவர்களின் பெரும்முயற்சியால் அணைக்கரை இல்ல குழந்தைகளுக்கு மண்சுவரால் ஆன ஓட்டுக்கட்டிடம் கட்டப்பட்டு, மதுரை ஆயர். மேதகு அமலநாதன் அவர்களால் திறக்கப்பட்டது.[15]

- 08-09-1995-இல் அணைக்கரைஇல்ல குழந்தைகள் தற்போது தங்கியுள்ள இல்லமானது அருட்சகோதரி மரிய செல்வம் அவர்களது முயற்சியால் தொடங்கப்பட்டது.[16]

- 2004-ஆம் ஆண்டில் அருட்சகோதரி புஷ்பதிரேஸ் அவர்களின் முயற்சியால் கருணை இல்லத்திற்கு அரசு அங்கீகாரம் கிடைத்தது. மேலும் 2004 -இல் தன்னிறைவு திட்டத்தின் மூலம் கட்டிடம் ஒன்று கட்டப்பட்டு கூடங்குளம் அனுமின் நிலைய திட்ட அலுவலர் திரு.அகர்வால் அவர்களால் திறந்து வைக்கப்பட்டது.[17]

- 2005-ஆம் ஆண்டில் அருட்சகோதரி ஆலிஸ் அவர்கள் இவ்வில்ல குழந்தைகளைச் சிறப்பான விதத்தில் கவனித்தற்காக திருநெல்வேலி மாவட்ட ஆட்சியாளர் உயர்திரு. அதுல் ஆனந்திடமிருந்தும் 2008-ஆம் ஆண்டில் துளிர் இயக்கத்திலிருந்தும் விருதுகள் பெற்று திரு இருதய கன்னியர் இல்லத்திற்கு பெருமை சேர்த்தார்கள்.[18]

- 2005-ஆம் ஆண்டு முதல் அருட்சகோதரி பிரிஜித் ஜான்சி அவர்கள் அனைத்து பிள்ளைகளையும் தாயன்போடு கவனித்து வந்தமைக்கு இயேசுவின் திருஇருதய சபையின் தலைமையன்னை பாராட்டுக்களைத் தெரிவித்துள்ளார்கள்.[19]

- 2005-ஆம் ஆண்டு மேதகு ஆயர் யுவான் அம்புரோஸ் அவர்கள் உதவியால் மினிபேருந்தும் ஆழ்குழாய் கிணறும், விளையாட்டுப் பொருட்களும் வாங்கப்பட்டது.[20]

- இவ்வில்லத்திற்கு இயலாக் குழந்தைகள், பெரியவர்கள் அதிகமாக வந்ததால் போதுமான கட்டிட வசதியை உருவாக்க வேண்டி 2007-ஆம் ஆண்டு நான்கு ஏக்கர் நிலம் வாங்கப்பட்டது.[21]

- 09-08-2007 அன்று இருபத்தைந்தாம் ஜூபிலியை முன்னிட்டு தூத்துக்குடி மறை மாவட்ட மேதகு ஆயர் யுவான் அம்புரோஸ் அவர்களால் அடிக்கல் நாட்டப்பட்டு பணி ஆரம்பித்து 12-06-2010 அன்று திறக்கப்பட்டது.[22]

- 09-02-2010 அன்று திரு.மனோகரன் (DRDO) அவர்களால் திருச்செந்தூர் கோவிலைச் சுற்றித் திரிந்த மனநலம் பாதிக்கப்பட்ட ஒன்பது பிள்ளைகள் இவ்வில்லத்தில் அழைத்து வரப்பட்டு, பராமரித்து வருகிறார்கள்.[23]

இவ்வில்ல குழந்தைகளின் மருத்துவச் செலவுக்காகவும் படிப்புச் செலவுக்காகவும் அடிப்படைத் தேவைகளை நிறைவேற்றவும் உதவியர்வர்கள் ஏராளம். இக்கருணை இல்லத்திற்கு கருணையால் உதவிய அருட்தந்தையர்கள், உபகாரிகள், வழிகாட்டிகள், வள்ளல்கள் ஏராளம்.

செய்யும் சேவைகள்

இவ்வில்லத்திற்கு வருகின்ற குழந்தைகளுக்கு தக்க பாதுகாப்பு வழங்கப்படுகிறது. இயலாத நிலையில் இருப்பதால் அனைத்து உதவிகளும் செய்யப்படுகிறது. (எ.கா.ஆடை மாற்றுதல், குளிக்க வைத்தல், துணிகளை துவைத்தல், சாப்பாடு ஊட்டுதல் மற்றும் பலவகை தேவைகளையும் கவனித்து வருகின்றார்கள்). உடல் ஆரோக்கியத்தைப் பேணும் வகையில்

நல்ல சத்தான உணவுப் பொருட்களையே அளித்து வருகின்றார்கள். மனநலம் அதிகமாக பாதிக்கப்படும் நாட்களில் தகுந்த தயாரிப்போடு தனி அறைகளில் வைத்து நாள் முழுவதும் கண்விழித்து கவனித்து வருகின்றார்கள். ஒவ்வொரு நாளும் அவரவர் உடல் நலனுக்கு ஏற்ப மருத்துவர்களின் உதவியுடன் மருந்து மாத்திரைகள் அளித்து வருகின்றார்கள்.[24] இவ்வில்லத்தில் இறக்கும் குழந்தைகளை மனித மாண்புடன் அடக்கம் செய்ய தனிநிலம் ஒதுக்கப்பட்டுள்ளது. உரிய மரியாதையுடன் இறுதிச்சடங்கு செய்கின்றார்கள். இயலாக் குழந்தைகள் தனது உடல்நலனில் முன்னேற்றம் காண பிசியோதெரபி கொடுத்து வருகின்றார்கள். மனநிலையை ஒருங்கிணைக்க ஆன்மீக பாடல்களை இசைக்கருவிகளின் மூலம் இசைக்கின்றனர். இல்லத்து பிள்ளைகளைப் போல் அனைத்து விழாக்களையும் கொண்டாடி குழந்தைகளை மகிழ்விக்கிறார்கள். வருடம்தோறும் அனைவருக்கும் பல நல்லுள்ளங்களின் உதவியால் புத்தாடை

எடுத்து கொடுத்து குழந்தைகளை மகிழ்விக்கிறார்கள்.உதவி செய்யும் உபகாரிகள், நண்பர்கள் அனைவருக்காகவும் ஜெபிக்கவும் நன்றி கூறவும் ஒருநாளும் இப்பிள்ளைகள் மறப்பதில்லை.[25]

இவ்வாறு இனிய சேவைகளை இவ்வில்ல குழந்தைகளுக்கு ஆற்றி வருவது இயேசுவின் திரு இருதய சபை சகோதரிகள்.

முடிவுரை

"இறக்கத்தான் பிறந்தோம் அதுவரை

இரக்கத்தோடு இருப்போம்"

என்ற புனித அன்னைதெரசாவின் புனித மொழிக்கேற்ப இரக்கத்தின் இல்லமாக ஜொலிக்கும் அணைக்கரை இல்லத்தின் வழியாக வாழ்வடைந்தோர் ஏராளம். இயலாக் குழந்தைகள் என்று புறந்தள்ளப்பட்ட குழந்தைகள், வெறுத்து ஒதுக்கப்பட்ட மக்கள் அனைவரையும் ஒருங்கிணைத்து வாழ்நாள் முடியும் வரை அவர்களுக்கு உரிய தேவைகளை இனம் கண்டு உதவிசெய்து வருகிறது இவ்வில்லம். இப்புவியில் பிறந்த ஒவ்வொரு உயிரும் வாழவும்

வாழ்விக்கவும் பிறந்தவர்களே என்பதை உணர்த்தவும் உணர வைக்கவும் அவர்களின் உணர்வுகளுக்கு மதிப்பளித்து செயல்படவே கருணை இல்லங்கள் இருக்கின்றன. அவற்றுள் ஒன்றே அணைக்கரையில் செயல்பட்டு வரும் இரக்கத்தின் இல்லம். அனைவரும் இயலாக் குழந்தைகளைப் புறந்தள்ளாமல் அரவணைத்து, அவர்களும் மனித மாண்போடு வாழ வேண்டும் என்ற எண்ணத்தோடு செயல்படுவோம், செயல்படுத்துவோம். இறையாசீர் என்றும் நிறையட்டும் இரக்கத்தின் செயல்கள் மிளிரட்டும்.

End notes:

1. அருட்சகோதரி அன்னம்மாள், சபை வரலாறு, ஆறாவது பொதுப்பேரவை உரை, 1.

2. கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 3.

3. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 5.

4. அருட்சகோதரி அகஸ்டினம்மாள் சபையின் ஆன்மீகம் ஆறாவது பொதுப்பேரவை உரை, 1.

5. மேலது அருட்சகோதரி அகஸ்டினம்மாள் சபையின் ஆன்மீகம் ஆறாவது பொதுப்பேரவை உரை, 1.

6. கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 3.

7. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 3.

8. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 3.

9. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 3.

10. கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 4.

11. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 4.

12. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 4

13. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 4.

14. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 4.

15. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 4.

16. கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 5.

17. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 5.

18. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 5.

19. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 5.

20. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 5.

21. கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 6

22. மேலது கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 6.

23. கருணை இல்லம், அணைக்கரை, 28 ஆவது வருட ஆண்டறிக்கை, 8.

An Economic Study on Cashew Nut Industry Workers in Kanyakumari District with special reference to Villukuri Town

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ABSTRACT

Cashew industry is one of the most important sources of employment and income especially to the rural people in Kanyakumari district. It also fetches foreign earnings. So its role is important in the determination of the economic development of the District. The economic and political importance of the cashew industry is based on the Great number of workers employed and the amount of foreign currency earned through cashew exports. The problem of the present study is to analyze the socio-economic conditions of cashew workers in Kanyakumari District. Cashew workers of different caste and age groups, marital status, level of education and economic background have been analysed for the study. Now-a-days, Cashew workers are facing many problems while running and working in the field. It is very essential to know about the important problems of the cashew workers because it plays an important role in the growth of the socio-economic conditions of the workers and in the economic development of the district, state and the country. Hence, the present study to analyse the economic status and problems of the cashew workers in Villukuri town.
Keywords: Cashew Industry, Income, Growth, Economic Status

Introduction

The cashew tree, native to Brazil, was introduced to Mozambique and then India in the Sixteenth century by the Portuguese, as a means of controlling coastal erosion. It was spread with in these countries with the aid of elephants that ate the bright cashew fruit along with the Attached nut. The nut was too hard to digest and was later expelled with the droppings. It was not until the nineteenth century that plantations were developed and the tree then spread to a number of other countries in Africa, Asia and Latin America. Cashew processing, using manual techniques, was started in India in the first half of the Twentieth century. It was exported from there to the wealthy western markets, particularly the United States.

Cashew nut, one of the most delicious and nutritious Nuts has been a product of wide demand all over the world. It is an item of food which is rich in protein, fats and vitamins that it is regarded as delicacy even in the advanced countries of the World. Botanically, cashew is a 'Wonder Nut', because it is the only nut which appears outside the fruit. It is funny looking With its nut snuggling close to its plump flesh, like a kangaroo With its young in it pouch in

fact, each part of the fruit is Useful to man. The Kidney shaped fruit's Kernel is available To the Consumers in its purest and natural form: that is why the saying "cashews care for your health".

The Importance of Cashew

Cashew is known by many names. In Mozambique, the Maconde tribe refer to it as the "Devil's Nut". It is offered at wedding ceremonies as a token of fertility and is considered by many to have aphrodisiac properties. The cashew industry ranks third in the world production of edible nuts with world Production in 2000 at about 2 million tonnes of nuts-in-shell and an estimated value in excess of US$2 billion. India and Brazil are the major cashew exporters, with 60 percent and 31 percent respectively of world market share. The major importers are the United States (55 percent), the Netherlands (ten percent), Germany (seven percent), Japan (five percent) and the United Kingdom (five percent). Cashew kernels are ranked as either the second or third most expensive nut traded in the United States. Macadamia nuts are priced higher and pecan nuts can be more costly, if the Harvest is poor. The extensive market connections of exporters from Brazil and India make it Difficult for the smaller exporters to make gains in the United States market. Importers may appreciate the low prices offered by small suppliers, but the lack of reliability in quality tends to make them favour the larger, more reputable suppliers.

Cashew Industry in India

Cash from cashew seems to reveal that cashews are commercially very Valuable processed nuts in the world. The English name cashew is derived from the Portuguese name for the fruit of a cashew plantation, caju. In India also, cashew is commonly known as kaju, and was brought by the Portuguese from Brazil during the 16th century. It was first planted in Goa, from where it spread to the other parts of the Country, and thereafter across to Southeast Asia, and even Africa.

Four centuries ago, when the Portuguese landed on the Indian soil, they brought with them the priceless tree nut, cashew. Cashew came, conquered, and took Deep roots across the entire coastal region of India. It found the Indian soil more Congenial for its growth than even its homeland—Brazil. Not surprisingly, it soon gained popularity as a cash crop in many parts of the country. But the large-scale Commercial cultivation of cashew commenced in India only during the early 1960s.

Today, India is one of the largest producers and processors of cashew in the World, and is still seeking new pastures for cultivation in the country. Cashew is presently grown in Kerala, Karnataka, Goa, and Maharashtra along the west coast, And in Tamil Nadu, Andhra Pradesh,

Orissa, and West Bengal along the east coast.

In India, cashew processing began during the first half of the 20th century. The processing was manual then. India is the second largest producer of raw cashew Nuts in the world, the first being Nigeria; India ranks number one in area under Cashew plantations, though. To be fair, almost 70 percent of the global raw cashew Production in 2010 was accounted for by just three countries, namely, Nigeria, India, and Vietnam. If three more countries, namely, Indonesia, the Philippines, and Brazil, Were added, then these seven countries together contributed as much as 84Percent to the total world production in that year. While India shared nearly 19.6 percent of the World acreage under cashew in 2010, it contributed 22.2 percent to the world Production. This was because it's per hectare yield of cashews in shell at 660 kg was then slightly higher than the global average of 585 kg. Nevertheless, India's average Yield was much less than similar yields of other major cashew producing countries Like Nigeria (2 tonnes), and Vietnam (1 tonne), and the Philippines (4.8 tonnes).

India is also the second largest exporter of shelled cashew (kernels) in the World, followed by Vietnam. India enjoys comparative cost advantage in not only Production of cashew fruit, due mainly to long coastal line of the country that favours Cashew cultivation, with apt soil and climatic conditions, but, more importantly, also Processing of raw cashews, owing to abundant availability of cheap and skilled Labour. To be sure, India may well be regarded as the global leader in cashew processing, mainly because of the dexterity of its labour. For, when processed manually, as in India, broken nuts hardly account for 20 Percent of the country's Output of processed kernels.

Methodology

A suitable methodology is necessary for any scientific analysis. The objectives and data interpretation of a problem cannot be done without research methodology. There are various methods to conduct research study. Researcher feels that questionnaire methods are more suitable. In this methods researcher prepare different questions, from a questionnaire and give to respondents. Whenever respondents feel any doubt with regard to any question it may be easily clarified by the researcher. Also the researcher adopts sampling methods to conduct the study.

Objectives

1. To study the socio-economic conditions of sample respondents.
2. To know the various problems faced by the sample respondents.

Statement of the Problem

Cashew industry is one of the most important sources of employment and income especially to the rural people in Kanyakumari district. It also fetches foreign earnings. So its role is important in the determination of the economic development of the District. The economic and political importance of the cashew industry is based on the Great number of workers employed and the amount of foreign currency earned through cashew exports. The problem of the present study is to analyze the socio-economic conditions of cashew workers in Kanyakumari District. Cashew workers of different caste and age groups, marital status, level of education and economic background have been analysed for the study. Now-a-days, Cashew workers are facing many problems while running and working in the field. It is very essential to know about the important problems of the cashew workers because it plays an important role in the growth of the socio-economic conditions of the workers and in the economic development of the district, state and the country. Hence, the present study to analyse the economic status and problems of the cashew workers in Villukuri town.

Method of data collection

An economic study on cashew nut workers with special reference to Villukuri Town requires primary and secondary data. Both the primary and secondary data have been used for the present study.

Primary Data

Primary data constitute of first-hand information on subject. The details regarding the data such as the level of income, expenditure and socio-economic condition of the sample respondents and such other information have been collected with the help of well-structured questionnaire.

Secondary Data

Secondary data were collected from the records of various journals, Magazines, books and internet, articles, websites.

Data Analysis

This chapter deals with an analysis of "An Economic Study on Cashew Nut Industry Workers in Kanniyakumari District with Special Reference to Villukuri Town". This Study is based upon both primary data and secondary data. This is collected from a sample respondent of Cashew workers. This present study has made use of the selection of sample respondents.

1. **Age Composition**

Age plays a vital role in determining the efficiency of individual. One's physical ability depends upon one's age. Table 1 shows the age wise composition of sample respondents.

Table 1.Age wise composition of the sample respondents

Age (in years)	No. of Respondents	Percentage
30-40	5	10
40-50	19	38
50-60	16	32
Above 60	10	20
Total	**50**	**100**

Source: Primary data

Table 1 shows the age wise distribution of the sample respondents. 38 per cent of sample respondents are between the age group of 40-50 and only 10 per cent of sample respondents are between the age group of 30-40.From this, it understood that maximum respondents is middle age group.

2. Gender Wise Classification

Gender is the main determinant of any action. The gender wise distribution of the sample respondents is shown in the table 2

Table 2. Gender wise classification of the sample respondents

Gender	No. of. Respondents	Percentage
Male	21	42
Female	29	58
Total	**50**	**100**

Source: Primary data

Table 2 shows 58 per cent of the sample respondents are female and 42 per cent of the sample respondents are male.

3. Health Issues

A health issue is a state in which a person is unable to function normally and without a pain. Health issues of a sample respondents is shown in table 3

Table 3. Health issues of the sample respondents

Health Issues	No. of Respondents	Percentage
Headache	13	26
Back pain	11	22
Leg pain	14	28
Depression	12	24
Total	**50**	**100**

Source: Primary Data

Table 3 indicates that 28 per cent of the sample respondents are having leg pain and 22 per cent of the respondents are having back pain.

4. Problem Faced By the Cashew Workers

The problems faced by the cashew worker are related to health issues, salary and lack of security. Table 4 shows the problem faced by the cashew workers.

Table 4. Problem faced by the sample respondents

Problems	No. of. Respondents	Percentage
Health issues	11	22
Lack of security	22	44
Salary	15	30
Others	2	4
Total	**50**	**100**

Source: Primary data

Table 4 shows that 30 per cent of the sample respondents have the salary problem and 4 per cent faces other problems. The cashew workers get only Low salary.

Findings

❖ Thirty eight percent of sample respondents are between in the age group of 40-50.

❖ Fifty eight percent of the sample respondents are female.

❖ Twenty eight percent of the sample respondents having leg pain.

❖ Thirty percent of the sample respondents have the salary problem.

Suggestions

❖ The cashew workers should be provided with adequate facilities like gloves, masks adequate number of clothes, washing allowance etc

❖ The primitive methods of cashew processing methods can be replaced by modern methods so that the work can be made easier and also helps allot for the cashew workers.

Conclusion

The cashew workers are having lot of hazards. In cashew processing the hazards are relatively less when compared to other high-risk occupations. Still, it poses Physical, Chemical, Biological and Psycho-sociological hazards to the employees. The Psycho-sociological hazards cause mental stress which in the long run causes other diseases caused by physical, chemical, ergonomically or biological hazards. Now, it's for the employers to take necessary steps to

prevent the risk of hazards in the cashew processing such as providing gloves, neat and clean environment including hygienically maintained toilets, ensuring minimum exposure to toxic gases and giving moral support to the suffering employees.

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An Economic Study on Consumer Preference of Branded Milk Consumption in Nagercoil

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ABSTRACT

Consumer behaviour refers to the mental and emotional processes and physical activities of people who purchase and use goods and services to satisfy needs and wants. Consumer preference is the reaction of human being in the selection of production. Consumers buy goods and services not just for their use value but to satisfy a variety of emotional needs. The quality of the product should meet the consumer needs. Consumption is an integral part of our life. It is present from the beginning to the end everywhere we go we buy, eat, use and take advantages of different things. In the course of time, we become aware of the negative impact of our consumption patterns on the environment. This allows us to change and join the sustainable development approach. Consumer patterns change for both micro and macro reasons. At the micro level, change is attributable to individual consumer's changing tastes.

Key words: Satisfaction, consumption

Introduction

Consumer preferences are subjective individual tastes, likes and dislikes, and predispositions. When you're building or marketing a product to your target consumers, you need to consider their personal preferences to get the best possible results.

Milk finds an essential place in our daily diet. The Indian medical association has recommended that an intake of ml of milk every day for an individual is necessary. Fat of butter fat is commercially the most valuable constituent of milk. A substance found only in milk is lactose or milk sugar. Milk is deficient in iron, but the others minerals make milk premier sources ofsupply of minerals for humans. Milk and milk products rank as a large secondary source of income of the farmers of the country. A good number of India's populations is engaged in the production, processing and marketing of dairy. Milk and milk products are very rich in protein, calcium, vitamins and milk sugar and they provide these nutrients in proper proposition.

Kanyakumari district is primarily an agriculture district with a sizable population depending on food crops and commercial crops. Dairy farming plays an important role in generating employment, income and capital storage, apart from and improving household nutrition in this district. In urban areas, the livestock owners adopt it as a fully-fledged business

for earning of livelihood.

Statement of the Problem

Agriculture is the backbone of the Indian Economy. Milk is the second largest agricultural commodity after rice. The major portion of dairying in India is carried on though co-operative societies. In Nagercoil dairy products are supplied in various ways. One among the ways is distributing them through shops, co-operative societies and through dealers. Branded milk is the dairy products supplied through shops and dealers. Majority of theconsumers in Kanyakumari District purchase branded milk through these sources. This motivated the research to do the research work on the topic.

Objectives

The following are the objectives of the present study.

1. To know the reasons for the purchase of branded milk.

2. To analyze the opinion of the respondents towards branded milk.

Methodology

The study made use of both primary data and secondary data. The primary data have been collected from 50 samples. The researcher collects the information through interview schedule method.

Results and Discussion

1. Age Composition

Age is an important factor which determines the satisfaction level of Sample respondents. The age wise distribution of the sample respondents given in table 1.

Table 1. Age Composition of the Sample Respondents

Age (in year)	No. of Respondents	Percentage
Below 20	9	18
20-30	14	28
30-40	21	42
Above 40	6	12
Total	**50**	**100**

Source: Primary Data

Table 1 reveals that 42 percent of the sample respondents belong to the age group of 31-40 years and 12 percent of the sample respondents are above 40 years.

2. Monthly Income

Income is the base on which everything can be done. Usually the people who get more income can lead a better life than the people with less income. Here income means the wages earned by the respondents. The following table 2 shows the monthly income of the sample respondents.

Table 2. Gender Classification of the Sample Respondents

Income (in Rs.)	No. of Respondents	Percentage
Below 5000	6	12
5000 – 10000	21	42
10000 – 15000	14	28
Above 15000	9	18
Total	**50**	**100**

Source: Primary Data

Table 2 reveals that 42 percent of the sample respondents are earning Rs. 10000 – 15000 and only 12 percent are getting above Rs. 15000. It shows that the dependent humans never consider the wage which is less.

3. Milk Brands

In the market, there are many kinds of branded milk such as Nanjil milk, Arokya, Cavin's milk etc. It creates heavy competition among each other. Table 3 shows the brand preferred by the sample respondents.

Table 3. Milk brands used by the sample respondents

Brand	No. of Respondents	Percentage
Nanjil	11	22
Arokya	13	26
Cavin's	5	10
Aavin	8	16
Matha	**4**	**8**
Jeppiaar	**6**	**12**
Others	**3**	**6**
Total	**50**	**100**

Source: Primary Data

Table 3 shows that 26 percent of the sample respondent likes to buy Arokya milk and 3 percent of the sample respondents like prefer other branded milk.

4. Buying pattern of the respondents

The customers buy the branded milk in different patterns. Some are buying the branded milk on a regular basis and some others buy the milk according to their requirements. Table 4 shows the buying pattern of sample respondents.

Table 4. Buying pattern of the sample respondents

Category	No. of Respondents	Percentage
Every morning	17	34
Every evening	13	26
Every morning and evening	11	22
As and when required	9	18
Total	**50**	**100**

Source: Primary Data

Table 4 reveals that 34 percent of the sample respondents buy milk every morning and 18 percent of the sample respondents buy milk as and when required.

5. Period of usage of branded milk

Period of usage of a product depends on the customer's satisfaction and preference towards that product. If a customer feels that the product has failed to satisfy him, then he will try to switch over to other product. Table 5 shows the period of usage of branded milk by sample respondents.

Table 5. Period of usage of branded milk by the sample respondents

Period (in year)	No. of Respondents	Percentage
1	7	14
2	11	22
3	14	28
Above 3	18	36
Total	**50**	**100**

Source: Primary Data

Table 5 shows that 36 percent of the sample respondents are consuming branded milk for 3 years and 14 percent of the sample respondents consume branded milk for 1 year.

6. Reasons for the purchase of branded milk

Reasons for the purchase of branded milk by the sample respondents are given in the table 6.

Table 6. Reasons for the purchase of branded milk by the sample respondents

Reasons	No. of Respondents	Percentage
Necessity	7	14
Growth of children	9	18
To make curd	6	12
To prepare tea and coffee	13	26
Balanced food	4	8
Give energy	8	16
Others	3	6
Total	**50**	**100**

Source: Primary Data

Table 6 discloses that 26 percent of the sample respondents purchase branded milk to prepare tea and coffee and 6 percent of the sample respondents purchase for other reasons.

7. Motivational factor

There are various factors that motivate the customers to buy the particular brand of milk. Table 7 shows the motivating factors for purchasing branded milk.

Table 7. Motivational factors for purchasing milk by the sample respondents

Factors	No. of Respondents	Percentage
Good Quality	**11**	22
Brand image	7	14
Easy availability	12	24
Tasty	6	12
Reasonable Price	9	18
Others	5	10
Total	**50**	**100**

Source: Primary Data

Table 7 reveals that 26 percent of the sample respondents buy milk because of its easy availability and 10 percent of sample respondents buy for other reasons.

Findings

- Forty two percent of the sample respondents belong to the age group of 31-40 years.
- Forty two percent of the sample respondents have monthly income ranging between Rs. 5000-10000.
- Twenty six percent of the sample respondents generally buy Arokya milk.

- Thirty four percent of the sample respondents buy milk every morning.

- Thirty six percent of the sample respondents have been consuming branded milk above 3 years.

- Twenty six percent of the sample respondents purchase branded milk to prepare tea and coffee.

- Twenty four percent of the sample respondents purchase branded milk because it is easily available

Conclusion

Branded milk was once enjoying monopoly in the field of Dairy in an economic study on branded milk consumption. But now the condition is not like that, since many new dairies are started with high distribution network which will affect the sales of this Dairy. So the union has to take necessary steps to increase the distribution and sales by procuring more milk and also by giving advertisement and consumers meeting to make this dairy to compete with the other firms.

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A Study on Agricultural Production in India

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ABSTRACT

Agriculture is an important sector in India. It is indispensable for the sustenance and growth of the Indian economy. On an average, about 70% of the households and 10% of the urban population is dependent on agriculture as their source of livelihood. Today, India is a major supplier of several agricultural commodities like tea, coffee, rice, wheat spices, oil meals, fresh fruits, fresh vegetables, meat and its preparations and marine products to the international market. India is a large producer of several agricultural products. In terms of quantity of production, India is the top producer in the world in milk, and second largest in wheat and rice. Agricultural production is prone to several risks which affect both producers and consumers. In order to enhance investment and achieve a sustained increase in production, coherent and integrated long-term strategies and policies are required to reduce risk aversion and build flexibility among Indian rural producers. There is a need to provide remunerative prices for farmers in order to increase the incomes of farmers.

Introduction

Agriculture is the primary source of livelihood for about 58% of India's population. Gross value added by agriculture, forestry and fishing was estimated at Rs.19.48 lakh crore (Us $276.37 billion) in FY20.Share of agriculture and allied sectors in gross value added (GVA) in India at current prices stood at 17.8 in FY20. Principal agriculture commodities export for April 2020-January 2021 was US $32.12 billion. The economic survey of India 2020-2021 report stated that in FY20, the total food grain production in the country was recorded at 296.65 million tonnes-up by 11.4 million tons compared with 285.21 million tonnes in FY19. The government has set a target to buy 42.74 million tonnes from the central pool in FY21. This is 10% more than the quantity purchased in FY20. For FY22 the government has set a record target for farmers to raise food grain production by 2% with 307.31 million tonnes of food grains. In FY21 production was recorded at 303.34 million tonnes against a target of 301 million tonnes.

Objectives

❖ To study the agriculture production in India from the year 2011-2021.

❖ To analyses sector wise commercial crop production in India from the year 2011-2021.

❖ To identify the food grain production in India from the year 2011-2021.

Statement of the Problem

Indian farmers are facing the problem of low income from the marketable surplus crop in the absence of proper organized market and adequate transportation facilities. Scattered and sub-divided holding are also creating serious problem for marketing their products. Slow Agriculture growth is a concern for policymakers as some two-third of Indian people depends on rural employment forliving. Current Agriculture practice are neither economically nor environmentally sustainable and Indian yield for many Agriculture commodities are low-poorly maintained irrigation system and almost universal lack of good extension services are among the factory responsible. Farmer access to markets is hampered by poor roads, rudimentary market infrastructure, and excessive regulation.

Methodology

The study makes use of secondary data. The secondary data collected from the websites of India Brand Equity Foundation, Reserve Bank of India and Economic and Political Weekly. The data were analyzed by using the statistical tools such as percentages and averages.

Analysis

The Table – 1 indicates the agriculture production in India from the year 2011 to 2021. The agriculture products are divided in to two viz. Food grains and commercial crops. The total food grain production in India during the period 2011 to 21 is 27384 lakh tonnes, the total commercial crops production is 199898 lakh tonnes and the total agriculture production during the same period is 227282 lakh tonnes.

Table 1. Agriculture production in India from the year 2011-2021

(Amount in lakh tonnes)

Year	Total food grains	Total commercial crops	Total agriculture production
2011-2012	2593	18,437	21030
2012-2013	2571	18,677	21248
2013-2014	2650	19,432	22082
2014-2015	2520	19,574	22094
2015-2016	2515	19,929	22444
2016-2017	2751	19,416	22167
2017-2018	2850	20,934	23784
2018-2019	2852	21,427	24279
2019-2020	2975	21,064	24039
2020-2021	3107	21,008	24115
Total	27384 (2738.4)	199898 (19989.8)	227282 (22728.2)

Source: Ministry of Agriculture & Farmers Welfare, Government of India, Coffee Board of India, Tea Board of India.

Note: Figures in the parentheses shows the averages

Food grain production in India

The table – 2 shows the food grains production in India from the year 2011-2021. As rice and wheat are the major food grains consumed by the people of India, only these two items were taken in this study. The total rice production is 1000.6 lakhs tons, and the average production is 1000.16 lakhs tons. From the Table 2 it is clear that the rice production is low during the year 2015-2016 and the production is 1044.1 lakhs ton during the period. The highest production is during the period 2020-2021 and the production during the same period is 1222.7 lakhs tons.

Table 2. Food grain production in India

(Amount in lakhs ton)

Source:

Year	Rice Production		Wheat Production	
	Amount	Percent	Amount	Percent
2011-2012	1053.0	10.5	948.8	9.7
2012-2013	1052.4	10.5	935.1	9.5
2013-2014	1066.5	10.7	958.1	9.8
2014-2015	1054.8	10.5	865.3	8.8
2015-2016	1044.1	10.4	922.9	9.4
2016-2017	1097.0	11.0	985.1	10.0
2017-2018	1127.6	11.3	998.7	10.2
2018-2019	1164.8	5.0	1036.0	10.5
2019-2020	1188,7	5.9	1078.6	11.0
2020-2021	1222.7	14.2	1095.2	11.1
TOTAL	10001.6 (Average: 1000.16)	100	9823.8 (Average: 982.38)	100

htt://m.rbi.in//scripts/Annualpublications.aspx?head=Handbook%20f%20statistics%20on%2 0Indian%20Economy

The table 2 also shows the wheat production in India from the year 201-2021. The total wheat production is 9823.8 lakhs tons, and the average production is 982.38 lakhs tons. From the table 2, it is clear that the wheat production is low during the year 2011-2012 and the production is 948.8 lakhs ton during the period. The highest production is during the period

2019-2020 and the production during the same period is 1078.6 lakhs ton.

Commercial crops production in India

The table 3 shows the major commercial crops of India i.e., cotton and raw jute production in India from the year 2011-2021. The total cotton production is 3350.1 lakhs tons, and the average production is 335.01 lakh tons. From the table – 3, it is clear that the cotton production is low during the year 2018-2019 and the production is 280.4 lakhs ton during the period. The highest production is during the period 2019-2020 and the production during the same period is 360.7 lakhs ton.

Table 3. Commercial crops production in India

(Amount in lakhs ton)

Year	Cotton Production		Raw Jute and Mesta Production	
	Amount	Percent	Amount	Percent
2011-2012	352.0	10.5	114.0	10.8
2012-2013	342.2	10.2	109.3	10.3
2013-2014	359.0	10.7	116.9	11.0
2014-2015	348.1	10.4	111.3	10.5
2015-2016	300.0	8.9	105.2	9.9
2016-2017	325.8	9.7	109.6	10.3
2017-2018	328.1	9.8	100.3	9.5
2018-2019	280.4	8.4	98.2	9.4
2019-2020	360.7	10.8	98.8	9.3
2020-2021	353.8	10.6	95.6	9.0
TOTAL	3350.1 (Average:335.01)	100	1059.2 (Average:105.92)	100

Source:

htt://m.rbi.org.in//scripts/AnnualPublications.aspx?head=Handbook%20Of%20statistics%20on%20Indian%20Economy

The table 3 also shows the raw jute and Mesta production in Indian from the year 2011-2021-2021. The total raw jute and Mesta production is 1059.2 lakhs tons and the average production is 105.92 lakhs tons. From the table 3, it is clear that the raw jute and Mesta production is low during the year 2020-2021 and the production is 95.6 lakhs ton during the period. The highest production is during the period 2013-2014 and the production during the

same period is 116.9 lakhs ton.

Investments

➢ From 2017 to 2020, India received – US $ 1 billion in agritech funding with. With significant interest from the investors, India ranks third in terms of agritech funding and number of agritech funding and number of agritech companies are likely to witness investment worth US & 30-35 billion.

➢ In March 2020, fact, the oldest large-scale fertilizer manufacturer in the country, crossed one million production and sale mark.

➢ Investment worth RS. 8,500 crore (US $ 1.19 billion) have been announced in India for ethanol production.

Government Initiatives

➢ As per Union Budget 2021-2022, RS 4,000 crore (US $ 551.08 million) was allocated towards implementing Pradhan Mantri Krishi Sinchayee Yojana (PMKSY-PDMC).

➢ The ministry of food processing has been allocated RS. 1,308.66 crore (US $ 180,26 million) in the union Budget 2021-2022.

➢ The total agricultural and allied products exports stood at (US $ 41.25 billion) in 2022-2021.

Road Ahead

India is expected to achieve the ambitious goal of doubling farm income by 2022. The agriculture sector in India is expected to generate better momentum in the next few years due to increased investment in agriculture infrastructure such as irrigation facilities, warehousing and coal storage furthermore. The growing use of genetically modified crops will likely improve the yield for Indian farmers. India is expected to be self-sufficient in pulses in the coming few years due to concerted effort of scientists to get early maturing varieties of pluses and the increase in minimum support price.

Findings

• The total food grain production in India during the period 2011 to 21 is 27384 lakh tonnes, the total commercial crops production is 199898 lakh tonnes and the total agriculture production during the same period is 227282 lakh tonnes.

• The total rice production in India during the study period from the year 2011-2021 is Rs.10001.6 lakhs ton and the average rice production in India during the same period is Rs.1000.16 lakhs ton. The total wheat production in India during the study period from the year 2011-2021 is Rs.9823.8 lakhs ton and the average wheat production in India during the same period is Rs.982.38 lakhs ton.

- The total cotton production in India during the study period from the year 2011-2021 is Rs.3350.1 lakhs ton and the average cotton production of India during the same period is Rs.335.01 lakhs ton. The total raw jute and Mesta production in India during the study period from the year 2011-2021 is Rs.1059.2 lakh ton and the average production is Rs.105.92 lakhs ton.

Suggestion

- ❖ New methods and techniques should be given to farmers to increase production and maintain their farm's long-term sustainability.

- ❖ Minimum support price should be provided to all the agricultural products of the farmers since they often get low price for their product.

- ❖ Agriculture marketing should be improved so that the farmer gets proper price for their produce warehousing facilities should be improved.

Conclusion

Agricultural sector is undergoing process of transition to a market economy, structural productive and supply setups, as is the case with all other sectors of the economy. Indian agriculture is mainly dependent on monsoon. So permanent means of irrigation should be developed. There should be large number of tubes well and canals for irrigation. Machines have the qualities that make rugged farming areas smooth to work on the field efficiently. Working on the field is easy, that means on improvement in productivity is easy if machines are introduced in all the agriculture production process.

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A Study on Consumer Behaviour Towards Instant Food Products in Nagercoil

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ABSTRACT

The study of consumer behavior has developed as an important and separate branch in marketing discipline. A huge population of consumers was spending large sum of money on goods and services. Besides this, consumer preferences were shifting and becoming highly diversified. The development of consumer behavior as a marketing discipline includes shorter product life cycles, increased environmental concerns, interest in consumer protection, growth of service marketing, opening up of international markets and the development of computers and sophisticated techniques of statistical analysis. Global firms tend to build consumer behavior by focusing on the following strategies to ensure the winning difference convergence of global brands to the requirement of local consumers. Enhancing customer value by offering quality products. Positioning products by developing the sense of high social equity. Consumer behavior is the study of individuals, groups, or organizations and all the activities associated with the purchase, use and disposal of goods and services. Consumer behaviour consists of how the consumer's emotions, attitudes, and preferences affect buying behaviour.

Introduction

In contemporary times, instant foods can be defined as foods that provide convenience to consumers and assists in reducing the time of preparation/cooking and drudgery , whereby no more than five minutes of time is required from the time of food preparation to the food being consumed. Some instant foods include a food product that involve the dissolving of a powder in hot water, or the dilution of a concentrated stock solution, such as occurs with condensed soup. The category of ultra-instant foodcomprises instant foods that require less than one minute of time to prepare, such as instant tea. Some instant foods are prepared using freeze-drying.

Instant foods, are food that is commercially prepared (often through processing) to optimize ease of consumption. Such food is usually ready to eat without further preparation or need some simple preparation such as adding hot water or milk. It may also be easily portable, have a long shelf life, or offer a combination of such convenient traits. Although restaurant meals meet this definition, the term is seldom applied to them. Convenience foods include ready-to-eat dry products, frozen foods such as TV dinners, shelf-stable foods, prepared mixes such as cake mix, and snack foods. Bread, cheese, salted food and other prepared foods have been sold for thousands of years. Other kinds were developed with improvements in food technology. Types of instant foods can vary by country and geographic region. Some instant

foods have received criticism due to concerns about nutritional content and how their packaging may increase solid waste in landfills. Various methods are used to reduce the unhealthy aspects of commercially produced food and fight childhood obesity.

Instant foods are commercially prepared for ease of consumption. Products designated as instant foods are often sold as ingredients, ready-to-eat dishes; as room-temperature, shelf-stable products; or as refrigerated or frozen food products that require minimal preparation (typically just heating). Instant foods have also been described as foods that have been created to - make them more appealing to the consumer. Instant foods and restaurants are similar in that way they save time. They differ in that restaurant food is ready to eat, whilst instant foods are usually requiring rudimentary preparations. Both typically cost more money and less time compared to home cooking from scratch.

Statement of the Problem

The kitchen, hitherto a domain of Indian housewives and withstood the storms of change for centuries, is no more an exception to change. The efforts of the marketers of instant food products shaken the country old and traditional bound Indian cooking food products. Indian housewives now are gradually moving towards these products due to socio-economic and cultural changes that are pervading the present-day Indian society. Initially there was a hesitation in accepting these products by Indians. But, to-day the companies have not only changed the lifestyle of urban population but also make deep inroads into rural markets of India. Consumer behavior study in any field being a potential research area, the present one is one such attempt prompt the researcher to analyses the preference and other related issues of research interest in buying the instant cooking food products by consumers residing in the Nagercoil, Kanniyakumari District.

Objectives

The following are the objectives of the present study.

1. To identify the reason behind the selection of the instant foods.
2. To analyze the consumer purchasing frequency and satisfaction of the instant foods.

Methodology

The study made use of both primary data and secondary data. The primary data have been collected from 50 samples. The researcher collects the information through interview schedule method.

Results and Discussion

1. Age Composition

Age is an important factor which determines the satisfaction level of Sample respondents. The

age wise distribution of the sample respondents given in table 1.

Table 1. Age Composition of the Sample Respondents

Age (in year)	No of Respondents	Percentage
Below 20	13	26
20-30	21	42
30-40	7	14
Above 40	9	18
Total	**50**	**100**

Source: Primary Data

Table 1 shown that 42 per cent of sample respondents are between the age group of 20-30 years and 14 per cent of the sample respondents are between the age group of 30-40 years.

2. Occupation

Occupation is one of the important factor for determining the income of the respondents. The occupation of respondents reveals the nature of work done. It is one of the profiles of the respondents. The occupational status of sample respondents is shown in the following Table 2.

Table 2. Occupation of the Sample Respondents

Occupation	No of Respondents	Percentage
Student	**18**	**36**
Home maker	13	26
Government Employee	5	10
Private Employee	14	28
Total	50	100

Source: Primary Data

Table 2 shows that 38 per cent of the sample respondents are students and 6 per cent are Government Employee. It is informed that majority of the sample respondents are students.

3. Monthly Income

Income is the base on which everything can be done. Usually, the people who get more income can lead a better life than the people with less income. Here income means the wages earned by the respondents. The following table 3 shows that the monthly income of the sample respondents.

Table 3. Monthly income of Sample Respondents

Monthly Income (in Rs.)	No of Respondents	Percentage
Below 10000	10	36
10000-20000	19	38
20000-30000	18	20
Above 30000	3	6
Total	**50**	**100**

Source: Primary Data

Table 3 reveals that 38 per cent of the sample respondents are earning Rs.10,000 - 20,000 and only 6 per cent are getting above Rs.30,000.

4. Consumed Products

Consumption is the use of goods and services for the satisfaction of individual or collective human needs or wants. It can be either intermediate or final. Table 4 shows products consumed by the sample respondents.

Table 4. Consumed Products of Sample Respondents

Products	Number of Respondents	Percentage
Bakery Products	10	20
Dairy Products	13	26
Packaged Foods	20	40
Beverages	5	10
Other	2	4
Total	**50**	**100**

Source: Primary Data

Table 4 shows that 40 per cent of the sample respondents are mostly consuming packaged foods and only 4 per cent of the sample respondents are consuming other products like pasta, frozen foods, sweet products. It is informed that majority of the sample respondents mostly consume packaged foods.

5. Factors Influencing consuming Products

The influencing factors are those factors that can affect some features of target object. Influencing factors can be used as control variables to determine the key influencing factors of

an object. Household income and the cost of food is an important factor influencing food choice, especially for low-income consumers. The following table 5 reveals that the important factors influencing instant food products consumed by the sample respondents.

Table 5. Important Factors Influencing consuming Products

Factors	Number of Respondents	Percentage
ReadilyAvailable	13	26
Packaging	7	14
Quality	17	34
EasyToMake	10	20
Other	3	6
Total	**50**	**100**

Source: Primary Data

Table 5 shows that 34 per cent of the sample respondents chosen quality as an influencing factor in instant food products and 6 per cent of the sample respondents chosen other like less time,emergence of nuclear family,convenient,etc.,So most of the sample respondents is important factor influenced by quality of instant food products.

6. Brand of Instant Food Products

In the market, there are many kinds of branded instant food products such as Aachi, MTR, Amul, Britannia and Patanjali etc., which are available in the market. It creates heavy competition among each other. Table 4.9 shows the suitable products preferred by the sample respondents.

Table 6. Brand of Instant Food Products

Brands	Number of Respondents	Percentage
Aachi	21	42
MTR	5	10
Amul	4	8
Britannia	12	24
Patanjali	8	16
Total	**50**	**100**

Source: Primary Data

Table 6 shows that 42 per cent of the sample respondents like to buy Aachi instant food products and 8 per cent of the sample respondents prefer Amul instant food products. Most of

the sample respondents like to prefer Aachi brand of instant food products.

7. Satisfactory level

It is the extent to which an individual's needs are satisfied with a product's features. For many consumers quality is a key aspect of consideration when purchasing a product. Table 7 shows that the satisfaction level of quality of the sample respondents.

Table 7. Satisfactory level of Sample Respondents

Category	Number of Respondents	Percentage
Highly Satisfied	13	26
Satisfied	24	48
Neutral	9	18
Unsatisfied	3	6
Highly Unsatisfied	1	2
Total	**50**	**100**

Source: Primary Data

Table 7 shows that 48 per cent of the sample respondents are satisfied and 2 per cent of the sample respondents are highly unsatisfied. Most of the sample respondents are satisfied with the quality of these products.

Findings

- Forty two per cent of the sample respondents belong to the age group of 20-30 years.
- Thirty six per cent of the sample respondents are students.
- Thirty eight per cent of the sample respondents have monthly income ranging between Rs. 10,000 – 20,000.
- Forty per cent of the sample respondents consumed packaged food.
- Thirty four per cent of the sample respondents are influenced by quality of the food products.
- Forty two per cent of the sample respondents consumed Aachi brand.
- Forty eight per cent of the sample respondents satisfied with quality.

Conclusion

The study concluded that most of the household families belong to middle class income groups, therefore people are more in demand of such products behaviour pattern of consumer regarding the usage for food has change with the increase in the disposable incomes of the people. The awareness of consumers across different income group people has increased to greater extent due to highly qualification and good sense of mind. Now a days consumers are

much more efficient in saving time and money, they are more authentic towards the hygiene food. The average monthly expenditure of instant food products is highest in most of the cities, sources of information about these products have made the consumers attracted towards it. By enabling creative innovations and advertising methods have raised the demand and supply of the instant foods. Customer prefers branded food products only. Customer prefer instant food products because of quality. Thus, concluding the need for instant food products will increase to its high in the coming years.

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An over view of Women Entrepreneurship with special reference to Textile Workers in Nagercoil.

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ABSTRACT

Development of entrepreneurship is a vital factor for the growth of a country. It is necessary for harnessing the vast untapped human resources of a country like India and to channelize them towards accelerating industrialization. Entrepreneurship is the purposeful activity of an individual or a group of associated individuals, undertaken to initiate, maintain or aggrandize profit by production or distribution of economic goods and services. An entrepreneuris the key person who envisages new opportunity, new techniques new line of production and co- ordinates all other activities. The growth of industrialization in a particular country is a functionof quality and quantity of entrepreneurs available in that country. Women constitute around half of the total world population. They are regarded as the better half of the societies. In traditional societies, they were confined to the four walls of houses performing household activities. In modern societies, they have come out of the four walls to participate in all sorts of activities.This paper throw light on the women textile workers.

Introduction of Entrepreneurship

Entrepreneurship like many other economic concepts has long been debated. It has been used in various ways and in various senses. It is an exclusive concept that cannot be defined precisely. According to A.H. Cole "Entrepreneurship is the purposeful activity of an individualor a group of associated individuals, undertaken to initiate, maintain or aggregate profit by production or distribution of economic goods and services". Entrepreneurship can be viewed as creative and innovative response to the environment and an activity to recognize initiate and exploit an economic opportunity.

Women Entrepreneurs

Women constitute around half of the total world population. They are regarded as the better half of the societies. In traditional societies, they were confined to the four walls of houses performing household activities. In modern societies, they have come out of the four walls to participate in all sorts of activities. Women have been performing exceedingly well in different spheres of activities like academics, Politics, Administration, soual work and so on. Women entrepreneurs may be defined as a women or group of women who initiate,

organize and run a business enterprise. The government of India has define a women entrepreneurs based on womenparticipation in equity and employment of a business enterprise. Women entrepreneur is defined as an enterprise owned and controlled by a women having a minimum financial interest of 51 percent of the employment generator in the enterprise to women.

Problem of Women Entrepreneurs

Women entrepreneur's encounter two sets of problems, viz, general problems of entrepreneurs and problems specific to women entrepreneurs.

Finance

Finance is regarded as "life blood" For any enterprise, be it big for small however, women entrepreneurs suffer from shortage of Finance on two countries. Firstly women do not generally have property on their names to use the as collateral for obtaining funds from external sources. Thus their access to the external Sources of funds is limited. Secondly the banks also consider women less credit worthy are women borrowers on the belief that they can at any time, leave their business. Thus women enterprise fails due to the shortage of Finance.

Family

In India, it is mainly a woman's duty to look after the children and other members of the family. Man plays a secondary role only. In case of married women, she has to strike a balancein her business and family, her total involvement in Family leaves little or no energy and time to devote for business. Support and approval of husbands seem necessary condition. For women's entry into business accordingly the educational level and family background of husbands positively inference women's entry into business activities.

Lack of Education

In India, around three—fifth (20%) of women are still illiterate. Illiteracy is the root cause of social economic problems. Due to the lack of education, and that too qualitative education, women are not aware of business, technology and market knowledge. Also lack of education causes low achievement motivation among women. Thus lack of education creates problems. For women in the setting up and running of business enterprises.

Review of Literature

1. Madasamy and A. Joseph Xavier in their article, "Women Entrepreneurs in Rural India" point out that all over the world women are playing a vital role in the business community. In India however women have made a comparatively late entry in to the business scenario mainly due to the orthodox and traditional socio – culturalenvironment.

2. Kamalakanan and Dr. N. Namasivayan in their article "Economic empowerment of women

through entrepreneurship" say that it is necessary to development income generating activities so that the significant work force of the country may be utilized more efficiently in order to generate more income reduce.

3. Dr. P. Sundara Pandian and Prof. M.Mariappan in their article "Information Technology and women Entrepreneurs" says that entrepreneurship can help women's economic independence and improve their social status automatically the women get empowered once they attain economic independence. The development of women entrepreneurship enables society to understand and appreciate their abilities.

Methodology

A suitable and reliable methodology is necessary for the scientific analysis and objective interpretation of an economic problem. Hence the research methodology adopted by the team is given in this chapter. It comprises of significance of the study, objectives, area profile, sources ofdata, selection of sample, statistical tools used, limitations of the study and chapter design.

The study makes use of primary and secondary data. The primary data have been collectedwith the help of the specially designed interview schedule. From the respondents a well-designedinterview schedule is used for the purpose of collecting information from the respondents. The study requires both primary and secondary data.

Objectives

* To analyse the investment of the respondents.
* To find the nature of work of the respondents.
* To know the amount of money taken as loan.
* To examine the problems of the respondents.

Collection of data

The study makes use primary and secondary data. The primary data has been collected with the help of designing interview schedule. From the respondents a well designedinterview schedule used for the purpose of collecting information from the respondents. The study requires both primary and secondary data; the secondary data was collected from district statistical office, journals and books available on labour studies. But the primary data related to economic conditions was collected only through interview schedule.

The relevant data for the present study has been collected by convenient random sampling method 50 samples are taken and studied. The collected information is presented in separate table. The presented data should be treated with approximate statistical technique.

Analysis of data

1. Educational Qualification

Education is a significant variable which determines the social status of sample respondents. The educational Qualification of sample respondents is shown in Table 1.

Table 1. Educational Qualification of the Sample Respondents

SI. No	Educational Qualification	No. of Respondents	Percentage
1	Primary	4	8
2	Secondary	14	28
3	Higher Secondary	20	40
4	Any Degree	12	24
	Total	50	100

Source: Primary Data

The above table 1 shows that 40 percent of the sample respondents have completed their higher secondary education. It points out that the women entrepreneurs are educated.

2 Investment

Investment refers to real investment which adds to capital goods. Initial investment increases the income of the individual. The following table 2 shows the amount of investment.

Table 2. Investment of the Sample Respondents

SI. No	Initial Investment (in Rs.)	No. of Respondents	Percentage
1	Below 20,000	20	40
2	20001 – 25000	21	42
3	25001 – 30000	9	18
	Total	50	100

Source: Primary Data

The above table 2 shows that 40 percent of the sample respondents' investment lies below20,000 and 18 percent of the sample respondents' investment lies between Rs. 25,001 – 30,000. From that it is clear that the respondents have well established their career.

3. Monthly Income

Income and Expenditure are the two edge of life the purchasing power of an individual isbased on income. The Following table 3 shows the monthly income of the sample respondents.

Table 3. Income wise Classification of the Sample Respondents

SI. No	Amount of Income (in Rs.)	No. of Respondents	Percentage
1	Below 10000	21	42
2	10000 – 20000	24	48
3	Above 20000	5	10
	Total	50	100

Source: Primary Data

The table 3 shows that 42 percent of the sample respondents have the income ranging below Rs. 10,000 and 10 percent of the sample respondents have the income above Rs. 20,000.

4. Training

The below table 4 shows the training experience of the sample respondents

Table 4. Training experience of the Sample Respondents

SI. No	Duration (in months)	No. of Respondents	Percentage
1	1 – 6	30	60
2	7 – 12	20	40
	Total	50	100

Source: Primary Data

The table 4 shows that 60 percentages of the sample respondents have learned tailoring between 1 to 6 months. 40 Percentage of the sample respondents have learned tailoring between7 and 12 month.

5. Loan

Loan is an incentive to do the business by the Government or private banks. Without a loan no one can survive in the business Field.

Table 5. Loan of the Sample Respondent

SI. No	Loan	No. of Respondents	Percentage
1	Yes	39	78
2	No	11	22
	Total	50	100

Source Primary Data

The table 5 shows that 78 percent of the sample respondents have the loan.

6. Income satisfaction

Income satisfaction of the sample respondents is shown in the Table 6.

Table 6. Income satisfaction faction of the Sample Respondents

SI. No	Satisfaction	No. of Respondents	Percentage
1	Yes	29	58
2	No	21	42
	Total	50	100

Source: Primary Data

The above table 6 shows that 58 percent of the sample respondents are satisfied with theirincome. 42 Percent of the respondents are not satisfied with their income.

7. Type of work

The following table 7 shows the type of work done by the Sample respondents.

Table 7. Types of Work of the Sample Respondents

SI. No	Type	No. of Respondents	Percentage
1	Hand embroidery	10	20
2	Machine embroidery	8	16
3	No. embroidering	32	64
	Total	50	100

Source: Primary data

The above table 7 shows that 64 percentages of the sample respondents are doing no embroidering work. 16 Percentage of the sample respondents are doing machine embroidery work.

8. Problem of the sample respondents

Problems faced by the women entrepreneur are many. The overall rank for the problemfaced by the women entrepreneurs are listed below.

Table 8. Over all rank for the problem faced by Women Entrepreneur

No	Weight	6	5	4	3	2	1	Total	Rank
		1	2	3	4	5	6		
1.	Financial Problem	7 (42)	5 (25)	4 (16)	4 (12)	4 (8)	6 (6)	107	I
2.	Composition	6 (36)	4 (20)	4 (16)	0 (0)	4 (16)	3 (3)	91	IV
3.	Lack of family support	5 (30)	4 (20)	1 (4)	1 (3)	3 (6)	1 (1)	64	VI
4.	Knowledge	5 (36)	2 (10)	3 (12)	6 (18)	5 (10)	7 (7)	93	III
5.	Lack of Mobility	3 (18)	2 (10)	3 (12)	5 (15)	4 (8)	6 (6)	69	V
6.	Lack of Opportunity to grow	7 (42)	4 (20)	6 (24)	2 (6)	1 (2)	2 (2)	96	II

Above table shows that finance is the main problem faced by women entrepreneur.

Findings:

1. Forty eight percent of the sample respondents have completed higher secondary education.

2. Seventy eight percent of the sample respondents have taken loan.

3. Fifty eight percent of the sample respondents are satisfied with their job.

4. Forty two percent of the sample respondents investment lies below Rs. 20,000-25,000

5. Forty eight percent of the sample respondents' income ranging between Rs. 10,000-20,000.

6. Sixty percent of the sample respondents have learned tailoring between 1 to 6 months.

7. Sixty four percent of the sample respondents are doing no embroidering work.

8. Finance is the main problem faced by women entrepreneur.

Conclusion

Due to the growth of globalization, Industrialization, Urbanization, education and democratic system in India, the women are now seeking gainful employment in several fields. The women entrepreneurship movement has taken off the ground and it is felt that the moment has crossed the stage of transition. It is only during the last 25 years women have started industries and business, and they are yet to go along way to be on a par with me.

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An Economic Study of Hotel Workers in Nagercoil

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ABSTRACT

Hotels are most important for enjoyment as they provide facilities such as recreation and entertainment, meeting and conferences, and business gathering. Hotel industry is the way for travelers for their accommodations, venues, meals, and drinks. Hotels are definitely one of the fastest-growing sectors in the tourism sector and are also the main source for development of the country. This article aims to spot light on the economic study of hotel workers in Nagercoil.

Introduction

The hotel industry is one of the most important components of the wider service industry, catering for customers who require overnight accommodation. It is closely associated with the travel industry and the hospitality industry, although there are notable differences in scope.

The biggest challenge of the employee motivation is that employees often motivate themselves, based on their perception of what they want to achieve and how they can achieve it. However, managers who are aware of what their employee wants from work can design a work environment that is able to accommodate employee's needs and desires. At the same time, well-informed managers may be able to avoid common pitfalls that tend to reduce employee motivation.

The amount of effort an employee spends towards accomplishing the hotel's goals depends on whether believes that this effort will lead to the satisfaction of his or her own needs and desire. When a need or desire is unsatisfied, a person experiences tension that drives him or her to satisfy the need.

Methodology

The study makes use of both primary data and secondary data. Fifty sample respondents were selected for the study. This study is carried out using convenient sampling technique.

Objectives

- ❖ To study the income and expenditure of the sample respondents.
- ❖ To understand the debt and savings of the sample respondents.
- ❖ To know the health condition and working hours of the sample respondents.

Analysis of Data

Income

Monthly income is paid per month without any deductions for taxes and benefit. Hence it is proved income is varied by the ability of the respondents.

Table 1. Monthly income of the sample respondents

Monthly income (in Rs)	No. of Respondents	Percentage
1000 – 3000	15	30
3001- 5000	28	56
Above5000	7	14
Total	50	100

Source: Primary Data

The table 1 shows that 56 percentages of the sample respondents earn a monthly income of Rs.3001 – 5000.

Expenditure

Expenditure is the index of the standard of living of the people. Generally if the income is more, one can spend more hence expenditure is based upon the earning.

Table 2. Monthly Expenditure of the sample respondents

Monthly expenditure (in Rs)	No. of Respondents	Percentage
1000 – 2000	10	20
2001 – 3000	12	24
3001 – 4000	15	30
4000 above	13	26
Total	**50**	**100**

Source: Primary Data

The above table 2 shows that 30 percentages of sample respondents spend Rs.3001-4000.

Savings

Money saved is a security to any person in later if when they are jobless or aged or hospitalized. Therefore it is clear that the women workers are saving according to their needs.

Table 3. Savings of the sample respondents

Monthly Savings (in Rs.)	No. of Respondents	Percentage
Below 200	27	54
201 – 300	14	28
301 – 400	9	18
Total	50	100

Source: Primary Data

The table 3 shows that 54 percentages of the sample respondents have savings.

Debt

A debt generally refers to sometimes by one borrowed and borrower on debt on to a second part the lender or creditor. Individual incurs debt in the form of borrowing from money lenders, relatives and financial institutions.

Table 4. Debt of the sample respondents

Debt (in Rs)	No. of Respondents	Percentage
1000 – 3000	12	24
3001 – 5000	13	26
Above 5000	25	50
Total	50	100

Source: Primary Data

The table 4 shows that 50 percentage of sample respondents have debt.

Working Hours

Proper working conditions help in increasing the efficiency of workers. The workers have different working hours.

Table 5. Working hours of the sample respondents

Duration (in hrs)	No. of. Respondents	Percentage
4 – 5	5	10
5 – 6	13	26
6 – 7	28	56
7 – 8	4	8
Total	50	100

Source: Primary Data

The table 5 shows that 56 percentage of the respondents work 6-7 hours.

Health Problems

Now-a-days hotel workers face many health problems due to their heavy work. The following table 6 shows the health problems faced by the sample respondents.

Table 6. Health Issues of the sample respondents

Health Issues	No. of. respondents	Percentage
Body pain	10	20
Diabetes	12	24
Mental stress	4	8
Lung problem	8	16
Heart problem	16	32
Total	**50**	**100**

Source: Primary Data

The table 6 shows that 32 percentages of the respondents are facing heart problems

Findings

➢ Fifty six per cent of the respondents have the income ranging between Rs.3001-4000.

➢ Thirty per cent of the respondents have expenditure between Rs.3001-4000.

➢ Fifty four per cent of the respondents have savings.

➢ Fifty five per cent of the respondents have debt above Rs.5000.

➢ Fifty six per cent of the respondents work for 6-7 hours.

➢ Thirty two per cent of the sample respondents are affected by heart problem.

Suggestions

• Hotel workers can be brought under the welfare fund scheme.

• Government should insist the owners of the hotel to give all the basic facilities to the workers.

Conclusion

Hotel workers play a vital role in business which run 24 hours daily regardless of holidays to accommodate customers. Generally, the hotel workers are as two, day shift and night shift. In particular fixed night shift hotel workers were most vulnerable to depression. Rotating day shift hotel workers without work could also have higher risk of depression.

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The Role of Micro and Small Enterprises for Poverty Alleviation

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ABSTRACT

Micro and small enterprises are basically set up with the goal of poverty alleviation. This enterprise have a very important and effective role in both developed and developing countries because it is considered the backbone of the economy. Micro and small enterprise can play a role in improving the socio-economic condition of the poor, create employment opportunity, job creates greater utilization of raw material and improve the economic condition and for the reduction of poverty. Even this enterprise play a vital role in the livelihood of rural household by generating income, people become little attention to them because of lack of necessary condition in order to run this enterprise. The review result suggest that major challenges and problems that faces the small scale enterprise in order to operate their business. Lack of access to capital, inefficient financial market, problem of skilled manpower, lack of market, lack of credit are the major factors influencing on the operation of micro and small enterprise for alleviation of poverty.

Keywords: Micro and small enterprise, Poverty, Role of micro and small enterprise, Challenges and problems, Poverty reduction.

Introduction

Poverty reduction of any country can contribute grossly to the improvement of people's life and economic growth of the country. This requires industrialization where micro and small enterprise comes into the focus as one of the packages and instruments which help to accelerate economic growth, socio-economic progress and then the overall reduction of poverty of the nation. They make a huge contribution to employment in many developing countries where the challenges of high unemployment and poverty exist. Globally, the small-scale industries are well-known for their immense contribution to poverty reduction, development process and as engines of economic growth, critical segment of the manufacturing sub-sector, effective strategy for tackling unemployment, diversifying output, achieving trade and balance of payment.

Micro and small scale enterprise are seen as the most important alternative sector in fostering socio-economic developments and reduction of poverty in both developed and developing countries. It is the chief sector to achieve the goal through creating employment, improve saving and wealth and improvement of living standards. Since poverty and unemployment rate are considerably higher in these countries than developed countries so micro and small enterprise is very important. In addition to this micro and small enterprise can

play a role in improving the socio-economic condition of the poor by enabling them through generate their income access for socio-economic merits such as education, better health condition, good housing and nutrition.

According to United Nations, report (2011), Ethiopia stands 174th of 187 countries in the global poverty index indicating that it is one of the poorest countries in the world. This is the reason for most developing countries which face multi-dimensional problems like unemployment, low per capita income, unequal income distribution, lack of access to credit, poor farming practices, deforestation and soil erosion, the willingness of the people to make micro and small enterprises, low agricultural productivity.

Objectives

1. To review the role of micro and small enterprise in poverty alleviation.

2. To know the challenges and problems that faced by the small scale enterprise while operating their business.

Role of Small Business in India

➢ **Industrial units**: In an economy like India, the majority of the industrial units are because of small business. This total accounts for more than 95 percentage of the units. Almost 40 percentages of the total industrial units are contributed because of small industries.

➢ **Human resources**: The small business rank next to agriculture to employ in Indian economy. As compared to many big companies, the small businesses are capable of generating the maximum employment opportunities of each unit of capital that is invested.

➢ **Labor oriented**: Small business generate a lot of labor. They give many employment opportunities to those living in rural and semi-urban areas. The small enterprise helps to lift the weight of unemployment in an economy.

➢ **Flexible and adaptable**: Any new business opportunity gets captured at the correct time. Small businesses get an edge when it comes to adapting and growing in the light of any upcoming charges.

➢ **Increased tax revenue**: The industries need to pay the required amount of tax to government bodies, which is in turn used for the development of rural regions and to fulfill the demand of cities.

Challenges and Problems Faced by Small and Micro Enterprise

• **Finance**: The major small business problems faced is the inadequacy of funds to funnel in the operations. This hinders the business from developing. The small business operates in the semi-urban and rural areas, and this makes it difficult for them to get their finances.

- **Raw material**: Businesses need raw material for production. They need some input to generate output. The raw material quality is the challenges faced by small business as it depends on what it inputted into it.

- **Skilled labor**: Skilled labor is among the problems of small scale enterprise. Small businesses have a fund shortage because of which they are not able to employ skilled labor to do the job, which is one of the challenges of small business.

Conclusion

Generally, micro and small enterprise are widely recognized as the most reliable economic development and growth, poverty reduction, income generation and employment creation. Inadequate credit assistance, lack of access to start up finance, problem of skilled man power, high interest for borrowing and lack of production place are major factor which hinder for the expansion of micro and small enterprise. Hence, attention should be given to these problems in order to improve the establishment of micro and small enterprise for poverty alleviation.

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An Economic Study of Freelancer Beautician in Nagercoil

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ABSTRACT

Women entrepreneurship is the process where woman take the lead and organize a business or industry and provide employment opportunities to others. In India though women entrepreneurship is a recent phenomenon which came into prominence at the initial stage women entrepreneurship developed only in urban areas and a later stage it extended its wings to rural and semi urban areas too. Though earlier women concentrated much on traditional activities, due to the spread of education, favorable government policies towards development women entrepreneurship, Women have changed their attitudes and diverted towards nontraditional activities. In today's world beauty treatments and therapies are becoming popular and therefore there is increase in number of beauticians those are attributed to this popularity. Nowadays there are beauticians who wash, cut and comb their hair; make highlights and add colors; provide facials and nail services; and everything related to hair that comes to mind.

Introduction

A beautician is a professional who enhances the facial appearance of a person with cosmetics. He or she discusses and plans to makeover the session to provide the clients' desired result. A cosmetologist career demands to analyze skin to figure out the skin type, natural curves and shape of the face. In several cases, cosmetologists are required to teach how to apply makeup or applying cosmetics on the skin or face. A beautician prepares the skin for the application of make-up. He or she cleans and moisturizes skin to prevent any adverse reactions. Over the years the term has evolved to mean an independent, self-employed personwhoprovides a service. Because a freelance is working on their own, it means that having business premises isn't usually viable, so a freelance beautician or hairdresser will tend to work on a mobile basis.

Freelancer beautician is a service-oriented establishment in which women receive treatment to increase their beauty. Skin care, facial make up, hair nourishment and model hair cutting are the most important nourishing activities of a beautician. The use of machinery, ayurvedic formulations and approved synthetic chemicals and medicines vary from person-to-person as per need. In present project the provision of different beauty therapy is present with use of limited amount of machinery.

Objectives

1. To find out the investment of the freelance beautician in Nagercoil.

2. To study the income level of the freelancer beautician in Nagercoil.

3. To study the various beauty treatment provided by freelancer beautician.

4. To study the Type of packages offered by the freelancer beautician in Nagercoil

Methodology

Collection of Data

A wide variety of methods and techniques have been employed by the economic researchers for the purpose of collection, processing, analysis and presentation of data. The ensuring analysis seeks to "**An economic study of freelancer beautician in Nagercoil".** The study is based on both primary and secondary data.

Sample Design

In this study the researcher has used multistage random sampling. At the first stage the Nagercoil Municipality was divided into 51 wards, and 5 wards selected at random. At the second stage, each ward may be subdivided into a number of households and 10 households from each of the five wards were taken at random. fifty were selected for the study.

Data Analysis

1 Initial investment

Investment refers to real investment which adds to capital goods. Initial investment increases the income of the individual. The following table 1 shows the amount of investment.

Table 1. Initial Investment by the sample respondents

Initial investment (in Rs)	Number of respondents	Percentage
Below 5000	5	10
5000-10,000	8	16
10,000-15,000	17	34
Above 15,000	20	40
Total	**50**	**100**

Source: Primary data

Table 4.1 shows that 40 percentage of the sample respondents invested above Rs.15,000 and 10 percentage of the sample respondents invested Below Rs.5000

2 Monthly Income

The purchasing power of an individual is based on income. Table 2 shows the monthly income of the sample respondents.

Table 2. Monthly income of the sample respondents

Monthly income (in Rs)	Number of respondents	Percentage
Below 5000	5	10
5000-10,000	14	28
10,000-15,000	15	30
Above 15,000	16	32
Total	**50**	**100**

Source: primary Data

The table 2 shows that 32 percentage of sample respondents monthlyincome is above Rs. 15,000 and 10 percentage of the sample respondent's income is below Rs. 5, 000.

3Types of beauty Treatment

The sample of respondents doing variety of treatment to the customers are given in Table 3

Table 3. Type of beauty treatment of the sample respondents

Type of beauty treatment	Number of respondents	Percentage
Waxing	19	38
perming	26	52
Straitening	27	54
Dark circle Removing	28	56
Total	**50**	**100**

Source: Primary data

The table 3 shows that 56 percentages of the sample respondents are doing dark circle removing treatment and 38 percentages of the sample respondents are doing waxing treatment.

4 Types of packages

The types of packages are used in freelancer beautician. Shown in table 4

Table 4. Type of packages of the sample respondents

Type of packages	Number of respondents	Percentage
Facial	5	10
Henna in hair	3	6
Bridal services	23	46
Mehandi	15	30
Threading	4	8
Total	**50**	**100**

Source: Primary data

The table 4 shows that46 percentage of the sample respondents is doing Bridal services and 6 percentage   of the sample respondents are doing Henna in Hair.

Findings

- Forty-four percentage of the sample respondents invested above Rs.5000

- Thirty-two percentage of sample respondents monthly income is above Rs.15, 000.

- Fifty-six percentage of the sample respondents are doing dark circle treatment.

- Forty-six percentage   of the sample respondents are doing Bridal services.

Conclusion

Beauty consciousness is high among people irrespective of gender. Beauty   boosts one's self-confidence, improves present ability and enhances chances in career development. Beauticians help to regain skin   radiance, suppleness and vitality. If the beautician service is rendered with aesthetic sense, devotion, dedication and determination there is every chance for winning the confidence of the users. Freelancer provide better job opportunities, mental relaxation and improve the appearance and status of the users. Users leave the beauty looking and feeling refreshed, revitalized and ready to take on the world again. In the present day, beautician services are not considered as a luxury, it is becoming an essential service.

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An Economic Study on Tribal People in Koovaikadu

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ABSTRACT

Tribals are known to be the autochthonous people of the land. Tribals are often referred to 'advise', 'canvas', 'pharm', 'animate', 'anusuchit janjati', etc. India has the second largest tribal population in the world, the first being Africa and tribal Communities are the integral segment of Indian society. India, with a variety of ecosystems, presents a varied tribal population throughout its length and breadth depicting a complex cultural mosaic. India is a home for large number of tribal people, known as "ADIVASI".

Keywords: Tribal people, Indian society, ecosystems and cultural.

1. Introduction

Tribal people comprise a substantial indigenous minority of the population of India. Adivasi societies are particularly present in the Indian states of Orissa, Madhya Pradesh, Bihar, Rajasthan, Gujarat, Chhattisgarh, Maharashtra, Andhra Pradesh, Jharkhand, West Bengal, Mizoram and other north-eastern states, and the Andaman and Nicobar Islands. Many smaller tribal groups are quite sensitive to ecological degradation caused by modernization. The backwardness of the areas has a contrasting feature of poverty amongst plenty due to low level of education and techno-economic profile of the tribes.

1.1 Statement of the problem

The economic problems need special attention in the context of tribal communication of India. The tribes in koovaikadu have problems related to various aspects of tribal people in koovaikadu viz. social, economic, educational, religions, law and order situation and they got meagre facilities from the government as the government schemes normally designed for the average district or village.

1.2 Objective

➢ To find out the social condition of the sample respondent.

➢ To examine the economic situation of the sample respondent

1.3 Design of the Study

The study has been conducted among the tribal people in Koovaikadu. Headquarter of Koovaikadu is Thadikarankonam. Thadikarankonam is a village in Thovalai Block in kanniyakumari District of Tamil Nadu State, India. This specific area was selected for the study

as we found that Kaani people in Thadikarankonam in Kanniyakumari district. The study was conducted in the villages of Koovaikadu, of Kanniyakumari District. In Koovaikadu forest area there are about 50 – 100 Kaani families in the locations.

2. Review of literature

Suresh Lal (1997) concentrated on the different aspects of migration of Banjara Tribal and to find out the impact of migration on them in terms of working conditions, wages and earnings and their living conditions.

Mohan Rao (1993) gives in sight in to the Kolams- a primitive tribe's transition, the genesis and affinity of the core aspects of the culture of Kolams and other neighbouring dominant tribe on one hand and total cultural heritage of local tribes and its affinity with culture of caste groups of this area on the other.

A. Jayakumar, P. Palaniyammal (2017) studied Social and economic justice, equality of status and opportunities and cultural and educational status are insured by the Constitution of India for all citizens and also provide enriched provisions for scheduled caste and tribes. This paper addresses the socio economic status of the scheduled tribes in kalrayan hills Salem district Tamilnadu (India). The majority of the household occupations are Agriculture. Cultivation is the primary occupation participated by the most heads of the sample households. Income from cultivation support majority of the sample population.

Jai Prakash Johan (2003) examined the food habits of tribal households. The tribal were forced to depend much upon agriculture and mainly on produce like vegetables, rice and some coarse grains such as maize, millet etc. The study revealed tremendous changes in the food habits of tribal.

3. Methodology of the Study

The study requires both primary and secondary data have been used for the present study. Under primary data the details regarding the data of tribal people have been collected. Secondary data were collected from the records of various journals, magazines, books, articles and theses.

3.3 Selection of Sample

This study is carried out by selecting 50 sample respondents in Koovaikadu by using convenient random sampling technique.

3.4 Tools of Analysis

The collected data are tabulated and analysed by using statistical tools such as, percentage and averages and tables related to socio-economic condition of the sample respondents.

3.5 Sample size

The total sample consists of 50 respondents from koovaikadu.

4. Analysis and interpretation of data

This chapter analyses the gender, age, education, marital status, occupation, monthly income, expenditure pattern, saving of the sample respondents.

Table 4.1 Age wise composition of the sample respondents

Age (in yrs.)	No. of. Respondents	Percentage
15-20	11	22
21-30	3	6
31-40	15	30
41-50	13	26
Above 50	8	16
Total	**50**	**100**

Source: Primary data

From the table 4.1 30 per cent of sample respondents are between the age group of 31-40. Because middle age tribals are highest in Koovaikadu.

Table 4.2 Gender wise distribution of the sample respondents

Gender	No. of. Respondents	Percentage
Male	21	42
Female	29	58
Total	**50**	**100**

Source: Primary data

Table 4.2 shows that 58 per cent of the sample respondents are female. Compare to male population female population is highest in Koovaikadu.

Table 4.3 Educational status of the sample respondents

Educational Status	No .of. Respondents	Percentage
Illiterate	30	60
Primary	10	20
Secondary	4	8
Degree	3	6
Diploma	3	6
Total	**50**	**100**

Source: Primary data

The table 4.3 shows that 60 per cent of the sample respondents are illiterate. They have poor education facilities compare to other places. They have to travel long distance to receive

good education.

Table 4.4 Religion of the sample respondents

Religion	No. of. Respondents	Percentage
Hindus	49	98
Christian	1	2
Total	**50**	**100**

Source: Primary data

Table 4.4 shows that 98 per cent of the sample respondents are Hindus. Tribal people majority from Hindu religious.

Table 4.5 Marital status of the sample respondents

Marital Status	No. of. Respondents	Percentage
Married	37	74
Unmarried	13	26
Total	**50**	**100**

Source: Primary data

Table 4.5 shows that 74 per cent of the sample respondents are married. Because of their culture they get marriage at very early age.

Table 4.6 Occupation of the sample respondents

Occupation	No. of. Respondents	Percentage
Government job	4	8
Agriculture	21	42
Coolie	25	50
Total	**50**	**100**

Source: Primary data

Table 4.6 indicates that among the total respondents 50 per cent of the sample respondents are coolie because of their illiteracy.

Table 4.7 Monthly Income of the sample respondents

Monthly Income (in rupees)	No. of. respondents	Percentage
1000-5000	15	30
5000-10000	29	58
Above 10000	6	12
Total	**50**	**100**

Source: Primary data

Table 4.7 indicates that 58 per cent of the respondents have the income ranking between Rs. 5000-10000; this shows the monthly income of the respondents gives less economic status in the economy.

Table 4.8 Monthly Expenditure of the sample respondents

Monthly Expenditure(in Rupees)	No. of. Respondents	Percentage
1000-5000	15	30
5000-10000	32	64
above 10000	3	6
Total	**50**	**100**

Source: Primary data

Table 4.8 shows that 64 per cent of the respondents are spending in between Rs.5000-10000, this show only few tribal people have money to spend more.

Table 4.9 Expenditure pattern of sample respondent

Expenditure pattern	No .of .respondents	Percentage
Food	18	36
Cloth	6	12
Medicine	3	6
Education	3	6
Liquor	6	12
Celebration	8	16
Miscellaneous	6	12
Total	**50**	**100**

Source: Primary data

Table 4.9 shows that 36 per cent of the sample respondent spends the money for food. This indicates that tribal people spend more money for food.

Table 4.10 Saving of the sample respondents

Saving	No. of. Respondents	Percentage
Yes	18	36
No	32	64
Total	**50**	**100**

Source: Primary data

Table 4.10 shows that 64 per cent of the sample respondents do not have any saving because of their poor economic status in our society.

Table 4.11 Mode of Transport of the sample respondents

Mode of Transport	No. of. Respondents	Percentage
Cycle	5	10
Bike	11	22
Walk	31	62
Auto	3	6
Total	**50**	**100**

Source: Primary data

Table 4.11 shows that 62 per cent of the sample respondents prefer walking rather other transport.

Table 4.12 Restroom Facilities of the sample respondents

Restroom Facilities	No. of. Respondents	Percentage
Yes	46	92
No	4	8
Total	**50**	**100**

Source: Primary data

Table 4.12 shows 92 per cent of the sample respondents have restroom in our houses or common place. The government helped to build these rest rooms in their house.

5. Findings of the study

- Thirty per cent of the sample respondents are in the age group of 31-40.
- Fifty eight per cent of the sample respondents are female.
- Sixty per cent of the sample respondents are illiterate.
- Ninety eight per cent of the sample respondents are Hindus.
- Seventy four per cent of the sample respondents are married.
- Fifty per cent of the sample respondents are coolie.
- Fifty eight per cent of the sample respondents are having income ranging between Rs 5000-10000**.**
- Sixty four per cent of the sample respondents are having the expenditure between Rs.5000-10000.
- Thirty six per cent of the sample respondents spend more money for food.
- Sixty four per cent of the sample respondents do not save.
- Sixty two per cent of the sample respondents prefer walking.
- Ninety two per cent of the sample respondents have restroom in our houses or common place.

6. Suggestions

- Educational facilities are to be improved in the tribal areas to eradicate illiteracy.

- Government schools to be strengthened as tribal children mostly depend on them.

- The socio economic condition is very important for our life. The tribal people earn low level of income which does not fulfil the basic needs. So the government has to provide provisions like loan facility to these people.

- Tribal people have poor economic status compared to other general category. So the government has to arrange development programme to improve their economic level.

7. Conclusion

The study finds that there is only a partial development in the socio-economic status of the tribals in the Koovaikadu. That every tribes man may have an equal opportunity with the rest of the fellow citizens who work in the fields, factories, and workshops in the open country and the plains. The socio-cultural change among the tribal communities has no doubt empowered the tribals. Educational level is not up to the mark and the extent of unemployment is low compared to city. It needs to be re-oriented to improve the quality of life of the tribals especially in regard to poverty eradication and restoring basic livelihood resources. Entire Tribal Sub-Plan funds are placed at the disposal of State Tribal Welfare Departments which is responsible for inter-sector prioritization and allocation of funds to various Departments.

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A Study on Covid-19 Affected People in Poochivilagam Village of Kanyakumari District

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ABSTRACT

Corona virus is a type of virus which affects the wide nation. There are many different kinds, and some cause disease. Corona virus is named for their appearance: "Corona" means "Crown". The virus outer layers are covered with spike proteins that surround them like a crown. A corona virus identified in 2019, has caused a pandemic of respiratory illness, called COVID-19. The corona virus that emerged in December 2019. Severe acute respiratory syndrome (SARS), Middle East Respiratory syndrome (MERS) and the common cold are examples of corona viruses that cause illness in humans COVID-19 can be severe, and has caused millions of deaths around the world as well as lasting health problems in some who have survived the illness. Corona viruses are often found in bats, cats, and camels. The viruses live in but didn't infect the animals. Sometimes these viruses then spread to different animal species. The viruses may change (mutate) as they transfer to other species. Eventually, the virus can jump from animal species and begin to infect humans.

Keywords: COVID, Symptoms, Side effect, Drugs

Introduction

Covid 19, the first people infected are thought to have contracted the virus at a food market the sold meat, fish and live animals. The corona virus can be spread from person to person. The virus that causes COVID-19, enters own body through own mouth, nose or eyes directly from the airborne droplets or from the transfer of the virus from our hands to our face. People also get Corona virus from close contact by touching, shaking hands with an infected person and then touching our face. It then travels to the back of our nasal passages and mucous membrane in the back of your throat. From there, the virus can spread to other body tissues. It is diagnosed with a test. The Corona virus is spread through droplets and virus particles released into the air when an infected person breathes, talks, laughs, coughs or sneezes.

This is why mask- wearing, hand hygiene and physical distancing are essential to prevent COVID-19.Symptoms show up in people within two to 14 days of exposure to the virus. A person infected with the corona virus is contagious to others for up to two days before symptoms appear, and they remain contagious to others for 10 to 20 days, depending upon their immune system and the severity of their illness. Children have similar, but usually milder,

symptoms than adults. Older adults and people who have severe underlying medical conditions are at higher risk of more serious complication from COVID-19. COVID-19 symptoms include Cough, Fever or Chills, Shortness of breath or difficulty breathing, Muscle or Body aches, Sore throat, new loss of taste or smell, Diarrheal, Headache, New fatigue, Nausea or vomiting, Congestion or runny nose. Some people infected with the corona virus have mild COVID-19 illness, and others have no symptoms at all. In some cases, however, COVID-19 can lead to respiratory failure, lasting lung and heart muscle damage, nervous system problems, kidney failure or death. Many of the people have a fever or any of the symptoms, call the doctor or a health care provider and explain the symptoms over the phone before going to the doctor's office, urgent care facility or emergency room. COVID-19 is diagnosed through a test. Diagnosis by examination alone is difficult since many COVID-9 signs and symptoms can be caused by other illness. Some people with the corona virus do not have symptoms at all. Treatment for COVID-19 depends on the severity of the infection. For milder illness, resting at home and taking medicine to reduce fever is often sufficient. More severe cases may require hospitalization, with treatment that might include intravenous medications, supplemental oxygen, assisted ventilation and other supportive measures. People have COVID-19 it can take several days to develop symptoms but it`s contagious during this time. Stay self- isolated at home if you are feeling ill with symptoms that could be COVID-19 or have a positive test for COVID-19 and clean and disinfect frequently touched surfaces.

Objectives

- To know the health issues of the sample respondents.
- To identify the problems faced by the sample respondents.

Statement of the Problem

The rapid spread of the novel corona virus and its resulting condition, COVID-19, has caught much of the world off-guard. The tragedy has yet to fully play out, but it is already clear that the crisis is thoroughly global in nature and that science is on the front lines in the fight against the virus. The researcher now engaged in the development of diagnostics, treatment. The COVID-19 makes upside down of the life style of the human being. It is the time of the hour to study the topic on Covid-19 affected people.

Method of Data Collection

The study on the corona affected people with the reference to Nagercoil Town requires primary and secondary data. Both primary and secondary data have been used for the percent study. Both primary and secondary data were used for the study. For this study the primary

data are collected from the respondent in Poochivilagam of Nagercoil Corporation. In the Poochivilagam village a number of COVID affected people were living   . This study is carried out by selecting 50 sample respondents of COVID -19 affected people by using random sampling technique.

Data Analysis

The Chapter deals with an analysis of "A study on Covid-19 affected people in poochivilgam village of kanniyakumari district**.** The study is based upon both primary data and secondary data. Primary data is collected from village people of poochivilgam village.

 1.   **Age Wise Composition of the Sample Respondents**

Age plays a vital role in determining the efficiency of an individual. Table 4.1 shows the age composition of the COVID-19 affected people of the sample respondents.

Table 1. Age wise composition of the sample

Age (in years)	No. of respondents	Percentage
Below 20	11	22
20 – 40	9	18
40-60	20	40
60 above	10	20
Total	**50**	**100**

Source: Primary data

Table 1 shows that 40 per cent of the sample respondents belong to the group of 40-60 years and 18 per cent of the sample respondents belong to the group of 20-40 years. It reveals that middle aged respondents are highly affected by COVID-19.

2.   Gender

Gender refers to either of the two sexes (male and female), especially when considered with reference to social and cultural differences rather than biological ones. The term is also used more broadly to denote a range of identities that do not correspond to established ideas of male and female.

Table 2. Gender wise distribution of the sample respondents

Gender	No. of respondents	Percentage
Male	32	64
Female	18	36
Total	**50**	**100**

Source: Primary data

Table 4:2 shows that 64 per cent of the respondents are male and 36 per cent of the respondents are female. It shows that responsibility is in the shoulders of male persons so they move around outside and easily affected by CORONA.

3. **Symptoms**

When the functioning of the body change, it gives certain abnormal signs of the disease. These visual changes in human beings are called symptoms. Symptoms give indication of the presence of a particular disease.

Table 3. Symptoms of the sample respondents

Symptoms	No. of respondents	percentage
Vomiting	15	30
Tiredness	18	36
Chest pain	17	34
Total	**50**	**100**

Source: Primary data

Table 4.9 reveals that 36 per cent of the sample respondents had Tiredness. Only 30per cent of the sample respondents had body pain. It table shows that the respondents are affected by CORONA with various symptoms.

4. **Impact of disease**

Side effect of   drugs, chemical, or other medicine that is in addition to its intended effect, especially an effect that is harmful or unpleasant.

Table 4. Impact of disease of the sample respondents

Impact of disease	No. of respondents	percentage
Tiredness	15	30
Full time sleeping	29	58
Stomach pain	6	12
Total	**50**	**100**

Source: Primary data.

Table 4 shows that 58 per cent of the respondents are steepy after Covid 12 per cent of the respondents are affected by stomach pain. It reveals that the respondents are not exempted from COVID's impact.

Findings

❖ Forty per cent of the samples respondents belong to the age group of 40-60 years.

❖ Sixty four per cent of the respondents are male.

❖ Thirty six per cent of the sample respondents were affected by tiredness.

❖ Fifty eight per cent of the respondents are affected by post COVID.

Suggestions

❖ Isolation should be maintained.

❖ Everyone should use a triple layer of medical mask, discard mask after & hours of use

❖ Mask should be discarded only after disinfecting it with 1% sodium Hypochlorite

❖ Everyone should take good rest and drink a lot of fluid to maintain adequate hydration.

Conclusion

In the era of globalization, all nations share weal and woe. In the face of the COVID-19 epidemic, no country can stand alone and only maintain its own safety. People from all over the world should put aside their differences in ideology, religious belief, politics, economy and culture. All countries should work together to fight against the virus instead of shifting blame and suspecting each other, It must be condemned for any government or individual to take advantage of the new pneumonia to stigmatize some other countries. Mankind is a community of destiny. Only by closer cooperation and mutual help with all countries, we can successfully overcome the pandemic in the global war against COVID-19.

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An Economic Study on Construction Workers in Sokkankudiruppu Village of Thoothukudi District

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ABSTRACT

In India many afford have been made from time to time to study the socio-economic conditions of construction workers in organized and unorganized industries. Construction workers occupy an extremely disadvantaged position in the society. They are the victims of multiple forms of depression. Despite the existence of various constitutional and legal provisions guarding construction employment, a large number of construction workers particularly in the unorganized sector, suffer from various disadvantages relating to their working lives as well as in their home. The aim of the study has been to improve the economic condition and protect them from exploitations. This study of construction workers confirms in principles to basic and explorative studies in labour economics.

Keywords: Construction, Afford, Organized, Labour

Introduction

A construction worker is part of a construction crew, and performs many basic tasks that require physical labour on construction sites. Tasks may include clearing and preparing the site, building scaffolding, barricades, bracing, and other temporary structures, and operating concrete mixtures, jack hammers, saws, drills, and more. Construction workers work on all construction sites, doing a wide range of tasks from the very easy to the extremely difficult and hazardous. Although many of the tasks they do require some training and experience, most jobs usually require little skill and can be learned quickly. Construction workers do physically demanding work. They carry heavy loads and often contort their bodies to access difficult to reach areas some work at great heights and some work in tunnels. Most work outdoors in all kinds of weather conditions. They must use earplugs around loud equipment and wear gloves, safety glasses, and other protective gear.

In the changing world there is a need for people to keep shaping and building it are a vital part of our society and our society moving and growing. Construction workers are often employed by governmental agencies, private companies and unions. "There are more than 13.4 lakh construction workers in Tamil Nadu, and construction workers experience some of the highest rates for fatal and non-fatal injuries resulting in lost work days. Construction workers

are both men and women, for many the hours and long and tiring, especially in areas where construction is difficult to complete in the winter.

Responsibilities of construction workers

❖ Preparing construction sites, materials, and tools.

❖ Following all health and safety regulations.

❖ Mixing, pouring, and levelling concrete.

Problems of construction workers

❖ Delayed payment to workers employed in construction projects.

❖ Workplace injuries due to lack of safety awareness and no use of PPEs.

❖ Poor conditions of migrant labour and drug addiction.

Methodology

A suitable methodology is necessary for any scientific analysis. The objectives and data interpretation of a problem cannot be done without research methodology. There are various methods to conduct research study. The feels that questionnaire methods are more suitable. In this method researcher prepare different questions, from a questionnaire and give to respondents. Also, the researcher adopts sampling methods to conduct the study.

Objectives

❖ To find out the educational status of the respondents.

❖ To know the experience of sample respondents in their occupation.

Dataanalysis

This study deals with an analysis of "An Economic Study on Construction Workers in Sokkankudiruppu Village of Thoothukudi District". It is based upon both primary and secondary data. This is collected from construction workers.

1. Age composition

Age is an important factor influences the productive capacity of the owners. The sample respondents are unevenly distributed among different age group. The following table 1 shows the age composition of the sample respondents.

Table 1. Age wise composition of the sample respondents

Age (in years)	No. of Respondents	Percentage
21-30	18	36
31-40	13	26
41-50	10	20
51-60	9	18
Total	**50**	**100**

Source: Primary data

Table 1 shows that 36 percent of the sample respondents belong to the age group of 21-30 and 18 percent of the sample respondents belong to the age group of 51-60. From this it is understood that maximum respondents are youngsters and they are the bread winners of the family.

2. Educational Status

Education is a significant variable which determines the social status of the sample respondents. The educational qualification of the sample respondents is given in the table 2.

Table 2. Educational qualification of the sample respondents

Education	No. of Respondents	Percentage
Primary	14	28
Secondary	18	36
Degree	8	16
Illiterate	10	20
Total	**50**	**100**

Source: Primary data

The above table 2 reveals that 36 percent of the sample respondents have completed secondary education. 16 percent of the sample respondents completed degree.

3. Gender wise classification

Gender is the main determinant of any action. The gender wise distribution of the construction workers of sample respondents is shown in the table 3.

Table 3. Gender wise classification of the sample respondents

Gender	No. of Respondents	Percentage
Male	35	70
Female	15	30
Total	**50**	**100**

Source: Primary data

The above table 3 shows that 70 percent of the sample respondents are male. 30 percent of the sample respondents are female. It clearly shows that the male is forced to earn to run their life.

4. Year of Experience

Experience shows one's efficiency in job. The sample respondents have many years of experience. This will certainly reduce their risk in their job. Table 4 shows the years of experience of the sample respondents.

Table 4. Years of experience of the sample respondents

Work Experience	No. of Respondents	Percentage
Below 1 year	5	10
1-5 year	11	22
6-10 years	8	16
11-15 years	6	12
More than 15 years	20	40
Total	**50**	**100**

Source: Primary data

The above table 4 shows that 40 percent of the sample respondents are having more than 15years of experience and 10 percent of the sample respondents have below one year of experience. It shows their active participation in construction work.

Findings

1. Thirty six percent of the sample respondents are in the age group of 21-30.

2. Thirty six percent of the sample respondents have completed secondary education.

3. Seventy percent of the sample respondents are male.

4. Forty percent of the sample respondents are having more than 15 years of experience.

Suggestion

❖ Construction workers can be brought under the provident fund scheme.

❖ The government can fix equal wage for the workers without any gender discrimination.

❖ Budget allocation for construction workers welfare fund can be made each year.

Conclusion

Construction workers are facing so many issues in the society. Most of them are occupied in low category work, where there is wage discrimination, and many more economic and social problems in their working places. Construction site involves a variety physical activity of workers movements of construction plans and the exposure of the nearby general public. Therefore, by managing safety within the construction sites has to involved different process in order to ensure that the site is safe working environment for workers and its surroundings.

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An Economic Study of Women Workers in Textiles Shop of Nagercoil Town in Kanyakumari District

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ABSTRACT

In Kanyakumari district women have employed in both agricultural activities and also working in factories like cashew, coir, fishnet, cloves, and loom, textile etc. But their situation are still worse even not providing the necessities. They usually have no permanency of job, no equal treatment and thereby they are affected by so many health hazards too. They undertook the jobs just to fulfil their needs and to earn something for their future. Irrespective of the wage structure and the mountainous difficulties the number of women who are working in this unorganised sector is getting increased.

Introduction

The textile industry is a high value sector in 2006 its contribution globally worth over one trillion, employing approximately 30 million people and supporting a significant number of economics and individual income around the world. According to Gold Bach and Securing the value adding process of textile consist of six chain levels.

Fibre production: Fibre are produced farming, includes growing and harvesting and finally cleaning them by process called ginning. E.g. Cotton fibre.

Spinning: During spinning fibres are converted into yam or in case of manmade fibres the yam is made from polymers which extrudes through spinneret to produce yam. There are various techniques by which it's produced. E.g. wet spinning, dry spinning.

Fabric production: The yam is converted into fabric by weaving and knitting. During this process, number of chemicals and dyes are used to make fabric whiter, colourful, attractive.

Clothing production: This includes cutting, sewing, ironing, packing.

Retailing: Finally, readymade garments are distributed and sold to the customer.

Advantages of Textile Industry

- The textile industry is one of the leading industries and this industry can surely accelerate the growth of the economy of a nation.

- A lot of labour work is required in the textile industries and that's why this industry creates a lot of employment.

- The national and international market demands for the textile goods are excellent. That's why this industry is an asset for the national and international trading.

Disadvantages of the Textiles Industry

- The main disadvantage of the textile industries is the pollution. The textile industries create a lot of air and water pollution.

- The water consumption of the textile industries is very high and that's why a lot of water resources is depleted by the textile industry.

Women Workers in Textile Industry

Problems and prospects of women workers play a necessary and important role in the economic structure of our country and have done so throughout its history, but their efforts and accomplishments have not been recognized. The condition of women in India today leaves much to be desired and they are still far away from the status of equality with men. Though our constitution has guaranteed certain Fundamental Rights and special provisions for the protection of the women, in reality they are relegated to an inferior status, economically, socially and politically. This is especially true the vast majority of the rights under the law. The condition of Indian also guarantees equality of opportunity relating to employment and directs the states to secure equal rights to livelihood, equal pay for equal work and just human conditions of work for all. Despite the concerted efforts of the states, the economic status of women is lagging far behind that of their male counter parts. Women have a significant part in the working of an economy. Women play a major role in the production process. The status of women in India is different from that of the developing countries of the world. In Indian society, women are considered as one of the two wheels of the life car. Society and the nation rests upon both men and women equally. Women are involved both in land based and home based occupations. Their contribution in agriculture, industry and service is crucial and their roles of women workers in their occupation are highly countable. The failure of Indian planners to take cognizance of the contribution of women in their crucial sector is one of the major reason for the short falls in the country's economic growth. If the women are left behind, nation cannot march forward.

Objectives

- To know the economic conditions of the sample respondents.

- To find the type of work carried on by the sample respondents.

- To focus on the problem encountered by the sample respondents.

Methodology

For this study primary data and secondary data was collected. A suitable questionnaire was constructed to collect the primary data. The secondary data was obtained from the materials published in journals, magazines, books and reports. For this study the primary data are collected from the respondents in Nagercoil town. The study is carried out on the basis of convenient random sampling method. Data have been collected from fifty textile shop women workers in Nagercoil town. A suitable questionnaire is constructed to collect primary data.

Analysis of Data

Monthly Income

Income and expenditure are the two edges of life. The purchasing power of an individual is based on income. Table 1 shows the monthly income of the respondents.

Table 1. Monthly Income of the Respondents

Monthly Income (in Rs.)	No. of Respondents	Percentage
Below 8000	17	34
8000 – 9000	8	16
9000 – 10000	10	20
Above10000	15	30
Total	**50**	**100**

Source: Primary Data

Table 1 show that 34 per cent of the sample respondents have income below Rs.8000 and 16 per cent of the sample respondents have the income between Rs.8000 - 9000.

Monthly Expenditure

The expenditure is based on their income. If the expenditure is more, one could spend more. Monthly expenditure is based on the earning capacity of the people. Table 2 shows the level of expenditure of the sample respondents.

Table 2. Monthly Expenditure of the Respondents

Monthly Expenditure (Rs.)	No. of Respondents	Percentage
Below 2000	10	20
2000 – 4000	12	24
4000 – 6000	15	30
Above 6000	13	26
Total	**50**	**100**

Source: Primary Data

Table 2 shows that 30 per cent of the sample respondents have expenditure between Rs.4000 - 6000 and 20 per cent of them have expenditure below Rs. 2000.

Amount of Borrowing

When expenditure exceeds income people borrow money. The borrowing of the sample respondents is given in table 3.

Table 3. Amount of Borrowing of the Respondents

Amount of Borrowing (Rs.)	No. of Respondents	Percentage
Below 10000	15	43
10000 – 15000	12	34
Above 15000	8	23
Total	**35**	**100**

Source: Primary Data

Table 3 shows that 43 per cent of the sample respondents borrowed below Rs.10000 and 23 per cent of the sample respondents borrowed above Rs. 15000.

Types of Work

Types of work depend upon the qualification of the sample respondents. It includes billing, cashier, sales and supervisor. Table 4 shows the types of work.

Table 4. Types of Work of the Respondents

Types of Work	No. of Respondents	Percentage
Billing	1	2
Cashier	2	4
Sales	38	76
Supervisor	9	18
Total	**50**	**100**

Source: Primary Data

Table 4 shows that 76 per cent of the sample respondents are working in sales section and 2 per cent of the sample respondents work in billing section. Since the work is mandatory they easily get the job.

Health Issues

Every man kind faces health problems in their day to day activities. Sickness is expected to decrease work productivity and life expectation to reduce economic development. The health problems of the respondents are shown in the table 5.

Table 5. Health Issues of the Respondents

Health Issues	No. of Respondents	Percentage
Head ache	5	10
Joint pain	22	44
Stress	17	34
Others	6	12
Total	**50**	**100**

Source: Primary Data

Table 5 shows that 44 per cent of the sample respondents affected by leg pain and 10 per cent of the sample respondents affected by headache.

Carrier Issues

Carrier Issues includes rude behavior of customer, heavy work and others. Others includes loss of beta, denied break,they don't get further increment.

Table 6. Carrier Issue of the Respondents

Carrier Issues	No. of Respondents	Percentage
Rude behavior of customer	9	18
Heavy work	29	58
Others	12	24
Total	**50**	**100**

Source: Primary Data

Table 6 shows that 58 per cent of the sample respondents face Heavy work in their carrier and 18 per cent of the respondents face rude behavior of customer in their carrier.

Findings

- Thirty four per cent of the respondents have income below Rs.8000.
- Thirty per cent of the respondents have expenditure between Rs.4000 and Rs 6000.
- Forty three per cent of the respondents borrowed money below Rs.10000.
- Seventy six per cent of the respondents are working in sales section.
- Forty Four per cent of the respondents affected by joint pain.
- Fifty eight per cent of the respondents face heavy work have in their carrier.

Suggestions

- Government should provide employees insurance facilities to the working women.
- Interest free loans must be provided to the women workers.

- Government should insist the owner of the shop to make all the basic facilities in the premises of the shop.

- Unions can be formed for working women to fight for their rights.

- The minimum wage shall be fixed for the working women and provident fund and pension plans shall be extended.

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Differences in Cognitive Style Among Management and Commerce Students

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ABSTRACT

The aim of the study is to assess the differences in cognitive style of Commerce and Management students across various colleges in Kanyakumari district. Cognitive Style is considered to be a strong predictor of Entrepreneurial Intention by various researchers. Since Commerce and Management students are potential entrepreneurs who are professionally eligible to start a Business, so this study has been conducted among commerce and management student. A purposive sampling is used to select the participants from two colleges in Nagercoil. 81 students both Male and Female students are administered questionnaires in the E-format for this Study. The Cognitive style of the students is measured by Cognitive Style Indicator (CoSI) developed by Cools and Van Den Broeck in 2007. The result indicates that there was no significant difference in cognitive style of Commerce and Management students with demographic variables such as gender, age, residential area, nature of the family and father's occupation. Since the cognitive style is a predictor of entrepreneurial intention in future studies, it is worthwhile to examine the association between Cognitive Style and Entrepreneurial Intention.

Keywords: Cognitive style, College Students, Course of study

Introduction

Cognitive style plays a significant role in deciding the behaviour (Aamir et.al). Cognitive style is critically important indicator of vocational choices and job selection (Armstrong et .al 2011). Now the term cognitive style is more attracted by researchers in the field of management and commerce because the effect of cognitive style of entrepreneurs as well as managers brings greater impact on organizational output. In the management sphere, it influences personnel selection, career guidance, task design, team composition, conflict management, and training and development (Hayes and Allinson, 1994).

Cognitive Style

The term 'style' usually refers to habitual pattern or preferred way of doing something (Grigorenko & Sternberg, 1995). Cognitive Style is a person's habitual, prevalent or preferred way of thinking (Riding, 1997). Thinking may involve perceiving information, processing

information, and applying information. (Sternberg ,1997). In detail Cognitive styles is defined as "an individual's preferred way of gathering, processing and evaluating data" (Brigham et al., 2007), The term 'cognitive style' is synonymous with thinking style, decision-making style, problem-solving style, learning style, mind style, perceptual style, and conceptual tempo (Zhang & Sternberg, 2005). Cognitive style influences how people look at their environment for information, how they organize and interpret this information, how they use these interpretations for guiding their actions (Hayes & Allinson 1998). For the purpose of this study, the model of cognitive style that has been proposed by Cools and Van den Broeck's (2007) is adopted. They have also developed a Cognitive Style Indicator based on this model. According to this model, cognitive style consists of three dimensions: knowing style, planning style and creative style.

Knowing style: This dimension refers to how individuals use analytical and conceptual approach to perceive facts and their details. They are task-oriented and they thrive on complex problems, if they can find a clear and rational solution.

*Planning style***:** Individuals with a planning style show a preferred way of doing something in a structured and ordered manner, Planners prefer a well-structured work environment and they give importance to preparation and planning to reach their objectives.

*Creating style***:** Individuals with a creating style tend to be creative and like experimentation and out of the box thinking, they tend to see opportunities, they do not like rules and procedures.

Statement of the Problem

The biggest hurdle today is job uncertainty. So equipping students with self-employment is the need of the hour. Keeping in this in mind, cognitive style plays a significant role in business and management. It is also an excellent indicator of entrepreneurial attitude (Allinson and heyes 2000). Because Entrepreneurial action is emergent arising out of the entrepreneur's underling cognitive process (Mitchell et al, 2002). Since commerce and management students are potential entrepreneurs who are professionally eligible to start a business, so this study has been conducted among commerce and management students.

Objective

- To explore if cognitive style of commerce and management students differ along demographic variables such as gender, age and basis of family income.

- To assess if cognitive style of students differs along with their course of study.

Method

Participants of the Study

The population of the study are commerce and Management students. A purposive sampling method is used to select the participants, in Nagercoil, the district headquarters of Kanyakumari District in Tamil Nadu, India.

In terms of demographic characteristics, the participants in the study consisted of 80 college students, 38.8% (n1=31) of them are students of MCom program, and 61.3% (n2=49) are drawn from the MBA program. Of the total participants, 48.8% were male and others female. The majority of participants fell in the age range of 21 to 22 years.

Instruments

Cognitive Style was measured using Cognitive Style Indicator (CoSI) developed by (Cools and Van Den Broeck 2007). This scale has three dimensions. ***Knowing style:*** measured with 4 items, ***Planning style:*** measured with 7 items, ***Creative style:*** measured with 7 items.

Data Analysis

The data were analyzed using SPSS version 21. Both descriptive and inferential statistics were used as presented in the results section, in responding to the research objectives.

Results and Discussion

Difference in Cognitive Style on the basis of Demographic Variables

There was an ample data set around many demographic variables: gender, age, course of study, place of residence (rural or urban), father's occupation, and family income levels. To begin with, the data emerging from a one-way ANOVA showed that there was a significant difference on the mean scores of Cognitive Style on the basis of gender. It is interesting to note that female participants have scored significantly higher mean score.

Table 1. Gender difference in Cognitive Style

	Mean (SD)		F-Ratio	Sig
Cognitive Style	Male	Female		
	53.43 (17.33)	62.00 (11.77)	6.29	.014

However, there was no significant difference on the basis of age (Table 2). Similarly, there was no significant difference on other demographic variables such as Place of Residence (Rural or Urban), and Father's Occupation.

Table 2. Age difference in cognitive style

Age		N	Mean	SD	F-Ratio	Sig
Cognitive Style	18-20 years	9	47.33	11.60	1.899	.137
	21-22 years	58	58.62	15.92		
	23-25 years	5	64.40	11.50		
	26 and above	3	61.66	0.57		
	Total	75	57.77	15.30		

Interestingly, the difference in Cognitive Style on the basis of family income levels is more nuanced. What is worth noting is that the group belonging to the income bracket of ₹ 50,000 to ₹75,000 has scored higher mean scores in Cognitive style (Table 3), however, this difference has been shown to be statistically not significant.

Table 3. Difference in Cognitive Style on the basis of Family Income Levels

Family income		N	Mean	SD	F-Ratio	Sig.
Cognitive Style	Below ₹25000	34	60.47	13.03	1.398	.250
	₹25000-50000	21	53.57	17.91		
	₹50000-75000	7	63.28	3.03		
	Above ₹ 75000	13	54.53	18.89		
	Total	75	57.77	15.30		

Similarly, on the basis of the course of the study clearly states that there is no significant difference in scores of Cognitive Styles between management students and those of commerce students (Table 4), even though the management students have scored slightly higher mean score.

Table 4. Difference in Cognitive Style on the basis of Course of Study

Conclusion

Course of study		N	Mean	SD	F-Ratio	Sig.
Cognitive Style	Commerce	28	57.67	14.93	.002	.967
	Management	47	57.82	15.68		
	Total	75	57.77	15.30		

The findings of the study indicates that there was no significant difference in cognitive style of commerce and management students with respect to the demographic variables such as gender, age and family income; as well as there is no difference in cognitive style of students

on the basis of course of study. The findings of the study conducted by (jena, 2014) is evidenced in accordance with the findings of the current study found no significant gender differences in cognitive style among undergraduate students. Since the cognitive style is a predictor of entrepreneurial intention, in future studies, it would be worthwhile to examine the association between Cognitive Style and Entrepreneurial Intention.

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A Study on Certain Services Offered by the Post Office

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ABSTRACT

Post office is the public department or corporation responsible for postal services and in some countries, it acts as a telecommunication. Indian postal service mainly concerned with collection, sorting and distribution of letters, parcels, packages etc. A post office is a public facility and a retailer provide mail services, such as accepting letters and parcels, providing post office boxes, selling postage stamps, packaging, and stationery. Post offices may offer additional services, which vary by country. A number of other services are also provided to general public as well as business enterprises. The main aim is to study the various services provided by post office to its customers.

Keywords: Post Office, Services, Post, Money, Customers

Introduction

The term "post office" usually refers to Government postal facilities providing customer service. "General Post Office" is sometimes used for the national headquarters of a postal service, even if the building does not provide customer service. The post office provides postal and non-postal services. For more than 150 years, post office has been acting as the foundation of the country. Post office offers many services to its customers. These include giving and tolerating Government structures (like identification applications), and handling taxpayer supported organizations and charges, (for example, street charge, postal reserve funds, or bank expenses). Postal administrations in developed countries have long appreciated the importance of collaborating in the improvement of postal services throughout the world. The arrangement of efficient postal services to the individuals has been acknowledged by the majority of the states as friendly commitment.

Objectives of the Study

Following are the objectives of selecting the topic.
- To outline the general postal services in the country.
- To know the current flow of services in Indian post based on their working style.
- To ascertain the importance of postal services in India.

Research Methodology

This study mainly includes literature review from secondary data. It includes different articles, other relative information published from the post office and other internet sites. The

study is based on earlier research done in this particular aspect. This is a descriptive study based on the findings of other researchers.

Postal Services

The service of carrying letters and parcels, arranging remittance of money, accepting deposits of money and so on are the different services offered by the post office which the public can avail of all. All these services are called postal services.

Nature of Postal Services

A post office serves variety of functions, in this manner making the idea of postal administrations unique. Post office services are directed by Government of India throughout the country. The charges for all these services are minimal, which the common public can afford. Postal service is a reliable means of sending money through money orders to individuals residing at far places.

Importance of Postal Services

- Postal services are available at lower rates than any other means of communication.
- Postal services encourage the people to save their money in saving schemes.
- Postal services facilitate the growth and expansion of both internal and external trade.
- Postal services facilitate distance learning.

Types of Postal Services

Indian postal services are mainly concerned with collecting, sorting and distributing letters, packages, parcels etc. They also provide number of services to the public as well as business enterprises.

Mail Services: Mail service is one of the main services of post office that deals with collection of letters and parcels from the sender and distribute among the receiver. Postal services deals with both inland and international mails. An inland mail is one where the sender and the receiver of the mail reside in the same country. In international mail, both the sender and receiver belong to different countries.

Post Cards: A postcard is a piece of thick paper or slender cardboard, commonly rectangular, expected for composing and mailing without an envelope. It is the cheapest mean of communication. There are two types of post cards available in post office one is "Ordinary post card" another one is "Competition post card". While ordinary post cards are utilized for writing letters, competition cards are utilized to send answers to questions asked in different rivalry through radio, TV, paper and magazines.

Inland Letter: Like post card, composed messages can likewise be sent utilizing inland letters.

The clear inland letters are sold by post office and are normally utilized for sending messages inside the country.

Envelope: Messages can be composed on the post cards or on the inland letters. In inland letters sending any enclosures is beyond the realm of possibilities. Postal envelopes are generally accessible in post office.

Parcel Post: The postal facility through which article can be sent in the form of parcel known as parcel post. Under parcel post services, parcel of indicated size and weight can be sent to the nation over as well as outside the country. Postal charges differ as indicated by the heaviness of the package. Separate postage is to be paid for inland and foreign parcel post.

Book Post: Article as written words, printed books, periodicals, welcoming cards can likewise be sent as book post. Under book post, envelopes containing books or documents should only be closed but not sealed. It should be mentioned on the face of the envelope as book post.

Remittance services: People can send money to their family with the help of remittance services offered by the post office. Post office provides money order and postal order facility with the help of which individuals can transfer money from one place to another within as well as outside the country.

Money order: Money can be sent through post office under money order service. Money order is an order issued by one post office to another post office to pay a certain sum of money only to person named therein. For the convenience of customers, post office offers different types of money order services like Ordinary money order, Telegraphic money order, Satellite money order, Speed post money order etc.

Postal Order: One can send more through postal order i.e Indian Postal Order (IPO). It is a convenient method of sending money from one place to another. It is mainly used for remitting examination fee. Postal orders are available at all post offices in different denominations.

Banking Services: A bank accepts deposits from the general public and awards credits and advances to the individuals who need reserves. Post offices also undertake some of these services like accepting deposits from the public and withdrawal of deposits. Under this, Post office offers various schemes to encourage savings and motivate people to save.

Post Office Savings Bank Account: It is an account where one can deposit their savings in post office and withdraw it whenever required. A minimum of five hundred rupees is required to open an account in post office savings account. The account can be operated jointly. Post offices pay 4% interest for the deposit, which is totally exempted from tax.

Post Office Recurring Deposit Account: The period for recurring deposit account is five years. This account can be opened with a minimum amount of Rs. 100. There is no restriction

to open more than one recurring deposits in the name of single individual. Post offices pay 5.8% interest per annum for the deposit. After completion of one year loan can be sanctioned.

Post Office Time Deposit Account: The minimum deposit allowed in this account is Rs 1,000. The interest is determined quarterly but is payable on a yearly basis. For 3-year term, the rate of interest is 5.5% p.a., and for a 5-year term, the rate of interest is 6.7% p.a. This account can also be opened by a trust. The deposit amount as well as interest amount is exempted from tax.

Post Office Monthly-Income Scheme: Under this scheme a fixed sum of money is deposited for 6-years and the depositors get the interest on it for every month. A minimum amount of Rs 1,000 and maximum of Rs 4.5 lakh in a single account and Rs 9 lakh incase of joint account. This account is suitable for retired employees or anybody who wants a regular income just like pension or salary.

National Savings Certificates Scheme: National Savings Certificates can be purchased from the post office by an adult for himself or herself or for any minor or by any minor, two adults jointly or a Trust. These certificates can be can be pledged or transferred as security to the housing finance company, banks, Government companies, and others. Interest is computed half yearly and payable at maturity.

Public Provident Fund

Individual can open this account in their own name or in the name of their minor child. The minimum deposit required to open the account is Rs 500, and the maximum limit is Rs 1.5 lakh. The scheme offers an interest rate of 7.1% p.a. compounded annually. Also, the interest earned on this account is tax-free.

Kisan Vikas Patra

In this scheme a fixed sum of money gets doubled within a certain period. The minimum deposit for this account is Rs 1,000 and there is no maximum limit of deposit. The applicable interest rate is 6.9% p.a. Money can be withdrawn before its maturity but there is a minimum period called lock-in period within which money cannot be withdrawn.

Senior-Citizen Savings Scheme: Individual above the age of 60 are eligible to open this account It can be operated individually or jointly with spouse. The deposit amount can range from Rs 1,000 up to Rs 15 lakh. The scheme offers an interest rate of 7.4% p.a.

Sukanya Samriddhi Account

Girl children below the age of 10 years are eligible to get the benefits of this account. The account must be opened and operated by parents or guardians. The minimum deposit amount is Rs 250 and a maximum of Rs 1.5 lakh per year. An interest rate of 7.6% p.a. is applicable to this account.

Insurance Services: With mail and remittance of money, post office provides life insurance coverage to individuals. Post office offers life insurance under two schemes namely

Postal Life Insurance: Postal Life Insurance was initially introduced for postal employees. Over the years it has been extended to the employees of central and state governments, public sector undertakings, universities, Government aided institutions and financial institutions.

Rural Postal Life Insurance: Post office provides life insurance coverage to the people living in rural areas and weaker section of the society. Under Rural Postal Life Insurance, the insured person pays low premium for the insurance coverage.

Other Postal Services

Apart from these services, Post office also provide other services like

Sale of stamps: Other type of stamps like revenue stamp, share transfer stamp, recruitment stamp is also sold by post office.

Sale of forms: Passport forms, Union Public Service Commision forms, Staff Selection Commision forms are also sold by post office.

Bill payment: Post office collects payment of telephone, electricity and water bills

Pension payment: Military, railways, coalmines, telecom pensioners can avail of this facility from post office.

Post shoppe: Post shoppers are the small retail shops established for the sale of postal stationery items, greeting cards and small gift items to its customers.

Philately: Special and commemorative postage stamps as well as special covers are issued by postal department.

Gramin Sanchar Sewak Scheme: It is a joint effort of postal department and Bharat Sanchar Nigam Limited (BSNL).

Specialised Mail Services: For the convenience of people post office offers various mail services.

Certificate of Posting: When ordinary letters are posted, post office does not issue any receipt. However, if a sender wants to have a proof, then a certificate can be obtained from the post office on payment of prescribed charge.

Registered Post: Sometimes a sender wants to ensure that the mail is definitely delivered to the addressee otherwise it should come back to him. In such situation, post office offers registered post facility through one can send letters or parcels.

Insured Post: Insured post is a type of mail services through which valuable articles may be sent after insuring. Here the post office act as a insurer and liable for the loss or damage occurred.

Speed Post: Under this service letters or parcels are delivered faster. This facility is available at specific post offices. Post office charges more postage for speed post than that of ordinary post.

Value Payable Post: Under this service post office receives the properly packed goods from the sellers and carries those to the customers. For this service post offices charge from the customers.

Business Rely Post: Post office allows the customers to send their reply through business rely post, which does not require any postage from the sender.

Media Post: Under this service, postal department allows the corporate and government organizations to reach their customers through advertisements on post cards.

Express Post: Post office offers a reliable, speedy and economical parcel service to the corporate and business customers through express post.

Business Post: Post office gives another opportunity to the business customers by undertaking their prevailing activities through business post.

Corporate Money Order: Under this service business organization can also transfer money through money order.

Post box and Post bags: Post office also provides post box and post bag facility to the receivers of the unregistered mails.

Interpretation of the Study

India Post provides various services to the customers. It also provides reliable investment and safe returns through post office saving schemes. India Post is the largest postal network in the world, which offers services ranging from conventional postal services to banking and e-commerce services, is administered by them. Additionally, it offers non-commercial services including paying Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) wages and disbursing old-age pensions. Indian postal service coordinates their activities with other Government agencies such as Police, District Administration etc. Similarly, this study explains the various services offered by the post office to the customers. Though there are large number of services provided by India post, people are not much aware about the services and saving schemes.

Conclusion

The post office is recognized as a facilitator of communication. It deals with number of postal services like Speed Post, Media Post, Business Post, Book Post etc. The various small saving schemes are very helpful to the small investors. Indian postal services has to meet all postal needs for all section of people both rural and urban areas, individual, corporate organization and business firm. Post office should provide quality of service to their customers

in upcoming years.

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An Overview of Green Product Labelling

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ABSTRACT

The products that are manufactured through green technology and made from materials that are free from harmful chemicals and components that caused no environmental hazards are called green products. A green product is a sustainable product designed to minimize its environmental impacts during its whole life cycle and even after it's not in use. These products are cost-effective, low maintenance, improves health, generate more jobs, prevent overuse of resources, and protect the environment. Overall, it helps to improve the *physical but also mental health* of consumers and *significantly decreases the number of pollutions released into the environment. Manufacturers have been forced to develop products that are both healthy for consumers' bodies and safe for the environment. However, due to a lack of trust, some of them are unwilling to buy green products. Trust in such products is boosted by their green product labels. Knowing a product's greenness and quality can be determined by its labeling or certification. The current article is an overview of green product labeling, focusing on types of green products and certification of green products which is seen as a crucial marketing strategy for environmentally friendly goods.*

Keywords: *Green products, sustainability, consumers, eco-friendly.*

Introduction

Green products are those that won't pollute the environment, can be recycled and well-maintained, include only permitted chemicals, and have natural ingredients. Sustainability and environmental friendliness are inherent characteristics of green products. Customers prefer to purchase green products since they are more environmentally friendly and health-conscious. The Chinese consumers' association gave a more authoritative definition of green consumption. It firstly, advocates for the consumer to choose products that are contamination free or healthy in public; secondly, pays attention to the disposal of garbage in the process of consumption, avoiding pollution; Thirdly, guides the consumer consumption idea to pursue a comfortable and healthy life. This paper's main goal is to identify the general characteristics of eco-friendly products and the possible advantages of switching to them for both customers and the environment. Due to environmental degradation, healthcare and environmental consciousness among our customers is on the rise, and they are motivated to include green products in their daily lives. Although the market for green products in our country is still in its infancy, this is anticipated to alter. Increasing the purchasing of green products benefits the environment and the health and well-being of customers. From that perspective,

green labeling is a crucial instrument for attracting customers. (Qinlin Zhang et al, 2019) defines green labeling as an accreditation activity of products in line with the specific environmental standards of authority.

Literature Review

"Eco-labeling" is the issuance of a mark or symbol by an independent and unbiased third-party organization to those products or services which have been proven to be environmentally safe. The purpose of this article is to give an overview of environmental labels. This article is about non-binding voluntary eco-labels. Consumer education plays an essential role in the adoption of eco-labels. Consumer awareness of eco-labeling is an important factor in determining its effectiveness (Malik Mohammed Salman, 2016). Eco-label verifies the ecological features of products and thus it's an important marketing tool for reaching green consumers. The aim of the article is to reveal the importance of eco-labeling as a marketing tool for green consumerism and it provides an exhaustive profile of typical green consumers. The researcher concluded that the green purchase perception is based on the degree of compromise and degree of confidence that is raised by the green label. (Golubevaite L, 2008).

Statement of the Problem

Green products improve customer health and wellness while also protecting the environment. As a result, companies commonly design and sell their products based on green technologies and certify such products. However, some consumers continue to be unaware of green products and green product labeling as a result, they do not place as much value on them. The purpose of this study is to explore the variety of green products and green labels which helps consumers to overcome their ignorance and to choose true green products.

Objectives of the Study

The principal objective of the study is to analyse types of green products and green product labels.

Research Methodology

In consideration of the objectives of the study, a descriptive research approach using secondary data has been adopted. Important information is gathered from various sources, including research papers, publications, yearly reports, and other relevant material found online and on websites.

Green Products

A green product is a sustainable product designed to minimize its environmental

impacts during its whole life cycle and even after it's of no use. Green products are usually identified by having two basic goals reducing waste and maximizing resource efficiency. They are manufactured using toxic-free ingredients and environmentally-friendly procedures and are certified by recognized organizations like Energy Star, Forest Stewardship Council, etc.

Types of Green Products

Green products that are safe for the environment are now so prevalent that people can use them for a variety of daily tasks. Following are a few examples.

- **Green Fast-Moving Consumer Goods**: Fast-moving consumer goods (FMCG), also called consumer packaged goods (CPG), refer to products that are highly in demand, sold quickly, and affordable. If the products are produced through green technology called green FMCG's. Green Fast-moving consumer goods include packaged food, toiletries, beverages, stationery, over-the-counter medicines, cleaning and laundry products, plastic goods, personal care products, as well as less expensive consumer electronics, such as mobile phones and headphones.

- **Eco-Friendly Dishwashers and Cleaning Products:** The amount of water and energy used by an eco-friendly dishwasher is halved compared to a standard dishwasher. Green goods differ from conventional ones in that they include more active ingredients. According to a company that promotes green products, the materials used in their products are "safe for the air, the surface, the clothes, the animals, and the humans."

- **Organic Food Articles/Vegetables/Fruits:** The cultivation and preparation of agricultural products, such as livestock, dairy, grains, fruits, and vegetables, are referred to as "organic" farming. Organic farming practices strive to reduce pollution while promoting soil and water conservation. Producers of organic food and meat don't use conventional weeding, fertilizing, or disease management methods.

- **Home Appliances:** Home appliance operating costs might vary substantially. It's crucial to look for efficient products with low operating costs. Knowing the energy ratings of appliances might help you conserve energy and reduce your energy costs. There are energy rating labels on televisions, air conditioners, washing machines, and the majority of refrigerators and freezers. The label on the appliance displays its annual energy usage as well as its energy efficiency.

Certification of Green Products

There are a few ways to be sure you are not being conned into purchasing a fake when hunting for green products, though they can be challenging. Walking through any supermarket

will reveal products marked "earth-friendly," "eco-friendly," "biodegradable," and many other buzzwords that may or may not be true but will make you feel good about the purchase. Some of the green labels are listed below.

Energy Star is a program for labeling energy-efficient household goods, including electronics, appliances, and building supplies. The U.S. Environmental Protection Agency and the U.S. Department of Energy collaborate on the ENERGY STAR program, which promotes environmentally friendly activities and products.

Green Seal Certification guarantees that a product complies with stringent, scientifically based leadership standards. It is a life cycle assessment-based labeling program for construction supplies, environmentally friendly operations, and upkeep techniques. Detergents, furniture polish, and items for cleaning vehicles all bear a green seal.

Forest Stewardship Council certification program for wood products that come from forests that are managed in an environmentally responsible, socially beneficial, and economically viable way. They are a non-profit organization, not affiliated with the government, working to promote responsible management of the world's forests since 1993.

Leadership in Energy and Environmental Design (LEED) certification was created by the U.S. Green Building Council in 2000, it in an internationally recognized standard for green building and design. The rating system works off 5 categories and is associated with both business and residential buildings. LEED focuses on whole-building sustainability which can be used by diverse professionals and government agencies.

USDA Organic Product: In organic food products many consumers look for certified organic foods. The United States Department of Agriculture has implemented the National Organic Program, which will indicate whether an agricultural product was produced in such a way that integrates biological, cultural, and mechanical processes to conserve biodiversity and foster the cycling of natural resources.

Consumers may identify products and initiatives that conserve water without compromising on performance or quality thanks to the **Water Sense** label. The U.S. Environmental Protection Agency (EPA) awards this mark to goods that use 20% less water than the typical item in their category. In categories including toilets, faucets, urinals, and showerheads, the goods must also perform on par with or better than those of their less efficient equivalents.

The percentage of fiber from certified forests, certified sourcing, and post-consumer recycled material are tracked by **Sustainable Forestry Initiative** (SFI) chain-of-custody (COC) certification. To assist consumers in making informed judgments about their purchases, SFI on-product labels clearly state both certified sourcing and COC claims.

A product that has received **Greenguard** Certification has proven that it has adhered to some of the strictest and most thorough standards for minimal emissions of volatile organic compounds (VOCs) into indoor air. This certification has gained significant traction as a reliable benchmark for low-emitting items.

This seal was developed by the **Rainforest** Alliance to attest to the sustainability of farms, forests, and any goods they yield in terms of the economy, society, and the environment. To make sure that their criteria are being upheld, the Rainforest Alliance collaborates with the Sustainable Agriculture Network, the Forest Stewardship Council, and the Global Sustainable Tourism Council.

Based on the popular book by Michael Braungart and William McDonough of MBDC (McDonough Braungart Design Chemistry), the Cradle to Cradle Certification confirms that a product employs healthy, environmentally safe materials and is made to be recycled, composted, or reused. The usage of renewable energy sources and energy-efficient manufacturing must also be taken into account.

Interpretation of the Study

As never shopping been so difficult. The selection criteria are always expanding, and there are hundreds of competitive products in the stores. Consumers may priorities pricing, brand familiarity or packaging from now and then. Too many people are making selections based on a product's environmental friendliness and health conscience. The eco-labels on product packaging can help consumers to make informed and responsible purchasing decisions. It assists consumers in making purchasing decisions that are equally health conscious and environmentally friendly. And it brings attention and attraction of the customers to choose their products. Similarly, this study, explained the several sorts of green products and green labels, which aid in identifying products that have been determined to be environmentally preferred within a certain category. Thus, green labeling systems are meant to assist customers in making informed decisions about the environmental effects of a product's creation, usage, and disposal.

Conclusion

Human activities continue to be impacted by environmental issues, and society is now quite concerned about them. The majority of businesses have begun utilising the sustainable development framework, also referred to as green marketing, and the majority of organisations now recognise green products as being ecologically safe. Marketing executives can profit by using green marketing and it satisfies customer demands while conserving the environment.

consumer awareness of eco-labeling is an important component of purchasing green products. An honest eco-label is a powerful tool for environmental conservation. It is important to note that marketers who label their products with fake green labels and make environmental safety promises should not be trusted by consumers. When purchasing environmentally friendly goods, consumers should look for the eco-label to verify they are getting real, high-quality green goods.

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Consumer Behaviour and Attitude on Value-Added Fish Products in Agastheeswaram Taluk

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ABSTRACT

Competition in both local and international markets for the food business requires the expansion of segregated products in order to meet the demand of more quality-stringent, health-conscious, and attribute-oriented consumers. This paper aims to show the consumers' behaviour and attitude towards value-added fish products in Agastheeswaram. This study is based on subjective and objective knowledge of the health benefits of fish, fish consumption, and social and demographic characteristics. The study is conducted by 60 sample respondents. The researcher made a thorough analysis of the study on consumer behaviour and attitude towards value-added fish products with reference to Agastheeswaram taluk in Kanyakumari district. The data were collected with the help of a well-structured questionnaire. The outcome of this paper helps to give ideas to fish processing companies that are looking for profitable business opportunities in local or international niche markets.

Keywords: Consumer behaviour, consumer attitudes, fish products, fish, fish and fish by-products, fishery products, value-added fish products.

Introduction

Fisheries have a significant place in the Indian economy as it acts as a source of income and employment for numerous fishermen, particularly in coastal areas. Fish and other aquatic animals are an important source of food as it is rich in proteins, minerals, and vitamins. Fish and fishery products are viewed as a healthier source of protein than red meat. The volume of worldwide fish production amounted to 174.6 million metric tons in 2020, up from 148.1 million metric tons in 2010. Fish is one of the most broadly consumed foods in the world, and it is only becoming more popular over time. Statistic shows the total world fish production from 2007 to 2021, 84.1 million metric tons were raised in aquaculture. Quality food with good taste fish is an overlooked food source for many people. Eating fish is a great alternative to eating red meat, potentially providing a broad range of health benefits from heart health to improved symptoms of depression.

The marketing of value-added fish products is completely different from the traditional seafood trade. It is dynamic, sensitive, complex and expensive. Market surveys, packaging and advertising are a few of the very important areas, which ultimately determine the successful movement of new products. Most of the market channels currently used may not be suitable to

trade value-added fish products. A new appropriate channel would be a supermarket chain; which wants to procure directly from the source of supply. Though, market research has been conducted in the field of fresh and frozen fish but still, the domain of value-added fish and fish products remains less explored. In this context, the present study was undertaken to analyze the consumer behaviour and attitudes towards value-added fish and fish products in Kanyakumari district with the objective of analyzing the consumer behaviour and attitude towards value-added fish and fish products.

Important health benefits of fish and fishery products

- Fish is high in numerous significant nutrients including high-quality protein, iodine, and various vitamins and minerals.

- Fish is considered one of the most heart-healthy food, number of observational studies demonstrated that people who eat fish consistently have a lower chance of heart attacks, strokes, and death from heart disease. Thus, eating at least one serving of fish per week has been connected to a reduced risk of heart attacks, blood pressure, abnormal heart rhythms and strokes.

- Fish is high in omega-3 fatty acids, which are essential for brain and eye development. It helps to healthy brain function and infant development of vision and nerves during pregnancy.

- Evidence recommended that higher consumption of omega-3s or fatty fish may also have a positive effect on glucose and insulin metabolism. These fatty acids also tone down the inflammatory processes that contribute to diabetes. Eating fish has been linked to a reduced risk of diabetes and several other autoimmune conditions.

- Fatty fish is an excellent source of vitamin D preliminary evidence indicates that eating fatty fish like salmon may improve sleep.

- Some studies show that children who eat more fish have a lower risk of asthma.

- People who eat more fish have a much lower risk of AMD (Age-related macular degeneration) is a leading cause of vision impairment and blindness that mostly affects older adults, a leading cause of vision impairment and blindness.

- Fish is delicious and easy to prepare. For this reason, it should be relatively easy to incorporate it into diet. Eating fish one or two times per week is considered sufficient to reap its benefits.

- Seafood makes everyone smarter. People who eat fish are frequently shown to have 14 per cent larger brain hippocampus - the big memory and learning center.
- Fish prevents inflammation and reduces the risk of arthritis.

Review of Literature

Nurhayati *et al.* (2018) analyzed and identified leverage factors to promote fishery-based innovative business in West Java. Their findings show that factors influencing the success of a fishery innovative business in West Java, Indonesia were consecutively: the existence of derivative products, product processing innovativeness, product price competitiveness, market place and promotion. The study discovered that fish onboard handling, post-harvest handling, and processing were in the development stage and therefore he suggested these production nodes need particularly high attention.

Kurien et al. (2013) summarized on Fisheries Management, Governance, Effective Monitoring Control and Surveillance, Trade and Food Security in list of six countries: Kenya, Malawi, Rwanda, Tanzania, Zambia and Zimbabwe. Their study revealed that the current fish consumption is not high in these countries but they have the resources and ecosystem potential for expansion of their fisheries. They indicated the issues are a lack of storage capacity and market infrastructure which results in high post-harvest losses and reduced production prices. They explored about the predominance of small-scale fisher folks and subsistence fisheries, along with the poor institutional on performance of the sector implies that, in many cases, the relevance of the fisheries sector might be underestimated. Their study recommended considering on promotion of consumption, capacity building, and deepening awareness of the need to include fisheries in the national food security policies of these nations.

Shyam S. Salim and Monolisha (2020) focused on analyzing the different types of domestic fish markets analyzing the opinions of consumers on buying fish while travel and travelling to buy fish, fish consumption and preference to choose markets were analyzed across 14 districts of Kerala. The outcome of the study discovered that the marketing efficiency was lowest in the registered domestic markets whereas it was highest in the unregistered way-side stall. They proposed government should pay attention to way-side stalls into stalls inside the sedentary well-structured domestic fish markets to avoid huge losses suffered by the structured domestic marketers. This could also reduce the overhead costs of way-side marketers. Their study also recorded specific policy recommendations to be implemented in Kerala fish markets to efficiently change both the registered domestic fish markets and unregistered way-side stalls.

Statement of the problem

Fish is rich in high-protein, low-fat food that gives a range of health benefits. For most

individuals, it's fine to eat fish every day. Kanyakumari district is known for its fresh fish availability. When it comes to Agastheswaram taluk, there is majority of the villages are in coastal belts. In the study area, most of the people are very fond of eating fish and seafood items and without fish meals they cannot get complete satisfaction in their daily meals' routine. They are giving more importance to buying fish and fishery products. People thoughts that dry fish the only thing which is consumed as value-added fish product, however there are many value-added products are available in the market in study area. There is a good scope in value-addition business in the study area. There is a need to analyse the attitudes and their expectations on value-added fish product in the study area.   Hence, the study analyzes consumer behaviour and attitudes towards value-added fish and fish products.

Objective of the study

The objectives of the paper are,

➢ To study the demographic profile of the value-added fish product consumer.

➢ To analyze relationship between income and consumer behaviour and attitudes towards value-added fish and fish products.

Limitations of the study

The following are the limitations of the present study.

1. The study is restricted only to Agastheeswaram taluk.

2. The number of respondents is restricted to 60 hence, that result is can't generalize to the large papulation.

3. Non-availability of sufficient and reliable secondary data is one of the major limitations of this study. In the absence of the study exclusively depends on data provided by the participants regarding their conditions.

Research Methodology

        The researcher was intended to study the factors influencing the purchasing of fish and fishery products. The present study is empirical in nature and based on both primary and secondary data. Primary data were collected with the help of a well-structured questionnaire. The researcher preferred Agastheeswaram taluk on the basis of simple random sampling. The size of the sample is 60 respondents was calculated on bases of Cochran's formula. Each and every respondent are interviewed with the help of questionnaire. Secondary data were collected from various books, journals and website.

Results and Discussion

        The demographic profiles of the respondents were categorized into several variables such as gender, age, marital status, educational qualification, occupation, monthly income and residential status. The table1 shows the demographic profile of the respondents.

Table 1. Demographic Profile

Variables	Particulars	No. of Frequency	Percentage
Gender	Male	28	47
	Female	32	53
	Total	**60**	**100**
Age	Less than 20 years	6	10
	21 -30years	20	33
	31-40years	18	30
	Above 40 years	16	27
	Total	**60**	**100**
Marital status	Married	48	80
	Unmarried	12	20
	Total	**60**	**100**
Educational qualification	UG	23	38
	PG	22	37
	Others	15	25
	Total	**60**	**100**
Occupation	Student	7	12
	Private employee	21	35
	Self-employed	8	13
	Government employee	15	25
	Other	9	15
	Total	**60**	**100**
Monthly Income	Less than ₹ 15,000	21	35
	₹ 15,001-₹30,000	13	21
	₹ 30001- ₹ 45000	19	32
	Above ₹ 45000	7	12
	Total	**60**	**100**
Residential Status	Urban	41	68
	Rural	19	32
	Total	**60**	**100**

Table 1 shows that 47 per cent of the respondents are male and 53 per cent of the respondents are female. 33 per cent of the respondents belong to the age group of 21-30 years.80 per cent of the respondents are married. 38 per cent of the respondents are undergraduates. 35 per cent of the respondents are private employed. 35 per cent of the respondents are earning income less than ₹ 15,000. 68 per cent of the respondents are in urban area. It is understood that adults are mostly involved in buying fish and fishery products.

Null hypothesis: There is no significant relationship between the income group and consumer behaviour and attitude on value-added fish products.

Table 2. ANOVA

Relationship between the Income Group and Consumer Behaviour and Attitude on

Value-Added Fish Products

Factor	Income group				F value	P value
	Less than ₹15,000	₹15,001-₹30,000	₹30001-₹45000	Above ₹45000		
Value added fish products are good alternatives for similar meat and chicken products	2.7500 (1.35680)	3.3667 (1 .7184)	4.2727 (.46710)	4.4286 (.53452)	9.459	.000**
The types of fish used to produce value-added are limited compared to similar meat and other chicken products	2.6667 (1.43548)	3.6667 (.92227)	4.4545 (.52223)	4.4286 (.53452)	8.229	.000**
Prefer to consume only the imported value-added fish products	2.500 (1.56670)	3.3333 (.99424)	4.0000 (1.0000)	4.4286 (.53452)	5.874	.001**
Value-added fish product prices are high compared to similar products of meat and chicken	2.5000 (1.5667)	3.1667 (1.01992)	4.1818 (.87386)	4.4286 (.53452)	7.132	.000**
Value-added fish products assurance is made that they are safe	2.5833 (1.5050)	3.3667 (1.03335)	3.9091 (1.04447)	4.2857 (.75593)	4.350	.008**
Increase the variety of value-added fish products available	2.5000 (1.56670)	3.2333 (.93526)	4.0000 (1.00000)	4.4286 (.53452)	6.366	.001**
Ready to use and eat	2.5000 (1.56670)	3.2667 (1.20153)	4.1818 (.8738)	4.4286 (.53452)	5.815	.002**
Satisfy with the product quality	2.5833 (1.5050)	3.2333 (1.00630)	3.9091 (1.04447)	4.2857 (.75593)	4.632	.006**
Satisfy on product taste	2.0833 (1.16450)	2.8667 (1.30604)	3.9091 (1.04447)	3.8571 (1.06904)	5.643	.002**
Fulfill the consumer's expectation	2.0000 (1.04447)	2.5000 (1.33261)	3.2727 (1.48936)	3.8571 (1.06904)	4.047	.011*

Source: Statistically analyzed data

Note: **Denotes significance at one per cent level

The above analysis states that the p value is less than 0.01, the null hypothesis is rejected with regard to all factors. Hence based on the mean score, there is a significant difference between the income group and consumer behaviour and attitude toward value-added fish products.

Implication

❖ Fishermen, investors, and distributors recognize the key role of consumers, their buying behaviour, and their preferences to promote their sales.

❖ The results of the study indicate that consumers have a good tendency towards choosing and eating more fish, therefore the producers aim to maximize the quality with a variety of fish products while maintaining an affordable food price.

❖ It might be a guide for fish producers and marketers to create goods that cater to consumer preferences.

Conclusion

This study has focused on consumer behaviour and attitude towards value-added fish products. Fish consumption was generally higher in areas with greater coastal access. Consumption is a key element in production and marketing decisions. Fish consumers play a key role because fishermen and distributors distinguish their purchase choices as a determinant of their operation. The result of the study revealed that, there are many available options to buy fish and fishery products. Moreover, consumers' attitudes are affected by their demographic and attitudinal characteristics. Successful fish traders act in response to consumers' preferences. Fishermen, investors, and distributors recognize the key role of consumers, their buying behavior, and their preferences in the development of market outlets, and the supply of products in the desired form and quality.

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A Study on Customers Satisfaction Towards Green Products in Nagercoil Town

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ABSTRACT

Green products are presumed to be environmentally safe. Green products are also known as environmentally safe products or sustainable products. Divergent aspects of green products include ecology safer products, recyclable and biodegradable packing, energy efficient & better pollution controls. The threatening alarm of global warming pushes the corporate towards sharing the responsibility of making a safe environment for all by involving themselves as a part to the social contract. Green marketing is still in its infancy and a lot of research is to be done on green marketing to fully explore its potential. Data were collected from hundred sample respondents who are using green products. The area selected for the study is in and around Nagercoil. From the findings made, the sample respondents very much prefer and satisfied with the organic food they are consuming. The respondents are not much aware of green products.

Keywords: Green, Satisfaction, Products, Customers.

Introduction

Green products are those items considered as eco-friendly. The manufacturer of a particular product take proper steps in ensuring that the environment was not harmed during its manufacturing process. The raw materials used in the product were derived from sustainable sources, and the production should have a low impact on the environment regarding waste, carbon emissions and energy use. The term 'Green' has nothing to do with colour, but the choice of name is appropriate because Green is a colour that is often associated with nature. Green products are considered kinder to the environment than non-green goods, in one way or another. The term is widely used and it do not take much for a product to be called Green, so it can cover a wide range of consumer goods. A product is considered earth-friendly if it is biodegradable, that it will pose no threat to the earth and environment, when it is released to the air, water or earth while in use or when disposed of. These types of products usually decompose much quicker in a landfill, than similar items that are not biodegradable. Biodegradable household cleaners, soaps, dish and dishwasher detergents and laundry soaps are just a few examples of green products. If a product contains any amount of recycled goods in its construction, it is also considered Green for two reasons, because recycling reuses a

material keeping it out of the landfill, as well as saves on the environment when alternative materials are not manufactured and used for that component.

Statement of the Problem

Green products have become a global struggling to achieve the purpose of environment protection by using various means to persuade the consumers segments to change their attitude from the conventional product towards green products and also to satisfy the needs. In this study, the researchers have made an attempt to highlight the preference, satisfaction level and the problems faced by the sample respondents while using green products.

Objectives of the Study

The following are the objectives of selecting the topic.

• To analyze the preference level of the sample respondents

• To find out the satisfaction level of the respondents.

• To find out the problems faced by the sample respondents.

Scope of the Study

The research is carried out among the respondents in Nagercoil. The main purpose of the research is to study the preference and satisfaction level of the sample respondents towards green products.

Methodology

Data are collected on the basis of both primary and secondary data. Primary data were collected by means of systematically prepared questionnaire by way of Google forms from the users of green products in Nagercoil. Secondary data has been collected from Websites, Newspapers, Books and Journals. The researchers collect the data by using convenient sampling technique.

Limitations of the Study

• The time at the disposal of the researcher was very short.

• The respondents were not co-operative while providing the information.

• The area of the study covers only Nagercoil town.

• Respondents are not much aware of green products.

Results and Discussion

Consumer Preference wise Distribution of Respondents

Green products are convenient and quick. But it is not suitable for all the products. Each customer has his own preference towards the product according to their level of comfort, ability and satisfaction.

Table 1. Consumer Preference wise Distribution of Respondents

S. No.	Preference	Garrett's mean score	Rank
1.	Organic food	69.3	I
2.	Detergent or cleaning	63.49	IV
3.	Soft drink or beverage	62.38	VI
4.	Herbal cosmetics	65.13	II
5.	Pure cotton dress	64.99	III
6.	Tupperware	62.37	VII
7.	Solar water heaters or solar energy	62.94	V
8.	Sanitary items	62.18	VIII
9.	Bio- degradable products	61.17	IX
10.	Electronic products	58.51	X

Source: Primary data

From the above table it was inferred that the first rank is given to `Organic food' with a mean score of 69.3, while the second rank is given to "Herbal cosmetics" with a mean score of 65.13 and the last rank is given to "Electronic products" with a mean score of 58.51. This shows that the respondents prefer 'Organic food' and not much interested in buying electronic products. This shows that most of the sample respondents are health conscious.

Satisfaction Level Wise Distribution of Respondents

Satisfaction varies from person to person and product to product. Following table 2 represents the Satisfaction level of the respondents towards green products.

Table 2. Satisfaction Level Wise Distribution of Respondents

S.No.	Particulars	Highly satisfied (5)	Satisfied (4)	Dissatisfied (3)	Highly dissatisfied (2)	No opinion (1)	Total	Rank
1.	Organic food	(82) 410	(13) 52	_	(2) 4	(3) 3	(100) 464	I
2.	Detergent or cleaning	(21) 105	(64) 256	(8) 24	(4) 8	(3) 3	(100) 396	VIII
3.	Soft drink or beverage	(42) 210	(36) 144	(11) 33	(3) 6	(8) 8	(100) 401	VI
4.	Herbal cosmetics	(32) 160	(50) 100	(8) 24	(8) 16	(2) 2	(100) 402	V
5.	Pure cotton dress	(48) 240	(32) 128	(10) 30	(3) 6	(7) 7	(100) 411	III

6.	Tupperware	(27) 135	(48) 192	(11) 33	(8) 16	(6) 6	(100) 382	X
7.	Solar water heaters or solar energy	(40) 200	(32) 128	(18) 54	(4) 8	(6) 6	(100) 396	VIII
8.	Sanitary items	(36) 180	(49) 196	(9) 27	(2) 4	(4) 4	(100) 411	III
9.	Bio-degradable products	(51) 255	(34) 136	(7) 21	(4) 8	(4) 4	(100) 424	II
10.	Electronic products	(35) 175	(42) 168	(13) 39	(5) 10	(5) 5	(100) 397	VII

Source: Primary data (Figures with parenthesis indicate the number of sample respondents)

The above table 2 portrays the Satisfaction level of the sample respondents. In this regard, first rank is given to 'Organic food' with a total of 464. Last rank is given to 'Tupperware' with a total of 382. It is observed that most of the respondents are very much satisfied by using green products. The respondents are not much satisfied about 'Tupperware' because using 'Tupperware' is not much advisable and not good for health too.

Problems Regarding Green Products

Every product or service or method or technique has both merits and demerits. The following Table 3 depicts the problems faced by the respondents while purchasing green products. This is analyzed with the help of Weighted Average method.

Table 3. Problems Regarding Green Products

S. No.	Particular	Agree (3)	Disagree (2)	No opinion (1)	Total	Mean score	Rank
1.	Lack of awareness	(78) 234	(15) 30	(7) 7	(100) 271	2.71	I
2.	Lack of availability	(48) 144	(37) 74	(15) 15	(100) 233	2.33	III
3.	High cost	(56) 168	(30) 30	(14) 14	(100) 242	2.42	II
4.	Inadequate promotional mix	(36) 108	(38) 76	(26) 26	(100) 210	2.10	VII
5.	Lack of Eco-Consciousness	(55) 165	(23) 46	(22) 22	(100) 233	2.33	III
6.	Minimum retail outlets	(45) 135	(32) 64	(23) 23	(100) 222	2.22	V
7.	Unbranded products	(42) 126	(33) 66	(25) 25	(100) 217	2.17	VI

Source: Primary data (Figures with parenthesis indicate the number of sample respondents)

From the above table it was inferred that 'Lack of awareness' ranks first with the mean score of 2.71. 'High cost 'ranks second with the mean score of 2.42. The last rank is given to

'Inadequate promotional mix' with the mean score of 2.10

Most of the respondents mentioned that their main difficulty is, lack of awareness, and cost is very high and it is not easily affordable by the middle-class people.

Findings

The summary of findings is the natural and logical result of analysis and interpretation carried out by the researchers.

- With regard to Preference level, first rank is given to 'Organic food' with a mean score of 69.3. The least rank is given to 'Electronic products' with a mean score of 58.51. This is because most of the sample respondents are interested in buying organic food. This shows that most of the sample respondents are health conscious.

- Regarding the level of satisfaction, first rank is given to 'Organic food' with a total of 464. Least rank is given to 'Tupperware' with a total of 382. It is observed that most of are very much satisfied with green products. The respondents are not much satisfied about 'Tupperware' because using 'Tupperware' is not much advisable and not good for health too.

- Regarding the problems faced by the respondents, 'Lack of awareness' ranks first with the mean score of 2.71. 'High cost 'ranks second with the mean score of 2.42. The last rank is given to 'Inadequate promotional mix' with the mean score of 2.10. Most of the respondents mentioned that their main difficulty is, lack of awareness, and cost is very high and it is not easily affordable by the middle-class people.

Suggestions

Following are the suggestions recommended by the researchers to the manufacturers.

- Take much care while manufacturing 'Electronic products', since less preference is given by the sample respondents.

- Health conscious should be taken into consideration while producing 'Tupper ware'.

- Provide information about eco label to those who are not aware of it.

Conclusion

Green products or eco-friendly products it has a prominent role in conservation of environment. So, there is a need for promoting the green products. From this study, it is clear that most of the people are having the habit of purchasing green products like solar light, solar heater, paper bags, handicraft items and clay products. Most of the customers are willing to pay higher price for these products because of the quality and environment protection. This study reveals that people have positive opinion towards solar lights and solar heater. On the other

hand, handicraft items, paper bags and clay products are not much attracted by the respondents. The sample respondents are very much satisfied with the organic foods. Most of the respondents feel that the cost is very high to afford green products.

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Mental Health and Level of Adjustment among School Students – A Comparative Study

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ABSTRACT

Looking after one's mind is as important as looking after one's body. As part of one's overall health, mental and emotional health or well-being is a necessary condition to enable one to manage one's life successfully. Mental health is the emotional and spiritual resilience that allows one to enjoy life and to survive pain, suffering, and disappointment. It is a positive sense of well-being and an underlying belief in one's own and others' dignity and worth. Some of the characteristics of people with good mental health: comfortable feelings about one's self, feeling 'right' about other people, and being able to meet the demands of life. Adjustment is the process of getting along with one's own self and with others. It is the ability of an individual to adapt or accommodate to changing circumstances that is a mark of maturity. The main aim of the study is to find out the mental health and level of adjustment among the Government & Private school students. Some of the objectives are to find out the level of mental health status of the respondents and the level of adjustment among government and private school students, compare the level of mental health and adjustment problems of the respondents, and provide recommendations and suggestions to the school students to cope with their adjustment problems and enhance their mental health. The research was conducted in Vadavalli area, Coimbatore District, with 150 samples. Disproportionate Stratified Random Sampling was used for this study. The findings will be discussed in the full paper.

Keywords: Mental Health, Adjustment, well-being.

Introduction

"Taking care of one's mind is just as important as taking care of one's body. "As part of one's overall health, mental and emotional health or well-being is a necessary condition to enable one to manage one's life successfully. Mental health is the emotional and spiritual resilience that allows one to enjoy life and to survive pain, suffering and disappointment. It is a positive sense of well-being and an underlying belief in one's own and others' dignity and worth.

Mental health is about:

- How one feels inside
- Balancing one's emotions and having control over them
- Self-esteem and confidence
- Being comfortable with whom they are
- Coping with one's feelings and building up resilience in one's "bounce-back ability"

Characteristics of Mental Health

Mental health is more than just the absence of mental illness. It includes how you feel about yourself and how you adjust to life events. However, the National Mental Health Association cites 10 characteristics of people who are mentally healthy.

- They feel good about themselves.
- They do not become overwhelmed by emotions, such as fear, anger, love, jealousy, guilt, or anxiety.
- They have lasting and satisfying personal relationships.
- They feel comfortable with other people.
- They can laugh at themselves and with others.
- They have respect for themselves and for others, even if there are differences.
- They are able to accept life's disappointments.
- They can meet life's demands and handle their problems when they arise.

Statement of the Problem

Mental health is not just the absence of mental illness. Mental health includes an individual's ability to enjoy life and process a balance between life activities and efforts to achieve psychological resilience. Mental health is a key component in an adolescent's healthy development, as it is believed to be a period of great stress and turmoil. Most of the problems centering on adolescents are health and physical development, marks earned, relationships with members of their families, their teachers, and peers of both sexes, as well as home adjustment. This maladjustment may lead to absenteeism, truancy, low achievement, and other unworthy habits in children. So, it being a problem, the researcher selected to study the Mental Health and Adjustment status for the study.

Aim of the Study

The main aim of the study is to find out the mental health and level of adjustment among the Government & Private school students.

Objectives

- ❖ To study the socio demographic status of the school students.
- ❖ To find out the level of mental health of the respondents.
- ❖ To find out the level of adjustment among government and private school students
- ❖ To compare the level of mental health and adjustment problems of the respondents.

❖ To provide recommendations & suggestions to the school students to cope up with their adjustment problems and enhance their mental health.

Hypotheses

❖ There is a significant association between the gender of the respondents in Government & Private schools and their type of family with the level of Adjustment.

❖ There is a significant association between the gender of the respondents in Government & Private schools and their Income with Mental health.

❖ There is a significant association between the gender of the respondents in Government & Private schools and their Educational Qualification of Fathers with Adjustment.

❖ There is a significant association between the gender of the respondents in Government & Private schools and their Educational Qualification of Mothers with Adjustment.

❖ There is a significant association between the gender of the respondents in Government & Private schools and their Domicile with Mental health.

Operational Definition

Mental health

Mental health is the successful performance of mental function resulting in productive activities fulfilling relationships with other people, and providing the ability to adopt to change and cope with adversity.

Adjustment

Adjustment is harmonious relationship with the environment involving the ability to satisfy most of one's needs and most of the demands, both physical and social that is put upon one.

Research Design

Research design is the logical and systematic plan to carry out a research preparation of the design for the research project is popularly known as the ''Research design." The study tries to describe the level of mental health& adjustment problems of School students. Further the researcher attempted to find out the relationship between significant variables hence the researcher adopted *Descriptive Research Design*.

Universe of the Study

The universe of the study consists of 11th standard students of Government & Private schools in Vadavalli area. There are totally four schools and the total number of students studying in the 11th standard in these four schools is 500.

Sampling

The participants of the present investigation consist of 150 respondents, the researcher adopted the Probability Sampling method for this study. The researcher collected the data from Government & Private Schools students. The researcher collected data from 75 respondents in Government & in Private schools respectively by stratifying them into groups based on their subject of study (Group I: Maths, Physics, Chemistry and Biology. Group II: Maths, Physics, Chemistry and Computer Science. Group III: Commerce, Accountancy, Economics and Computer Science / Business Maths). Hence the researcher used ***Disproportionate Stratified Random Sampling.***

Inclusion Criteria

Only 11th Std students in Government & Private schools in Vadavalli area were included for the study.

Exclusion Criteria

Primary school students, High school students & 12th standard students.

Tools of Data Collection

The researcher adopted questionnaire for data collection. First part of questionnaire included demographic details of the respondents. The second part of the questionnaire included Mental Health Scale & Adjustment Inventory scale.

⦿ Scales - 29 item Mental Health Questioner developed by Priya Daniel (1997) was used to measure mental health.

⦿ Adjustment Inventory for School Students (AISS) has been developed by the Dr.AKP SINHA AND Dr.R.P SINGH.AISS.

Data Analysis

The data obtained for the study were quantitative in nature. Quantitative analysis of data was done through Statistical Package for Social Sciences (SPSS Version 20.0) by the researcher. The responses were examined carefully for processing data.

Statistical techniques like Chi square are used for the purpose of analysis. Scores of the scales used in this study. In Mental Health scale & Adjustment Inventory scale the score ranges from Low, Moderate, and High.

Findings

1. Age

The Government school has a majority of female respondents (66.7%) and the Private School has a vast majority of the male respondents (76.5%) of 16 yrs. old.

2. Gender

Above half of the respondents (55%) in the Private School are male.

3. Type of family

Vast majority of the male respondents (80%) in the Govt. School and (78%) in the Private school are from the nuclear family.

4. Domicile

Majority of the female respondents (63.9%) in the Govt. school come from the urban areas and vast majority of the female respondents (87.5%) in the private school are also from the urban area.

5. Hobby

Above half of the female respondents (53.8%) in the Govt. school have the hobby of playing. One –third of the female respondents (37.5%) in the private schools have the hobby of listening to music.

6. Extra-curricular activities

All of the male respondents (100%) in the Govt. school and the female respondents (100%) in the private schools have sports as an extracurricular activity.

7. No. of family members

Above half of the male respondents (56.4%) in the Govt. School and (54.2%) in the private schools have four members in their family.

8. Educational qualification of fathers

Nearly half of fathers of the male respondents (48.7%) in the Govt. school is high school have qualified high school. Above half of the father's qualification of male respondents (52.9%) in the private schools is degree and above.

9. Educational qualification of mothers

Above half of the mother's qualification of male respondents (59%) in the Govt. school is primary school. Nearly half of the mother's qualification of male respondents (47.1%) in the private schools is degree and above.

10. Occupation of the family head

Vast majority of the female respondent's fathers (86%) in the Govt. school works in the private sector. Vast majority of the female respondent's fathers (86.7%) in the private schools are government servants.

11. The Total Mental health

Nearly half of the female respondents (47.2%) in the Govt. schools have a moderate

level of total mental health. Nearly half of the male respondents (49%) in the private school possess high level of total mental health.

12. The Total Adjustment

Nearly half of the male respondents (48.7%) in the Govt.schools and (49%) in the private schools have a moderate level of adjustment.

Findings Related to association of variables

- There is a significant association between types of family of male respondents in Government school with adjustment. By using chi-square test researcher find there is no significant between type of family and adjustment. Hence the null hypotheses are accepted.

- There is a significant association between the head of the family income of male respondents in Government school with mental health status. By using chi –square test researcher finds there is no significant association between the head of the family income and mental health status. Hence the null hypothesis is accepted.

- There is a significant association between the educational qualifications of fathers of male respondents in Government school with adjustment. By using chi –square test researcher finds there is no significant association between the educational qualification of fathers and adjustment. Hence the null hypothesis is accepted.

- There is a significant association between the educational qualifications of mothers of male respondents in Government school with adjustment. By using chi –square test researcher finds there is no significant association between the educational qualification of mothers and adjustment. Hence the null hypothesis is accepted.

Suggestions to the Government

- The government should take the initiative to appoint social workers in all schools.
- The government should insist schools to conduct medical camps, counselling sessions, and special care relationship programmes to improve and maintain a healthy environment.
- Development and evaluation of a programme to assist parents in developing effective skills in schoolchildren, including skills in providing support and guidance.

Suggestions to the Social workers

- A social worker may help them overcome their level of mental health & adjustment problems.
- A social worker should always provide counselling to students, teachers, and parents.
- A social worker should arrange school health programmes.

Suggestions to the Teachers

- Teachers should be trained to identify and provide support for children with psychological distress.

- Teachers should emphasis personality development and teach specific strategies for stress management.

- Teachers should teach moral lessons related to positive adaptation for mentally depressed students.

Suggestions to the Parents

- Parents need to recognize their relationship with children and provide proper guidance especially during adolescence.

- Parents should be the best counsellors and guide for children especially during the age of transition.

- Parents should teach possible ways for their children to lead autonomy to live an autonomous life.

Conclusion

The study found that several basic mental health services—assessment, behaviour management, crisis intervention, and counselling – were not available in schools. While the extent of this service array might suggest that schools were providing the full continuum of services required by students with mental health needs, this finding must be interpreted cautiously. The survey did not ask about the quantity of services, the specialty qualifications of staff providing services, or the extent of unmet need for services. Responses to open-ended questions suggested that existing mental health resources may not be sufficient to support the services necessary to fully address the needs of students. School staff providing mental health services described many competing demands and significant role constraints. This study offers a baseline regarding mental health services provided in high schools and their associated school districts in Coimbatore. The study's findings confirm that mental health services currently play an integral role in the school setting. However, the findings also suggest that there are needs for mental health services in schools, and that the availability of community resources is essential if schools are to meet the challenge of addressing these needs.

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French Feminism: A Literary Perspective

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ABSTRACT

The word 'Feminism' was coined by the French Philosopher and Utopian socialist Charles Fourier. Feminism is a socio-political movement that aimed at establishing equality among the sexes and was shaped by local, social, political, and economic factors. Feminism in France can be distinguished into three waves such as first wave, second wave, and third wave. As a revolutionary movement, Feminism originated in France in the year 1789. The Second-wave feminism that began in the 1940s was a protest against women's role in society. They fought for gender equality as they were tortured for aborting and under taking measures for birth control. The third wave of feminism added some more elements of post-colonial feminism and approached the rights of women with other ongoing discourses including racism. The fourth wave that started in 2010 argued a step further for sex and body positivity as well as reinforcing women's empowerment. Women had taken several steps to improve their status in society. Radical feminism and psychoanalytic feminism were the steps undertaken that made them analyze how gender was constructed in society. They came to know the central meaning and structures of society. This paper deals with French Feminism from the literary perspective and the toils and turmoil that women had undergone through out the four phases of French Feminism.

Keywords: Female suffrage, Feminism, Gender Equality, Racism, Underprivileged.

For centuries, over the world, many women fought for their gender equality, basic needs, hopes and rights. The society attributed greater significance to the opinions of men and on the other hand, it often sidelined women's opinion and treated them unjustly. As a result of bringing in desirable changes, and to alter such stereotyped mindsets, a group of people started agitating. Many scholars quoted that, "Feminist campaigns are the main force behind many social changes for women in society". [1] Simone de Beauvoir, a French feminist, and philosopher was the pioneer of women's liberation. Throughout her life, she fought for the freedom of women to lead an independent life. The second half of the 19th century saw the beginning of the first wave of French feminism.

Simone de Beauvoir published "The Second Sex" in 1949. It gives a detailed analysis of women's oppression. She argued that women had been historically branded as a deviant and abnormal people in society and men were considered ideal. At the beginning of the 1960s, women developed approaches that did not make them depend on men. Married women were

given working rights in 1965.

In France, Feminism had always been around in some form or shape and it mainly focused on separation and on changing relations. Women joined hands and organized unions and committees to fight for their rights like equal wages, the right to education, divorce, etc. They even took part in violent confrontations. Important figures like Louise Michael and Andre Leo joined them to support the underprivileged women. The Suffragettes' Movement started with the first voting issues in 1914 and remained unfinished since 1944.

In the beginning, the questions pertaining to equal property rights and abolishment of husband ownership were at the front. Later, it was shifted to the right to vote. The first wave came to an end around 1920 when women had been granted the right to vote. The second wave began in 1963. 'The Feminine Mystique" by Betty Friedman which was written about second-wave feminism gained remarkable value in the US. It argued the problem of female stereotypes that prevailed in the country.

During the later 1970s, feminists focused on the economic, political, and legal structures of society. The main element of this movement was to analyze women's role in reproduction. Radical feminists attracted others' attention to the practices surrounding mothers, sexuality, and the definition of gender roles. The radical feminist argued that it is not the biological fact that the women bear children which was the cause of women's subordination; but, rather the cultural construction of mothering and sexuality that defines women's status.

"The Dialectic of Sex" (1970) by Shulamaith Firestone gave the first clear statement of the radical feminist position. Firestone argued for women being merely treated as child bearing machines, the ones responsible for raising them, which made them to be kept in a subordinate position. She continued her argument against the legal, political and economic barriers. Many other radical feminists accepted Firestone's conclusion. They continued to explore their questions as men enjoyed control over the process of reproduction. O'Brien argued that women should also reclaim the same control and decide upon when to bear a child. The main controversial aspect of radical feminism was its stance on pornography.

Pornography revealed the essence of the construction of women, it made others see women's purpose in life was to satisfy the sexual desires of men. As feminists began to explore the difference between men and women from a psychological perspective, everyone developed a very different understanding of the origin. Women differed from men in the society not because their psyches were innately different but because they were raised by mothers who taught them that men were superior to them. The result was when boys and girls become men and women, their psychological makeups were different.

France was the last European country to introduce female suffrage. As the time passed by, women gained more supporters. The women's liberation movement was founded in 1968 in connection with American Women's and Student Movement. The popular slogan which became popular during the second wave was "The Personal is Political".

In the 1970s and 1980s feminist movement gained momentum and women began to protest again the dominance of white and middle-class women. White women dominated in several ways. White women, lesbians, bisexuals, and transgenders started their organizations for feminism. Women from each group had developed their theories to fight against social justice.

The 1980s and 1990s were the periods of postmodernism. Postmodernism is a broad phenomenon that affected all areas of academic life. Postmodern feminism had the most effect on several French thinkers in the late twentieth century. French writers, who developed ideas during the postmodernism period were Luce Irigaray, Julia Kristeva, and Helene Cixous. These writers developed an idea to move feminism in a postmodern direction. Although French feminism had a significant impact on feminist thoughts, Postmodern feminism revealed the dualistic, hierarchical, and gender structure of modern thoughts.

Due to globalization, many social and political movements gained popularity and, feminism in France started fading. From a political point of view, France had only a smaller number of female delegates. Only 5% of women were allowed to participate in elections until 1944 and in 1993 it increased to one percent.   Many parties enlisted more men than women and the male-dominated legacy was established in 2017 parliamentary election.

France produced some influential as well as controversial female writers, who had contributed to a large number of works regarding French feminism. Some of the important works of French feminism were "Declaration des droits de la femme et de la citoyenne" (1791) by Olympe de Gouges; Les Guerilleres" (1969) by Gisele Halimi, "King Kong Theory" (2006) by Virginie Despentes and "La Poudre" (2020) by Lauren Bastide.

Olympe de Gouges played a major role in the development of women's society. Her works inspired other women to fight against the lives that society had imposed upon them. Olympe de Gouges was not only France's first feminist thinkers but also one of the country's early abolitionists.

The French revolution had a great impact on French women as they had no rights until the pre-revolutionary period. They were seen as "passive" citizens. They were forced to rely on men to choose what was better for them. Feminism first emerged in Paris from where a broad group of women demanded social and political reforms. These women demanded

equality with men and desired to end the male domination. In certain places, women were allowed to be a part of the contractual relationship with men. Single and married women also faced the same issues of freedom. Until marriage, the rights of the women were exclusively determined by their father and after marriage, it was passed on to their husbands concerned. Married women had no rights to any property. Only if her husband dies, she would be given ownership over the property. Laws and traditions were taught to women to follow their husband's words. They were expected to satisfy everything that their husband needed. Mostly, the education of women is on how to be good wives and mothers. Women were not allowed to be involved in political activities because their work was to raise future citizens. Society ordered and compelled all women to wear the Tricolored cockade. They were ordered to stay at home and take care of their families. Men were authorized to maintain public affairs.

The theory of feminist literary criticism was mainly influenced by Derrida and Lacan. Women were not allowed to become judges until 1946, in France. After a couple of years, France approved of abortion as a legal procedure, that too, only during the first fourteen weeks of conception.

The writers from other countries also contributed works towards feminism in France and for the promotion of French tradition. French feminism differed from Anglo-American feminism as the latter was more activity-oriented than French feminism. It was rather theory-oriented and it is still active among specific groups. Around 30% of women claimed that France was a feminist country.

In response to the protests and advocacy, there was some improvement in the treatment extended to women. There occurred a drastic change between the years 2019 and 2020. The government considerably reduced gender violence and perpetrated several hopeful developments for gender equality in France specially to reduce sexual harassments, gender violence, and wage gaps.

Philosopher Judith Butler was seen as the central figure of the third wave of feminism. She fought for the differentiation between sex and gender in the third wave of feminism, especially women in their twenties and thirties were not interested to develop a theory war of their mother's generation. They were interested in developing their own ideologies. It was a monolithic movement in the twenty-first century, securing the right to vote and legal equality that had not produced equality for women. Women were defined as irrational because they are more emotional and dependent. Women had to fight in all areas not just in the political area and many argue that treating women as a monolithic one, did more harm than good. Everyone needed to recognize and examine the differences and create a world better for both women and

men. Each woman had to be ready to confront the unique problems pertaining to her personal or professional life. Feminists could find a common ground which was not a homogeneous concept of women though Feminism continued to be at the forefront of contemporary critical theory. The identity of the woman was thus created but not shaped by the discourses that defined it.

French women had entered the political arena in the recent years, with the aim to establish freedom and equality. French President Emmanuel Macron's motto is to propagate and establish gender equality. He passed the election with this motto only. Contemporary feminism began in the eighteenth century and had passed through several stages. Another feminist theory of political liberalism is 'Marxism'. In the twentieth century, many feminist writers started using the Marxist theory of feminism. The Marxist theory goes beyond and started exploring the political and legal roots of women's subordination examining the objective structures of society.

Many people claimed that the third wave gave a way to the fourth wave in 2010. The fourth wave of feminism supported the features of the third wave. The government took measures to protect women, including laws against street harassment, and feminist activities. Like this, as the era started to develop, the women began to enjoy self-respect, freedom, taking care of themselves with integrity and could run a family even without the help of a man.

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Impact of War on Women
in Nayomi Munaweera's *Island of a Thousand Mirrors*

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ABSTRACT

The paper "Impact of War on Women in Nayomi Munaweera's Island of a Thousand Mirrors" attempts to bring out the realities of a war torn nation and exposes the harsh realities faced by the common population in Sri Lanka due to the war. It brings out the terror and trauma encountered by women due to the ethnic and cultural conflicts that continue to haunt the island nation. It shows how women are forced to become circumstantial victims. This paper targets the victimized women of the war and shows how it affects them mentally and physically.

Keywords: *women, war, ethnic conflict, civil war, terrorist, refugee*

Island of a Thousand Mirrors is a debut novel by the Sri Lankan writer Nayomi Munaweera who is a critically acclaimed Bay Area novelist and non-fiction writer. Because of the civil war, Munaweera's family left Sri Lanka when she was three. They immigrated to the United States and settled in Los Angeles. Her debut novel *Island of a Thousand Mirrors* won the *Commonwealth Regional Prize for the Asian Region* and her work has been shortlisted for the *Northern California Book Award* and the *DSC Prize for South Asian Literature*. Munaweera is a member of the project 'Write to Reconcile in Sri Lanka' which brings together Tamil, Sri Lanka and Muslim kids who want to write, so that they might address issues of conflict, peace, reconciliation, memory and trauma. Her writings serves as a sharp reminder of the devastation and lifestyle loss brought on by war.

Women frequently have intimate and terrible encounters as a result of the repercussions of war. Because of the challenging circumstances and constant suffering, women in conflict are often forced to perform tasks and take on responsibilities that were not traditionally part of their position. One of history's great silences is the violence against women during conflicts. The fact that women make up the majority of war survivors means that they must learn how to cope with their suffering and begin to rebuild their families and lives. Women are more likely to face situations where someone wants to establish dominance over them because of the tension and level of violence present during a war. The loss of women's freedom was caused by oppressive power structures, sexual assaults, attacks, family member disappearances and general insecurities on the streets. They are particularly exposed to violence in refugee camps.

In front of their husbands and kids, women are occasionally mistreated and tortured. Women who are pregnant are beaten to cause miscarriages. Sometimes, women witness acts of severe brutality that leave them feeling as though survival is a worse fate than death. Groups who utilise terror as a tactic of war now primarily target civilians. Both women and men, as well as girls and boys, are the victims of this, but women are victimised by gender-based violence far more often than males. Opposing forces fight over their bodies, which turn into a battlefield. This essay focuses on the suffering felt by the female protagonists who were on opposing sides of the Sri Lankan civil war and on their dual roles as terrorists and refugees. It aims to highlight the idea of women being oppressed as a result of the long-running conflict between the majority Sinhalese and the minority Tamils.

In comparison to other developing countries, Sri Lanka claims to be the least authoritarian country in terms of women's rights. Modern women in Sri Lanka were expected to act as the reservoir for the "culture" and "tradition" of Ceylon in the early days of colonialism. In the post-colonial era, they were viewed as reproducers, nurturers and stereotypes of tradition, culture, community and nation. The preservation and exportation of Sri Lankan culture and tradition, both inside and outside the nation, was seen as being possible through women. During the civil war, some young women from the northern part of the country were compelled to join the Tigers, while others did so voluntarily. Women were treated very differently and had very different roles to play. They were perceived as terrorists, separatists and combatants supporting the country of Eelam. In Sri Lankan writing, both fiction and non-fiction, that was produced in the years after the end of the civil war, women are portrayed in an uncommon way. The issue at hand is suicide terrorism, specifically the part that culture and society play in normalising such crimes. Instead of being a representation of femininity, purity and brotherhood, they are now depicted as armed women in the lexicon of terror and violence. Before being ripped apart by civil war, two female characters and their families are shown living conventional lives full with romance, marriage, dreams and happiness with one another in Munaweera's *Island of a Thousand Mirrors*. The conflict is examined from several angles in the book against the backdrop of the 1983–2009 civil war. Yasodhara Rajasinghe, a Sinhala girl who eventually becomes a refugee and Saraswathi, a Tamil girl who subsequently joins the Liberation Tiger of Tamil Eelam (LTTE) and perishes as a suicide bomber, are the two main characters in the novel. The narrative deviates from the typical portrayal of women as objects of subjugation and instead paints them as fierce militants. Here, the idea of marriage is called into question, which alters how people view women's roles in sexuality and reproduction. The novel illustrates through a number of situations how severely abused and victimised women

are. In addition to the burning down of the Jaffna Tamil library and the bullying of a little girl named Radhini, the book also includes evocative depictions of the ocean, the natural environment, childhood memories and Sinhala people's hate toward Tamils. Radhini agonizes out of pain when "A machete tip traces her upper arm where uniform gives way to smooth flesh. Cold metal on skin. A tear trembles on her lash, catching light in that dark interior" (28). Violence due to their racial discrimination is inflicted even upon the children. During the battle, they slaughtered the elderly and burned children in an unjustified fit of rage. When the mobs mercilessly murdered Yasodhara's uncle Anuradha, the family was immediately affected by the violence. In this case, Mala, Anuradha's wife was held accountable for the suffering she caused her husband. She is called "bad luck woman from somewhere" by her mother-in-law (91).

Yasodhara's family was forced to leave their nation and seek sanctuary elsewhere in the world as a result of the crimes they witnessed first-hand. The author illustrates the predicament of war refugees through the first protagonist, Yasodhara. As an immigrant, Yasodhara discovers that even the most commonplace things in America can take on previously unanticipated forms. They felt guilty about their situation as parasites who were dependent on America as their host nation to survive. They are forced to negotiate playing the minority after choosing to give up their majority status in Sri Lanka in search of safety and the opportunity to exist. The second main character, Saraswathi, belonged to the Tamil Minority group, which served as the primary catalyst for her change from a young, aspirational innocent girl to a suicide bomber. She had hopes of becoming a licenced teacher, getting married and starting a family, just like any other young lady. She had a sister and three brothers. The Tamil Tigers abducted all of her brothers and used them as weapons against the Sinhala ethnic group. Her family was happy that they had died as martyrs for their race.

The saddest part is that victims of sexual assault are stigmatised as being untouchable and should not be seen or approached. The whole village would make fun of them. The victims ended their lives because of this. Saraswathi thought back to how Parvathi, her companion, had been mistreated by soldiers on the way home from school and how her family and society had pushed her to attempt suicide by jumping into a well. Saraswathi, however, had no idea that she would also experience an assault similar to her friend. This is because one day, as Saraswathi was home alone, a gang of Sinhala troops abducted her and cruelly tortured her before sexually assaulting her. Her suffering in the hands of the soldiers is given as follows:My wrists and ankles are caught in their iron grip. Tiger Bitch. I am pulled apart, uncovered, exposed. They hold me down. Their sweat falls in shining drops and they will not let me avert

my face. I am drenched and soaked. Their mouths come down upon me like the salivating tongues of dogs. They tear me upon with their nails, bite me with their fangs, their spittle falls thick across my breasts. They break into me. Break me. Break into me. Break me. (145)

This paper brings to light the victimized women of the war and shows how it affects women physically, psychologically and emotionally. Munaweera shows how war has made the women stronger in the novel. Through Yasodhara's story the author focuses on the sense of loss and suffering brought on by exile from home and the struggles of re-rooting in a new place and she tackles the trauma of living in the middle of conflict through the character Saraswathi.

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Critique of Dominance: An Anti-hegemonic Discourse
in Toni Morrison's *Sula* and *Beloved*

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ABSTRACT

The burden of race, class and gender has a strong influence on Morrison's novels. This research paper delves into the lives of black women who are affected due to racial and gender discrimination and class restrictions. In her exploration of the black women, Morrison exhibits the modes of practice through the categories of gender and race. Racism, which is constant in the lives of the characters, whose past, present and future form continuity in the cycle of frustration from which the townsfolk cannot easily escape, affects them psychologically. This dark racial reality has made the African-Americans victims of a cultural and psychic split that has resulted in developmental inhibition and the need for pathological defence movements. Her novels show how slippery it may be to enlist the politics of everyday life and to criticise, oppose, subvert or escape the racialised and gendered nation-orders.

Keywords: Anarchism, Anarcho Feminism, race, gender

Feminism is interpreted as a critique that centralises the oppression of women due to their sex based on the dominant ideology of patriarchy. Therefore, on one hand feminism can be comprehended as an analysis of patriarchy and on the other hand as an ideology consigned to women's liberation. Feminism is also a term that denotes various social theories and political movements based on the belief that rights, privilege, status and obligations should not be determined by gender. Different approaches to feminism offer different analyses of the causes and nature of oppressions upon women leading to possible solutions. Feminism as an ideology has branched out on various theoretical intersections like Marxist feminism, anarcho feminism, radical feminism, liberal feminism, postcolonial feminism, ecofeminism etc. The effect of feminism has led women, all over the social world, to identify with the feminist stand, voicing against the otherness. *Sula* and *Beloved* of Morrison can be examined using the tenets of anarcho feminism.

Anarcho Feminism focuses on critiquing society based on race, gender and social class. In the beginning, anarchism and feminism were basically different expressions. In the end of nineteenth century and at the beginning of twentieth century Mary Wollstonecraft, Lucy Parsons, Voltairine de Clayre and Emma Goldman made the connection between anarchism and feminism. Anarchism is fighting in its bases with every kind of authorities and their

authoritarian systems, also against the authority of man over woman and against patriarchy. Anarcho feminism is against all types of oppression and dominance. As Vandiver says, "Since anarchy is opposed to all forms of domination, anarchy without feminism is not anarchy at all. Since anarchy declares itself opposed to all anarchy, all rulership, true anarchy is by definition opposed to patriarchy, i.e. it is, by definition, feminist. But it is not enough to declare oneself opposed to all domination; one needs to try to understand domination in order to oppose it" (40). Peggy Kornegger, author of an influential anarcho-feminist, argues that anarcho feminism is based on "critiques of dominance" and "sought to replace power relations with equality" (Epstein 168).

In this sense, Morrison can be considered Anarcho feminist since she opposes race, gender and social class in her novels. *Sula* focuses on race and gender through the lens of black women and the unique experiences they face as black and female in a patriarchal racist society. Morrison in *Sula* addresses the problems within the black community. The town of Medallion, Ohio, is a white city that forced the blacks into the hills on the outskirts of the city. Furthermore, whites limit the employment opportunities for blacks by only hiring them in servile positions with low wages, which forces many of the men to find work outside the town. The blacks are once again excluded from access to social mobility, when the government hires whites and white immigrants to build a tunnel in 1927. When Nel, the best friend of Sula looks back on the history of the town in 1965, she understands that some progress occurs on race. However, by 1965, most of the blacks have left the hills and rich whites have taken over, building new homes and planning a golf course, which would erase the history of the black community that existed in the city. As Nel reflects back, she says: "The black people, for all their new look, seemed awfully anxious to get to the valley, or leave town, and abandon the hills to whoever was interested. It was sad, because the Bottom had been a real place. These young ones kept talking about the community, but they left the hills to the poor, the old, the stubborn—and the rich white folks" (166).

Though Nel criticises the well-to-do blacks for leaving the Bottom in the 1940s and 1950s for the white, many poor blacks are left in the valley. In the 1960s, rich whites started moving in and established a suburb in the place which was once a black community. When Nel looks back at the black community's past with nostalgic eyes she views a real sense of community in the previous decades. The area fostered a sense of community because every family knew each other. Parents and children interacted with other families, and despite the problems of poverty, racism, and sexism, the black community was united for the most part.

Morrison highlights the huge flaws within the black community as well. Nel's mother,

Helene, a New Orleans-raised Creole of colour, is disappointed with her daughter's flat, Negroid nose she inherited from her father. Helene also looks down on many of the darker-skinned inhabitants of Medallion, despite being a part of the community. She joins the most conservative Protestant church and initially disapproves of her daughter's decision to befriend Sula because of her perceived lower-class origins. So problems of colour prejudice are still entrenched within the community.

Paradoxically, the black community accepts the social outcasts and the mentally ill more than the white society. Sula, though accused of being evil, remains a tolerated presence in the city. Shadrack, the insane drunkard and WWI veteran who establishes the National Suicide Day is also accepted. Tar Baby, a white alcoholic is also tolerated in the community. These people are allowed to stay in the black neighbourhood though they are considered as social outcasts, mentally ill and evil. Surprisingly, black folks do participate for the funeral service of Sula, and sing gospel songs for her despite their previous hatred for her.

Issues of race are interwoven throughout the fabric of the novel. The dewey's lack of development is one of the examples of racism. Each of the deweys has physical characteristics completely distinct from the others. Yet they appear to look alike, reminding the reader of the stereotype, all niggers look alike. Also their growth is stopped at a particular height which suggests that living in a racist society thwarts the natural development of African people. Also, Tar Baby's and Ajax's arrest symbolises just one more incident in which African people or anyone associated with them are routinely arrested and beaten. Ajax calls the cycle of oppression as the natural hazards of Negro life.

Sula foregrounds the conflicted status of race and gender in post-slavery American culture. The inhabitants of the Bottom represented a political system which has enslaved, emancipated and enfranchised the people. Responding to the interrelationship between gender, class and race, Morrison creates situations which concentrate on the ways in which black women attempt to structure their own social orders but who are limited by their class and race identities.

Morrison's Beloved highlights the relationship between black and white and the way colour affects the character in the story. As a result of racial prejudice the characters of darker colour undergo more hardships than the other characters. Morrison in the following lines project the savagery of white racism:

White people believed that whatever the manners, under every dark skin was a jungle. Swift unnavigable waters, swinging screaming baboons, sleeping snakes, red gums ready for their sweet white blood. . . . But it wasn't the jungle blacks brought with them

to this place from the other (livable) place. It was the jungle whitefolks planted in them. And it grew. It spread. In, through and after life, it spread, until it invaded the whites who had made it. . . . The screaming baboon lived under their own white skin; the red gums were their own. (234)

Taking the time period of the novel into consideration, it is obvious that there will be issues of slavery and segregation, which are both problems that revolve around race. Since Morrison has based her story on the real life of Margaret Garner, the reader is able to see racial issues on a deeper level. Through the character Sethe, Morrison tries to address the race issue present in the United States.

It is the belief of the white people during this era that most black families do have single mothers, males who abandon the family and one or more illegitimate children. Segregation occurs because of these beliefs and because white parents instill a sort of fear of the black race in their children. Also, there is overlying issue of white superiority from the slave days and the idea of ownership. Millie Tran says, "The lasting effects of slavery induce the white characters to acts of violence and feelings of superiority that degrade and dehumanize the blacks". Grounded on the theory that slaves are not human beings, but animals, the schoolteacher and his nephews abuse the power of the institution of slavery. Moglen rightly comments, "Schoolteacher, the slave-master who inherits Sweet Home along with Sethe, Paul D, and Halle, beats one of his blacks "'to show him that definitions belong to the definers, not to the defined'" (qtd. in Keating).

Morrison also addresses this race issue through the painful realities experienced by Sethe at Sweet Home, under the watchful eye of the schoolteacher. She remembers how he regarded them as simple-minded farm stock and ideal creatures to experiment on: "Schoolteacher'd wrap that string all over my head, 'cross my nose, around my behind. Number my teeth" (226). By using string, the schoolteacher measures the body parts of the blacks and studies them. This action of physical measurement becomes a form of oppression, as it subjugates the slaves into biological specimens. Ryan Smith says,

> The science of the time, now identified correctly as pseudoscience… forms an integral part of the system of interlocking oppressions as it synthesized a number of areas under the guise of science, reason and proof. Races were seen as distinct and hierarchical, women were diagnosed with phantom medical and mental problems, lower classes were deemed naturally less fit to survive economically, and so on.

One day, Sethe overhears a lesson being instructed by the schoolteacher to his nephews. During his instruction, the schoolteacher directs his nephews to categorise Sethe's

characteristics. As she walks past the tutorial, Sethe hears him say, "No, no. That's not the way. I told you to put her human characteristics on the left; her animal ones on the right" (228). In this manner, the schoolteacher continues to reduce Sethe and the slaves to animals. Sethe recognises schoolteacher's words and realises it as almost a greater threat to blacks than the material conditions of slavery itself. She discerns that his instructions promote an unspeakable terror and violence. By teaching his nephews this lesson, schoolteacher is ensuring the racial attitudes of the next generation.

By ordering his nephews to rape Sethe, the schoolteacher displays his aggressive nature of dehumanising the slaves at Sweet Home. Sethe is still haunted by the memory of the horrible act of cruelty and degradation. She powerfully states, " I am full God damn it of two boys with mossy teeth, one sucking on my breast the other holding me down, their book-reading teacher watching and writing it up. I am still full of that. . ." (83). The nephews hold her down, and attack her like some sort of animal that needs to be captured and subdued.

While the schoolteacher provides an example of a more direct and vicious version of bigotry, Mr. and Mrs. Garner play the roles of the kind and humane slave owners. But their attitude towards the blacks cannot remain untainted by racism and slavery. The Garners exemplify a more enlightened mentality about slavery, yet the slave's humanity and status is still subject to their whim. Baby Suggs' treatment by the Garner's at Sweet Home is seemingly fair: "[Lillian Garner] never pushed, hit or called her mean names. . . . nobody knocked her down" (164). The Garners' special kind of slavery allowed the slaves to feel less threatened by their masters. Though their paternalism demonstrated more compassion, it only masked their true beliefs about their slaves. They considered the slaves not to be men at all, but "niggers" (12). By referring to the slaves as "niggers," Garner exposes his contempt and his overall loathing of them. Therefore, though the Garners' actions are accepted as more humane, their view of the blacks does not differ from the rest of the slave owners.

One of the first white characters the reader sees interacting with a black character outside of Sweet Home is Amy Denver. Not only does Amy nearly save Sethe's life near the Ohio River, but she also delivers Denver, who is named in her honour. Amy's actions, such as helping Sethe, massaging her feet, redefining her wounds as a "chokecherry tree" (93) with "tiny little cherry blossoms" (93) are seen as benevolent and almost altruistic. In these scenes, Amy serves as the antithesis to the cruel white characters. However, her conversation with Sethe is littered with racist epithets and fraught with dehumanising remarks, as she casually mentions her "old nigger girl . . . don't know nothing. . . . just like you" (94). She sarcastically asks her, "'What you gonna do, just lay there and foal'" (41)? By using the word "foal," Amy

degrades Sethe to a horse and it's only when she sees Sethe as helpless does she finally help.

When first introduced, Mr. and Miss Bodwin, the brother and sister appear to embody hope and a chance of freedom for the blacks. The Bodwins helped the blacks whenever they are in need of a place or some other help: "the Bodwins—the white brother and sister who gave Stamp Paid, Ella and John clothes, goods and gear for runaways" (162). They have a particular stake in Sethe's life by taking Baby Suggs from Mr. Garner and giving her a job in their home. Miss Bodwin even reminds Mr. Garner, "'We don't hold with slavery, even Garner's kind'" (171). The overall sentiment of the black community is that "for every schoolteacher there would be an Amy; that for every pupil there was a Garner, or Bodwin, or even a sheriff" (222).

Amy's innocence and her willingness to help Sethe, the Garner's empathy and care, and the Bodwins' abolitionist attitude may seem kind, but they are only a diluted version of the schoolteacher's blatant and violent racism. This becomes clear when Paul D warns Sethe, "'It don't matter, Sethe. What they say is the same. Loud or soft'" (231). Although the white characters all express different degrees of superiority through verbal or physical means, both result in the subjugation of the blacks. The schoolteacher and his nephews illustrate the extremity on the spectrum of racism, through their violence and shameless studying of the slaves as animals. Additionally, the Garners' benevolent actions toward their slaves at Sweet Home are negated by their arrogance and ultimately still rob the slaves of their humanity. Finally, the Bodwins fail to comprehend the implications behind the statue, that it is analogous to the physical, mental, and emotional attack by whites and slave owners and thus, fail to be the exception amongst the white people. Though the whites' belief in their own superiority enables them to treat the blacks as innately inferior creatures, Morrison reverses this cycle by presenting the perspectives of the blacks and ultimately depicts the whites as being inhumane themselves.

Morrison focuses on the hardships of women. She is candidly writing about the innermost experiences of women; openly critiquing the redundant patriarchal values; and, giving vent to an uninhibited expression to the feelings and desires of women. If women are dominated today, it testifies not to the weakness of women but to the strength of sexism. As women do not belong to the dominant part of hegemonic society, their capacity to make decisions and craft opinions, is limited. Like the female characters in the novels, many women today long for freedom and cry for independence. In this situation, if sexism is to be subjugated, women should fight their way back to independence. Consciousness raising is important to change women's feelings of isolation and loneliness. In order to attain power, women have to draw inner strength. They must attempt to critique hegemonic power.

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Bliss in Blemish: Acceptance of Self in Indra Sinha's *Animal's People*

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ABSTRACT

Indra Sinha's Animal's People is a tale of pain and suffering uttered through the mouth of a nineteen-year-old boy Animal. The novel vividly portrays the repercussions of Bhopal disaster that demolished the lives of many innocent people. Even after years people combat with the physical and mental trauma of the calamity. Animal is one such victim who is pushed to poverty and deformity because of poisonous gas. He even loses his identity as a human being and is forced to live in streets. Because of his disability, he feels inferior and restricts himself to live within a small circle. Though he desires to look beyond the horizon, his crippled self, serves as a chain that confines his wings. This paper attempts to show how an individual can live a happy life by accepting one's self with all frills and flaws.

Keywords: Disability, Identity, Trauma, Realisation

Indra Sinha's novel *Animal's people* brings to light the aftereffects of Bhopal gas tragedy that left incurable scars in the lives of many people. The toxic gas percolated from the factory wiped away happiness from the life of many. The protagonist Animal serves as a voice to the muted community of Khaufpur, a place ruined by the poisonous gas released from the chemical company. Animal is the representation of an entire community who are left traumatized and denied justice. He was born normal but he does not remember himself as a normal human being. He was told by the people that he used to walk on two feet. He says "I used to be human once, so I'm told, I don't remember it myself..." (1). Every child born in this world desires and deserves the love and care of family and the identity of a child is derived from the parents. Animal has no name or religion because he is an orphan who lost his family in the disaster. He got the name 'Animal' because of his twisted spine. When Animal turned six, he loses his walking ability because of the effects of chemical gas. Even his friends started teasing him for his disability. They address the dog Jara as his girlfriend. When they see dogs mating in streets, his friends mock Animal. They say "Hey Animal, is this how you do it" (16)? Exposed to the darker side of the society right from the childhood, he detaches himself physically and emotionally from the society. To sooth his hidden wounds he even visits a brothel house and develops a bond with a girl named Anjali.

All the hatred and humiliation received from his fellow beings creates a deep scar inside the heart of Animal and he hesitates even to trust the people with good intentions. When a

foreign doctor Elli Barber, sets up a free clinic to treat the victims of the disaster, he hesitates to trust her. He firmly believes that no one can understand his pangs because he is the one who lived through the sea of struggles. When a journalist approaches him to record his story he is unwilling because he thinks that the story of person like him has no power to sow seeds for a better change. Society shows a disgusted face towards him which adds to the bitterness that rules his heart. There is no one to listen to the stories that are entombed in his mind. He says "People see the outside, but it's inside where the real things happen, no one looks in there, maybe they don't dare" (11). He is victimised both by the society and by the company. He feels bad for everything that turned his life upside down but somehow manages to survive amidst all the ill treatments,

Animal wishes to show a good face to the society but sometimes unpleasant situations force him to act savagely. He is a good human by heart but to protect himself from the annoying attitude of the society, he wears a mask of insouciance. He hates the people who show pity towards him and fights with people who criticise him. Deep down he longs to walk like normal people but has no dare to say it loud. Animal lives in an abandoned factory where cobras reside and considers it as his kingdom. He feels comfortable inside that locked up building because there is no one to intrude his inner peace. His physical disability creates a mental disability which results in a deep sense of insecurity and inferiority. He is very careful in voicing his feelings because he wants no one to sympathise him. When Nisha, a daughter of a local musician treats him with respect, Animal let her inside his small circle. He likes her for accepting him as he is, because in his life, as far as he could remember, people looked down on him because of his deformity. He loves Nisha but never opens up his feelings because he thinks that Zafar, Nisha's fiancé is a better suit for Nisha. Because of his misshape, he feels insufficient and says "my back was bent as a scorpion's tail" (47). Zafar is also a sensible character who thinks that Animal deserves, dignity, love and respect like his fellow humans. He invites Animal to work with him and asks Animal to keep his ears and eyes open to notice the unusual happenings in Khaufpur. Zafar advises Animal not to allow people to address him after his disability and asks him to choose a name for himself. Animal refuses the offer because he has created a boundary inside his heart, forcefully accepting his non-human identity. He says "'My name is Animal', I say. I'm not a fucking human being, I've no wish to be one.'" (23).

People of Khaufpur respect him when he starts working with Zafar. But Animal wishes to be respected as an individual. After seeing the selfless services of Elli Barber, Animal trusts her and asks her whether she can do something to make him walk on four feet. When Elli sends

his x-ray to America, Animal finds a strange hope growing within him and starts saving money for his operation. He even believes that Nisha will fall in love with him when he walks like a human being. Though he wishes to stroll forward, towards a better future, the struggles of the people around him coerce him to think other way. Orphaned from the childhood, Animal secretly yearns to have a family of his own. He desires to get married and live a life of a man but thinks that no one will marry him. When Nisha states that he is a beautiful man by heart, he replies "I'm not a man" (47). Pushed to the margin by the society and the company, there is no hope inside the heart of Animal. He considers this nothingness as his big strength and says "Hope is a crutch for weaklings. The strong carry on without" (75). He has no steam left to fight for his rights and respect because he always feels exhausted after gaping at the unfair side of the society. Rather than fighting for his human identity, he looks for the benefits that he can enjoy as an animalized human being. In an argument with Farouq, he claims "I'm an animal, I don't have to do like the rest of you, laws of society don't apply to me because I'm a fucking animal" (87). Farouq opines that to shun from the commitments of a human being, Animal considers himself to be an animal and Animal denies that instantly. He thinks that if he admits himself as a human being, he will have to agree that he is wrong shaped. Armed with unity the people of khaufpur manages to overcome the pangs caused by the bitter incident.

Even after bundles of struggles, fate targets Animal, once again grabbing some of his dear ones away from him forever. He misses them badly and believes that he can meet them in paradise. However, at the end he learns the nuances of life and decides to go with the flow. With countless twists and turns, life teaches him to accept himself and he decides to use his savings to free Anjali. He plans a new life with Anjali, embracing himself as he is. Acknowledging the positive side of his disability he says that he is unique because he can do things that are impossible for a man. He chooses to be a perfect animal rather than being a flawed human being. With the acceptance of his non-human identity all his longings come to an end and he sings "I am Animal fierce and free, in all the world is none like me," (366).

The life of Animal is like a box of surprises, sometimes sweet and other times bitter. All the trials he faces, shells out enormous strength to mould him into a better personality. Without the shocking turns, life becomes prosy with no fabricating tints. Every adventurous experience that comes in the life of Animal grooms him to learn and grow, accepting all the shocks and surprises offered by universe.

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Women under Patriarchal Hegemony: A Study of Meena Kandasamy's
When I hit you: or, a Portrait of the Writer as a Young Wife

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ABSTRACT

Women suffering under patriarchal society in reality are not a new phenomenon or experience faced by women throughout the world. In the Indian mythology women are worshiped and respected as goddesses. The present research paper is an attempt to analyse the role of a married woman inside her home and outside the society. Evidently it is proved that throughout the years women whether being a daughter, sister or wife are placed next to their male counterparts and will often search for their identity and individuality. Though education plays an important role in every woman's life they have never reached the destiny of bringing complete freedom in their life. Attaining the status of being a liberated individual has become a continuous effort and the biggest dream to each and every woman in the corner of any part of the world.

Keywords: patriarchy, myth, conventional, education, marriage, individuality, dream.

The traditional view of women in their stereotypical function as wives within the constraints of the marriage structure is also expressed in women's literature. These writers visualize marriage as an entrapment where men dominate over women and also consider this as a symbolic authority. This attitude make the women to strongly believe that they belong to the second class gender and part of the male ownership.

The protagonist of the selected novel whose name is not mentioned is a writer who never understands the confused patriarchal system which has been followed throughout ages and fails to attain equality between men and women. She tries to compare and contrast the bitterness face by the women in the past and in the present. The heroine of the novel marries a man of her choice hoping to lead a happy and content life. She believes that her educated husband will stand by her side and support her in all her endeavors. Her dreams shatter when the reality hits her hard, it is evident in the following lines, "Marriage became a Re-education camp. He transformed into a teacher, and I became the wife-student learning from this communist Crusader" (32). She clearly explains the brutal nature of her husband, further she talks about how he mistreats her day after day.

In the view of public, she is leading a happy and cheerful life and has a stable and

healthy relationship with her husband. The truth behind her marriage life is totally covered to the world . She narrates, "I must learn that a Communist woman is treated equally and respectfully the comrades in public but can be slapped and called a whore behind closed doors" (34). Even in her working place she receives awful comments about her outward appearance. While receiving comments upon her short hair, she utters, "A woman with short, loose hair in the bazaar also became synonymous with the white man's prostitute" (74).

The love that is once the foundation of the relationship between the protagonist and her husband is suppressed by patriarchy. Both the protagonist and her husband are highly educated, progressive, and proponents of the ideas of equality. Their early involvement is centered on a fondness of radical politics. With a thorough exposition of Marxist, Maoist, and Leninist philosophy, it becomes firmer. The narrator falls in love with him and is married as a result of his commitment to the Marxist philosophy of equality and revolutionary ideas, but when he marries the narrator, it appears that the patriarchal mindset begins to come out of him. The narrator says, "Let me tell you something that goes against popular wisdom. Love is not blind; it just looks in the wrong places" (122).

The protagonist's husband is unable to keep the love alive in their relationship because of the patriarchal predomination. In a patriarchal culture, men are viewed as superiors. Since the word 'oppression' means 'to push down or restrain,' women are not permitted to hold the positions of leadership or make choices. Additionally, women are not permitted to show their individuality or promote reforms in any social structure.

The protagonist becomes a victim to the patriarchal social structure rather than her husband. Her father advises her to be submissive to her husband and says, "I know you, you are my daughter you do not like to lose a fight. The marriage is a give and take. Listen to him" (157). Her parents are much curious about the social structure, custom and belief. Her mother says, "All change is slow. A marriage is not magic. You will have to give him time. He still come around" (158).

In the Indian culture and society, gender-based violence against female is institutionalized and supported by the patriarchal system. In fact, it is the patriarchal system that places women in a subordinate position and gives men all freedom in decision making. The protagonist's husband becomes a tyrannical patriarch who has gone beyond the limitation in using his wife's body and soul as tools for his personal needs, he also controls over not only her feelings but also her desires.

Women are often victimized by bullying, continually made fun and sometimes assaulted. Indian women though take different avatars, finally become victims in the hands of

men. Sexual harassment is clearly depicted in Shashi Deshpande's novel, The *Dark Holds No Terrors*, the author writes on behalf of all those who are suffering silently as a result of their nightly terrors: "I was a female. I was born that way that was the way my body had to be, those were the things that had to happen to me. And that was that!" (Deshpande 63).

The protagonist, who stands in for all women who are subjected to abusive marriages in patriarchal societies, experiences marriage as a terrible nightmare. She says, "Marriage has ruined my romanticism, by teaching me that this thing of beauty can be made crude" (92). Her husband goes beyond all boundaries with the guidance of patriarchal mentality. He used to beat her violently and rapes her whenever he feels like. He used marital rape as a tool to gain control over his wife. In the Indian society the subject of marital rape is still considered to be a taboo to be spoken and majority of the people would laugh at the use of the word marital rape. Men continue to think that a wife's body belongs to her husband, which gives him a sense of ownership.

The female protagonist in the selected novel experiences a lot of emotional repression and oppression in her marriage. She often senses suffocation because of lot of abusiveness in her marriage. Despite the fact that it was a love marriage, she eventually had to deal with her husband's distorted mentality. He reveals his actual, awful self. She becomes the target of exploitation, and her husband beats, rapes, tortures, and abuses her in an effort to subjugate her. The narrator describes her bathetic condition as "I never understood rape until it happened to me. It was a concept of savagery, of violence, of disrespect" (167). She thinks it would be sinful to have his child in her womb. She was raped within the marriage where her 'NO' held no meaning. The protagonist says, "I do not want to bring a baby into a world in which I have no love. I do not want to bring into the world a son who will watch his mother being beaten up, I do not want to bring into the world a daughter who will be beaten up" (200).

The narrator's parents being so traditional never want their daughter's marriage to collapse at any circumstance and they believe that things will be better in due course of time. They have paid little attention to her sufferings. When she is denied all kinds of communication with the outer world and received emotional blackmail from her husband, that moment she decides to depart him.

Home is said to be a safer place for everyone especially for women and girl children and at the same this is the place where they undergo silent sufferings which can be witnessed only by the four walls. Primrose Villa which is the residence of the protagonist is compared to a theatre where she is compelled to act, she states:

In the middle of this, the house itself stands, small and self-contained, its well- defined

boundaries in sharp contrast to the open, vibrant garden. It makes a perfect film set. And in some ways, that is how I think of it: it is easier to imagine this life in which I'm trapped as a film; it is easier when I imagine myself as a character. It makes everything around me appear less frightening; my experiences at a remove. Less painful, less permanent. Here, long before I ever faced a camera, I became an actress (13).

She further speaks that home is the place where she receives commands from her husband as a whore, middle – class bourgeois, a pseudo feminist and this is where she suppresses all her desires and dreams.

Traditional values control Indian society especially Indian women. Women find it a great challenge to free themselves from their gendered roles as wife, mother, and daughter. Any attempt to stay away from these responsibilities would only lead to loneliness or self-destruction. Kandasamy depicts the narrator's struggle with rigorous social rules, a conformist husband, and the status quo of society as she pursues self- actualization and self-assertion.

Social expectations strive to make women docile and are suppressive. Financial freedom will definitely make a woman stronger so that men are afraid of providing such freedom to their life companions. Moreover they consider that as a disgrace because the society will look upon them as useless. Another major issue which threatens a woman is her pregnancy. In the life of the narrator pregnancy is something which is viewed by her as a shame because she is not truly loved by her husband and not treated in a proper way.

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Assault and Amercement in Fyodor Dostoevsky's *Crime and Punishment*

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ABSTRACT

The act of crime generates a law and order situation and it is great trouble in the world. The causes of illegal acts are complex, parental neglect, low self-esteem, and alcohol and drug abuse. B.F Skinner introduced that punishment has a more restrictive and technical definition. Even philosophers have presented various definitions of punishment. Punishment can be seen as good in society to prevent people from doing bad things. It can also be seen as cruel, unnecessary, and does not do any good. The path from crime to punishment is not straight, or smooth and it is non-existent. Harshit Walia says that the criminal mind needs consideration rather than the criminal itself. In truth, there are more criminals than those who committed a crime. This paper analyses the measures one takes to acquire a state of peace that makes him do an extreme act to take another person's life which is 'crime'. The entire novel Crime and Punishment portrays the torture the protagonist undergoes as his mind slowly reaches insanity.

Keywords: Crime, Punishment, Murder, Law

Russia's St. Petersburg experienced widespread poverty in the 1860s, and many struggled to survive. Due of this, many people turned to committing crimes, particularly sexual assaults on women, which were also common in St. Petersburg, in order to survive. Crime and Punishment by Fyodor Dostoevsky examines how living in the hazardous city of St. Petersburg has a negative psychological impact on the protagonist, the poor student Raskolnikov. The growth of the characters is heavily influenced by the city. Even though he is good, he commits a serious offence, feels lost and unworthy, and decides he wants to take action.The majority of the book is devoted to discussing his punishment, which is a form of torment as his mind steadily devolves into insanity. He robs and kills the pawnbroker Alyona Ivanovna and her imprisoned sister Lizaveta. When he presents the "Silver cigarette case" to the pawnbroker, which she accepts and unwraps, Raskolnikov recognises his chance and hits her, almost "mechanically" with the blunt end of the axe, and she cries very faintly, suddenly sank all of a heap on the floor. He has multiple reasons to kill the pawnbroker, but Raskolnikov is forced to kill Lizaveta and this is more distressing for him, because she is both mentally slow and a good person, and he feels terrible about her murder.He uses the blunt end of the axe to repeatedly and violently strike the elderly woman, killing her. Then, he takes the keys out of her pocket

and tries to open the bedroom's chest of drawers. He returns to the woman's body and takes the purse that was wrapped around her neck after becoming frustrated with the keys. He doesn't even look at the purse as he stuffs it into his pocket. He struggles more with the drawers before looking below the woman's bed and discovering a trunk. Fortunately, Raskolnikov discovers some hidden objects in their clothing. He stuffs these items into his coat without carefully inspecting them.He has regret immediately after committing the crime, and this sensation intensifies until it completely dominates his body and mind. He becomes mentally and physically unwell after this murder. In order to suffer alone, he pushes everyone away and seeks seclusion from society.

Many people experience guilt, a universal emotion, after committing crimes, wrongdoings, or even just simple acts of cruelty. This can be seen in Dostoevsky's Crime and Punishment, where the poor student Raskolnikov develops a theory that the world's extraordinary young men have a right to commit suicide. Raskolnikov sees himself as an extraordinary young man. He kills an elderly pawnbroker and her step-sister to support his theory. Raskolnikov becomes ill right away, loses his mind, and spends several days semi-conscious in his room after committing the crime. When Raskolnikov is feeling better, Luzhin, who is betrothed to Dounia, the sister of Raskolnikov, pays him a visit. Raskolnikov insults Luzhin and excommunicates him because he disapproves of the way Luzhin treats Dounia. Raskolnikov's mental health is deteriorating due to poverty as well as his remorse and paranoia over the murder, and Razumihin, Pulcheria, and Dounia are afraid about this. "He was not completely unconscious, however, all the time he was ill; he was in a feverish state, sometimes delirious, sometimes half conscious. He remembered a great deal afterward. Sometimes it seemed as though there were several people around him; they wanted to take him away somewhere, and there was a great deal of squabbling and discussing him" (119).

Porfiry Petrovitch is made intriguing by Raskolnikov's "On Crime" piece in the Periodical Review. This essay is crucial to comprehending his views and has a significant impact on crime and punishment. He contends that a portion of all crimes can be attributed to the environment. The psychology of a criminal is discussed in the text, which was inspired by Raskolnikov's legal studies. Porfiry is particularly disturbed by the conclusion, which makes the case that for some remarkable people, conventional rules do not apply and that these laws must really be disregarded. In an effort to elucidate his claim, Raskolnikov claims that "great men," as defined by society, frequently violate the laws of their period in the interest of new laws or a new morality. Porfiry admits that he liked the article and felt a connection with it. "In his article, all men are divided into "ordinary" and "extraordinary". Ordinary men have to live

in submission, and have no right to transgress the law, because, don't you see, they are ordinary. But extraordinary men have a right to commit any crime and to transgress the law in any way, just because they are extraordinary" (245).

Raskolnikov secretly wonders and frets about what Razumihin would think of him when he hears the truth after speaking with Porfiry Petrovitch and Zamyotov after Svidrigailov leaves and claims they have found Raskolnikov to be the murderer. Raskolnikov then goes to Sonia's flat, but they do not engage in any close talk. He notices her attractiveness when he sees her for the first time. When he discovers that the worn-out Bible was a present from her close friend Lizaveta, he is shocked. Despite Raskolnikov's claim that he does not believe in God, it appears that he asks Sonia to familiarise him with religious doctrine.She initially hesitates to read since she does not want to read to someone who is not a believer, but she eventually reads the full Lazarus account to him. Raskolnikov is drawn to the Lazarus story's unbelievable element. As he prepares to depart, he promises Sonia that if he sees her again, he will reveal who killed Lizaveta.

Raskolnikov and Porfiry Petrovich have a tumultuous relationship. When Raskolnikov shows up for an interview with Porfiry, he is welcomed warmly and presents himself as though it were a delightful social visit, forgetting that one is not kept waiting for a social visit for such a long time. While conversing, Porfiry "resumes and intensifies his insinuating, provocative, ironic chatter, without ever making a direct accusation" (Mirza 54). Raskolnikov makes an effort to keep the meeting professional and speculates that they might discuss the murder, but Porfiry wanders off and talks about the government quarters, a significant issue, particularly theories about crime and crime detection. As the interview drags on and becomes increasingly rambling and irrelevant, Raskolnikov eventually loses patience and informs Porfiry that he has realised the interview has become a "cat and mouse game."Raskolnikov then asserts that he is suspected of being the murderer of "that old woman and her sister Lizaveta," (320) that he demands to be arrested immediately or allowed to leave, but Porfiry reveals that he knows many unusual things about Raskolnikov. Porfiry also explains his approach, saying that while he can always make an arrest, he likes to give a suspect some privacy so that they can reflect on their crime. This demonstrates that Porfiry ultimately wants Raskolnikov to confess to the crime he committed, and that all of the evidence he has against him is psychological. Porfiry's final admission that he was well aware of Raskolnikov's recent behaviour, as well as the fainting and the conversation he had with Zamyotov in the tavern, are startling admissions of guilt.

Raskolnikov is raffled, but Porfiry is intelligent, in charge, and equipped with a variety of tactics. He pushes himself from the people nearby and reverts to his caustic, proud side, blaming himself for his frailty. His internal struggle between pride and the need to confess becomes more intense, veering back and forth and extending the anticipation of how the battle will end.Raskolnikov faces an unending amount of coincidences and hurdles as Dostoevsky continues to use all of his characters to superb advantage. Raskolnikov is surprised by Nikolai's dramatic confession, which Dostoevsky adds into the story. All of a sudden, Nikolai falls to his knees and admits to killing the victim. Raskolnikov thinks Nikolai's confession is proof that he is the object of some grand design. Raskolnikov is shocked, and Porfiry questions him for specific information about a crime while also using psychological tricks to get him to confess.

The act of confession in *Crime and Punishment* by Dostoevsky is the book's climax and denotes significant changes in Raskolnikov's emotional and physical state. Before he ultimately dares to confess his wrongdoing, he endures extended periods of mental suffering and conscience-wracking. Raskolnikov is internally torn between the options of suicide and confession as well as between faith and unbelief.Sonia is the "one who assists Raskolnikov with his arrival at the necessity for confession and reunion with the moral world" (Mirza 24). Raskolnikov's guilt and need to confess were as intense as his wrath prior to speaking with Sonia. Raskolnikov, on the other hand, is relieved of his bodily and moral pain after confessing since he understands the gravity of his crime.

Raskolnikov considers telling the kind, suffering prostitute Sonia about what he did. Their lives have become entwined. He is pressed by Sonia to reveal who killed her friend Lizaveta and her sister. Although he lacks the courage to tell her the truth, he is aware that she has already discovered it. Significant developments include Raskolnikov's confession to Sonia and his pledge to confess to the police. Sonia is stunned to learn the truth and stands still.She expresses her pain for his illegal act and interrogates him about the reason for the crime. But his only answer is "Don't torture me, Sonia." (382). Although he is a remarkable man, he lacks the ability to live with the crime he committed but has the drive to do it.He says, "I wanted to become a Napoleon that is why I killed her… do you understand now?" (383). The real reason to kill the pawnbroker is that she is immoral, cheats on the poor, and considers her as a creature.

Ivanovich, Arkady *Crime and Punishment*'s villain could be deemed Svidrigailov. His actions are false atonements since he destroys the lives of people who are close to him. He has no interest in salvation. The person Svidrigailov is evil. Without recognising it, Raskolnikov is captivated to Svidrigailov, who symbolises a certain facet of his personality. Since their first encounter, Svidrigailov has constantly claimed that they had something in common. The vices

that Svidrigailov has are openly discussed in the book. He betrays his wife, pursues his staff, and bullies his nanny. In *Crime and Punishment*, Svidrigailov experiences a storm that may portend disaster or doom. It might represent the evil in his heart or portend his demise. Maybe that is it. The Siberian prison is portrayed in the book as a hospital for criminals, a place to heal and seek forgiveness, rather than as a place to continue their misery. The contrast between Raskolnikov's chamber and the Siberian prison is intriguing.

Raskolnikov's circumstances haven't made him sick since the demanding job, subpar food, and other difficulties of prison life can all be tolerated. He is ill because of his wounded pride. He promises to make up for all of Sonia's losses with love. It is fresh for him only to feel. Raskolnikov feels the thrill of love when he thinks of Sonia. He takes a copy of the New Testament that Sonia gave him out from under his pillow. He feels one with her. The narrator closes the novel by stating that this man's renewal is a matter of another story. "That might be the subject of a new story, but our present story is ended" (501).

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Teaching through Hybrid Learning – An Overview

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ABSTRACT

The newest continuous trend in education is hybrid learning, which combines elements of traditional offline instruction with those found online. It is used to coordinate teaching that takes place both physically and virtually, both in-person and online. It fosters an environment that allows for greater flexibility in the teaching and learning process so that students may fully comprehend the instructional tactics. It is tough for both teachers and students because it is different from standard education. The disruption of digital technology and the departure from the traditional classroom may be a challenge for learners. Technical difficulties impede not only the individual student's learning but also the learning of other crew members. The variety of technological problems experienced by remote students ranges from voice clarity and connection issues to more complicated computer/laptop problems or the inability to use software that is appropriate for the course. The likelihood of having a positive learning experience is extremely slim, depending on how serious the technological problems are. It is also crucial for teachers to transition from traditional classroom instruction to the development of digital skills, pedagogical effectiveness, or the capacity to recognise when various hybrid learning models are appropriate given the circumstances. The hardest part of providing an equal learning experience is keeping both the students who are physically in the classroom and the students who are learning remotely engaged. The detailed review of hybrid learning is the paper's main topic.

Keywords: Classroom Learning, Hybrid Learning, Online Teaching, Student Community, Teaching-Learning Process

In contrast to traditional classroom instruction, hybrid learning completely alters how education is provided in the contemporary period. The term "hybrid learning" refers to synchronous learning that incorporates both in-person and online learning at the same time. Understanding how hybrid learning bridges the virtual and classroom modalities of education is crucial. By carefully examining the challenges experienced by both students who are physically present in the classroom and those who are learning remotely in the virtual mode, educators can overcome their teaching commitments. The utilisation of numerous online resources, including video conferencing, testing, and teaching software, is a component of hybrid learning. Asynchronous learning methods like online exercises and video tutorials are a part of hybrid education. When hybrid learning successfully blends in-person instruction with

online learning that can also be adjusted based on the requirements of the learners, it is at its finest. The learners can select their preferred learning style during the online or offline lessons. They are given access to internet learning tools, and they have freedom in how they choose to learn.
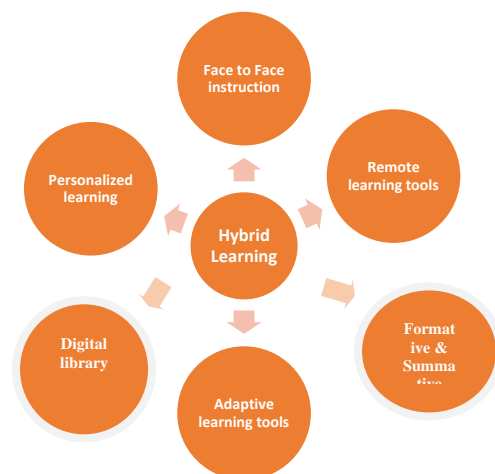
Hybrid Learning Vs Blended Learning

Due to their greater similarities, the phrases hybrid learning and blended learning are sometimes used interchangeably. Both are separate instructional paradigms, though. Blended learning blends synchronous and asynchronous learning methods, allowing students to work at their own leisure on online projects and watch instructional videos. On the other hand, hybrid learning is a teaching strategy in which instructors instruct both in-person and online students at the same time. In contrast to blended learning, hybrid learning combines face-to-face training with asynchronous learning techniques.

Importance of Hybrid Learning

Hybrid learning combines traditional and online instruction at the same time, and this approach gained popularity, particularly after the COVID - 19 pandemic when students were compelled to stay at home. However, hybrid learning came to the aid of the teachers, allowing the students to complete their study. Due to the distance, limited availability of transportation options, and accessibility issues for those with disabilities when students were required to attend classes on a regular basis after lockdown, hybrid learning became more appealing to students. The students were able to resume their education because the teachers delivered lessons in both offline and online formats to isolated areas. This allowed the students to maintain contact while away from school for an extended period of time.

<h3 style="text-align:center">Hybrid Learning Model</h3>

A hybrid learning model combines in-person training with online learning resources. To better meet the needs of the students, it also incorporates adaptive and remote learning

techniques. It gives students a tailored learning experience. Students gain from both online and traditional classroom instruction. Additionally, it offers a flexible learning environment and conducts ongoing formative and summative assessments for the students. The use of a digital library and online internships by students also helps them learn more effectively.

Role of the teacher

In hybrid learning, teachers play the role of a supervised professional. The teacher is required to offer both offline and online teaching strategies to the students. The professors must be present in the students' digital domain, too, according to the students. Teachers should start conversations with the students so that they can ask questions, get answers, and have meaningful interactions. The instructor serves as a digital motivator and teaches the students appropriate online conduct. In an electronic classroom, a teacher's duties include adaptability, punctuality, digital engagement, practice-spaced virtual learning, and efficient communication with the students.

Student Engagement and its difficulties

The main potential issue with hybrid learning is how to keep students interested. It is difficult for the teacher to maintain student engagement while ensuring an equal teaching-learning experience for those physically present in the classroom and those who are learning remotely. Because remote learners would be excluded from the face-to-face activities, the approaches utilised in the classroom may not be feasible or appropriate for students in the hybrid learning environment. The students in the classroom learning environment may become distracted and have their train of thought interrupted by the continual and focused efforts to engage the remote learners.The lack of direct eye contact and the educator's expression may cause remote learners to show signs of disengagement, which can result in boredom and a lack of interest in the course material. The educator must concentrate on activities that are appropriate regardless of the teaching-learning techniques used if they are to overcome student engagement issues. Active learning can be accomplished by engaging in group or classroom discussions, administering tests, and exchanging study materials online. These activities can be made possible by screen sharing and live streaming technologies with the aid of the Google Classroom, Google Meet, and Zoom platforms.

The Technical Obligations

Technology must be used both in the classroom and for online instruction in hybrid learning. Another potential issue that can arise while using the hybrid learning approach is the appearance of technological problems. Technical challenges affect students who are learning remotely as well as those present in the classroom. It is impossible for distant learners to have

a positive learning experience because of challenges with the sound, connecting to the live stream, and significant hardware and software problems with their computers. Technical problems have varying effects on pupils at different times because there is no "one size fits all" solution, although some learning challenges can be avoided by training and other activities. Remote students must sign in to the online platforms in advance; doing so will make it simple to spot technological problems and attempt to fix them. The study materials' recording and uploading could help with the follow-up of lessons that are missed later on because of technical difficulties.

Problems faced in facilitating Collaborative Learning

In a hybrid learning environment, it is challenging to promote collaborative learning. In a traditional classroom setup, learners can be physically organised into groups, but live social interaction opportunities may not be practical for distant learners. The simultaneous use of two learning styles is therefore a barrier to collaboration. The online platform's shared whiteboarding, screen sharing, and live annotations with "Huddle groups" allow the hybrid learning course to be engaging for distant learners. Online platforms that offer synchronous communication chats can aid in simulating the advantages of face-to-face conversations.

Sharing of Files and Learning Materials

Since students are taking part in the hybrid learning course from various physical and geographic places, the requirement to transfer files, learning materials, and other content between devices becomes more important. To guarantee that there is no disruption in understanding and applying the shared study materials, the educators must establish a clear sharing plan. Since collaborative projects may lose its critical substance if two students find it impossible to share and access the shared files of the project they are working on, compatibility of sharing the learning materials is crucial. The inability to access the shared files could cause the project submission to be delayed. The students should use standardised technologies as they work together on a single assignment. In a hybrid learning environment, cloud computing technology can be utilised to standardise the hardware that distant learners use. A wonderful technique to allow file sharing in a secure setting where security features like passwords may be employed and access can be easily controlled to those who do not truly require it is through cloud file-sharing alternatives.

Advantages of Hybrid Learning

The main aim of hybrid learning is to adapt and adopt the benefits of both online and face to face instruction. The advantages of hybrid learning are:

- It provides flexible learning experience to the learners.

- It enhances communication between the teacher and learners and among the peers

- It is comfortable for the learners those who are not able to attend the classes in person

- It engages the learners with classroom interaction, presentations and group work

- It motivates the learners to engage in meaningful interaction

- It provides opportunities for the learners with learner autonomy

- It enables the learners to expand their knowledge horizon by independent academic exploration

- It enables effective and efficient use of learning resources

- It provides flexible teaching and learning experience

- It accommodates differently abled learners as well

- It reaches all the learners even from remote areas

- It reduces absenteeism among the learners

- It acquaints leaners to use modern technology

Disadvantages of Hybrid Learning

Although hybrid learning has many advantages, it also has certain setbacks, namely,

- Not all the learners have accessibility to technology

- Learners may lack accountability

- It requires specially designed courses

- It increases teachers workload

- It increases learners cognitive load

- It is not cost effective as it employs more online tools

- It limits the teacher – learner interaction

- Learners may get distracted

- It lacks human touch

    Besides these disadvantages, hybrid learning is a blessing in disguise for the learners to pursue their education without any hindrance especially during the pandemic.

Recommendations

The following recommendations can be followed by the teachers for effective employability of hybrid learning in their classrooms. They are

- Teachers should frame relevant subject/course to teach using hybrid model

- Instructional objectives and specific outcome of learning should be defined clearly for each course

- Proper interaction should be initiated among the learners so as to ensure smooth conduct of the course

- After the completion of discussion in the forum, the learners can come to their respective home groups which are well equipped with the texts

- Teacher training programmes should be organized by the educational institutions so as to enable them to use technology without any complexity.

Conclusion

Hybrid learning offers learners to resume their education irrespective of time and space. It enhances the technological skills among the teachers and learners. It provides teachers and learners to adapt and adopt emerging technologies so as to keep them updated which will in turn enable the learners to develop their technological competence. This research paper has offered opportunities to explore hybrid learning to be implemented for the betterment of the learners. Hybrid learning has turned the future of learning.

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Overcoming Victimization:
A Thematic Reading of the *Second-Class Citizen* by Buchi Emecheta

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ABSTRACT

Feminism strives for equal rights and opportunities for women in society. They aim to achieve equal opportunities and chances for women. It also expresses their views and ideologies. It is a political movement that insists on the equality of gender. The paper attempts a feminist analysis of the novel The Second-Class Citizen by Buchi Emecheta through Gynocritical lens of American literary critic, Elaine Showalter's Towards the Feminist Poetics. Here the protagonist Adah fights for her identity amidst the cultural barriers and dominating society. Feminism celebrates women who fight back oppression in the society and still raise voice for the dominated.

Keywords: Female identity, Oppression, Subjectivity

In every society, women are marginalised, but African women experience double marginalisation due to their gender and colour. They are isolated and rendered defenceless while experiencing physical and sexual torture. They are not permitted to discuss their viewpoint. Men's actions are never a problem, but when women speak up for justice, they are labelled as liars who harm society. Men exploit women for their personal gain and amusement, showing little concern or interest in their mental health. Women continue to be an unacknowledged part of the family and society from conception to death.

In the book *The Second-Class Citizen*, the narrator describes how African women's rights and desires are ignored in the home and in society. Adah, the main character, was a young, intelligent Nigerian woman. Her parents were disappointed by her delivery because everyone had been hoping for a male. No one bothered to record her birthdate because of the hostility. Adah is aware that women are disregarded in her community. After seeing her brother, Adah was eager to start school, but her parents and the wider community discouraged sending girls to school. Adah's mother wished for her to learn domestic skills like sewing. Adah was made to feel inferior to her brother as a result of this.

After the death of the spouse, African women were not permitted to live by themselves with their children. Adah's mother was forced to live with her uncle and work as an unpaid servant for them. Adah assisted her mother with housework as well. Adah witnessed her uncle's

kid receiving an excellent degree and landing a respectable job. She felt alienated from other male people.Adah was beaten heavily, when she hid two shillings for her entrance exam. Emecheta says that, "She began to see herself as another martyr… Meanwhile Cousin Vincent's anger increased; he caned her wildly, all over her body. After a hundred and three strokes, he told Adah that he would never talk to her again" (14). Adah managed to gain an education by being beaten with a cane by her uncle. She fights for her education instead than allowing victimisation to continue unopposed. Adah received funding for further education. She travelled alone to obtain an education because no one helped her. Here, Adah defies social conventions regarding women's education. Her uncle gave her the go-ahead to study so she could get a higher marriage price.

Adah began to make money after her marriage, but Francis was busy with his schoolwork. He didn't want to be supported by a woman's wage, so he asked her to quit her job. The family wanted Adah to work so she could fund her husband's sisters' education in addition to her own. Emecheta says, "But to him he was the male, and he was right to tell her what she was going to do" (19). They saw Adah as a money bearing machine and didn't want their son to work. Though Adah was helping the family financially, her feelings and desires were suppressed.

The critic Elaine Showalter divides feminine tradition into three distinct periods. They are the stages of the feminine, feminist, and female. Adah's life illustrates these three stages. Women initially strive to be on par with their male counterparts. Despite Francis' objections, Adah makes money and provides for her family. She is aware that unless she works, her necessities won't be met. As emphasised by Showalter, she treated males in her culture as equals and played her roles accordingly.

Adah wanted to visit the UK. While Francis was allowed to study in the UK, her in-laws did not want an African woman to work abroad. Francis did not take her desires or feelings into account. Adah's brother and uncle did not pay her a visit after her marriage. She felt completely alone in a world where no one was interested in her. "Nobody talked of who was going to support her, nobody talked of where she was going to live. So she found herself alone once more, forced into a situation dictated by society" (19).

Adah did not want to give up her dream for the rules of society. Adah tells herself, "Be as clever as the serpent but as harmless as the dove!" (13). She was adamant that she be allowed permission to travel to England. Francis pressured Adah to work in factories like their African neighbours because he was jobless. Adah, however, did not want to conform to the expectation that Africans should do menial jobs in the west. Adah was chosen as a senior library assistant,

which is a First-Class position, because she had a strong education and command of the English language. She overcomes the challenge of being a Second-Class citizen in the UK.Adah says, I did not bring my children into the world to be brought up by a women who can't even sign her name… If you want to really know, I brought my children here to save them from the clutches of your family, and God help me, they are going back as different people; never, never, are they going to be the type of person you are. My sons will learn to treat their wives as people, individuals, not like goats. (103)

Adah's neighbours suggest that she send her kids to a foster mother so they can learn the normative language and culture. Adah firmly believed that she should not raise her children. Adah doesn't want to give in to societal expectations. She has the guts to oppose the prevailing ideologies. Adah demonstrates to other women how to live their own lives and not rely on society and their families. When she was exhausted, Francis would call her lazy and remind her that he needed her money. He showed little support for Adah and her family.

Francis continued to attend classes but kept failing. Adah's income barely covered their rent, Francis's course, his books, and Adah's childcare costs. Vicky was admitted to the hospital one day with a viral illness, and Adah was upset to see Vicky in such poor condition. Francis was unconcerned about that circumstance. Adah was aware that Trudy, the native child care provider, had neglected Vicky and caused her illness. She was also aware of Francis' affair with Trudy. Despite crying in front of Francis, she went to Trudy and addressed her instead of staying in the background. Adah demonstrated that African women do not accept injustice without protest.

Women who reject the socially prescribed definitions of feminity are considered to be in the second phase of development, according to Showalter. Adah appears as a person who is not a victim to social mores. She disregards her neighbours who are from Africa. Adah worked as a First-Class citizen; unlike her neighbours, she did not place her children in foster care, and she included cake in her meals, which her neighbours did not like. Adah demonstrates to Trudy that African women will not keep silent in the face of injustice. She disagrees with the stereotypes of feminity that society has created.

Adah didn't have enough money to cover all of her expenses. Adah informed Francis that she would stop feeding him and supporting his education. He considers it dishonourable to comply with a woman's threats. Despite her physical infirmity, Adah wills herself to be strong enough to give birth to her fourth child. She resolves to confront the difficulties and challenges. She made an effort to stay away from negative people who were often critical of her. Francis was forced to work as a postal clerk by hunger. Adah has trouble covering her

expenses for food and childcare. She then considered penning a work for publication that is somewhat autobiographical.

Francis did not want Adah to be a writer. He said, "You keep forgetting that you are a woman and that you are black… to say nothing of brainless females like you who could think of nothing except how to breast-feed her baby"(144). This hurts Adah badly. One day when she was returning home, Adah was shocked to see that Francis had burnt all her manuscripts and hardwork. Francis showed her a triumphant smile and challenging face. Adah couldn't forgive him. Francis gave up his job. She readied to live in another flat with her children. Francis blamed her for not behaving like an African women. He says that,

In our country, and among our people, there is nothing like divorce or separation. Once a man's wife, always a man's wife until you dies… 'Yes', agreed Adah again, 'but … Can you, Francis, show me some vests or anything these children can lay their hands upon which you can claim to have bought for them? No, Francis you broke the laws of our people first, not me. (147,148)

The landlady had to contact the cops every day because of the sounds of fighting. She feared Francis would murder Adah. Francis was told by police to surrender her belongings. Adah was relieved to say goodbye to Francis and left with a fractured finger and swollen lips. Adah needs to earn extra money to support her family because she was unable to pay her daily costs. She felt that her rights were being denied to her when her spouse forbade her from being a writer.

Adah is tortured while Francis tracks down her new address. Later, he threatens her while carrying a knife. Adah makes a help request. Adah believed she needed his defence. In order to live in peace and protect her children and herself from harm, she filed for divorce. Francis was told by the magistrate to contribute for their kids.Adah felt no need of his help forever and said, "Don't worry sir. The children are mine, and that is enough. I shall never let them down as long as I am alive" (150). Adah's economic support and education helped her to take a strong decision.

Within this novel lie kernels of women empowerment amidst all challenges and the denials. This showcases the power of women's writing and the crucial role they can play in reshaping women's destiny. This is what Elaine Showalter says,

The analysis of women's literature, to develop new models based on the study of female experience, rather than to adapt male models and theories. Gynocritics begins at the point when we free ourselves from the linear absolutes of male literary history, stop trying to fit women between the lines of the male tradition, and focus instead on the newly visible world of female culture.

The study of gynocriticism is crucial to understanding Adah's life. The third phase in Showalter's book is called the Female, in which women look to their own experiences as the inspiration for independent creativity. They live as if it were their own, developing the self-assurance to take on obstacles. Adah succeeded in overcoming the hardships and restrictions placed on her by her husband and society, freeing herself from both men and society.

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Underground Railroad as a path towards Manumission in Colson Whitehead's *The Underground Railroad*

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ABSTRACT

In America, the Underground Railroad was a network that helped the runaways to escape from the horrible conditions of southern plantations to north where they can be free. It has rescued many slaves from their horrible lifestyle. Colson Whitehead's The Underground Railroad is a kind of historical document about the plight of the slaves in their plantation and their desire to get rid of the plantation. This novel focuses on rail transport system and secret routes with a lot of historical references recounting the sufferings of the victims of slave trade. This paper titled as "Underground Railroad as a Path to Manumission in Colson Whitehead's The Underground Railroad" aims to bring out how a slave named Cora, achieves her release from slavery.

Keywords: underground railroad, discrimination, domination, oppression, escape, freedom

Colson Whitehead, as an Afro-American novelist, focuses on slavery, racism, social norms and other incorporating elements of discrimination. Whitehead is best-known for his writing style and handling the themes at hand. People criticized his book as hybrid forms. He has won the Pulitzer Prize for his two novels *The Underground Railroad* and *The Nickel Boys*. His other fictional novels are *The Intuitionist, John Henry Days, Sab Harbor.* The term underground railroad is said to have appeared in the autobiographic work of Frederick Douglass in the year 1845. It has also appeared in Harriet Beecher's *Uncle Tom's Cabin* in the year 1852. The slaves travelled only in darkness. The conductor's journeys with the slaves were quite risky. Among others, Harriet Tubman (1822-1913) was a very famous black conductor in the projects of the underground railroad.

There was an assumption that the underground railroad was not operated in south. "The underground railroad- Caesar had been very busy. Did they really operate this deep in Georgia? The idea of escape overwhelmed her" (62). South region was mainly known for its white domination and the oppression of the slaves. Cora has never witnessed the outside world in her whole life. No one was allowed to escape from that area but the thought of escape lit up her face. Caesar's motivation and her inner feeling boasted her to escape from the plantation. "This was her first time out in the world and there was much she did not know. Her own vote was for

lighting out as soon as possible. Every mile between her and the plantation was a victory" (76). All she wanted is to run away from the plantation and that city. Right from their childhood, the slaves were trained to do works assigned by the masters. The slaves were ignorant that there is a beautiful world waiting out for them.

Whitehead described the Underground Railroad in a positive manner, calls it that God has created that for the slaves to make their way to the freedom. It is a big thing to escape from the plantation life. "There are so many people being moved around, one station at a time. It's hard to get messages through. The railroad is God's work, but maddening to manage" (109). Teaching the slaves was considered as illegal in certain states like Georgia and North Carolina. "She has come here to learn" (114). But Cora was blessed to receive education in South Carolina. In the plantation, Cora had nobody to share her emotions, her good and bad times. Her grandmother was dead, her mother left her and ran away from the plantation. "Royal turned over her palm and slid a thumb across her fresh calluses. No need to fret about that" (305). But in valentine farm she had Molly, Sybil and Royal to spend her happy moments. Royal comforted her when she was worried whether she would be put out of the farm. He has been her guide, gives support and encouragement. "We have a train leaving in one hour and another in six hours. Not the most convenient schedule" (81). The slaves had to make decisions quickly. The runaways should make use of their opportunities as soon as possible.

When Cora was a slave in the plantation, she never received wages for her work. They were not seen as workers by the masters. "The next day they set out in a buggy pulled by two piebald horses. With her wages she had bought a new dress and bonnet" (305). But on her way to freedom through underground railroad, she received wages for her hard work which was a booster for her. In Indiana, she bought a dress and bonnet with her own money. Moving away from the region where they were kept as slaves, seems to be a delightful thing to the slaves. "Away from here, that's all I can tell you" (81). They attained a sense of relief and happiness whenever they moved from one place to other with the help of the underground railroad. Even the smallest thing seems to be bigger achievement to them. The slave catchers and the masters did not want themselves to be lower than American slaves. After their escape the runaways hide themselves in secret places. So that the runaways could protect themselves from their predators. The escape of Cora was a success.

Martin helped the runaways to reach north. "Donald functioned as a human telegraph, relaying messages up and down the coast" (211). Besides the situation in North Carolina, Martin's father Donald had helped many runaways to attain freedom. Cora was extremely happy to be free in South Carolina. "She walked down the sidewalk as a free woman. No one

chased her or abused her. Some of Mrs. Anderson's circle, who recognized Bessie as her girl, sometimes even smiled" (104). Cora disguised herself as Bessie in order to lead a free life. There was no one to control her in South Carolina. Even some whites gave dignity to her which was never experienced by Cora in her entire life.

Everything on Valentine was the opposite. Work needn't be suffering, it could unite folks. A bright child like Chester might thrive and prosper, as Molly and her friends did. A mother raise her daughter with love and kindness. A beautiful soul like Caesar could be anything he wanted here. (325) The slaves were forced to complete their tasks in Georgian plantation. Every child was treated without any mercy. But in valentine farm everyone worked happily and the bond of daughter and mother increased. Mainly one could attain the feeling of freedom in that place. Through the underground railroad, only a small number of slaves traveled by the organized network of routes. "To escape the boundary of the plantation was to escape the fundamental principles of your existence: impossible" (9). Some African slaves of both sex of all ages tried to escape from the plantation and headed to North for freedom.

Most of the runaway slaves were young men who could withstand the hardships of fugitive life. "He suffered on his journey, delivering a pouty soliloquy on hunger, cold, and wild beasts" (188). Escaped slaves faced hardships in life, with little food, infrequent access to shelter or medical care, and the constant threat of local sheriffs, slave catchers or civilian lynch mobs. In South Carolina, slaves suffered in plantation and after escaping to North Carolina it is hard to tolerate the physical torture. The Emancipation proclamation freed the slaves, many men and women in bondage ran away from their masters to freedom. In the novel, slaves are escaped to the North from the masters and from their struggles. The aim of runaway fugitives are, North will give them shelter. Underground Railroad was not only a railroad but also a secret pathways for the enslaved people to escape. Whitehead wrote this novel, due to the childhood incident regarding the misunderstanding of underground railroad as an ordinary railroad.

According to the White's, antislavery literature is illegal system. Abolitionists and sympathizers who came from Georgia and Florida were run off, abused and feathered. "The slave catcher shared rumors of a new branch of the underground railroad said to be operating in the southern part of the state, as impossible as it sounded" (49). Randall plantation was considered to be very cruel and had severe restrictions for the people. There was no people who escaped from this plantation before as the fellow friends of the slaves has always betrayed them. The people in Randall plantation were not trustworthy. "Randall retained the services of a witch to goofer his property so that no one with African blood could escape without being

stricken with hideous play" (48). Randall a merciless man, who kept possession to avoid the African slaves to escape from his place. This was great confusion for the people whether this conjure apply only to the slaves who escaping from the plantation or for the coloured people too.

In Indiana, Cora place to live where she was free from the masters. In the plantation the slaves did not admire the beauty of land because they have undergone lots of struggles. '"Did you all have a pleasant day?" Gloria said when the room quieted. "I was down in the root cellar all day and then I come up to see what a gift God gave us today. That sky"' (296). Gloria who is working in the laundry of an indigo plantation felt it is good to see the sky. It gives them great pleasure. In North Carolina, Cora was out of imagination and she easily believed the false promises the South Carolina. "The entire farm was something beyond her imagination. The Valentines had performed a miracle. She sat among the proof of it; more than that, she was part of that miracle" (300).The farm in the North gave her miracle because it was out her imagination. In North, the walls were very large with gives terrific nature of the land but apart from this majestic appearance in out they enjoy the freedom of living.

The underground railroad is bigger than its operators it's all of you, too. "The small spurs, the big trunk lines. We have the newest locomotives and the obsolete engines, and we have handcars like that one. It goes everywhere, to places we know and those we don't. We got this tunnel right here, running beneath us, and no one knows where it leads" (319). While looking the running pathways they do not know where the railroad leads them. This railroad was the symbol of freedom. For these slaves, freedom was attained only by traveling this railroad.

In North, Cora underwent hard circumstances when it comes to the case of slave catchers. Violence is common in everywhere. "They fought and grappled in the violence of their fall" (361). But they fought to overcome those trouble. They raise against the dominators. After the struggles, Cora get rid of the place and escaped through the tunnel. No one told that this underground railroad was made by the men and women to escape. "I was in Georgia. I ran away". She said her name was Cora. She unfolded the blanket at her feet and wrapped herself in it. "I go by Ollie," he said. The other two wagons came into view around bend" (366).

The slaves looked for a way to live their dream life and underground railroad created a way for their deliverance. Nothing in this world is easy to attain, but with persistence it can be achieved. Many slaves attained immense happiness after their struggles. Cora, the protagonist attains her freedom through underground railroad. This historical evidence of journey towards freedom is one of the most innovative and successful liberation tactics.

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சங்க இலக்கியத்தில் மருத நில தாவரங்கள்

சி. ஆன்சி மோள்

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ஆய்வுச்சுருக்கம்

தமிழ் மொழியின் இலக்கியப் பரப்பில் காலத்தில் முற்பட்ட இலக்கியம் சங்க இலக்கியாகும். இச்சங்க இலக்கியம் எட்டுத்தொகை பத்துப்பாட்டு என்னும் இரு தொகுப்புகளாக அமைகின்றது. தமிழர்கள் இயற்கையுடன் இயைந்து பண்டுதொட்டே வாழ்ந்து வரும் சிறப்புக்குரியவர்கள். சங்க காலத்தில் தாவரங்களின் பங்களிப்பு முக்கியமானதாக இருந்திருக்கின்றன. இவற்றில் வயலும் வயலும் சார்ந்த இடமான மருத நிலத்தில் உள்ள தாவரங்களின் அமைப்பு இயற்கையின் அழகு இயல்பு கூறுகள், மருத்துவ பயன்கள் ஆகியவற்றை ஆராய்வதே இவ்வாய்வில் வெளிப்படுத்தும் நோக்கமாகும்.

முன்னுரை

மருதம் என்பது பண்டைத் தமிழகத்தில் பகுத்து அறியப்பட்ட ஐந்து வகைத் தமிழர் நிலத்திணைகளில் ஒன்றாகும். வயலும் வயலும் சார்ந்த இடம் மருதம் என அழைக்கப்படுகின்றன. இந்நிலத்திலுள்ள தாவரங்களான தாமரை, அல்லி, ஆம்பல், குவளை, செங்கழுநீர் ஆகியவற்றின் அமைப்பு, இயல்பு சிறப்புகளை பற்றி இக்கட்டுரையில் காண்போம்.

தாமரை

தாமரை மருத நிலத்தின் சிறந்த தாவராகும் தாமரையை கமலம் எனவும் சங்க இலக்கிய நூல்கள் கூறுகின்றன. இது நன்னீர்க் கொடியில் மலரக் கூடியது. தாமரை மலரைத் தெய்வ மலர் என்றும் கூறுவர். இதன் தாவரப் பெயர் 'நிலம்பியம் ஸ்பீசியோசம்' என்று அழைக்கப்படுகிறது.

சிறுபாணாற்றுப்படை தாமரையைத் தெய்வத் தாமரை என்று கூறுகின்றது. சிவ பெருமானுடைய விருப்பம் மருவிய செம்மையாகிய திருவடி தாமரை மலரைப் போன்றது என்று தாமரை மலரை உவமையாகக் கூறுகிறார் பாரதம் பாடிய பெருந்தேவனார்.

தாமரை ஒரு கொடி; நன்னீரில் வாழும். தாமரையின் தண்டு அது வளரும் சேற்றில் புதைந்திருக்கும். அதிலிருந்து இலைகளும் மலர்களும் நீண்ட காம்புகளைக் கொண்டு நீர்ப் பரப்பின் மேலே மிதந்து வளரும். இலைக்காம்பிலும் மலர்க்காம்பிலும் முட்கள் மலிந்திருக்கும். புலவர்கள் முள் நிறைந்த தாளையுடைய தாமரையை,

> "தாழை தவளம் முட்டாள் தாமரை (குறிஞ்சிப்பாட்டு - 80)
>
> "முள் அரைத் தாமரை – (சிறுபாணாற்றூப்படை – 144)
>
> "முட்டாட்டாமரை துஞ்சி – (திருமுருகாற்றுப்படை – 73)

தாமரையின் காம்புகள் நுண்ணிய துளைகளை உடையவை. இவற்றுள் காற்று நிறைந்திருக்கும். தாமரை மலரிதழ்களின் நிறத்தால் செந்தாமரை, வெண்டாமரை என இருவகை உள்ளன. செந்தாமரையின் அகவிதழ்கள் கருஞ்சிவப்பு நிறமாகக் கூறப்படுகின்றன.

> "மெல்லியல் மேவந்த சீறடித் தாமரை
>
> அல்லிசேர் ஆயிதழ் அரக்குத் தோய்ந்தவை போல்" (கலித்தொகை 13: 11-13)

வெண்மாமரையின் இதழ் நல்ல வெண்மை நிறமானது. இதனை முயல் காதிற்கு ஒப்பிடுவர்.

> "முள்ளரைத் தாமரை புல்லிதழ் புரையும்
>
> நெடுஞ்செவிக் குறுமுயல்" (பெரும்பாணாற்றுப்படை 114 – 115)

சேற்றில் வளரும் செந்தாமரை கதிரவனைக் கண்டு மலர்வது, ஐந்து புறவிதழ்களை உடையதும் அகவிதழ்கள் ஏறக்குறைய 20 முதல் 25 ஒரே மாதிரியாக இருக்கும். தாமரையில் நூற்றுக் கணக்கான அகவிதழ்கள் உண்டென்பர் புலவர்.

> "சேற்றுவளர் தாமரை பயந்த ஒண்கேழ்
>
> அலரின் நிரை கண் டன்ன
>
> வேற்றுமை யில்லா விழுத்திணைப் பிறந்து (புறநானூறு – 27: 1-3)
>
> "நூற்றிதழ்த் தாமரை" (ஐங்குறுநூறு – 20)

கதிரவன் தாமரையை மலர்த்தித் தனது வெப்பத்தை அதனுள் வைக்கிறது. மாலையில் பனி பெய்யுகின்ற போது தாமரை சுருங்குகிறது கதிரவனின் சிறு வெப்பம் உள்ளே பொதிந்திருந்து காலையில் மலராகி விரியும் போது மலரின் உட்புறத்தில் சிறிது வெப்பம் உண்டாகுமென்பது தாவர அறிவியல் உண்மையை சங்க புலவர் அறந்திருந்தனர். இதனை

> "……………………….. பனியே
>
> வாங்குகதிர் தொகுப்பக் கூம்பி ஐயென
>
> அலங்கு வெயிற் பொதித்த தாமரை
>
> உள்ளகத் தன்ன சிறுவெம் மையனே" (குறுந்தொகை 376: 4 - 6)

தாமரைக்குக் 'கமலம்' என்ற சங்கத் தமிழ்ப் பெயரும் உண்டு என்பதை,

> "மையில் கமலமும் வெள்ளமும் நுதலிய" (பரிபாடல் - 2:14)

திருமகள், கலைமகள், நான்முகன் முதலிய தெய்வங்கள் தாமரை மலரின் மேல் இடம் பெற்றனர் என்பர். மாந்தரின் உறுப்புகளான முகம், கை, கன்னம் முதலிய புறஉறுப்புகள் தாமரை மலருக்கு உவமையாக்கப்பட்டுள்ளன. இதயமும் தாமரை மொட்டுக்கு உவமிப்படுகிறது.

அல்லி – ஆம்பல்

இது மருத நிலத்தில் பூக்கும் இரு வித்திலைத் தாவரம். நிம்பயேசீ எனும் தாவரக் குடும்பத்தை சார்ந்தது. பலபருவ நீர்த்தாவரம், நீர்வாழ்க்கொடி என்பது இதன் தாவர இயல்பாகும்.

அருவி, ஓடை, பொய்கை முதலிய இடங்களிலும் நன்னீரிலும் வாழும் நீர்ச்செடி. தரையில் அதிலும் சேற்றின் அடிமட்டத்தண்டு எனப்படும் கிழங்கு இருக்கும். அதிலிருந்து சிறுவேர்கள் உண்டாகும். இதன் மேற்புறத்தில் தோன்றும் இலைக்காம்பின் நுனியில் இலைகள் காணப்படும்.

இதன் இலைகள் தனி இலை. முட்டை அல்லது வட்ட வடிவமானது. பசிய நிறம் உள்ளது. அடியில் அடர்ந்த உரோமம் உள்ளது. இலைக்காம்பு, நீளமானது. தூம்புடையது இதனைக் 'கால்' எனவும் 'தாள்' எனவும் இலக்கியங்கள் கூறுகின்றன. இதில் பல சிறிய நுண் துளைகள் உள்ளன. இவற்றுள் காற்று நிரம்பியிருக்கும்.

இதன் மலர்கள் அகன்று விரியும் இரு சமச்சீரானது. ஒழுங்கானது. பல இதழ்கள் அடுக்கடுக்காய் அமைந்துள்ளன. அல்லி மலர் பொதுவாக வெண்மையானது. இதனை,

> "ஒண் செங்காந்தன் ஆம்பல் அனிச்சம்" (குறிஞ்சிப்பாட்டு - 62)

"அயிரை பரந்த அம்தண் பழனத்து

ஏந்து எழில் மலர தூம்புடைத் திரள்கால்

ஆம்பல் குறுநர்." (குறுந்தொகை. 178: 1 - 3)

"பொய்கை பூத்த புதைக் காலாம்பல்" (ஐங்குநுறூறு 34:2)

"புறங்கால் ஆம்பல் அகல் அடை" (புறநானூறு 266:3)

என்பனவற்றால் தமிழர் ஆம்பலின் இலைக்காம்பிலும் பூக்காம்பிலும் உள்ள தூம்புதனை அறிந்திருந்தனர் என்பது புலலாகிறது.

ஆம்பலின் பூக்காம்பை ஒடித்து மணிமாலை போலாக்கி மகளிர் வளையலாக அணிவர் என்பதனை,

"ஆம்பல் வள்ளித் தொடிக்கை மகளிர்" (புறநானூறு 63:12, 352:5)

என்ற பாடல் வரி விளக்குகிறது.

குவளை – செங்கழுநீர்

மருத நிலத்தில் பூக்கும் இன்னொரு தாவரம் குவளை – செங்கழுநீர் ஆகும். இதன் தாவரப் பெயர் நிம்பேயா ஸ்டெல்லேட்டா என்று குறிப்பிடப்பட்டது. குவளை என்பது பொதுவாகச் செங்குவளையாகும். இதனை செங்கழுநீர் எனவும் நிலோற்பலம் எனவும் கூறுவர்.

"தண்கயக் குவளை" (குறிஞ்சிப்பாட்டு 63)

"பெரும்பல் குவளைச் சுகும்புபடு பன்மலர்" (மதுரைக்காஞ்சி:566)

"குளிர்ந்த குளத்தில் பூத்த செங்கழுநீர்"

என்று கூறினார் நச்சினார்க்கினியர் 'குவளை' என்பதைச் 'செங்கழுநீர்' என்று புறநானாற்று உரை கூறுகிறது.

"……………….. பெருந்துறை

நீர்தரு மகளிர் குற்ற குவளையும்" (புறநானூறு 42:16)

மேலும், செங்குவளையாகிய செங்கழுநீர் மலரை மகளிரது கண்களுக்கு உவமிப்பது புலவரின் மரபாக இருந்தது என்பதை

'பசலை யார்ந்தரும் குவளையங் கண்ணே' (குறுந்தொகை: 13:5)

"கண்போல் பூத்தமை கண்டு நுண்பல்

சிறுபா சடைய நெய்தல்" (நற்றிணை 27: 9 - 10)

இதன் அரும்பு சிவந்த நிறமுடையது என்பதை குவளைக்குப் 'பறியாக் குவளை' என்றொரு சிறப்பு உண்டு.

"கடவுள் கற்சுனை அடையிறந் தவிழ்ந்த

பறியாக் குவளை மலரொடு" (நற்றிணை 34: 1-2)

குவளை மலரின் மணத்தைத் தலைவியின் கூந்தல் கொண்டிருக்கும் என்பதை

"குவளை நாறுங் குவையிங் கூந்தல்" (குறுந்தொகை – 300)

செங்குவளையாகிய செங்கழுநீர் மலரைச் சிவபெருமானுக்குரிய மலராகப் போற்றும் மாணிகவாசகர்,

"கழுநீர் மாலைக் கடவுள் போற்றி" (திருவாசகம் 4:217)

குவளைச் செடிக்கு அடியில் வேருடன் கூடிய கிழங்கு உண்டு என்பர். இதனை அடிமட்டத்தண்டு என்பர் தாவரவியலாளர். புலவரும் கிழங்கின் துணை கொண்டு இச்செடி நீர் வற்றிப் போனாலும் அழிவதில்லை என்பர்.

"நீர் கால் யாத்த நிறை இதழ்க் குவளை

கோடை ஒற்றினும் வாடாதாகும்." (குறுந்தொகை – 388)

குவளையின் இலைகளும் மலர்களும் நீண்ட காம்புடையன. குவளை காம்புகள் கொண்டு மகளிர் கைகளில் காப்புகளாக அணிவர்.

"பவள வளைசெறிந்தாட் கண்டு அணிந்தாள்

குவளைப் பசுந்தண்டு கொண்டு

கல்லகாரப் பூவால் கண்ணி தொடுத்தாளை

நல்லிகா என்பாள் போல் நெய்தல் தொடுத்தாளே

மல்லிகா மாலை வளாய்" (பரிபாடல் 11: 101-105)

குவளை மலர்கள் இலை மட்டத்திற்குச் சற்று உயர வளர்ந்து பூக்கும் இயல்பின. இதனை நற்றிணைப் பாடல்.

"கடவுட் கற்சுனை அடையிறந் தவிழ்ந்த

பறியாக் குவளை மலரொடு" (நற்றிணை 1 - 2)

என்ற வரிகளின் மூலம் அறிய முடிகிறது.

முடிவுரை

தமிழரின் ஐவகை நிலங்களில் வயலும் வயலும் சார்ந்த இடமான மருதநிலத்திணையில் உள்ள தாவரங்களின் தன்மைகள், வளரும் இடம் இயல்புகள் சிறப்பியல்புகள், பயன்கள், முக்கியத்துவம் முதலியவற்றை மேலே கூறிய கருத்துக்கள் மூலம் அறிய முடிகிறது

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9. நக்கீரர், இறையனார் அகப்பொருள் உரை. சைவ சித்தாந்த நூற்பதிப்புக்கழகம் பிரகாசம் சாலை, சென்னை – 1.

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ஆய்வுச்சுருக்கம்

பிள்ளைத்தமிழ் சிற்றிலக்கியத்தின் தன்மையை மிகைப்படுத்தும் இலக்கியமாகும். பிள்ளைத்தமிழ் நூல்கள் பத்துப் பருவங்களைக் கொண்ட சிற்றிலக்கியமாகும். பிள்ளைத்தமிழ், ஆண்பால் பிள்ளைத்தமிழ் பெண்பால் பிள்ளைத் தமிழ் என இரண்டு வகைப்படும். ஆண்பால் பிள்ளைத் தமிழ் காப்பு, செங்கீரை, தால், சப்பாணி, முத்தம், வருகை, அம்புலி, சிற்றில், சிறுபறை, சிறுதேர், எனப் பத்து பருவங்களாகப் பாடப் பெறும். பெண்பால் பிள்ளைத்தமிழ் காப்பு, செங்கீரை, தால், சப்பாணி, முத்தம், வருகை, அம்புலி, கழங்கு, அம்மானை, ஊசல் எனப் பத்துப் பருவங்களாகப் பாடப்பெறும். குழந்தையின் மூன்றாம் மாதம் முதல் இருபத்தோராம் மாதம் முடிய மாதங்களுள் சிறந்த (3, 5, 7, 9, 11, 13, 15, 17, 19, 21) ஒற்றைப்படை எண்களாக அமைந்த பத்து மாதங்களையும் காப்பு முதலிய பத்துப் பருவங்களாக வகுத்துக் கொண்டு பாடுவது பிள்ளைத்தமிழ் என்னும் இலக்கியத்தின் மரபாகும். பிள்ளைத்தமிழ், பெரும்பான்மையாக, ஒவ்வொரு பருவத்திற்கும் பத்துப் பத்துப் பாடல்கள் வீதம் பாடப்பெறுவது ஆகும். இது குழந்தைப் பருவத்தைத் தலைமையாக வைத்துப் பாடப்பெற்றிருந்தாலும் பாட்டுடைத் தலைவரின் வீரச் செயல்கள், சிறந்த குணங்கள் முதலியன புகழப் பெற்றிருக்கும்.காப்புப் பருவம் குழந்தை பிறந்த மூன்றாம் மாதத்தில் பிள்ளையைக் காப்பதற்காக திருமால், சிவபெருமான், உமையம்மை, பிள்ளையார், கலைமகள், அரிகரபுத்திரன், பகவதி, காளி, ஆதித்தர், முப்பத்து முக்கோடி தேவர்கள் ஆகிய தெய்வங்களைப் பாடி வணங்குவதாக அமைந்துள்ளது. பகழிக்கூத்தர் திருச்செந்தூரில் வீற்றிருக்கும் முருபெருமானை உவகையுடன் போற்றி இப்பிள்ளைத் தமிழ் இலக்கியத்தைப் படைத்தருளினார். தெய்வங்கள் எவ்வாறு முருகப்பெருமானைக் காத்து நின்றன என்பதே இக் கட்டுரையின் ஆய்வுப் பொருளாகும்.

முன்னுரை

சிற்றிலக்கியங்களுள் பிள்ளைத்தமிழ் இலக்கியமும் ஒன்று. பிள்ளைத்தமிழ் என்பது, தெய்வத்தையோ மக்களுள் சிறந்தவர்களையோ குழந்தையாக எண்ணி அவரின் பெருமைகளைச் செய்யுளில் புகழ்ந்து பாடுவதாகும். காப்புப் பருவம் என்பது, திருமால் முதலாக பல்வேறு தெய்வங்களை வேண்டி குழந்தையைக் காக்குமாறு பாடுவது ஆகும். இது குழந்தையினுடைய மூன்றாம் மாதத்தில் நிகழ்வதாகக் கருதப்படுகிறது. இக்கட்டுரையில் திருச்செந்தூர் முருகனைக் குழந்தையாகப் பாவித்து பகழிக் கூத்தர் பாடும் திறனை ஆய்வு செய்யலாம்.

திருமால்

இனிமையும் சிறப்பும் அழகும் செழுமையும் கொண்டுள்ள செந்தாமரையில் வீற்றிருக்கும் நான்முகனைப் படைத்ததுடன் அவனுடன் இயற்கையையும் படைத்து, அதில் படைக்கப்படும் உயிர்கள் அத்தனையும் தழைத்து வளரும் அளவுக்குத் தானே வழிவகை செய்யும் அளவினையுடையவனாக இருந்தும் அருள்செய்து காக்கக் கருதி ஒப்பற்ற சங்கினையும் சக்கரத்தையும் கைக்கொண்ட பெருமாளாகிய திருமாலே,

"தேமா மலர்ப்பெற்ற செழும்பொருட்டுச்

செந்தா மரையில் வீற்றிருக்கும்

தேவைப் படைத்துப் படைக்குமுதல்

சேரப் படைத்துப் படைக்கும் உயிர்

ஆமா நளவுக் களவாகி

அனைத்தும் தமைக்கும் படிகருதி

அளிக்கும் படிக்குத் தனியேசங்கு

ஆழி படைத்த பெருமாளே." (திரு.பிள்:1)

புவிமகள் வீற்றிருப்பதும் சிறந்த மணப்பொருள்கள் விளங்குவதும் மலை போன்றதும் ஆகிய தோள்களையுடைய இந்திரனால் போற்றப்படுபவனும் ஆகாய வெளியினது உச்சியில் வாழும் தேவனால் துதிக்கப்படுபவனும் பொதிகை மலையில் வாழும் அகத்தியராகிய சிறந்த முனிவருக்குத் தமிழ்மொழியைக் கற்பித்த ஆசிரியனாக விளங்கியவன் நீ. முழங்கும் கடலுக்கு மேற்கேயுள்ள திருச்செந்தூரில் குடிகொண்டிருக்கும் முருகப் பெருமானைக் காத்தருள்வீராக என்று திருமாலிடம் வேண்டுகிறார்.

சிவபெருமான்

கந்தன், இனிமையாக ஒலிக்கும் மிகுதியான வரிவண்டுகள் முழங்கி இடறச்செய்த கலவைச் சாந்தும் குங்குமப் பொடியும் நிறைந்த நீர் ஒழுகும் பருத்த கொங்கைகளும் வேட்கையும் எழுமாறு, குறவர் குலத்து அழகியான வள்ளியம்மையின் மனத்தில் உறைபவன். இடிபோன்ற முரசுகள் முழங்க எதிர்த்துப் போர்செய்த அரக்கர் படைக்குப் போர்க்களத்தில இடமில்லாமல் செய்து முதிய பேய்கள் நடனமிடும் படி அரக்கர்களைக் கொலை புரியும் வலிமையுள்ளவன். மத நீரைச் சிந்தும் பெரிய யானை முகக் கடவுளான கணபதிக்குக் கருணையே வடிவான தம்பி. பார்வதியின் கையாகிய மலரணையில் கண்துயின்று மழலைச் சொல் பேசும் மைந்தன். பூக்கள் மிகுந்த மணம் வீசும் கற்பக மரத்தின் நிழலில் அரசு புரியும் இந்தரனின் மகள் தெய்வானையின் கணவர்.கலைமகளின் குமரன். அவனைக் காப்பதற்காக சிவபெருமானுடைய மணம் மிகுந்த இரண்டு திருவடிகளையும் வணங்குகிறோம். சிவபெருமான் இளைய பிறைச் சந்திரனும், கங்கை நதியும் பாம்பும் வளரும் சிவந்த சடையை உடையவர். உமையம்மையின் கணவர். சிறந்த சொற்களால் வணங்கும் சிவனடியார்களைக் காத்தவர். சிவபெருமானை நோக்கி குழந்தையைக் காக்க இறைஞ்சுகின்றார்.

உமையம்மை

திருச்செந்தூரில் எழுந்தருளிருக்கும் வேலவன் சிறுவனுக்குரிய பதினெண் கணங்களும் நான்கு வேதங்களை ஓதும் முனிவர்களும் வீடுபேறு அடைவதற்கு நின் திருவடிதான் உறுதி வாய்ந்தது என்று எண்ணுகின்றனர்.ஆகையால் நாள்தோறும் நாவெடுத்து ஓதி, உள்ளம் மிக மகிழ்ந்து, சிவந்த கைகளினால் மலர்களைத் தூவி வணங்கி, 'எம்மை அடிமையாக உடையவனே அஞ்சற்க என்று எமக்கு பாதுகாப்பு அளித்து நீ எம்மைக் காத்தருள்வாயாக' என்று வேண்ட அவர்களைக் காத்தளித்த நட்பினையுடையவன். விண்மீனின் உச்சி அதிர்ந்து ஆகாயங்களும் அரிய பேரண்டமும் பிளக்குமாறு தோகையை உதறும் மயிலை ஊர்தியாக உடையவன். உபநிடத மந்திர தந்திரங்களில், வெளிப்படாமல் உள்ளே செபிக்கும்

அம்சமந்திரத்தில் அடங்கும் ஐம்புலன்களில் தோன்றியெழும் மகிழ்ச்சி மிகுதியாகும் மனோகரக் கூத்தன்.

> "உடுமுகடு அதிர்ந்து விண்த லங்களும்
>
> அரியபகி ரண்ட மூம்பி எந்திட
>
> உதறுதோகை மயூரனைத் தோற்ற முற்றெழும்
>
> உபநிடத மந்திர தந்தி ரந்தனில்
>
> அசபையில் அடங்கும் ஐம்பு லன்களில்
>
> உவகை கூரும னோகரக் கூத்தனை" (திரு.பிள்:4)

போர் செய்யும் பகைவர் நெருங்கும் சிவந்த போர்க்களம் புகுந்த அரக்கரை வெட்டி வீழ்த்திய கொடிய போர்க்களத்தைத் தழுவும் பாடல் பெற்ற விசாகன். பாற்கடல் எனத்தகும் வெண்மையான பற்களையும் செவ்வரி கலந்த கரிய விழியையும் கொண்ட இலக்குமி போன்றவளும் குறக்குடியில் தோன்றியவளுமான வள்ளியம்மையை மணம் புரிந்த வலிய தோளாகிய மலையும் அழகிய மார்பும் கொண்டவன். இலையோடு இதழும் நிறைந்து தழைந்த முகையானது உடைந்து விரிந்து தோன்றிய புதிய தேன் சிந்தும் பசுமையான கடம்பமலரை அணிந்த புதுமையும் குளிர்ச்சியும் கொண்ட அழகன். இமயமலை அடிவாரத் தடாகமான சிறந்த சரவணப் பொய்கை விளங்கவந்த கந்தன். போரை விரும்பும் முருகன். ஆவனைக் காத்தருள்வதற்காக முறைமுறையாக முழங்குகின்ற சதங்கையும் சிலம்பும் ஒலிப்பதும் அன்றலர்ந்த தாமரை மலரைப் போன்றதுவும் ஆகிய உமையம்மையின் சிவந்த திருவடிகள் வாழ்கவெனப் போற்றி வணங்குவோம்.

பிள்ளையார்

ஆறுமுகங்களையுடைய முருகன், இம்மை மறுமைப்பயனை அடைய உதவும் மேலான சைவ சமயத்தையும் தேவர் உலகத்தையும் காத்தளித்த களிப்பினையுடையவன். இசையை எழுப்பும் வண்டுகள் தத்தம் பெடையோடு முறையாகக் கூடியதால் அரும்பு மலர்ந்த வெட்சியைப் போன்ற வனப்பையுடையவன். போர்புரியும் மிகுந்த அரக்கர் குலத்தை அளித்தவன். என்னை வழிவழி அடிமையாகக் கொள்ளும் நட்பையுடையவன். தேவர்களும் தம் திருவடியைத் தொழுமாறு, அரிய வேதங்களை உரைத்த பிரமனை அரக்கர் சிறையினின்றும் மீட்ட திறமையுடையவன். அடியவர்களுடைய கொடிய வினைகள் தூளாகுமாறு நடனமிடும் அழகிய பாதங்களை அடியவர்களுக்கு அளிக்கும் வரங்களைக் கொடுப்பவன். குறமகளாகிய வள்ளிநாயகியாரின் அழகில் மயங்கியிருப்பவன். அலைவீசும் அழகிய நகரான திருச்செந்தூரில் விரும்பி வீற்றிருக்கும் குமரன். அவனை நாள்தோறும் காப்பாற்றுவதற்காக, பிள்ளையார் செவிகளில் புகழ் மொழிகளை நிறுத்தி அவரைப் போற்றுவோம். பிள்ளையார், அன்பினாலே தன்னை வழிபட்ட முதியவளான ஒளவையாரை ஒரு முறை தன் துதிக்கையால் எடுத்து உயர்ந்த கயிலை மலையில் கொண்டுவிட்ட தன்மையையுடையவர். வடக்கேயுள்ள பெரிய மேரு மலைமீது குருகுல மன்னர்களான கௌரவ பாண்டவர்களின் கதையாகிய பாரதத்தை எழுதி முடித்தவர்.

"கருணையின் வழிபடு முதியவள் தனையுயர்

கயிலையில் ஒரு முறை உய்த்த விதத்தினர்

கனவட கிரிமிசை குருகுல மரபினர்

கதைதனை எழுதிமு டித்த கருத்தினர்". (திரு.பிள்:5)

கலையோடு கூடிய சந்திரனை இரண்டு பிளவாகப் பிளந்து ஒருபக்கத்தே ஒளி வீசுமாறு செய்தவர். நஞ்சுண்ட சிவபெருமானே வலமாக வந்து நன்கு பழுத்த கனியைக் கவர்ந்த நுட்பமான அறிவில் மிகுந்தவர். ஒப்பற்ற இமயமலையில் விரும்பி வீற்றிருக்கும் பெண் யானை போன்ற உமாதேவி பெற்றெடுத்த போர்செய்யும் களிறு என்று சொல்லுமாறு போர் புரிந்தவர். கொத்தாக மலர்ந்த மணம் பொருந்திய மலரணையின் மீது தமது உடலில் மயிர்க்கூச்செறியும்படி மகிழ்ச்சி பெறுவதற்குரிய சக்தியைத் தரித்தவர். தனக்கே உரிய ஒளியான மாணிக்கம் போல ஒளிவிட்டு அழகுறத் திகழும் பவளமும் மதிக்கும்படியான பவள நிறங் கொண்டவர். புள்ளிகளுடைய முகத்தையுடையவர். குடம் போன்ற வயிற்றினைக் கொண்டவர். இத்தகைய பிள்ளையாரிடம் திருச்செந்தூர் பிள்ளையைக் காப்பாற்ற வேண்டுகிறார்.

கலைமகள்

பழைமையான மேட்டு நிலத்தின்மீது கடல்நீர் பாயுமாறும் செய்தவன். நஞ்சு நிறைந்த மாணிக்கம் பொருந்திய ஆதிசேடன் என்னும் பாம்பின் தலை நசுங்கும் படியும், மந்தரமலை தன் நிலை அழியும் படியும் செய்தவன். கழன்று வீசும் காற்றை எல்லாவிடங்களிலும் சிதற வீசுகின்ற சிறகுகளைக் கொண்ட மயிலை ஊர்தியாக உடையவன் முருகப்பெருமான்.இதனை

"உவரி முதுதிடர் பாயவி டம்பொதி

உரகன் மணிமுடி தூள்பட மந்தரம்

உலைய ஏறிசுழல் மாருதம் எங்கணும்

உதறு சிறைமயில் வாகனன்."

இவ்வாறு பாடுகின்றார். மேலும்

"கவரில் வரிவளை சூல்கொடு தாங்கிய

கமட முதுகினில் ஏறநெ டுந்திரை

கதறு கடலலை வாய்முரு கன்பெறு

கருணை தருகவி மாலைவி எங்கவே." (திரு.பிள்:6)

வெடிப்பில் தங்கியுள்ளதும் சூல்கொண்டதுமான ஆமையினது முதுகின்மீது வரிகளையுடைய சங்கு ஏறுமாறு நீண்ட அலைகளை வீசுவதும் ஒலிப்பதுமாகிய கடலையுடைய திருச்சீரலைவாய் என்னும் தலத்தில் அவன் இன்பங்கொண்டு எழுந்தருளியுள்ளான். அம்முருகன் பெறுவதும் அவனது அருளைத் தருவதுமான திருச்செந்தூர்ப் பிள்ளைத் தமிழாகிய கவிமாலை நன்கு விளங்குவதற்குக் கலைமகளுடைய சிலம்பணிந்த திருவடிகளை வணங்குவோம்.

அரிகரபுத்திரன்

நான்கு வேதங்களாலும் நாள்தோறும் உறுதியாக வாழ்த்தப்படுபவனும் உவமையோடு கூடிய ஆசுகவி முதலான கவிகளைப் படுவதற்கு அருள் செய்யும் நாவலனும் முதிர்ந்து வளர்ந்த

பருத்த வாளைமீன் துள்ளிக் குதிக்கும் கடல் சூழ்ந்த நகரான திருச்செந்தூர்க்குத் தலைவனும் ஆன பழநி வேலனைப் புகழ்ந்து பாடும் பாமாலையாகிய இப்பிள்ளைத் தமிழ் நன்கு தழைத்துச் சிறக்கச் செய்தவர். அரிகரபுத்திரர் கட்டமைந்த நீண்ட சடையில் கிரீட கூட்டம் அணிந்தவர். வளைந்த நீண்ட கருப்புவில்லில் மலர் அம்பைத் தொடுத்தவர். அழகு மிகுந்த சிறந்த பூரணை புட்கலை என்னும் இரண்டு பெண்களையும் தன் இரண்டும் பக்கங்களிலும் இருத்தி மகிழ்ச்சி அடைபவர். அப்படிப்பட்ட அரிகரபுத்திரருடைய திருவடிகளை விடாமல் பற்றிக்கொண்டு முருகனுக்காக வணங்குவோம்.

பகவதி

கடலானது வருத்தும் பெரிய அலைகளை வீசும். இருள் போன்று கருமையானது. பேரொலி செய்யும். உவர்ப்பு நீங்காதது. மகர மீன்களைக் கொண்டது. அக் கடல் வற்றி மேடாகுமாறு வேற்படையை உறையிலிருந்து எடுத்து, அரக்கராகிய களையைக் களைந்து, அணிகலன்களை அணியும் இந்திராணியின் மங்கல நாணைக் காத்தவன் முருகன். அவன் வேகமாக செல்லும் மயிலை ஊர்தியாக உடையவன். அம் முருகன் மகிழ்த்து எனது கவிமாலையாகிய பிள்ளைத்தமிழை ஏற்று அருள் செய்ய, பகவதியின் தாமரை மலர் போன்ற திருவடிகளை வணங்குவோம். அப் பகவதி, அரும்பு விரிந்து செழுமையான தேன் ஒழுகும் வெண்டாமரை மலரில் வீற்றிருக்கும் பிரமனது முடிசூடிய தலையைக் கிள்ளி எறிவதற்குக் காரணமாக அமைந்தவள். கொடிய கொலைத் தன்மை கொண்ட சிங்கத்தின் மீது ஏறி, வளைத்து குளிர்ச்சி பொருந்திய பிறைச்சந்திரனைப் போன்ற கொம்பும் சிறிய கண்ணும் கொண்ட பெரிய மயிடாசுரன் தலையில் வலிய நடனம் புரிந்த குமரி.

> "வெங்கொலை மடங்கல் ஏறி
> வளையும் பனிப்பிறை மருப்புக் குறுங்கண்நெடு
> மயிடாசுரன் சிரத்தில்
> வலியநடம் அடுகுமரி பகவதி." (திரு.பிள்:8)

முருகன் மகிழ்ந்து எனது கவிமாலையாகிய பிள்ளைத்தமிழை ஏற்று அருள் செய்ய, பகவதியின் தாமரை மலர் போன்ற திருவடிகளை வணங்குவோம் என்கின்றார்.

காளி

ஆய்வு செய்யப்படும் சிறந்த பாடல்களான ஆசுகவி, மதுரகவி, அருமையான சித்திரகவி, வித்தாரகவி ஆகியவை கொடுக்கும் முடிவுகளுக்கு மனம் கலங்காதபடி அடியவர்களுக்கு அருள்செய்பவன் குருபரன்.

> "ஆயும் பெரும்பனுவல் ஆசுகவி மதுரகவி
> அரியசித் திரகவிதை வித்
> தாரகவி இடுமுடிப் புக்குள மயங்காமல்
> அடியவர்க்கு அருள் குருபரன்." (திரு.பிள்:9)

குளிர்ச்சி பொருந்திய பிறைச்சந்திரனைப் போன்ற அழகிய நெற்றியையுடைய நெய்தல் நில மகளிர், தெளிந்த முத்துக்களைக் கொழித்துச் சிற்றில்கட்டி விளையாடும் திருச்செந்தூரில்

வீற்றிருக்கும் வீரன் அக் குருபரன். அவனது புகழைப் பாடுவதற்காக காளிதேவியின் திருவடித் தாமரைகளை நினைப்போம். காளி சினக்கும் கொடிய பகையான தாருகாசுரனைக் கொன்றவள். மண்டையோடுகளை மாலையாக அணிந்தவள். எலும்புகளை மாலையாக அணிந்தவள்.அவள் நீலி. மூன்று கண்களையுடையவள். எட்டுத் தோள்களையுடையவள். அவள் மாதிரி, வீரி, கௌரி. மானை வாகனமாக உடையவள். அவள் கன்னி. நெருப்புப்புகை பரவும் பாலைநிலத்தேவி. கொடுமையும் சிறந்த அழகும் உடைய பாம்புகளைக் கொண்டவள்.அவள் மோடி (வனக்காளி). மழுப்படையை ஏந்திய சிவபெருமானுடன் நடனம் ஆடும் சூலி மற்றும் சாமுண்டி.

> "காயும் கொடும்பகைத் தாருக விநாசினி
>
> கபாலிகங் காளிநீலி
>
> காளிமுக் கண்ணிளண் தோளிமா தரிவீரி
>
> கவரிகலை யூர்திகன்னி
>
> பாயும் தழற்புகைப் பாலைக் கிழத்திவெம்
>
> பண்ணம் பணத்திமோடி
>
> பரசுதரன் உடன்நடனம் இடுசூலி சாமுண்டி" (திரு.பிள்:9)

ஆதித்தர்

திருச்சீரலைவாய் என்னும் திருச்செந்தூரில் எப்பொழுதும் மனமகிழ்ச்சியோடு வரிகளையுடைய வண்டுகள் இசைபாடும். அன்னம் நடனமிடும். முள் நிறைந்த வாயும் உள்ளே குடம் போல வளைந்து இருக்கும். வலம்புரிச் சங்கு முத்துக்களை ஈனும்.நீர் ஓடையில் நாரைகள் காணப்படும். கள்ளம் நிறைந்த கரிய கண்ணையும் சிவந்த வாயையும் வெண்மையான பற்களையும் கொண்ட பெண்களான உழத்தியரும் நுளைச்சியரும் மனமகிழ்ச்சி மிகுவர்.

> "உள்ளக் களிப்பற வரிவண்டு பண்பாட ஓதிமம் நடிக்க முன்வாய்
>
> உட்குடக் கூன்வலம் புரிமுத்தம் உமிழ்நீர் ஓடையிற் குரகு காணக்
>
> கள்ளக் கருங்கட் சிவந்தவாய் வெண்ணகைக் சடைசியர் நுளைச்சியருளாம்
>
> களிகூரும் அலைவாய்." (திரு.பிள்:9)

வெண்மையான அலைகளின் ஊடே மூழ்கி நீரைப் பெரிய பெரிய துளிகளாக வாரி இறைக்கும் பெருங்காற்றைப் போல ஏழு கொடிய குதிரைகளைப் பூட்டியிருப்பதும் ஒற்றைச் சக்கரத்தையுடையதும் ஆகிய பெரிய தேரின்மீது ஏறி, வேதத்தை மேற்கொண்ட வேதியர் வணங்க, ஆழமான கடல் அலைகளைக் கலக்கி, ஊழிக் காலத்தின் இருட் படலத்தை முழுவதும் போக்கி, படரும் ஒளியை விரிவாக்கி வருபவர்கள் அச்சூரியர்கள்.

> "வெள்ளிப் பெருந்துளி இறைக்கும் பெருங்காற்று
>
> வெண்டிரையின் மூழ்கியேழு
>
> வெம்புரவி ஒற்றையா மித்தடந் தேர்ஏறி
>
> வேதபா ரகர் இறைஞ்சப்
>
> பள்ளக் கடல்திரை கலக்கியூ மியின் இருட்
>
> படலம்முழு தும்துடைத்துப்
>
> படர்சுடர் விரித்துவரு பன்னிரு பதங்கர்" (திரு.பிள்:9)

அத்தகைய திருச்செந்தூரை விரும்பிய வேலவனை எங்கள் கந்தனைக் காப்பாற்றுவீராக என்று பன்னிரண்டு சூரியர்களின் அழகிய திருவடி மலர்களைத் தலைமீது சூடுவோம்.

முப்பத்து முக்கோடி தேவர்கள்

முருகன், அம்பலத்தில் ஆடுபவரும் ஊமத்தம்பூ மாலையை அணிந்தவருமாகிய சிவபெருமானுக்குப் பெரும் பொருளை ஓதி உபதேசித்தவன். கடல்படியும் நகரான திருச்செந்தூருக்கு உதவியாளன். புலமைக்கும் நீதிக்கும் ஒப்பற்ற நண்பன். மழலை மொழிபேசும் பாலகன். குருதிக் கறை படிந்த ஒளிவீசும் வெற்றியைத் தருவதாகிய வேற்படையையுடையவன். குறக்குடியிற் பிறந்த பெண்ணான வள்ளிநாயகியின் இன்பத்திற்கு மோகம் கொண்டவன்.

> "பொதுவில் ஆடும் மத்தற்கு நீடு
> 　　பொருளை ஓதி ஒப்பித்த சீலர்
> புணரி தோய்ந்த கர்க்குச்ச காயர்
> 　　புலமை நீதி ஒப்பற்ற கேள்வர்
> குதலை வாய்மொ ழிச்சத்தி பாலர்
> 　　குருதி பாய்க திர்க்கொற்ற வேலர்
> குறவர் பாவை சொர்க்கத்தின் மோகர் குமரர்." (திரு.பிள்:10)

அத்தகைய முருகனைக் காப்பதற்கு ஏற்ற காவலர்கள் முப்பத்து முக்கோடி தேவர்களே. அத்தகைய தேவர்கள், இனிமையான கீதம் பாடுவதிலும் கல்வியிலும் வல்லவர்கள். சடைமுடியில் மகுடம் அணிந்தவர்கள். முத்துக்களைப் பதித்த மேலாடையர். மௌனமான முனிவர்கள். மயிலையுடைய முருகனிடத்தில் அன்புள்ளவர்கள். மனைவியோடு வாழும் வாழ்க்கையில் பற்று வைத்தவர்கள். பழமையான சொற்களைப் பேசும் நாவினையுடையவர்கள். முனிவர்கள் செய்யும் வேள்வியை விரும்புவர். உணவில் விருப்புள்ளவர்கள். முடிவிலாத கற்பகாலத்தின் ஊழி முதல்வர்கள்.

> "மதுர கீத விற்பத்திவாணர்
> 　　மகுட வேணி முத்துத்த ரீகர்
> மவுன மோனர் பத்திக்க லாபர்
> 　　மனையில் வாழ்வு வைப்புற்ற நேயர்
> முதுமை யான சொற்பெற்ற நாவர்
> 　　முனிவர் வேள்வி இச்சிக்கும் ஊணர்
> முடிவிலாத கற்பத்தின் ஊழி
> 　　முதல்வர் தேவர் முப்பத்து மூவரே" (திரு.பிள்:10)

அத்தகைய திருச்செந்தூரை விரும்பிய வேலவனை எங்கள் கந்தனைக் காப்பாற்றுவீராக என்று முப்பத்து முக்கோடி தேவர்களின் திருவடிகளில் மலர்களைச் சூடி வணங்குவோம்.

முடிவுரை

பிள்ளைத்தமிழ் இலக்கியத்தின் முதல் பருவம் காப்பு பருவம் ஆகும். அதன்படி திருச்செந்தூர் பிள்ளைத்தமிழின் முதல் பருவம் காப்பு ஆகும். இதில் திருமால், சிவபெருமான்,

உமையம்மை, பிள்ளையார், கலைமகள், அரிகரபுத்திரன், பகவதி, காளி, ஆதித்தர், முப்பத்து முக்கோடி தேவர்கள் ஆகிய தெய்வங்களை நோக்கி பாலகனாம் முருகனை காத்தருளுமாறு ஆசிரியர் வேண்டுகிறார். மனிதர்கள் பொதுவாக தங்கள் நலன் வேண்டி இறைவனிடம் முறையிடுவது வழக்கம். ஆசிரியர் முருகனை குழந்தையாக பாவித்து தெய்வங்களிடம் முறையிடுகிறார். திருச்செந்தூர் முருகனை வழிபட்டால் கல்வி, செல்வம், ஆயுள், நிலபுலம், நன்மக்கள்பேறு அனைத்தையும் அடையலாம் என்ற நம்பிக்கை இன்றளவும் உள்ளது. தன்னுடைய வயிற்றுவலியைப் போக்கிய முருகன் அனைவருக்கும் நலமே அருளுவான் என்ற நம்பிக்கையுடன் பகழிக்கூத்தர் பாடியுள்ளார். காப்பு பருவத்தில் அவர் ஒவ்வொருவராக அழைத்து மூன்று மாத குழந்தையைப் பாதுகாப்பதற்காக வேண்டுவது அவரின் பக்தி மிகுதியையே காட்டுகின்றது. பக்தியால் இறைவனையே குழந்தையாக்கி குழந்தைக்காக ஒவ்வொரு இறைவனிடமும் வேண்டுவது அவரின் அளவிடமுடியா பக்தியை வெளிப்படுத்துவதாக உள்ளது.

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ACKNOWLEDGMENTS: Collate acknowledgments in a separate section at the end of the article before the references. Information concerning research grant support, assistance of colleagues or any other notes of appreciation should appear in this section.

8. REFERENCES: The references should be cited in the text in square brackets e.g. [1] not in superscript or subscript. Ensure that every reference cited in the text is also present in the reference list and vice versa. Only appropriate references should be cited.

9. REFERENCE FORMAT:

1. Reference to a journal publication:
I. Kumar A., Choudhary P., Verma P. A comparative study on the treatment methods of textile dye effluents. Global J. Environ. Res. 2011; 5: 46 - 52.
II. Reference to a book:
1. Strunk W., White E.B. The elements of style. 3rd ed. New York: Macmillan; 2005.

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