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# BIOMIMETIC SYNTHESIS AND CHARACTERIZATION OF SILVER NANOPARTICLES (AGNPS) USING *VINCA ROSEA* AQUEOUS EXTRACT

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## ABSTRACT

Biomimetic route for the synthesis of silver nanopartilces with using biological source play a very important role in nanotechnology without any harmful chemical. The present study deals with the synthesis of silver nanopartilces by treating silver nitrate with aqueous extract *Vinca rosea* at room temperature. The effect of the *Vinica rosea* aqueous extract on the formation of silver nanopartilces was characterized by UV-visible spectroscopy (UV-Vis), X-ray Diffraction Spectrum (XRD), Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Analysis (EDX). The UV spectra results show a strong resonance centre and surface of silver nanopartilces (AgNPs) at 461 nm. XRD and SEM studies revealed that the synthesized AgNPs shows spherical in shape with average particles size around 30- 70 nm.

**Keywords:** *Vinica rosea*, AgNPs, SEM, XRD, UV-Vis, EDX.

## 1. INTRODUCTION

In the modern material science, nanotechnology plays a remarkable role with its eminent salient features such as manipulating nano-scale structures, engineering of atoms and designing of materials with improved properties (Jain *et al.,* 2009). Nano-scale particles with size range of 1-100 nm and different shapes were commonly synthesized either by top-down or bottom-up strategies. At present development of reliable green chemistry route to synthesis nanoparticles is essential for their potential applications in diverse fields, specifically in biology and medicine (Narayanan and Sakthivel, 2011). The nanoparticles are synthesized through physical, chemical and biological methods (Chen *et al*., 2008). The physical and chemical methods are extremely pricey (Li *et al*., 1999). The biological methods of nanoparticles synthesis would assist to remove ruthless processing conditions, by allowing the synthesis at physiological pH, temperature, pressure, and at the same time, at negligible cost. Huge number of micro organisms have been found competent of synthesizing inorganic nanoparticles composite, either intra or extracellularly. Ranjithkumar *et al*. (2013) reported plant extract based silver nanoparticles and achieved good antibacterial activity against human pathogens. Due to implausible properties, nanoparticles have turned into noteworthy in many fields in the recent years, such as energy, health care, environment, agriculture, etc. (Raveendran *et al*., 2003).

On other hand, nanotechnology is now creating a growing sense of excitement in the life sciences especially biomedical devices and Biotechnological applications (Prabhu *et al*., 2010). It has been reported that silver nanoparticles (SNPs) are non-toxic to humans and most effective against bacteria, virus and other eukaryotic micro-organism at low concentrations and without any side effects (Jeong *et al*., 2005). Moreover, several salts of silver and their derivatives are commercially manufactured as antimicrobial agents (Krutyakov *et al*., 2008). Sharma *et al.* (2009) report suggested in small concentrations, silver is safe for human cells, but lethal for microorganisms**.** Antimicrobial capability of silver nanoparticles allows them to be suitably employed in numerous household products such as textiles, food storage containers, home appliances and in medical devices (Marambio-Jones *et al*., 2010). The objectives of this study were to synthesize silver nanoparticles using *Vinca rosea* aqueous extract.

## 2. MATERIALS AND METHODS

### *2.1. Materials*

The chemical silver nitrate ($AgNO_3$) was purchased from SD Fine Chemical Pvt. Ltd., Mumbai.

### *2.2. Plant material*

The leaf of *Vinca rosea* was collected from Coimbatore district, Tamilnadu, India. The plant was identified *Vinca rosea* at the Department of Botany,

Kongunadu Arts and Science College, Coimbatore, Tamilnadu, India.

*2.3. Preparations of the extract*

The leaf of *Vinca rosea* (*V. rosea*) was collected from Coimbatore district, Tamilnadu, India. The *V. rosea* plant leaf was washed with tap water followed by rinsed with distilled water thoroughly to remove dust and other any attached particles. The *V. rosea* aqueous leaf extract was prepared by taking 15g of thoroughly washed and finely cut *V. rosea* leaves in a 250 ml Erlenmeyer flask with 100 ml of sterile distilled water and then boiled the mixture for 30 min at 60°C to obtain bioorganic compounds from *V. rosea* leaves. Followed by this step, after heating treatment, the solution was then removed from the heat source and left at room temperature and obtained aqueous extract was then filtered through a normal filter paper followed by Whatman filter paper No. 1. The final filtrate of the *V. rosea* leaf extract was used as a reducing agent to synthesis biomimetic silver nanoparticles.

*2.4. Synthesis of silver nanoparticles*

The aqueous solution of silver nitrate ($AgNO_3$) at concentration of 1mM was prepared to synthesize biomimetic silver nanoparticles from aqueous extract of *V. rosea* leaf. In details, 500ml of aqueous solution of at the concentration of 1mM silver nitrate solution was added to 25 ml of *V. rosea* aqueous leaf extract while stirring for reduction into silver ions and the reaction mixture was kept at room temperature for 24-48h. The formation of dark brown colour was observed after suitable incubation time at room temperature and *lambda* max was taken using UV-Visible spectroscopy (JASCO V-670). Then the biomimetic silver nanoparticles solution was purified by repeated centrifugation at 6,000 rpm for 20 min to isolate pure biomimetic silver nanoparticles free from other bioorganic compounds that present in the reaction mixture. After centrifugation the obtained particles were several time washed with distilled water for 10 to 20 min and kept it in Hot air oven for drying at 50˚C for 3h to obtain powder form of silver nanoparticles.

*2.5. Characterization Techniques*

*2.5.1. UV-Visible spectroscopy*

Formation of maximum production of biomimetic silver particles after 48h incubation at room temperature the reaction mixture was confirmed by the colour change of the solution and the surface plasmon resonance band was obtained by UV-Visible spectral analysis which was done by using UV-Visible spectrophotometer (JASCO, V-670) from 300-800 nm at a resolution of 1 nm.

*2.5.2. X-ray Diffraction spectrum*

X-ray diffraction (XRD) measurement of the biomimetic synthesized silver nanoparticles which were carried out using X'Pert Pro X-ray diffractometer (PAN analytical BV, The Netherlands) equipped with Cu/Kα radiation source using Ni as filter at a setting of 30kV/30mA. All X-ray diffraction data were collected under the standard experimental conditions in the regular angular range. The crystalline silver nanoparticles was calculated from the width of the XRD peaks, using a Debye-Scherer formula,

$$D = \frac{0.94\lambda}{\beta\cos\theta}$$

Where D is the average crystallite domain size perpendicular to the reflecting planes, λ is the X ray wave length, β is the full width at half maximum and θ is the diffraction angle.

*2.5.3. Scanning Electron Microscopy*

The reaction solution containing silver nanoparticles synthesis using *V. rosea* aqueous leaf extract was centrifuged at 6,000 rpm for 20 min. The supernatants were discarded and the final pellets were dissolved in 1ml of deionized water. The pellet was mixed properly and carefully placed on a glass cover slip followed by air-drying. The cover slip itself was used during scanning electron microscopy (SEM) analysis. The images of biomimetic silver nanoparticles were obtained in a SEM (Fb-Quanta 200 SEM machine) at different magnification level.

*2.5.4. Energy-dispersive X-ray (EDX) analysis*

The synthesized silver nanoparticles using *V. rosea* aqueous leaf extract subject to the Energy dispersive spectrum using SEM attached Fb-Quanta-200 resolution to confirm the presence of silver in the particles as well as to detect other elementary compositions of the particle.

## 3. RESULTS AND DISCUSSION

A wide range of metabolites are presented in the plant extracts, nanoparticles produced by plants are more stable and the rate of synthesis is faster in comparison to other biological sources such as microorganisms. Thus, the advantages of using plant and plant derived materials for biosynthesis of metal nanoparticles have instigated researchers to investigate mechanisms of metal ions uptake and bioreduction by plants, and to understand the possible mechanism of metal nanoparticles

formation in and by the plants (Naheed and Seema, 2012). In the present study the aqueous silver nitrate solution was reducing during exposure to the *V. rosea* (Fig. 1) plant leaf aqueous extract at 24-48h incubation at normal room temperature.

**Fig. 1. The leaf of *Vinca rosea***

The colour of the reaction mixture changed from glow yellow to dark reddish brown after 48h incubation at room temperature which indicates the formation of silver nanoparticles using *V. rosea* leaf aqueous extract. It is well known that silver nanoparticles exhibit dark brown colour in water due to excitation of surface Plasmon vibration in metal nanoparticles (Abhishek *et al.*, 2014). Control (without silver nitrate) shows no colour change, when the *V. rosea* leaf aqueous extract with aqueous silver nitrate solution when incubated at 24-48h showed reddish brown colour this indicated the synthesis of silver nanoparticles (Fig. 2) due to present of bioactive compounds in aqueous extract of *V. rosea* leaf responsible for the reduction of silver nitrate to silver nanoparticles (Ranjithkumar *et al.*, 2013). The different type of antioxidant and phytochemical are present in *V. rosea* plant extract, these phytochemical are responsible for the reduction of silver ions (Jayakumar *et al.*, 2010).


**Fig. 2. Visual appearances of flask containing the aqueous extract of *V. rosea* leaf and $AgNO_3$ solution after 48h reaction time**

a) aqueous extract of *V. rosea* leaves b) 1mM $AgNO_3$ c) reaction mixture $0^{th}$ min incubation d) reaction mixture after 48h incubation at room temperature. The change of colour is an indication of the production of biomimetric silver nanoparticles.

*3.1. UV-visible spectroscopy analysis*

Formation of silver nanoparticles (AgNPs) by reduction with silver nitrate ($AgNO_3$) by aqueous extract of *V. rosea* leaf after 48h incubation samples were characterized by using UV-Visible spectroscopy (JASCO-V/670) and this technique has proved to be very useful for the analysis of biomimetric silver nanoparticles formation in the reaction mixture. In the UV-Vis absorption spectrum, a strong, broad peak located between 420 to 471 nm was observed (Fig. 3). UV-Visible spectra also revealed that formation of AgNPs occurred rapidly within the 48 hours only and the AgNPs in solution remained stable even after 48 hour of completion of reaction. The similar type of the silver nanoparticles peaks were reported in Geranium leaf extract (Shankar *et al.*, 2003), aqueous extract of areca nut (Ranjithkumar *et al.*, 2013) and pomegranate peel extract (Shanmugavadivu *et al.*, 2014). In this present study, the synthesized silver nanoparticles (AgNPs) were shown characteristic peak at 461 in visible light regions.

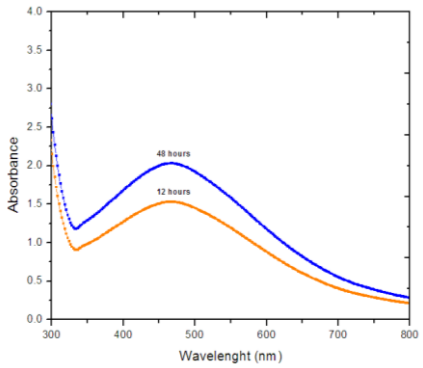


**Fig. 3. Absorption spectrum of AgNPs synthesized by aqueous extract of *Vinca rosea.***

*3.2. XRD analysis*

Fig. 4 shows the X-ray diffraction spectrum of biomimetric synthesized AgNPs. The Braggs reflections were observed in the XRD pattern at 2θ =32.27, 46.25, 59.60 and 78.69 These Braggs reflections clearly indicated the presence of (200), (202), (311) and (402) sets of lattice planes and further on the basis that they can be indexed as face-centered-cubic (FCC) structure of silver. (Debabrat *et al.,* 2012) reported that the XRD pattern green synthesized silver nanoparticles showed number of Braggs reflections that may be indexed on the basis of the face centered cubic structure of silver. Since, the present study clearly indicated the x-ray diffraction pattern of biomimetic synthesized silver nanoparticles formed crystalline in nature. Additional as yet unassigned peaks were also observed and suggesting that the crystallization of

bioorganic phase occurred on the surface of the nanoparticles (Zuzer and Hemlatta, 2012).

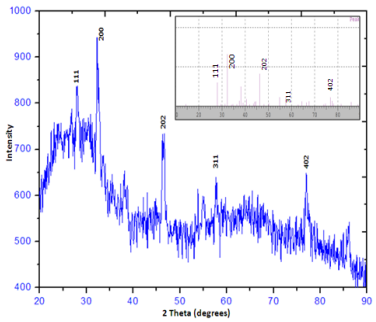


**Fig. 4. X-ray diffraction spectrum of silver nanoparticles synthesized by aqueous extract of *V. rosea* leaf.**

*3.3. SEM image*

The morphology of nanoparticles was determined by scanning electron microscope. The image of scanning electron microscopic of aqueous extract *V. rosea* plant leaf medicated biomimetric synthesized AgNPs shows high aggregation of silver particles on the surface of the cell. The XRD and SEM analysis revealed that the green synthesized silver nanoparticles were shown spherical in shape with particles size below 40-80 nm in diameter. The larger silver nanoparticles may be due to the high aggregation of the smaller ones. This may be due to availability of different quantity and nature of bioorganic compounds present in the aqueous extract of *V. rosea* leaf. Fig. 5 shown different magnification scanning electron microscopic images of biomimetric synthesized silver nanoparticles using *V. rosea* leaf extract. Previous observations indicated that the plant phytochemicals may be responsible for bioreduction of $Ag^{+}$ to $Ag^{0}$ and subsequent formation of silver nanoparticles, the obtained AgNPs shown spherical in shape with high aggregation (Ranjithkumar *et al*., 2013; Shanmugavedivu *et al*., 2014).

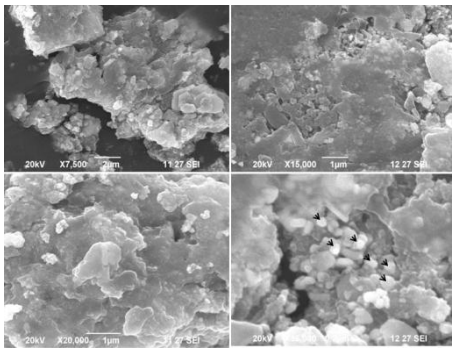

**Fig. 5. SEM image of biomimetic synthesized AgNPs**

*3.4. EDX analysis*

Energy-dispersive X-ray spectroscopy (EDX) is an analytical technique used for the elemental analysis or chemical characterization of a sample. In this present study, the element analysis of the biomimetic synthesized AgNPs was performed using EDX spectrum (Fig. 6). The EDX spectrum of spherical in shape with high aggregation of silver nanoparticles on the surface of the cell prepared with this bioreduction method using *V. rosea* shown maximum peaks around 3.28 keV correspond to the binding energies of silver ions. Throughout the scanning range of binding energies, some addition peaks belonging to bioorganic compound present in the reaction mixture. The EDX analysis revealed strong signals in the silver region and confirms the formation of silver nanoparticles by using biological source. There were other EDX spectrum peaks for Cl, Si, O and Ca suggesting that they are mixed precipitates present in the plant extract (Usha and Gladys, 2014).

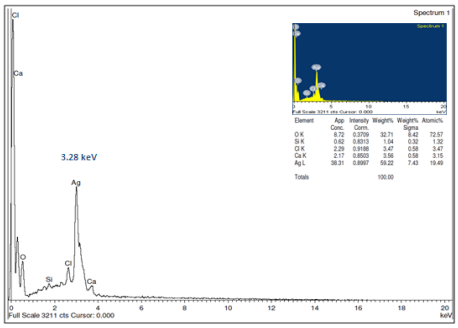


**Fig. 6. EDX spectrum of prepared AgNPs using *V. rosea* at room temperature.**

## 4. CONCLUSION

A simple and environmental free green route was used to synthesis AgNPs from silver nitrate using aqueous extract of *Vinca rosea* leaf. The effect of the Vinica rosea aqueous extract on the formation of silver nanopartilces after 48 incubation showed reddish brown colour. From UV-Vis spectrum indicated the synthesized AgNPs were shown characteristic peak at 461 in visible light regions. From XRD and SEM studies revealed that the synthesized AgNPs shows spherical in shape with average particles size round around 30- 70 nm. From the present work the aqueous extract of Vinca rosea leaf was appropriate for synthesis silver nanopartilces at room temperature.

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# GREEN SYNTHESIS OF SILVER NANOPARTICLES USING GRAVIOLA LEAF AQUEOUS EXTRACT AT ROOM TEMPERATURE

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## ABSTRACT

Improvement of green route for the synthesis of silver nanoparticles with plant extracts plays a very important role in nanotechnology without any harmful chemicals. The present investigation demonstrates the synthesis of silver nanoparticles by treating silver nitrate with Graviola leaf extract at room temperature. The effect of the extract on the formation of silver nanoparticles was characterized by UV-Vis spectrum, Fourier transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD) and Scanning electron microscopic (SEM) analysis. The UV-Vis spectra results show a strong resonance centered on the surface of silver nanoparticles (AgNPs) at 400-450 nm. The Fourier transformation infrared spectroscopy spectral study demonstrates Graviola leaf aqueous extract acted as the reducing and stabilizing agent during the synthesis of silver nanoparticles. XRD and SEM studies revealed that the synthesized silver nanoparticles shows spherical in shape with average particles size around 30-70 nm.

**Keywords**: Silver nanoparticles, Graviola leaf, aqueous extract.

## 1. INTRODUCTION

Nanoparticles are of great scientific interest as they effectively bridge between bulk material and atomic or molecular structure. The two principles ways of preparing nanoscale materials are "Bottom up" and "Top down" approaches. In bottom up approach, materials and devices are built from molecular compounds which assemble themselves using the principle of molecular. In top down approach, nano objects are constructed from larger entities without atomic level control, when we bring constituents of materials down to nanoscale. Nanotechnology finds wide range of applications such as medicine, information technologies, biotechnologies, energy production and storage, material technologies, manufacturing instrumentation, environmental application and security (Wang and Xia, 2014). In biological science, many applications of metal nanoparicles are being explored including labels for cells and biomolecules and cancers therapies among noble metals nanoparticles, silver nanoparticles have received considerable attention due to their attractive physiochemical properties. Silver nanoparticle reserve important role in the electronic industries and they also exhibit remarkable size effect in biological and medicine related properties (Protima *et al*., 2015). Basically most of the physical and chemical methods used to synthesis of nano material are too expensive and also involve the use of toxic, hazardous chemicals that are responsible for various biological risks. It is very important to develop ecofriendly processes through green route and other biological approaches using microbes, enzymes and plant materials (Ranjithkumar *et al*., 2013). The present study deals with synthesis of silver nanoparticles from green route using Graviola plant leaf aqueous extract at room temperature.

## 2. MATERIALS AND METHODS

### *2.1. Materials*

The chemical silver nitrate ($AgNO_3$) was purchased from SD Fine Chemical Pvt. Ltd., Mumbai.

### *2.2. Plant material*

**Fig.1: The leaves of Graviola collected from Kannur district, Kerala.**

The leaf of Graviola (*Annona muricata*) was collected from Kannur district, Kerala, India. The plant was identified *Annona muricata* common name Graviola (Fig. 1) at the Department of Botany, Government Arts College, Ooty, Tamilnadu, India.

*2.3. Preparations of the extract*

The Graviola plant leaf was rinsed with distilled water thoroughly to remove dirt and other attached particles. The Graviola aqueous leaf extract was prepared by taking 5g of thoroughly washed and finely cut Graviola leaf in a 100 ml Erlenmeyer flask with 50 ml of sterile distilled water and then boiled the mixture for 5 min. The solution was then removed from the heat source and left at room temperature. Following this step the extract was then filtered through a normal filter paper followed by Whatman filter paper No. 1. The extract was kept in refrigerator at 4˚C for further experiments.

*2.4. Synthesis of silver nanoparticles*

The aqueous solution of silver nitrate ($AgNO_3$) at concentration of 0.002 M was prepared to synthesize silver nanoparticles from aqueous extract of Graviola leaf. 50 ml of aqueous solution of 0.002M $AgNO_3$ was slowly added to 10 ml of Graviola aqueous leaf extract while stirring for reduction into Ag ions. The formation of dark brown colour was observed after 1h incubation at room temperature and *lambda* max was taken using UV-Visible spectroscopy (JASCO V-670). Then the silver nanoparticles solution was purified by repeated centrifugation at 6,000 rpm for 30 min to isolate Ag nanoparticles free from other bioorganic compounds present in the reaction medium. After centrifugation the obtained particles were washed with distilled water for 5 to 10 min and kept it in Hot air oven for drying at 100˚C for 1 h.

*2.5. Characterization techniques*

*2.5.1. UV-Visible spectroscopy*

Formation of silver particles (after 1h incubation at room temperature) was confirmed by the colour change of the solution and the surface plasmon resonance band was obtained by UV-Visible spectral analysis which was done by using UV-Visible spectrophotometer (JASCO, V-670) from 300-700 nm at a resolution of 1 nm.

*2.5.2. Fourier transform infrared spectrum (FTIR)*

After 1 hour incubation the silver nanoparticles were isolated by repeated centrifugation and 100˚C for 1 h. The obtained dried silver nanoparticles were subjected to Fourier transform infrared (FTIR) spectrum analysis in the range from 4,000 to 400 $cm^{-1}$ on IR-Tracer-100 shimadzu FT-IR spectrophotometer.

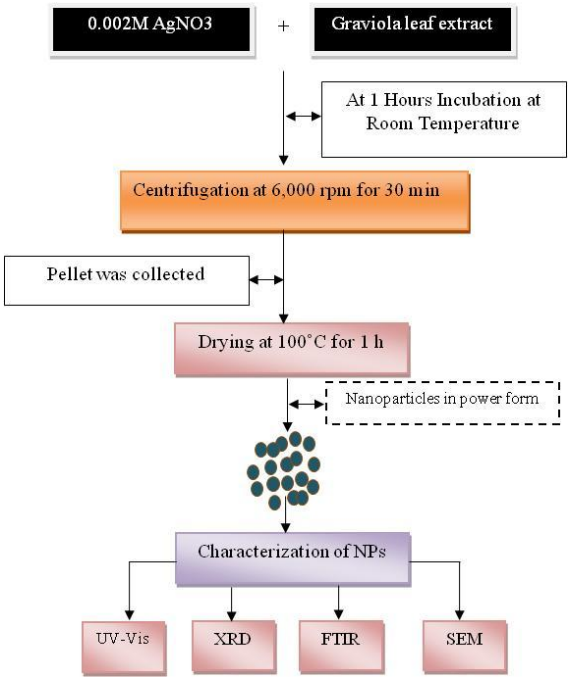
*2.5.3. X-ray Diffraction spectrum*

X-ray diffraction (XRD) measurement of the green synthesized using Graviola aqueous leaf extract reduced silver particles was carried out using X'Pert Pro X-ray diffractometer (PAN analytical BV, The Netherlands) equipped with Cu Kα radiation source using Ni as filter at a setting of 30kV/30mA. All X-ray diffraction data were collected under the experimental conditions in the regular angular range.

The crystalline silver nanoparticle was calculated from the width of the XRD peaks, using a Debye-Scherer formula,

$$D = \frac{0.94\lambda}{\beta\cos\theta}$$

Where D is the average crystallite domain size perpendicular to the reflecting planes, λ is the X ray wave length, β is the full width at half maximum and θ is the diffraction angle.




*2.5.4. Scanning Electron Microscopy*

Each of the colloidal solution containing silver nanoparticles was centrifuged at 6,000 rpm for 30 min. The supernatants were discarded and the final pellets were dissolved in 1000µL of deionized water. The pellet was mixed properly and carefully

placed on a glass cover slip followed by air-drying. The cover slip itself was used during scanning electron microscopy (SEM) analysis. The images of silver nanoparticles were obtained in a scanning electron microscope (Fb-Quanta 200 SEM machine). The details regarding applied voltage, magnification used and size of the contents of the images were implanted on the images itself.

## 3. RESULTS AND DISCUSSION

Aqueous Silver nitrate solution was reducing during exposure to the Graviola leaf aqueous extract. The colour of the reaction mixture changed from pale yellow to reddish brown after 1 hour incubation at room temperature (Fig. 2) which indicates the formation of silver nanoparticles. It is well known that silver nanoparticles exhibit dark brown colour in water due to excitation of surface Plasmon vibration in metal nanoparticles. Control (without silver nitrate) shows no colour change with aqueous silver nitrate solution when incubated at same condition Control showed pale yellow colour solution with culture filtrate and Silver nanoparticles showed Dark brown colour solution after 1 hours of inhibitions. Shanmugavadivu *et al*. (2014) reported that the green synthesis of silver nanoparticles using pomegranate fruit peel extract to the aqueous solution of the silver nitrate the colour of the reaction medium changed rapidly from coloreless to brown.

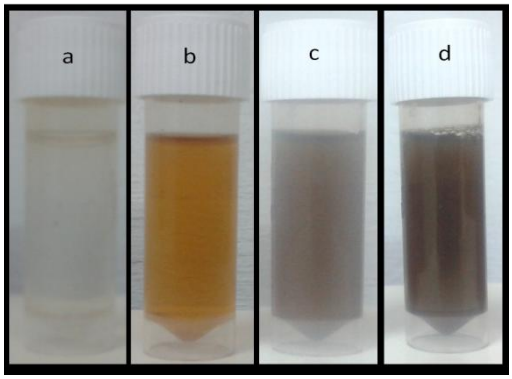



**Fig. 2. Visual appearances of vials containing the aqueous extract of Graviola leaf and $AgNO_3$ solution after 1h reaction time**

a) 0.002 M $AgNO_3$ b) aqueous extract of Graviola leaf c) reaction mixture 5 min incubation d) reaction mixture after 1h incubation at room temperature. The change of colour is an indication of the growth of silver nanoparticles.

### *3.1. UV-Visible spectroscopy analysis*

Formation of silver nanoparticles (AgNPs) by reduction with $AgNO_3$ (Silver nitrate) by aqueous extract of Graviola leaf samples were characterized by UV-Visible spectroscopy at 5 min interval time (JASCO-V/670) and this technique has proved to be very useful for the analysis of silver nanoparticles formation. In the VU-Vis absorption spectrum, a strong, broad peak located between 440 to 460 nm was observed (Fig. 3). UV-Visible spectra also revealed that formation of AgNPs occurred rapidly within the first 10mins only and the AgNPs in solution remained stable even after 1 hour of completion of reaction. Metal nanoparticles such as gold and silver have free electrons, which give rise to surface plasmon resonance absorption band. Biogenic synthesis areca nut aqueous extract medicated silver nanoparticles showed the surface plasmon resonance peak observed at 414 nm (Ranjithkumar *et al*., 2013).

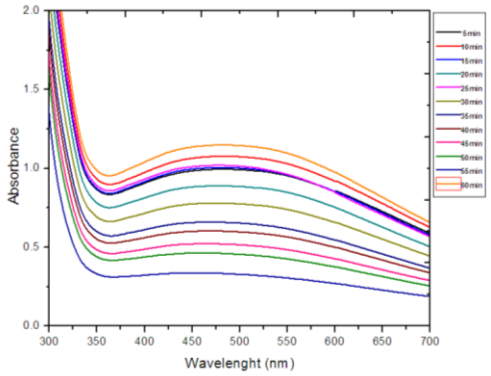



**Fig. 3. Absorption spectrum of silver nanoparticles synthesized by aqueous extract of Graviola leaf**

### *3.2. Fourier transform infrared spectrum (FTIR) analysis*

The presence of some functional groups as revealed by FTIR spectral analysis is shown in Fig. 4. The FTIR spectral analysis of aqueous extract of Graviola leaf reduced silver nanoparticles showed shape absorbance peak at 1219.01, 1365.60, 1635.64 and 3371.57 $cm^{-1}$ assigned to C–O stretching vibration of alcohols, carboxylic acids, esters, ether, alkanes and N–H bending vibration of primary and secondary amines or amides. On other hand, synthesized silver nanoparticles showed light absorbance peak at 2152.56, 2183.42 and 2646.34 $cm^{-1}$ assigned to –C≡C– stretching vibration of alkynes, C–H stretching vibration of aldehydes and C≡N stretching vibration of nitriles. The amine and alkynes groups present in the sample this may be responsible for the reduction and capping of silver nanoparticles Vanaja *et al*. (2014) reported that the functional biomolecules are hydroxyl, carboxylic, phenol, and amine group in *M. tinctoria* leaf extract

involved in the reduction of silver ions which was confirmed by FTIR spectrum. Moreover, in the present study indicated, the FTIR spectrum revealed various functional groups present at different position.

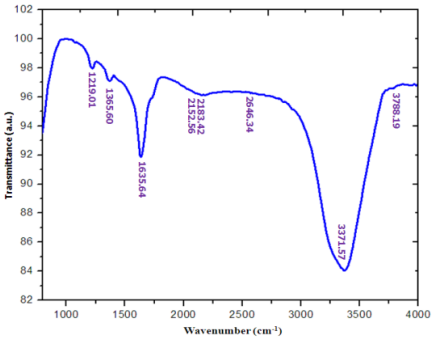



**Fig. 4. FTIR spectrum of silver nanoparticles synthesized by aqueous extract of Graviola leaf.**

*3.3. X-ray Diffraction spectrum (XRD) analysis*

Fig. 5 shows the X-ray diffraction spectrum of silver nano particles synthesized from aqueous extract of Graviola leaf at room temperature. The Braggs reflections were observed in the XRD pattern at 2θ = 27.32, 32.4 and 46.4 These Braggs reflections clearly indicated the presence of (111), (200) and (402) sets of lattice planes and further on the basis that they can be indexed as face-centered-cubic (FCC) structure of silver. Hence XRD pattern thus clearly illustrated that the silver nanoparticles formed in this present synthesis are crystalline in nature and the average size of nanoparticles around 30-70 nm. Additional as yet unassigned peaks were also observed and suggesting that the crystallization of bioorganic phase occurred on the surface of the nanoparticles. The noise due to the protein shell surrounding the nanoparticles is visible from the spectrum.

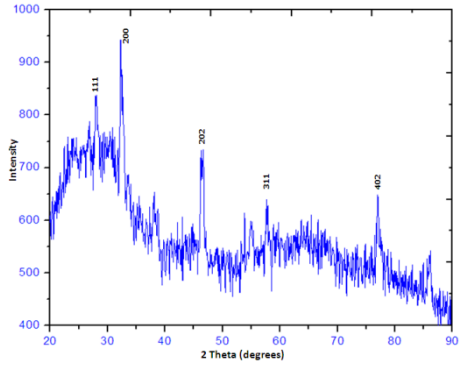



**Fig. 5 X-ray diffraction spectrum of silver nanoparticles synthesized by aqueous extract of Graviola leaf.**

*3.4. Scanning electron microscope (SEM) analysis*

The morphology of silver nanoparticles was determined by scanning electron microscope. SEM image of Graviola leaf medicated biosynthesized silver nanoparticles shows uniformly distributed silver nanoparticles on the surface of the cell. The green synthesized silver nanoparticles were spherical in shape with high aggregation. The larger silver nanoparticles may be due to the aggregation of the smaller ones. This may be due to availability of different quantity and nature of capping agents present in the aqueous extract of Graviola leaf. Ranjithkumar *et al*. (2013) reported areca nut medicated green synthesis silver nanoparticles showed spherical in shape with high agglomeration.

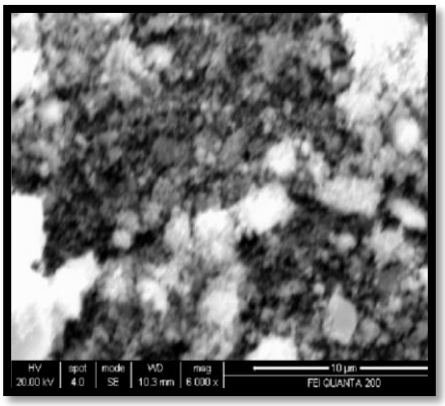



**Fig. 6. SEM image of green synthesis silver nanoparticles using aqueous extract of Graviola leaf at room temperature.**

## 4. CONCLUSION

A simple and eco-friendly green route was used to synthesis silver nanoparticles from silver nitrate using Graviola leaf aqueous extract. Graviola leaf extract is found suitable for the green synthesis of silver nanoparticles at 1h incubation in room temperature. Colour change occur due to surface plasmon resonance during the reaction with the ingredients present in the Graviola leaf extract resulting in the formation of silver nanoparticles, which is confirmed by UV-vis spectroscopy, FT-IR, XRD and SEM. XRD and SEM analysis revealed spherical shaped nanoparticles of size about 30-70 nm.

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# CHARACTERIZATION OF LANTHANUM ALUMINATE NANOPARTICLES PREPARED BY SOL-GEL ROUTE

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## ABSTRACT

Lanthanum aluminate was synthesised by simple sol-gel route to get a homogenously mixed powder. Hexahydrated Lanthanum Nitrate and Aluminium Nitrate were used as precursors, heat treated to obtain a fine grained powder of Lanthanum Aluminate. The powder was calcined at 800°C to get fine Lanthanum Aluminate powder and then characterised by XRD, SEM and EDAS to obtain the structure, morphology and composition. The XRD revealed the formation of a crystalline phase of lanthanum aluminate with a rhombohedral structure. The SEM revealed the agglomeration of lanthanum aluminate nanoparticles and energy dispersive spectrum indicated the existence of O, Si and Al in the sample. The observed results indicated the feasibility of utilizing Lanthanum aluminate nanoparticles to prepare thin film using evaporation technique which could find application as dielectric in thin film transistors.

**Keywords**: Lanthanum aluminate nanoparticles, sol-gel route, SEM.

## 1. INTRODUCTION

The preparation of new materials possessing desired property continuous to be a challenge nowadays. Lanthanum aluminate is one of the important materials which has received much attentation due its dielectric properties. Lanthanum aluminate can be used as resonators in microwave filter application due to its microwave dielectric property (Reaney and Iddle, 2006) and has potential applications in the areas of high frequency capacitors, magneto hydrodynamic generators, substrate for super conducting, ferro electric thin films, gas sensors, catalyst for oxidative coupling, hydrogenolysis of hydrocarbons and colossal magneto resistance (Berkstresser *et al*., 1993 and Sung, 1991). Normally lanthanum aluminate nanoparticles is synthesised by solid state reaction method in the temperature range of 1500-1700 °C (Kilner *et al.*, 1978; Nguyen, 2000). In the present study an attempt has been made to prepare lanthanum aluminate at lower temperature ($800^0$C) by using a simple sol-gel method.

## 2. EXPERIMENTAL

The starting materials used were lanthanum nitrate and aluminium nitrate. Stoichiometric amounts of aluminium nitrate and lanthanum nitrate were allowed to dissolve in distilled water by gradually heating it up to 110 °C, until a clear solution is obtained. This solution was quenched at room temperature to avoid phase separation. The resulting solid mass was broken into lumps and dehydrated for 24 h at a temperature of 80°C and was decomposed at a temperature of 400 °C. The powder was well grinded and calcined at 800°C.

### *2.1. Characterisation of nanoparticles*

The crystallinity and crystal structure of the nanoparticles were analysed by using X Ray Diffraction. The morphology, composition and structure of the nanoparticles were examined by Scanning Electron Microscopy (SEM), and Energy-dispersive X-ray spectroscopy (EDS).

## 3. RESULTS AND DISCUSSION

Fig. 1 shows the XRD pattern of lanthanum aluminate nanoparticles calcined in air at 800°C. The particles are crystalline in nature. The observed intense peaks at 2θ=23, 33, 41, 48, 54, 59, 70, 75, 80, 84 and 89 are in accordance with the JCPDS card No 82-0478. These peaks correspond to reflection from rhombohedral lanthanum aluminate with perovskite structure. The particle size of the lanthanum aluminate was calculated by using Scherer formula

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

where t is average particle size, λ is the wavelength of Cu-Kα radiation, β is the full width at half maximum of the diffraction peak and θ is the Bragg diffraction angle. The crystallite size of

lanthanum aluminate calcined at 800°C was found to be 22nm.

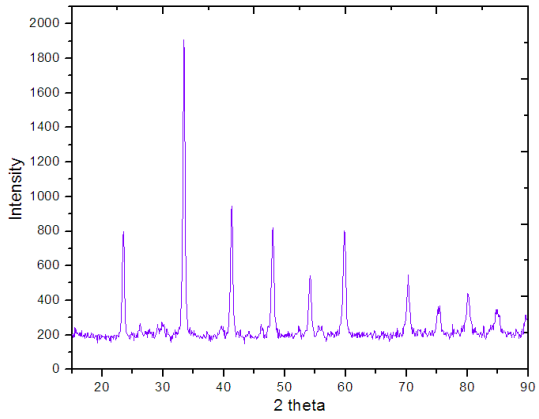


**Fig. 1. XRD pattern of lanthanum aluminate nanoparticles**

The morphology of the sample is observed with the help of scanning electron microscope (SEM). SEM images of lanthanum aluminate nanoparticles with different magnifications are shown in Fig. 2. Surface morphology of the as prepared lanthanum aluminate showed agglomeration of cubic like particles. The distribution of the crystallite sizes is not homogenous. It also indicates the highly crystalline nature of the synthesized particles. The characteristic peaks observed in the EDS spectrum indicated the presence of La, Al and O atoms (Fig. 3).

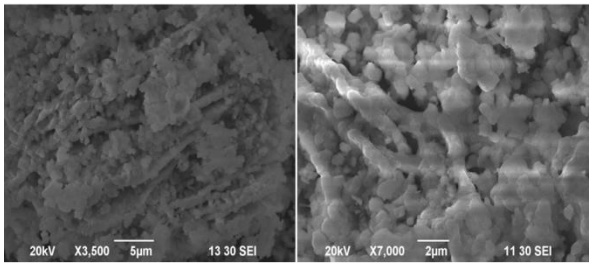


**Fig. 2. SEM Images of lanthanum aluminate particles**

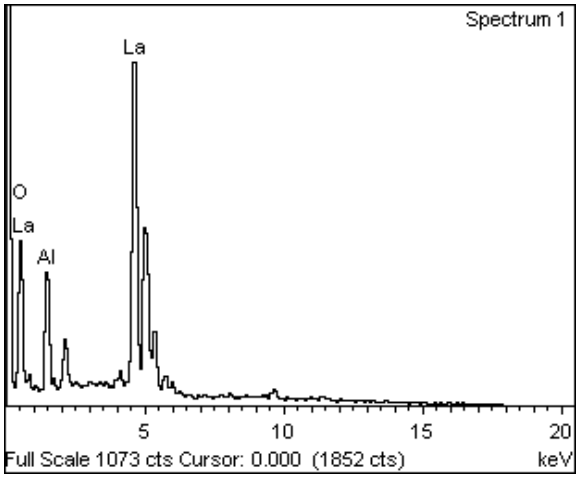


**Fig. 3. EDS of lanthanum aluminate particles**

## 4. CONCLUSION

Lanthanum aluminate nanoparticles were prepared by simple sol-gel method at lower temperature. The XRD pattern of lanthanum aluminate nanoparticles calcined at $800^0$C showed crystalline nature. The SEM image of lanthanum aluminate nanoparticles showed agglomeration of cubic like particles. The peaks observed in the EDS spectrum of lanthanum aluminate nanoparticles indicated the presence of La, Al and O atoms.

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# ZnO NEEDLE-LIKE STRUCTURES: SYNTHESIS AND CHARACTERIZATION

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**ABSTRACT**

We report in this paper, the structural and I-V properties of ZnO nano needle-like structure synthesized by Co-precipitation method. X-ray diffraction (XRD) result shows that the ZnO nano needle-like structure with hexagonal phase and no secondary phase was observed. The crystallite size has been calculated by Scherrer's equation which was found to be in the range 40-60 nm. SEM images reveal that ZnO nano needle-like structure has the length of ~5.5 μm and base of ~5 μm are consistent with the results from SEM investigations. I-V characteristics have been carried out to study the conducting behaviour of the prepared ZnO nano needle-like structures.

**Keywords**: ZnO nano needle-like structure, Co-precipitation, I-V characteristics, SEM.

## 1. INTRODUCTION

Nanoscale semiconductor materials have attracted great interests of researchers because of their importance not only in fundamental research areas but also in practical applications. ZnO nanostructures have been studied intensively and extensively over the last decSade not only for their remarkable chemical and physical properties, but also for their current and future diverse technological applications. ZnO is a typical inorganic semiconductor and piezoelectric material; this material has a direct wide band gap of 3.37 eV and a large exciton binding energy of 60 meV at room temperature (Ozgur *et al*., 2005). It has enormous applications in electronic and electromechanical devices (Wang, 2009), such as ultraviolet (UV) lasers (Kota *et al*., 2011), high performance nanosensors (Zhou *et al*., 2009), solar cells (Weintraub et al., 2009), piezoelectric nano generators (Yang *et al*., 2009), and nanopiezotronics (Wang, 2008). In order to grow one-dimensional (1D) ZnO nanostructures, various techniques have been developed like wet chemical methods (Narkiewicza *et al*., 2008), physical vapour deposition (Onur et al., 2011), pulsed laser deposition (Hong *et al*., 2009), sputtering (Dang, 2007). This article gives a comprehensive overview of the progress that has been made within the context of one-dimensional (1D) ZnO nanostructures synthesized via chemical precipitation method.

## 2. EXPERIMENTAL

ZnO nano needle have been prepared using the required precursors by chemical precipitation method. An aqueous solution of 1M Zinc acetate dihydrate $\{Zn(CH_3(COO))_2.2\ H_2O\}$ dissolved in water and stirred for about 30 min at room temperature. Sodium hydroxide (NaOH) (0.7 M) was added drop wise to the above mentioned solution. The colour of the solution changed into milk white coloured, indicating the formation of ZnO nano particles in the solution. The solution was stirred for 10h at room temperature. After 10h the supernatants were removed and the deposited precipitate was centrifuged and washed with water and ethanol several times. The samples were then suspended in ethanol and allowed to age for 6h without stirring. After centrifugation, the samples were then dried in oven at 60°C for 2 h. Then, the as prepared ZnO nanoparticle is placed in the middle of a muffle furnace in silica crucible. The samples have been annealed at 400°C for one hour.

### *2.1 Characterization of ZnO nanoparticles*

X-ray diffraction studies have been carried out using PANalytical x-ray diffractometer and surface morphology and the compositional analysis of the samples has been studied using scanning electron microscope (JEOL JSMS 800-V) and energy dispersive analysis studied using the prepared ZnO nano needle-like structured samples have been recorded using a JEOL JEM2100 microscope. I-V characteristics of ZnO nano needle-like structured

samples have been recorded by using four-probe method.

## 3. RESULTS AND DISCUSSION

Fig. 1 shows the X-ray diffraction patterns of the ZnO nano needle-like structure. The diffraction peaks at 2θ (degrees) of 31.63°, 34.61°, 36.32°, 47.66°, 56.94°, 62.97°, 66.57°, 68.12°, 69.48°, 72.11° and 72.26° are respectively indexed as the (100), (002), (101), (102), (110), (103), (200), (112), (201), (004) and (202) planes of ZnO. All the diffraction peaks in the 2θ range measured corresponds to the hexagonal structure of ZnO with lattice constants a = 3.253Å and c = 5.214Å and are in good agreement with those on the standard data card (JCPDS card No. 36-1451).

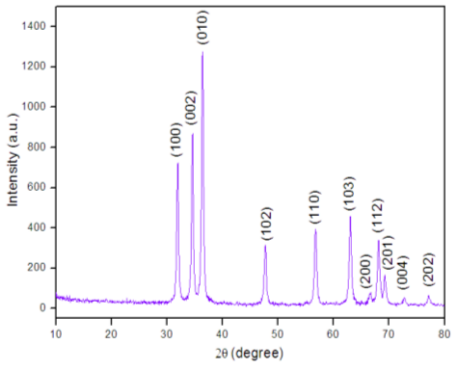


**Fig. 1. X-ray diffraction pattern of as prepared ZnO nano needle-like structure**

The sharpness of the diffraction peaks suggests that the product is well crystallized. The crystallite size of ZnO is calculated using Scherrer's equation

$$D = \frac{K\lambda}{\beta Cos\theta}$$

where, D is the crystallite size, K is a constant taken to be 0.94, λ is the wavelength of the X-ray radiation, β is the full width at half maximum and θ is the angle of diffraction. The crystallite size has been calculated and is found to be in the range 40-60 nm for as prepared ZnO nano needle-like structure.

Fig. 2a displays an SEM image of the sample prepared with zinc acetate and sodium hydroxide as reactants under conventional conditions, from which it can be seen that there are many nanorods with flat ends, are seen to arise from centre, it gives the appearance of a needle, their average diameter are 20 to 30 nanometers and length varies from 70 nanometers to 5μm and the average size of whole needle is 5 μm shows needle-like structures. The size of the complex structure and the diameter and length of the ZnO nano needle-like structure are consistent with the results from SEM investigations. Energy dispersive X-ray analysis (EDS) of ZnO nano needle-like structures are shown in Fig. 2b. The chemical constituents present in the ZnO sample are of Zn-49.65% and O-50.35%. In the EDS, Zn and O are the element detected, indicating that the sample is highly pure.

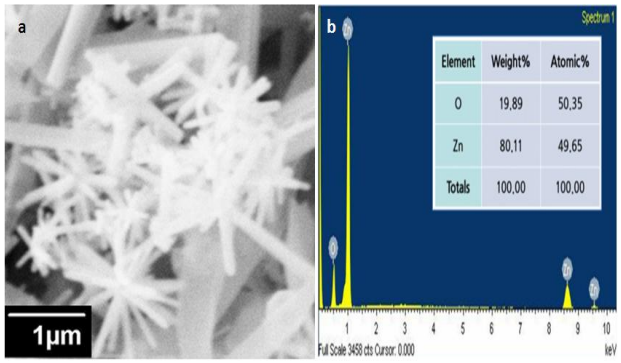


**Fig. 2. a)SEM images of ZnO nanoparticles and b) EDS spectra of ZnO nanoparticles**

For I-V measurements in bulk, pellets of 13 mm diameter and thickness ≈ 1 mm were prepared under a load of 5 tons. These pellets were used in Four-Probe method. The I-V characteristics of the samples were studied at the room temperature as well as at various temperatures (125K, 200K, 273K, 300K, 350K and 400K) using the Four-Probe method. The temperature dependence of resistivity was measured at constant current by varying the temperature continuously. The silver paste was used for Ohmic contact between the sample and the copper probes. DC voltage across the electrodes was measured by varying the current. I-V plots are shown in Fig. 3(a) which shows the temperature dependence of I-V characteristic of ZnO nano needle-like structure as a representative case.

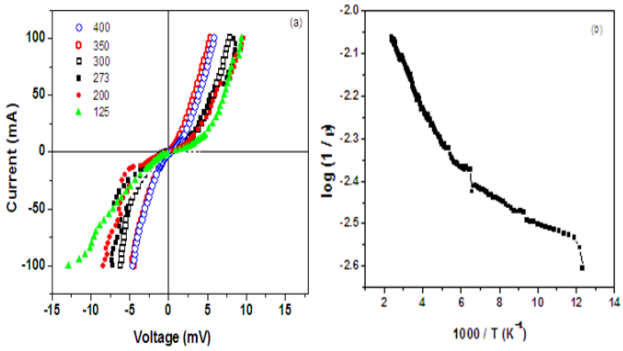


**Fig. 4 (a) I-V characteristics (b) Conductivity Vs Temperature ZnO nano needle-like structure sample**

I–V characteristics of the samples are measured in presence of argon gas at low as well as at high temperatures. Liquid Nitrogen is used for lowering the temperature. Argon gas is necessary to eliminate the moisture content otherwise the moisture present in air will change the electrical properties of the sample (especially at low temperatures). Fig. 3(a) depicts the characteristics of pure ZnO at the constant current, where the voltage decreases as we go on lowering the temperature. The conductivity of the sample increases with increasing temperature, as shown in the Fig. 3(b) and in the Table 1.

**Table 1. Temperature with Conductivity**

| T(K) | $\sigma(\Omega^{-1})$ | R(Ω) |
|---|---|---|
| 400 | 0.66511 | 1.5035 |
| 350 | 0.77082 | 1.2973 |
| 300 | 0.85095 | 1.1751 |
| 273 | 1.08472 | 0.9219 |
| 200 | 1.25094 | 0.7994 |
| 125 | 1.66917 | 0.5991 |

## 4. CONCLUSION

The structural and electrical properties of ZnO nano needle-like structure was synthesized by a simple chemical bath deposition method. The sizes of the needle-like structures are about ~5.5μm on an average. The length and breadths of the needle-like structure are about ~5.5 μm and ~5 μm. The size of the complex structure and the length and breadths of the ZnO nano needle-like structure are consistent with the results from SEM investigations. The conductance of the ZnO nano needle-like structure was estimated from the I-V characteristic from lower temperature to higher temperature. The conductance of the sample increases with decreasing temperature. The increase in the conductivity can be attributed to the increase in the electrical property.

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# SYNTHESIS AND CHARACTERIZATION OF SOME HYDRAZINEDERIVATIVES WITH A, B UNSATURATED ACIDS

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## ABSTRACT

Metal cinnamate monohydrazinates of the formula $M(cin)_2N_2H_4$, where M= Co or Zn, nickel crotante monohydrazinate monohydrate $Ni(crot)_2N_2H_4.H_2O$, metal cinnamate and crotonate dihydrazinates $M(cin)_2(N_2H_4)_2$ Where M = Co, Ni, Zn or Cd , $M(crot)_2(N_2H_4)_2$ Where M = Co or Ni and cadmium crotante dihydrazinate monohydrate $Cd(crot)_2(N_2H_4)_2.H_2O$ have been prepared and characterized by spectral, thermal and X-ray diffraction studies. Electronic spectra indicate that the cobalt and nickel complexes are high-spin octahedral complexes. The IR data show that the binding of hydrazine and the unsaturated carboxylate anion to the metal ion is bidentate. TG-DTA studies show that metal complexes undergo decomposition through metal carboxylate intermediate to give respective metal oxide as the final product. X-ray powder diffraction patterns of the complexes indicate isomorphism among them.

**Keywords**: IR, Electronic Spectra, TG-DTA, X-ray power diffraction pattern.

## 1. INTRODUCTION

Hydrazine complexes of the first row transition metal ions with a variety of carboxylic acids have been reported in the literature (Schmidt, 1984). These include simple aliphatic monocarboxylic acids (Ravindranathan *et al.,* 1983; Sivasankar *et al.,* 1995; Sivasankar *et al.,* 1997; Sivasankar *et al.,* 1994) aliphatic dicarboxylic acids (Gajapathy *et al.,* 1983; Sivasankar, *et al.,* 1996; Sivasankar *et al.,* 1994; Yasodhai *et al.,* 2000; Govindarajan *et al.,* 1995), aromatic mono and dicarboxylic acids (Kuppusamy *et al.,* 1995 and 1996) aliphatic and aromatic hydroxyl acids (Yasadhai *et al.,* 1999; Kuppusamy, *et al.,* 1996), halo acids (Sivasankar *et al.,* 2004), amino acids(Sivasankar *et al.,* 1996; Sivasankar *et al.,* 1994; Sivasankar, 2005) and heterocyclic carboxylic acids(Premkumar *et al.,* 2002). However hydrazine complexes of first row transition metal with unsaturated carboxylic acids are limited except maleate and fumarate derivatives (Govindarajan *et al.,* 1995). The coordinating ability of the acids are also of interest which have two different donor sites for forming bond with metal ions, the double bond between the carbon atoms and the oxygen atoms of the carboxylate group. Hence an attempt has been made to study the metal hydrazine complexes of simple unsaturated acids like cinnamic and crotonic acids. In this chapter the preparation, spectral and thermal properties of some new metal cinnamate monohydrazinates, metal cinnamate and crotonate dihydrazinates, metal crotonate monohydrazinate monohydrate and metal crotonate dihydrazinate monohydrate are reported.

## 2. EXPERIMENTAL

### *2.1.Preparation of Metal cinnamate monohydrazinates*

#### *2.1.1. $M(cin)_2.N_2H_4$ (M = Co (or) Zn)*

The cobalt and zinc complexes are prepared by the addition of an aqueous solution (50 mL) of hydrazine hydrate (1 mL, 0.02 mol) and cinnamic acid (0.74 g, 0.005 mol) to the corresponding aqueous solution (50 mL) of metal nitrate hexahydrates ($Co(NO_3)_2{\cdot}6H_2O$, 0.73 g, 0.002 mol; $Zn(NO_3)_2{\cdot}6H_2O$, 0.73 g, 0.002 mol). The complexes are precipitated immediately. They are washed with water, alcohol followed by diethyl ether and air dried.

### *2.2. Preparation of metal cinnamate dihydrazinates*

#### *2.2.1 .$M(cin)_2.(N_2H_4)_2$ [M = Co, Ni, Zn (or) Cd]*

The cobalt and nickel complexes are prepared by the addition of an aqueous solution (50 mL) of hydrazine hydrate (0.5 mL, 0.001 mol) and cinnamic acid (0.74g 0.005 mol) to the corresponding aqueous solution (50 mL) of metal nitrate hexahydrates [$Co(NO_3)_2.6H_2O$, 0.73 g, 0.002 mol; $Ni(NO_3)_2.6H_2O$, 0.73 g, 0.002 mol]. The complexes are formed immediately. They are kept aside for an hour to digestion, then filtered and washed with water, alcohol followed by diethylether and air dried.

The zinc and cadmium complexes are prepared by the same procedure with the molar ratio of metal nitrate hydrates: cinnamic acid: hydrazine hydrate, respectively given in parentheses [For zinc, 0.7437 g, 0.002 mol: 0.74 g, 0.005 mol: 2 mL, 0.4 mol] [for cadmium 0.77 g, 0.002 mol: 0.74 g, 0.055 mol: 1 mL, 0.01 mol].

*2.3. Preparation of metal crotonate dihydrazinates*

*2.3.1.M(crot)$_2$.($N_2H_4$)$_2$ [M = Co (or) Ni]*

The cobalt, nickel crotonate dihydrazinates are prepared by heating aqueous suspension of the corresponding metal carbonates ($CoCO_3$, 1 g, 0.008 mol; $NiCO_3.2Ni(OH)_2.4H_2O$, 1 g, 0.002 mol) and crotonic acid (3.44 g, 0.03 mol) in 50 mL of water. It is filtered and cooled. To this resulting clear solution aqueous solution (50 mL) of hydrazine hydrate (2.5 mL, 0.05 mol) is added. Cobalt and nickel crotonate dihydrazinates are formed after few minutes. They are kept an hour for digestion, then filtered and washed with water, alcohol followed by diethylether and air dried.

*2.4. Preparation of Nickel crotonate monohydrazinate monohydrate*

*2.4.1. Ni(crot)$_2$.$N_2H_4$.$H_2O$*

Nickel crotonate is prepared by the same procedure as above. To this an aqueous solution (25 mL) of hydrazine hydrate (1.25 mL, 0.02 mol) is added. The complex is separated out after 10 minutes from the clear solution. Then it is kept aside half an hour for digestion, filtered and washed with water, alcohol followed by diethylether and air dried.

*2.5. Preparation of Cadmium crotonate dihydrazinate monohydrate*

*2.5.1. Cd(crot)$_2$.($N_2H_4$)$_2$.$H_2O$*

This complex is also prepared by the same procedure as above with molar ratio of $CdCO_3$, 1 g, 0.006 mol: Crotonic acid, 3.44 g, 0.04 mol: hydrazine hydrate, 2.5 mL, 0.05 mol. The colourless spongy crystals of Cadmium complex formed slowly.

The complexes obtained as polycrystalline powders insoluble in water, alcohol, diethyl ether and other organic solvents, but decompose in dilute HCl. This is only to be expected these types of complexes prefer to exist in polymeric structures. All the complexes are stable in air and insensitive to light.

## 3. RESULTS AND DISCUSSION

Cobalt, nickel and cadmium cinnamate monohydrazinates, dihydrazinates are prepared by the reaction of the aqueous solution of the corresponding metal nitrate hydrate, aqueous solution of hydrazine hydrate and cinnamic acid

1. $M(NO_3)_{2(aq)} + N_2H_{4(aq)} + 2C_6H_5\text{-}CH{=}CH\text{-}COOH \rightarrow M(C_6H_5\text{-}CH{=}CH\text{-}COO)_2.N_2H_4 + 2HNO_3$

Where M = Co or Zn

2. $M(NO_3)_{2(aq)} + 2N_2H_{4(aq)} + 2C_6H_5\text{-}CH{=}CH\text{-}COOH \rightarrow$

$M(C_6H_5\text{-}CH{=}CH\text{-}COO)_2(N_2H_4)_2 + 2HNO_3$

Where M = Co, Ni, Zn or Cd

Metal crotonate complexes are prepared from the corresponding aqueous solution of metal crotonates and aqueous solution hydrazine hydrate. Metal crotonates are prepared from aqueous suspension of corresponding metal carbonates and crotonic acid.

1. $CoCO_3 + 2CH_3\text{-}CH{=}CH\text{-}COOH \rightarrow Co(CH_3\text{-}CH{=}CH\text{-}COO)_2 + CO_{2(g)} + H_2O$

$Co(CH_3\text{-}CH{=}CH\text{-}COO)_2 + 2N_2H_{4(aq)} \rightarrow Co(CH_3\text{-}CH{=}CH\text{-}COO)_2(N_2H_4)_2$

2. $NiCO_3.2Ni(OH)_2.4H_2O + 4CH_3\text{-}CH{=}CH\text{-}COOH \rightarrow 2Ni(CH_3\text{-}CH{=}CH\text{-}COO)_2 + CO_{2(g)} + H_2O$

$Ni(CH_3\text{-}CH{=}CH\text{-}COO)_2 + 2N_2H_{4(aq)} \rightarrow Ni(CH_3\text{-}CH{=}CH\text{-}COO)_2(N_2H_4)_2$

3. $Ni(CH_3\text{-}CH{=}CH\text{-}COO)_2 + N_2H_{4(aq)} \rightarrow Ni(CH_3\text{-}CH{=}CH\text{-}COO)_2(N_2H_4)_2.H_2O$

4. $CdCO_3 + CH_3\text{-}CH{=}CH\text{-}COOH \rightarrow Cd(CH_3\text{-}CH{=}CH\text{-}COO)_2 + CO_{2(g)} + H_2O$

$Cd(CH_3\text{-}CH{=}CH\text{-}COO)_2 + 2N_2H_{4(aq)} \rightarrow Cd(CH_3\text{-}CH{=}CH\text{-}COO)_2(N_2H_4)_2.H_2O$

All the metal hydrazine carboxylates prepared are insoluble in water, alcohol and other organic solvents. The compositions of these complexes are assigned on the basis of hydrazine and metal contents (Table 4.1)

*3.1. Electronic spectra*

The electronic spectrum of the cobalt cinnamate monohydrazinate, cobalt cinnamate and crotonate dihydrazinates, display a broad band at 20000, 20202 and 21053 $cm^{-1}$ respectively (Table 1), which is assigned to the transition $^4T_{1g}(F) \rightarrow {}^4T_{1g}(P)$. This band and pink colour of the complex are indicative of the octahedrally coordinated Co(II) ion (Lever, 1984). All nickel complexes exhibit two bands at 20408 and 13158-13154 The important IR absorption frequencies of prepared complexes are listed in Table 4.2 and are assigned on the basis of earlier studies (Sivasankar,

*et al.,* 1994; Yasodhai, *et al.,* 1999; Braibanti, *et al.,* 1968). Mono hydrated cadmium crotonate dihydrazinate and nickel crotonate monohydrazinate displays a broad band in the region, 3680 – 3300 $cm^{-1}$, due to O-H stretching of water. The N-H stretching frequency of all the complexes appears in the region 3380-3148 $cm^{-1}$. The metal complexes show a band in the region 1663 -1636 $cm^{-1}$, which is assigned to the stretching frequency of C=C vibration of the unsaturated system (Allan, *et al.,* 1989). There is no reduction or increase in the $\nu$ (C=C) band of the metal complexes indicate that the coordination does not take place between the $\pi$ electron $cm^{-1}$, which are attributed to $^4T_{1g}(F) \rightarrow {}^4T_{1g}(P)$, and $^3A_{2g} \rightarrow {}^3T_{1g}(P)$, respectively. These transitions are characteristics of octahedral environment around Ni(II) ion (Lever, 1984).

*3.2. Infrared spectra*

The important IR absorption frequencies of prepared complexes are listed in Table 4.2 and are assigned on the basis of earlier studies (Sivasankar, *et al.,* 1994; Yasodhai, *et al.,* 1999; Braibanti, *et al.,* 1968). Mono hydrated cadmium crotonate dihydrazinate and nickel crotonate monohydrazinate displays a broad band in the region, 3680-3300 $cm^{-1}$, due to O-H stretching of water. The N-H stretching frequency of all the complexes appears in the region 3380-3148$cm^{-1}$. The metal complexes show a band in the region 1663 -1636 $cm^{-1}$, which is assigned to the stretching frequency of C=C vibration of the unsaturated system (Allon, *et al.,* 1989). There is no reduction or increase in the $\nu$ (C=C) band of the metal Complexes indicate that the coordination does not take place between the π electron system of theC=C bond and the metal ion due to more effective coordinating property of carboxylate ions.

In all the complexes, the carbonyl asymmetric and symmetric stretching frequencies are observed in the range, 1612-1541 and 1420-1384 $cm^{-1}$, respectively. The $\Delta\nu$ ($\nu_{asy}$ - $\nu_{sym}$) separation is in between 288 - 180 $cm^{-1}$ suggest that carboxylate group is monodentatively coordinated to the central metal ion (Nakamoto, 1978) in metal cinnamate and crotonate dihydrazinate complexes, whereas the monohydrazinate complexes show small separation between asymmetric and symmetric stretching i.e., 160–147 $cm^{-1}$ indicating chelate bidentate coordination of the carboxylate groups to the central metal ion (Nakamoto, 1978). The N-N stretching frequency of the complexes appears in the range, 976 - 959 $cm^{-1}$, confirming the bridging bidentate coordination of hydrazine molecules. The infrared spectrum of some complexes given in the following Figs. 4.1 – 4.6.

*3.3. Thermal studies*

The thermal decomposition patterns of all the complexes are listed in Table 4.3. The observed mass losses from TG coincide well with the theoretical mass losses. Thermogravimetric results are in good agreement with the DTA data. All the metal complexes yield their oxides as the final residue.

*3.3.1. $M(cin)_2.N_2H_4$, Where M = Co or Zn*

Both the complexes undergo two step decomposition through metal cinnamate intermediate. The first step, i.e., dehydrazination in cobalt compound is obtained as an exotherm, whereas in the zinc compound, it is observed as an endotherm. The variation in the thermal nature of transformation may be due to the catalytic activity difference of the metal ion in the complexes. In both the complexes, the disproportionation of the metal cinnamate intermediate decomposes exothermically yielding the respective metal oxide as the final residue. The CoO is formed with in 450°C observed from TG, whereas ZnO is formed only at 530°C.

*3.3.2. $Zn(cin)_2.(N_2H_4)_2$*

The thermograms of this complex show a distinct three step decomposition. In the first step, one of the hydrazine molecules is lost between 142-201°C. The corresponding peak in DTA is observed as an endotherm in contrast to nickel and cobalt complexes at 173°C. The zinc cinnamate monohydrazinate formed in the first step undergoes a further decomposition yields the second intermediate as zinc cinnamate. In the second step also, the thermal nature of transformation is endothermic, and observed at 219°C from DTA. The decomposition of zinc cinnamate takes place exothermically in the third step, giving zinc oxide as the final residue in the temperature range, 231-525°C.

*3.3.3. $Cd(cin)_2.(N_2H_4)_2$*

The TG-DTA curves of this complex shows a three step decomposition. Dehydrazination of two hydrazine molecules is observed endothermically in the first step. The unstable cadmium cinnamate gives cadmium acetate as the intermediate exothermically in the temperature range, 297-395°C. Our attempt to separate the cadmium acetate intermediate was unsuccessful since the decomposition is continuous and is proposed from the percentage weight loss

which best fit with the TG curve. The proposed intermediate undergoes exothermic decomposition to give CdO as the end product

*3.3.4. $Ni(crot)_2.N_2H_4.H_2O$*

This compound decomposes in two steps. The dehydration in the first step at 37°C confirms the presence of water molecule as lattice water. The anhydrous hydrazinate is stable upto 140°C, then it is decomposed in a single step to yield nickel oxide with at 385°C.

*3.3.5. $Cd(crot)_2.(N_2H_4)_2.H_2O$*

This compound decomposes in three steps. The dehydration in the first step at 66°C (from DTA) confirms the presence of water molecules as a lattice water. The endothermic disproportionation of the anhydrous dihydrazinate loses its one molecule of hydrazine, yielding cadmium crotonate monohydrazinate, which on exothermic decomposition directly affords CdO as the final residue.

*3.3.6. $MX_2(N_2H_4)_2$, where M=Co or Ni and x = cinnamate or crotonate.*

The simultaneous TG-DTA curves of all the four complexes show two step decomposition. In the first step, of TG, dehydrazination of two hydrazine molecules occurs in the temperature range of 158-256°C. In DTA, the corresponding decomposition is observed as an exotherm within the temperature range of TG inflexion. The intermediate formed in all the complexes is the respective metal carboxylate. The metal carboxylate intermediates are not thermally stable, which undergo gradual decomposition exothermically to yield corresponding metal oxide as the end product.

In order to confirm the intermediates, end products proposed and the fueling nature of hydrazine, the TG-DTA analysis of zinc crotonate hydrate has been carried out, which is obtained as a stable product during the attempts to prepare the hydrazine derivatives. The water molecule is lost exothermically at 193°C, (from DTA), which shows the presence of water molecule as a coordinated one. In the second step, the anhydrous zinc crotonate continuously decomposes to yield zinc oxide as the final product, in the temperature range 201-496°C.

The formation of zinc oxide as the final residue authenticates the oxide end products in the hydrazine derivatives. It is worth mentioning that the reported simple cobalt and nickel cinnamates and crotonates yielded only their metal oxides as the finalresidue during thermal analysis (Allan, *et al.,* 1989). However, the fueling nature of hydrazine is observed in the prepared hydrazine derivatives( Allan, *et al.,* 1989). TG – DTA curve of $Co(cin)_2N_2H_4$ (fig 1) is given as representative examples.

**Table 1. Analytical and Electronic Spectral Data**

| | Analytical Data | | | Electronic Spectral Data | |
|---|---|---|---|---|---|
| **Compound** | **Hydrazine (%) Obsd. (Calcd.)** | **Metal (%) Obsd. (Calcd.)** | **Yield (%)** | **Absorption Maxima ($cm^{-1}$)** | **Assignments** |
| $Co(cin)_2.N_2H_4$ | 09.00 (08.31) | 14.80 (15.31) | 90 | 20000 | $^4T_{1g}$ (F) → $^4T_{1g}$ (P) |
| $Co(cin)_2.(N_2H_4)_2$ | 14.90 (15.35) | 14.00 (14.13) | 90 | 20202 | $^4T_{1g}$ (F) → $^4T_{1g}$ (P) |
| $Ni(cin)_2.(N_2H_4)_2$ | 15.00 (15.36) | 14.10 (14.08) | 90 | 13514, 20408 | $^3A_{2g}$ (F) → $^3T_{1g}$ (F), $^3A_{2g}$ (F) → $^3T_{1g}$ (P) |
| $Zn(cin)_2.N_2H_4$ | 08.49 (08.18) | 16.10 (16.70) | 83 | - | - |
| $Zn(cin)_2.(N_2H_4)_2$ | 14.50 (15.12) | 15.00 (15.44) | 85 | - | - |
| $Cd(cin)_2.(N_2H_4)_2$ | 13.70 (13.61) | 23.60 (23.90) | 82 | - | - |
| $Co(crot)_2.(N_2H_4)_2$ | 21.80 (21.83) | 19.70 (20.11) | 85 | 21053 | $^4T_{1g}$ (F) → $^4T_{1g}$ (P) |
| $Ni(crot)_2.(N_2H_4)_2$ | 21.50 (21.85) | 20.40 (20.04) | 83 | 13158, 20408 | $^3A_{2g}$ (F) → $^3T_{1g}$ (F), $^3A_{2g}$ (F) → $^3T_{1g}$ (P) |
| $Ni(crot)_2.N_2H_4.H_2O$ | 11.10 (11.47) | 20.90 (21.05) | 90 | - | - |
| $Cd(crot)_2.(N_2H_4)2.H_2O$ | 17.30 (17.56) | 31.00 (30.84) | 80 | - | - |

**Table 2. Infrared Spectral Data ($cm^{-1}$)**

| Compound | $\nu_{(OH)}$ of acid/ water $cm^{-1}$ | $\nu_{(N-H)}$ $cm^{-1}$ | $\nu_{asy(OCO)}$ $cm^{-1}$ | $\nu_{sym(OCO)}$ $cm^{-1}$ | $\Delta\nu$ [$\nu_{asy(OCO)}$-$\nu_{sym(OCO)}$] $cm^{-1}$ | $\nu_{(C=C)}$ $cm^{-1}$ | $\nu_{(N-N)}$ $cm^{-1}$ |
|---|---|---|---|---|---|---|---|
| $Co(cin)_2 \cdot N_2H_4$ | - | 3350<br>3315<br>3258 | 1559 | 1399 | 160 | 1646 | 965 |
| $Co(cin)_2.(N_2H_4)_2$ | - | 3372<br>3310<br>3250 | 1600 | 1400 | 200 | 1636 | 962 |
| $Ni(cin)_2.(N_2H_4)_2$ | - | 3351<br>3305<br>3270 | 1612 | 1384 | 288 | 1651 | 972 |
| $Zn(cin)_2 \cdot N_2H_4$ | - | 3380<br>3320<br>3219 | 1553 | 1395 | 158 | 1645 | 976 |
| $Zn(cin)_2.(N_2H_4)_2$ | - | 3350<br>3320<br>3270 | a<br>1600 | 1406 | 194 | 1641 | 968 |
| $Cd(cin)_2.(N_2H_4)_2$ | - | 3300<br>3285 | 1600 | 1396 | 204 | 1638 | 962 |
| $Co(crot)_2.(N_2H_4)_2$ | - | 3304<br>3260<br>3188 | 1607 | 1415 | 192 | 1663 | 964 |
| $Ni(crot)_2.(N_2H_4)_2$ | - | 3300<br>3270<br>3188 | 1605 | 1415 | 190 | 1655 | 962 |
| $Ni(crot)_2 \cdot N_2H_4 \cdot H_2O$ | 3680-3300(b) | 3300-<br>3200(b) | 1541 | 1394 | 147 | 1650 | 970 |
| $Cd(crot)_2.(N_2H_4)2.H_2O$ | 3600-3360(b) | 3283<br>3225<br>3148 | 1600 | 1420 | 180 | 1661 | 959 |

**Table 3. Thermal Decomposition Data.**

| Compound | DTA Peak Temp./°C | Thermogravimetry (TG) | | Decomposition Product |
|---|---|---|---|---|
| | | Temp.range/°C | Mass loss(%) Obsd. (Calcd.) | |
| $Co(cin)_2 \cdot N_2H_4$ | 208 (-) | 188 – 212 | 08.50(08.31) | $Co(cin)_2$ |
| Mol. Wt : 387.31 | 415 (-) | 212 – 450 | 80.00(80.65) | CoO |
| $Co(cin)_2.(N_2H_4)_2$ | 211 (-) | 195 - 251 | 15.50(15.35) | $Co(cin)_2$ |
| Mol. Wt : 419.37 | 426 (-) | 251 – 470 | 60.00(60.45) | $Co_2O_3$ |
| $Ni(cin)_2.(N_2H_4)_2$ | 246 (-) | 222 - 256 | 15.00(15.36) | $Ni(cin)_2$ |
| Mol. 419.13 | 416 (-) | 256 – 465 | 81.07(82.17) | NiO |
| $Zn(cin)_2 \cdot N_2H_4$ | 226 (+) | 200 – 240 | 07.50(08.18) | $Zn(cin)_2$ |
| Mol. Wt : 393.77 | 511 (-) | 240 – 530 | 73.34(79.33) | ZnO` |
| $Zn(cin)_2.(N_2H_4)_2$ | 173 (+) | 142 – 201 | 6.50(07.56) | $Zn(cin)_2.N_2H_4$ |
| Mol. Wt : 425.83 | 219 (-) | 201 – 231 | 14.50(15.12) | $Zn(cin)_2$ |
| | 505 (-) | 231 – 525 | 80.00(80.55) | ZnO |
| $Cd(cin)_2.(N_2H_4)_2$ | 193 (+) | 166 – 297 | 14.00(13.61) | $Cd(cin)_2$ |
| Mol. Wt : 472.85 | 333 (-) | 297 – 395 | 51.00(51.02) | $Cd(CH_3COO)_2$ |

| | | | | |
|---|---|---|---|---|
| | 507 (-) | 395 – 536 | 74.00(72.84) | CdO |
| $Co(crot)_2.(N_2H_4)_2$ | 181 (-) | 158 – 233 | 22.00(21.83) | $Co(crot)_2$ |
| Mol. Wt : 295.23 | 383 (-) | 233 – 398 | 69.24(71.91) | $CoO_{1.5}$ |
| $Ni(crot)_2.(N_2H_4)_2$ | 231 (-) | 207 – 237 | 26.00(21.85) | $Ni(crot)_2$ |
| Mol. Wt : 284.99 | 378 (-) | 237 – 390 | 74.00(74.68) | NiO |
| $Ni(crot)_2.N_2H_4.H_2O$ | 55 (+) | 37 – 100 | 06.00(06.45) | $Ni(crot)_2.N_2H_4$ |
| Mol. Wt : 280.93 | 375 (-) | 141 – 385 | 76.43(73.41) | NiO |
| $Cd(crot)_2.(N_2H_4)_2.H_2O$ | 66 (+) | 50 – 77 | 05.50(04.94) | $Cd(crot)_2.2N_2H_4$ |
| Mol. Wt : 366.71 | 168 (+) | 151 – 181 | 12.00(13.71) | $Cd(crot)_2.N_2H_4$ |
| | 454 (-) | 181 – 474 | 62.93(64.98) | CdO |
| $Zn(crot)_2.H_2O$ | 193 (-) | 166 – 201 | 08.00(07.10) | $Zn(crot)_2$ |
| Mol. Wt : 255.57 | 485 (-) | 201 – 496 | 71.43(68.15) | ZnO |

All the complexes the thermogravimetric analysis, thermogram is found to have increase in mass after the decomposition of the complex to the corresponding metal oxides, this may be due to decomposition of carbon particles, at the end of the thermal analysis.

*3.4. X - ray diffraction studies*

In order to compare and also to confirm the structural similarity among the complexes, the 'd spacing' of $Co(cin)_2.(N_2H_4)_2$ and $Ni(cin)_2.(N_2H_4)_2$ have been compared . Similar complexes have almost same values of d-spacing and number of peaks. Hence these are isomorphous in nature. The X – ray pattern of $Co(cin)_2.(N_2H_4)_2$ and $Ni(cin)_2.(N_2H_4)_2$ are given in fig 2.

*3.5. Coordination geometry*

The analytical and physicochemical studies suggest that, in these complexes hydrazine molecule is present as a bridging bidentate ligand. In monohydrazinate complexes, cinnamate and crotonate ions are seen to present as chelating bidentate ligand and in dihydrazinate complexes these are present as monodentate ligand. The complexes are isolated only as polycrystalline powders. Hence, without crystal structure, it is very difficult to predict the environment of the metal in the complexes. Therefore six - coordination has been tentatively proposed for all the complexes with octahedral stereochemistry (fig 3 and 4). The insoluble nature of these complexes confirms the polymeric structure.

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# COMPLETELY SUPRA N-CONTINUOUS FUNCTION

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**ABSTRACT**

In this paper, we introduce a new concept called completely supra N-continuous function and investigated its relationship with other functions.

**Keywords:** Completely supra N-continuous function.

## 1. INTRODUCTION

The notion of supra topological spaces, s-continuous functions and $s^*$ -continuous functions was introduced (Mashhour *et al*, 1983). Supra N-closed set was introduced and supra N-continuity and supra N-irresoluteness investigated (Vidyarani and Vigneshwaran, 2013a).

In this paper, we introduce the concept of completely supra N-continuous function and investigated its relationship with other functions in supra topological space.

## 2. PRELIMINARIES

*2.1. Definition*

A subfamily μ of X is said to be supra topology on X if

i) $X, \phi \in \mu$

ii) If $A_i \in \mu \ \forall i \in j$ then $\cup A_i \in \mu$. (X,μ) is called supra topological space.

The element of μ are called supra open sets in (X, μ) and the complement of supra open set is called supra closed sets and it is denoted by $\mu^c$.

*2.2. Definition*

The supra closure of a set A is denoted by $cl^{\mu}(A)$, and is defined as supra cl(A) = ∩{B : B is supra closed and A ⊆ B}.

The supra interior of a set A is denoted by $int^{\mu}(A)$, and is defined as supra int(A) = ∪{B : B is supra open and A ⊇ B}.

*2.3. Definition*

Let (X, τ) be a topological space and μ be a supra topology on X. We call μ a supra topology associated with τ, if τ ⊆ μ.

*2.4. Definition*

Let (X, μ) be a supra topological space. A set A of X is called

(i) supra semi- open set (Levine, 1991), if $A \subseteq cl^{\mu}(int^{\mu}(A))$.

(ii) supra α -open set (Devi *et al.,* 2008), if $A \subseteq int^{\mu}(cl^{\mu}(int^{\mu}(A)))$.

(iii) supra Ω closed set (Noiri and Sayed, 2005), if $scl^{\mu}(A) \subseteq int^{\mu}(U)$, whenever $A \subseteq U$, U is supra open set.

(iv) supra N-closed set (Vidyarani and Vigneshwaran, 2013a), if $\Omega cl^{\mu}(A) \subseteq U$, whenever $A \subseteq U$, U is supra α open set.

The complement of above supra closed set is supra open and vice versa.

*2.5. Definition*

A map $f:(X,\tau) \rightarrow (Y,\sigma)$ is said to be

(i) supra N-continuous (Vidyarani and Vigneshwaran, 2013b), if $f^{-1}(V)$ is supra N-closed in (X, τ) for every supra closed set V of (Y, σ).

(ii) Supra N-irresolute (Vidyarani and Vigneshwaran, 2013a), if $f^{-1}(V)$ is supra N-closed in (X, τ) for every supra N - closed set V of (Y, σ).

(iii) strongly supra N-continuous (Vidyarani and Vigneshwaran, 2013b), if $f^{-1}(V)$ is supra closed in (X, τ) for every supra N-closed set V of (Y, σ).

## 3. COMPLETELY SUPRA N-CONTINUOUS FUNCTIONS

*3.1. Definition*

A map $f:(X, \tau) \to (Y, \sigma)$ is called completely supra continuous function, if $f^{-1}(V)$ is supra Regular closed in $(X, \tau)$ for every supra closed set V of $(Y, \sigma)$.

*3.2. Definition*

A map $f:(X, \tau) \to (Y, \sigma)$ is called completely supra N-continuous function, if $f^{-1}(V)$ is supra Regular closed in $(X, \tau)$ for every supra N-closed set V of $(Y, \sigma)$.

*3.3. Theorem*

Every completely supra N-continuous function is completely supra continuous function.

Proof Let $f:(X, \tau) \to (Y, \sigma)$ be a completely supra N-continuous function. Let V be supra closed set in $(Y, \sigma)$. Then V is supra N-closed set in $(Y, \sigma)$, since every supra closed set is supra N-closed set. Since f is completely supra N-continuous function, then $f^{-1}(V)$ is supra regular closed in $(X, \tau)$. Therefore f is completely supra continuous function.

The converse of the above theorem need not be true. It is shown by the following example.

*3.4. Example*

Let $X=Y=\{a, b, c\}$ and $\tau = \{X, \varphi, \{a\}, \{b, c\}\}$, $\sigma = \{Y, \varphi, \{a\}\}$. Let $f:(X, \tau) \to (Y, \sigma)$ be the function defined by $f(a)=a$, $f(b)=c$, $f(c)=b$. Here f is completely supra continuous but not completely supra N-continuous, since $V=\{a,c\}$ is supra N-closed in $(Y, \sigma)$ but $f^{-1}(\{a,c\}) = \{a,b\}$ is not supra regular closed set in $(X, \tau)$.

*3.5. Theorem*

Every completely supra N-continuous function is supra N-continuous function.

Proof Let $f:(X, \tau) \to (Y, \sigma)$ be a completely supra N-continuous function. Let V be supra closed set in $(Y, \sigma)$. Then V is supra N-closed set in $(Y, \sigma)$, since every supra closed set is supra N-closed set. Since f is completely supra N-continuous function, then $f^{-1}(V)$ is supra regular closed in $(X, \tau)$. Since every supra regular closed set is supra closed set and every supra closed set is supra N-closed set, then $f^{-1}(V)$ is supra N-closed in $(X, \tau)$. Therefore f is supra N-continuous function.

The converse of the above theorem need not be true. It is shown by the following example.

*3.6. Example*

Let $X=Y=\{a, b, c\}$ and $\tau = \{X, \varphi, \{a\}, \{b, c\}\}$, $\sigma = \{Y, \varphi, \{a\}\}$. Let $f:(X, \tau) \to (Y, \sigma)$ be the function defined by $f(a)=b$, $f(b)=c$, $f(c)=a$. Here f is supra N-continuous but not completely supra N-continuous, since $V=\{a,c\}$ is supra N-closed in $(Y, \sigma)$ but $f^{-1}(\{a,c\}) = \{a,b\}$ is not supra regular closed set in $(X, \tau)$.

*3.7. Theorem*

Every completely supra N-continuous function is supra N-irresolute function.

Proof Let $f:(X, \tau) \to (Y, \sigma)$ be a completely supra N-continuous function. Let V be supra N-closed set in $(Y, \sigma)$. Since f is completely supra N-continuous function, then $f^{-1}(V)$ is supra regular closed in $(X, \tau)$. Since every supra regular closed set is supra closed set and every supra closed set is supra N-closed set, then $f^{-1}(V)$ is supra N-closed in $(X, \tau)$. Therefore f is supra N-irresolute function.

The converse of the above theorem need not be true. It is shown by the following example.

*3.8. Example*

Let $X=Y=\{a, b, c\}$ and $\tau = \{X, \varphi, \{a\}, \{b, c\}\}$, $\sigma = \{Y, \varphi, \{a\}\}$. Let $f:(X, \tau) \to (Y, \sigma)$ be the function defined by $f(a)=b$, $f(b)=c$, $f(c)=a$. Here f is supra N-irresolute but not completely supra N-continuous, since $V=\{a,c\}$ is supra N-closed in $(Y, \sigma)$ but $f^{-1}(\{a,c\}) = \{a,b\}$ is not supra regular closed set in $(X, \tau)$.

*3.9. Theorem*

Every completely supra N-continuous function is strongly supra N-continuous function.

Proof Let $f:(X, \tau) \to (Y, \sigma)$ be a completely supra N-continuous function. Let V be supra N-closed set in $(Y, \sigma)$. Since f is completely supra N-continuous function, then $f^{-1}(V)$ is supra regular closed in $(X, \tau)$. Since every supra regular closed set is supra closed set, then $f^{-1}(V)$ is supra closed in $(X, \tau)$. Therefore f is strongly supra N-continuous function.

The converse of the above theorem need not be true. It is shown by the following example.

*3.10. Example*

Let $X=Y=\{a, b, c\}$ and $\tau = \{X, \varphi, \{a\}, \{b\}, \{a,b\}, \{b, c\}\}$, $\sigma = \{Y, \varphi, \{a,b\}, \{b,c\}\}$. Let $f:(X, \tau) \to (Y, \sigma)$ be the function defined by $f(a)=a$, $f(b)=c$, $f(c)=b$. Here f is strongly supra N-

continuous but not completely supra N-continuous, since V={a,c} is supra N-closed in $(Y,\sigma)$ but $f^{-1}(\{a,c\}) = \{a,b\}$ is not supra regular closed set in $(X,\tau)$.

*3.11. Remark*

Composition of two completely supra N-continuous function is completely supra N-continuous

*3.12. Theorem*

If $f:(X,\tau) \rightarrow (Y,\sigma)$ is supra N-continuous and g: $(Y,\sigma) \rightarrow (Z,\eta)$ is completely supra N-continuous then gof: $(X,\tau) \rightarrow (Z,\eta)$ is supra N-irresolute.

Proof Let V be supra N-closed set in Z. Since g is completely supra N-continuous, then $g^{-1}(V)$ is supra regular closed set in Y. Since every supra regular closed set is supra closed set, $g^{-1}(V)$ is supra closed set in Y. Since f is supra N-continuous, then $f^{-1}\ g^{-1}(V)$ is supra N-closed in X. Hence gof is supra N-irresolute.

*3.13. Theorem*

If $f:(X,\tau) \rightarrow (Y,\sigma)$ is completely supra N-continuous and g: $(Y,\sigma) \rightarrow (Z,\eta)$ is supra N-continuous then gof: $(X,\tau) \rightarrow (Z,\eta)$ is completely supra continuous.

Proof Let V be supra closed set in Z. Since g is supra N-continuous, then $g^{-1}(V)$ is supra N-closed set in Y. Since f is completely supra N-continuous, then $f^{-1}g^{-1}(V)$ is supra regular closed set in X. Hence gof is completely supra N-continuous.

*3.14. Theorem*

If $f:(X,\tau) \rightarrow (Y,\sigma)$ is strongly supra N-continuous and g: $(Y,\sigma) \rightarrow (Z,\eta)$ is completely supra N-continuous then gof: $(X,\tau) \rightarrow (Z,\eta)$ is strongly supra continuous.

Proof Let V be supra N-closed set in Z. Since g is completely supra N-continuous, then $g^{-1}(V)$ is supra regular closed set in Y. Since every supra regular closed set is supra closed set and every supra closed set is supra N-closed set, $g^{-1}(V)$ is supra N-closed set in Y. Since f is strongly supra N-continuous, then $f^{-1}g^{-1}(V)$ is supra closed set in X. Hence gof is strongly supra N-continuous.

*3.15. Remark*

The following implications is obtained from the above theorems

Completely supra N-continuous → strongly supra N-continuous→ supra N-irresolute → supra N-continuous

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# NANO bT CLOSED SET IN NANO TOPOLOGICAL SPACES

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## ABSTRACT

In this paper, we introduce a new class of set namely nano bT -closed sets in nano topological space. We also discussed some properties of nano bT closed set.

**Keywords**: Nano T closed and nano bT-closed.

## 1. INTRODUCTION

Nano topological space was introduced (Lellis Thivagar and Camel Richard, 2013a, b) with respect to a subset X of a universe which is defined in terms of lower and upper approximations of X. He also established certain weak forms of nano open sets such as nano α – open sets, nano semi- open sets and nano pre open sets. b- open sets in topological spaces was introduced and studied (Andrijevic,1996). Several properties of a new type of sets called supra T-closed set and supra T-continuous maps was studied (Arockiarani and Trintia Pricilla, 2011). Also a new class of bT – closed set in supra topological spaces was introduced and studied (Krishnaveni and Vigneshwaran, 2013). In this paper, we introduced a new class of set called nano bT- closed sets and study its basic properties.

## 2. PRELIMINARIES

*2.1. Definition*

Let U be a non-empty finite set of objects called the universe and R be an equivalence relation on U named as the indiscernibility relation. Then U is divided into disjoint equivalence classes. Elements belonging to the same equivalence class are said to be indiscernible with one another. The pair (U,R) is said to be the approximation space. Let $X \subseteq U$.

(i) The lower approximation of X with respect to R is the set of all objects, which can be for certainly classified as X with respect to R and it is denoted by $L_R(X)$.That is $L_R(X) = \bigcup_{x \in U}\{R(x): R(x) \subseteq X\}$ ,where R(x) denotes the equivalence class determined by $x \in U$.

(ii) The upper approximation of X with respect to R is the set of all objects, which can be possibly classified as X with respect to R and it is denoted by $U_R(X)$.

That is $U_R(X) = \bigcup_{x \in U}\{R(x): R(x) \cap X \neq \phi\}$

(iii) The boundary region of X with respect to R is the set of all objects, which can be classified neither as X nor as not-X with respect to R and it is denoted by $B_R(X)$.

That is, $B_R(X) = U_R(X) - L_R(X)$.

*2.2. Property*

If (U,R) is an approximation space and $X, Y \subseteq U$, then

(i) $L_R(X) \subseteq X \subseteq U_R(X)$.

(ii) $L_R(\phi) = U_R(\phi) = \phi$ and $L_R(U) = U_R(U) = U$

(iii) $U_R(X \cup Y) = U_R(X) \cup U_R(Y)$

(iv) $U_R(X \cap Y) = U_R(X) \cap U_R(Y)$

(v) $L_R(X \cup Y) = L_R(X) \cup L_R(Y)$

(vi) $L_R(X \cap Y) = L_R(X) \cap L_R(Y)$

(vii) $L_R(X) \subseteq L_R(Y)$ and $U_R(X) \subseteq U_R(Y)$ whenever $X \subseteq Y$

(viii) $U_R(X^c) = [L_R(X)]^c$ and $L_R(X^c) = [U_R(X)]^c$

(ix) $U_R U_R(X) = L_R U_R(X) = U_R(X)$

(x) $L_R L_R(X) = U_R L_R(X) = L_R(X)$.

*2.3. Definition*

Let U be the universe, R be an equivalence relation on U and $\tau_R(X) = \{U, \phi, L_R(X), U_R(X), B_R(X)\}$, where $X \subseteq U$. Then by property 2.2, $\tau_R(X)$ satisfies the following axioms:

(i) U and $\phi \in \tau_R(X)$.

(ii) The union of the elements of any subcollection of $\tau_R(X)$ is in $\tau_R(X)$.

(iii) The intersection of the elements of any finite subcollection of $\tau_R(X)$ is in $\tau_R(X)$.

That is, $\tau_R(X)$ is a topology on U called the nano topology on U with respect to X. We call $(U, \tau_R(X))$ as the nano topological space. The elements of $\tau_R(X)$ are called as nano open sets.

*2.4. Definition*

If $(U, \tau_R(X))$ is a nano topological space with respect to X where $X \subseteq U$ and if $A \subseteq U$, then the nano interior of A is defined as the union of all nano open subsets of A and it is denoted by Nint(A). That is, Nint(A) is the largest nano open subset of A. The nano closure of A is defined as the intersection of all nano closed sets containing A and it is denoted by Ncl(A).

That is, Ncl(A) is the smallest nano closed set containing A.

*2.5. Definition*

A subset A of a topological space $(X,\tau)$ is said to be b-open

if $A \subseteq cl(int(A)) \cup int(cl(A))$. The complement of b- open set is called a b – closed set.

*2.6. Definition*

A set A of X is called generalized b-closed set (simply gb–closed) if $bcl(A) \subseteq U$ whenever $A \subseteq U$ and U is open. The complement of generalized b-closed set is generalized b-open set.

*2.7. Definition*

Let $(X,\mu)$ is a supra topological spaces. A subset A of $(X,\mu)$ is called $T^{\mu}$-closed set if $bcl^{\mu}(A) \subseteq U$ whenever $A \subseteq U$ and U is $g^{\mu}b$ - open in $(X,\mu)$. The complement of $T^{\mu}$- closed set is called $T^{\mu}$-open set.

*2.8. Definition*

A subset A of a topological space $(X,\tau)$ is called regular open if $A = cl(int(A))$. The complement of regular open set is called regular closed set .

*2.9. Definition*

A subset A of a topological space $(X,\tau)$ is called generalized b- regular closed set if $bcl(A) \subseteq U$ and whenever $A \subseteq U$ and U is regular open of $(X,\tau)$. The complement of generalized b- regular closed set is called generalized b- regular open set.

*2.10. Definition*

A subset A of a supra topological space $(X, \mu)$ is called $bT^{\mu}$-closed set (Krishnaveni and Vigneshwaran, 2013) if $bcl^{\mu}(A) \subseteq U$ whenever $A \subseteq U$ and U is $T^{\mu}$- open in $(X, \mu)$.

## 3. NANO bT-CLOSED SET

*3.1. Definition*

Let $(U,\tau R(X))$ be a nano topological space. A subset A of $(U,\tau R(X))$ is called nano T - closed set if $Nbcl(A) \subseteq U$ whenever $A \subseteq U$ and U is nano gb- open in $(U,\tau R(X))$.

*3.2. Example*

Let U = {a,b,c,d} with U/R = {{a},{d},{b,c}} and X = {a,c}. Then the nano topology $\tau_R(X)$ = {U,ϕ,{a},{b,c},{a,b,c}}. The nano T closed sets are U, ϕ, {a}, {b}, {c}, {d}, {a,d}, {b,c}, {c,d}, {b,c,d}, {a,c,d} and{a,b,d}.

*3.3. Definition*

Let $(U,\tau R(X))$ be a nano topological space. A subset A of $(U,\tau R(X))$ is called nano bT - closed set if $Nbcl(A) \subseteq U$ whenever $A \subseteq U$ and U is nano T - open in $(U,\tau R(X))$. The complement of nano bT - closed set is called nano bT -open set

*3.4. Example*

Let U = {a,b,c,d} with U/R = {{a},{d},{b,c}} and X = {a,c}. Then the nano topology $\tau_R(X)$ = {U,ϕ,{a},{b,c},{a,b,c}}. The nano bT closed sets are U, ϕ, {a}, {b}, {c}, {d}, {a,d}, {b,c}, {c,d}, {b,c,d}, {a,c,d},{a,b,d} and {a,b,c}.

*3.5. Theorem*

Every nano closed set is nano bT closed.

**Proof** Let $A \subseteq U$ and U is nano T- open set. Since A is nano closed then $Ncl(A) = A \subseteq U$. We know that $Nbcl(A) \subseteq Ncl(A) \subseteq U$, implies $Nbcl(A) \subseteq U$. Therefore A is nano bT - closed.

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

*3.6. Example*

Let U = {a,b,c,d} with U/R = {{a},{d},{b,c}} and X = {a,c}. Then the nano topology $\tau_R(X)$ = {U,ϕ,{a},{b,c},{a,b,c}}. The nano closed sets are U,ϕ,{b,c,d},{a,d} and {d}.

The nano bT closed sets are U, ϕ, {a}, {b}, {c}, {d}, {a,d}, {b,c}, {c,d}, {b,d}, {b,c,d}, {a,c,d}, {a,b,d} and {a,b,c}. Here the sets {b}, {a}, {c}, {d}, {b,c}, {c,d}, {a,c,d}, {a,b,d} and {a,b,c} are nano bT closed sets but not in nano closed sets.

*3.7. Theorem*

Every nano b closed set is nano bT closed.

**Proof** Let $A \subseteq U$ and U is nano T- open set. Since A is nano b closed then $Nbcl(A) \subseteq U$. Therefore A is nano bT - closed.

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

*3.8. Example*

Let U = {a,b,c,d} with U/R = {{a},{d},{b,c}} and X = {a,c}. Then the nano topology $\tau_R(X)$ = {U,ϕ,{a},{b,c},{a,b,c}}. The nano b closed sets are U,ϕ,{b,c,d}, {a,c,d}, {a,b,d}, {c,d}, {b,d}, {a,d}, {b,c},{a},{b},{c}and{d}.The nano bT closed sets are U, ϕ, {a}, {b}, {c}, {d}, {a,d}, {b,c}, {c,d}, {b,c,d}, {a,c,d},{a,b,d}and{a,b,c}. Here the set {a,b,c} is nano bT closed sets but not in nano b closed set.

*3.9. Theorem*

Every nano bT - closed set is nano gb - closed set.

**Proof** Let $A \subseteq U$ and U is nano open set. We know that every nano open set is nano T - open set , then U is nano T- open set. Since A is nano bT -closed set, we have $Nbcl(A) \subseteq U$. Therefore A is nano gb-closed set.

*3.10. Example*

Let U = {a,b,c,d} with U/R = {{a},{c},{b,d}} and X = {b,d}. Then the nano topology $\tau_R(X)$ = {U,ϕ,{b,d}}. The nano gb closed sets are U, ϕ,{b,c,d}, {a,c,d}, {a,b,d}, {a,b,c}, {c,d}, {a,b},{a,c},{a,d}, {b,c}, {a},{b}, {c} and {d}.The nano bT closed sets are U, ϕ, {a}, {b}, {c}, {d}, {a,d}, {b,c}, {c,d},{a,b},{a,c},{a,c,d} and {a,b,c}. Here the set {b,c,d} and {a,b,d} is nano gb closed sets but not nano bT closed set.

*3.11. Theorem*

Every Nano bT- closed set is nano gbr - closed set.

**Proof** Let $A \subseteq U$ and U is nano regular open set. We know that every nano regular open set is nano T-open set, then U is nano T-open set. Since A is nano bT -closed set, we have $Nbcl(A) \subseteq U$. Therefore A is nano gbr- closed set.

*3.12. Example*

Let U = {a,b,c,d} with U/R = {{a},{d},{b,c}} and X = {a,c}. Then the nano topology $\tau_R(X)$ = {U,ϕ,{a},{b,c},{a,b,c}}. The nano gbr closed sets are U,ϕ, {a,b,c}, {b,c,d}, {a,c,d}, {a,b,d},{a,b}, {a,c} {c,d}, {b,d}, {a,d}, {b,c},{a},{b},{c}and{d}. The nano bT closed sets are U, ϕ, {a}, {b}, {c}, {d}, {a,d}, {b,c}, {c,d}, {b,c,d}, {a,c,d},{a,b,d} and {a,b,c}. Here the sets {a,b}, {a,c} and {b,d} is nano gbr closed sets but not in nano bT closed set.

*3.13. Theorem*

The union of two nano bT - closed set is nano bT- closed set.

**Proof** Let A and B two nano bT - closed set. Let $A \cup B \subseteq G$, where G is nano T - open. Since A and B are nano bT-closed sets. Therefore $Nbcl(A) \cup Nbcl(B) \subseteq G$. Thus $Nbcl(A \cup B) \subseteq G$. Hence $A \cup B$ is Nano bT- closed set.

*3.14. Theorem*

Let A be nano bT -closed set of (U,X). Then Nbcl (A) - A does not contain any non empty nano T- closed set.

**Proof: Necessity** Let A be nano bT - closed set. suppose $F \neq \phi$ is a nano T - closed set of Nbcl (A) - A. Then $F \subseteq Nbcl(A) - A$ implies $F \subseteq Nbcl(A)$ and $A^c$. This implies $A \subseteq F^c$. Since A is nano bT - closed set, $Nbcl(A) \subseteq U^c$.Consequently, $F \subseteq [Nbcl(A)]^c$.Hence $F \subseteq Nbcl(A) \cap [Nbcl(A)]^c = \phi$. Therefore F is empty , a contradition.

**Sufficiency:** Suppose $A \subseteq U$ and that U is nano T - open. If $Nbcl(A) \not\subset U$. Then $Nbcl(A) \cap U^c$ is a not empty nano T- closed subset of Nbcl(A) - A.

Hence $Nbcl(A) \cap U^c = \phi$ and $Nbcl(A) \subseteq U$.Therefore A is nano bT - closed.

*3.15. Theorem*

If A is nano bT - closed set in a supra topological space (U,X) and $A \subseteq B \subseteq Nbcl(A)$ then B is also nano bT- closed set.

**Proof** Let U be nano T- open in set (U,X) such that $B \subseteq U$. Since $A \subseteq B \Rightarrow A \subseteq U$ and since A is nano

bT -closed set in (U,X). Nbcl (A) $\subseteq$ U, since B $\subseteq$ Nbcl(A). Then N bcl(B) $\subseteq$U. Therefore B is also nano bT - closed set in (U,X)

*3.16. Theorem*

Let A be nano bT - closed set then A is nano b- closed if Nbcl(A)-A is nano T- closed.

**Proof** Let A be nano bT- closed set. If A is nano b- closed, we have N bcl (A) - A =$\phi$ , which is nano T-closed. Conversely, let N bcl(A)-A is nano bT - closed. Then by the theorem 3.13, Nbcl (A) - A does not contain any non empty nano T- closed and N bcl (A)-A=$\phi$. Hence A is nano b - closed.

*3.17. Theorem*

A subset A$\subseteq$X is nano bT - open iff F $\subseteq$ N bint(A) whenever F is nano T - closed and F$\subseteq$ A.

**Proof** Let A be nano bT - open set and suppose F$\subseteq$ A, where F is nano T- closed. Then X-A is nano bT - closed set contained in the nano T - open set X-F. Hence N bcl (X-A )$\subseteq$ X-F. Thus F$\subseteq$ N bint(A). Conversely, if F is nano T - closed set with F$\subseteq$ Nbint(A) and F$\subseteq$A , then X-Nbint(A) $\subseteq$X – F. This implies that N bcl(X-A) $\subseteq$ X-F. Hence X-A is nano bT - closed. Therefore A is nano bT - open set.

*3.18. Theorem*

If B is nano T- open and nano bT - closed set in X, then B is nano b- closed.

**Proof** Since B is nano T- open and nano bT - closed then Nbcl (B) $\subseteq$ B, but B$\subseteq$ Nbcl(B). Therefore B=Nbcl(B).Hence B is nano b - closed.

*3.19. Corollary*

If B is nano open and nano bT - closed set in X. Then B is nano b-closed.

*3.20. Theorem*

Let A be nano g b-open and nano bT - closed set. Then A$\cap$ F is nanoT- closed whenever F is nano b- closed.

**Proof** Let A be nano g b-open and nano bT-closed set then Nbcl (A)$\subseteq$ A and also A$\subseteq$ Nbcl (A). Therefore N bcl (A) = A. Hence A is nano b-closed. Since F is nano b-closed. Therefore A$\cap$ F is nano b - closed in X. Hence A$\cap$ F is nano T - closed in X.

From the above theorem and example we have the following diagram

nano closed
↓
nano b closed
↓
**nano bT-closed** → nano gb-closed
↓
nano gbr-closed

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# b-CHROMATIC NUMBER OF CORONA PRODUCT OF CROWN GRAPH AND COMPLETE BIPARTITE GRAPH WITH PATH GRAPH

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**ABSTRACT**

A b-coloring of a graph is a proper coloring where each color admits at least one node (called dominating node) adjacent to every other used color. The maximum number of colors needed to b-color a graph G is called the b-chromatic number and is denoted by φ(G). In this paper, we find the b-chromatic number and some of the structural properties of corona product of crown graph and complete bipartite graph with path graph.

**Keywords:** Corona product, crown graph, complete bipartite graph, path graph.

## 1. INTRODUCTION

A b-coloring by k-colors is a proper coloring of the vertices of graph G such that in each color classes there exists a vertex that has neighbors in all the other k-1 color classes. The b-chromatic number φ(G) is the largest number k for which G admits a b-coloring with k-colors (Irving and Manlove, 1999). The corona G1 ◦ G2 of two graphs G1 and G2 is defined as a graph obtained by taking one copy of G1 (which has p1 vertices) and p1 copies of G2 and attach one copy of G2 at every vertex of G1 (Harary, 1972).

In this paper we find for which the largest number k for which corona product of crown graph and complete bipartite graph with path graph admits a b-coloring with k-colors. And also we find some of its structural properties (Venkatachalam and Vernold Vivin, 2010; Vernold Vivin and Venkatachalam, 2012; Vijayalakshmi and Thilagavathi, 2012)

## 2. Definition

### *2.1. Crown Graph*

A crown graph on 2n vertices is an undirected graph with two sets of vertices $u_i$ and $v_i$ and with an edge from $u_i$ to $v_j$ whenever $i \neq j$. The crown graph can be viewed as a complete bipartite graph from which the edges of a perfect matching have been removed (Wikipedia).

### *2.2. Complete Bipartite Graph*

A complete bipartite graph is a graph whose vertices can be partitioned into two subsets $V_1$ and $V_2$ such that no edge has both endpoints in the same subset, and every possible edge that could connect vertices in different subsets is part of the graph. That is, it is a bipartite graph ($V_1$, $V_2$, $E$) such that for every two vertices $v_1 \in V_1$ and $v_2 \in V_2$, $v_1v_2$ is an edge in $E$. A complete bipartite graph with partitions of size $|V_1|=m$ and $|V_2|=n$, is denoted $K_{m,n}$ (Balakrishnan, 2004; Balakrishnan and Ranganathan, 2012).

### *2.3. Fan Graph*

A Fan graph $F_{m,n}$ is defined as the graph join and $K_m$ , where $K_m$ the empty graph on nodes is and $P_n$ is the path on n nodes (Wikipedia).

### *2.4. Path Graph*

The path graph $P_n$ is a tree with two nodes of vertex degree 1, and the other n-2 nodes of vertex degree (Harary, 1972).

### *2.5. Corona Product*

Corona product or simply corona of any graph G1 and graph G2, defined as the graph which is the disjoint union of one copy of G1 and |V1| copies of G2 (|V1| is the number of vertices of G1) in which each vertex of the copy of G1 is connected to all vertices of a separate copy of G2 (Harary, 1972).

### *2.6. b-coloring*

A b-coloring of a graph is a proper coloring such that every color class contains a vertex that is adjacent to all other color classes. The b-chromatic number of a graph G, denoted by φ (G), is the maximum number t such that G admits a b-coloring with t colors (Irving and Manlove, 1999).

## 3. CORONA PRODUCT OF CROWN GRAPH WITH PATH GRAPH

*3.1. b-chromatic number of corona product of Crown Graph with Path Graph*

*3.1.1. Theorem*

For any n ≥ 3, $\varphi[S_n^0 \circ P_n] = 2n$.

Proof: Let $S_n^0$ be any Crown graph with vertices, V = $\{v_1, v_2, \ldots, v_n\}$ and $V' = \{v'_1, v'_2, \ldots, v'_n\}$ i.e. $V(S_n^0)$ = V U $V'$. Let the edges of $L_n$ be $E(S_n^0)=\{e_j : 1 \le j \le n^2 - n\}$ where $e_j$ is the edge connecting $v_i$ and $v_j$ for every $i \neq j$.

Let $P_n$ be ant path graph of length n-1 with n-vertices. $V(p_n') = \{u_{ij} : 1 \le i \le 2n, 1 \le l \le n, 1 \le j \le n\}$ and and $E(P_n)$ be $\{e_{pi} : 2n - 1 \le i \le n-1\}$.

By the definition of corona graph each vertex in $S_n^0$ is adjacent to every vertex copy of $P_n$, i.e. vertices of $V(L_n \circ P_n) = V(S_n^0) \cup V(P_n)$ .Let $E[S_n^0 \circ P_n]$ be $E(S_n^0)$ U $E(P_n)$ U$\{e_i : n^2 - n + 1 \le i \le 5n^2 - 3n\}$.

Consider the color class C = $\{c_1, c_2, , c_3, \ldots, c_n, c_{n+1}, c_{n+2}, \ldots, c_{2n}\}$ to color the vertices of $(S_n^0 \circ P_n)$. Assign the colors $c_1, c_2, , c_3, \ldots, c_n$ to $v_1, v_2, \ldots, v_n$, *i.e.* $v_i$'s and $c_{n+1}, c_{n+2}, \ldots, c_{2n}$ to $v'_j$'s , j = 1,2,3,...,n respectively for every i≠ j, i,j= 1,2,...,n.

From the figure we see that, each $v'_i$'s are adjacent to every $v'_j$'s for every i not equal to j and vice versa. Hence both $v'_i$'s and $v'_j$'s earns its adjacent color for every i≠ j. To make the above coloring to be b-chromatic proper coloring of $V(p_n')$ by corresponding non-adjacent vertices of its $v_i$'s or $v'_j$'s respectively. Thus each color has the neighbour in the every other color class. Thus, $\varphi[(S_n^0 \circ P_n] = 2n$.

Let us assume that $\varphi[S_n^0 \circ P_n] > 2n$, let it be $\varphi[S_n^0 \circ P_n] = 2n+1$. The graph $[S_n^0 \circ P_n]$ must requires 2n+2 vertices of degree 2n+1, all with distinct color and each must have adjacent with all of the other color class, but at least one color class which does not have a color dominating vertex in $[S_n^0 \circ P_n]$, which invalidates the definition of b-coloring. Hence, $\varphi[S_n^0 \circ P_n]$ not equal to 2n+1, it must be less than 2n+1 i.e. $\varphi[S_n^0 \circ P_n] = 2n$ . Thus, for any n ≥3, the b-chromatic number of corona graph of crown graph with path graph is 2n.

*3.2. Illustration: b-coloring of corona product of Crown Graph with Path Graph*

*3.2.1. Theorem*

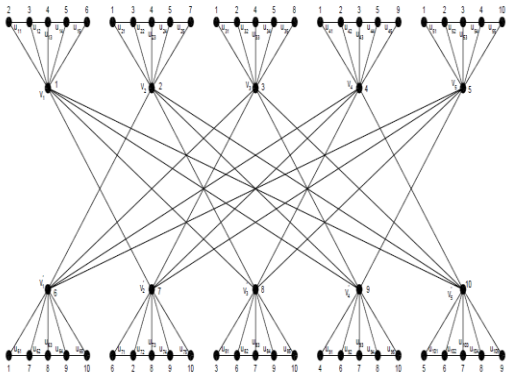
For any n ≥ 3, $q[S_n^0 \circ P_n] = 5n^2 - 3n$

Proof: $q[(S_n^0 \circ P_n]$ = Number of edges in $S_n^0$+ 2n x Number of edges in $F_n$

$= n^2 - n + 2n(2n-1)$

$= n^2 - n + 4n^2 - 2n - 1.$

$= 5n^2 - 3n.$



$\varphi[S_5^0 \circ P_5] = 10$

*3.2.1. Theorem*

For any n ≥ 3, the vertex polynomial of $(S_n^0 \circ P_n)$ be $4nx^2 + (2n^2 - 4n)x^3 + 4x^{n+2}$

Proof: $V((S_n^0 \circ P_n; x) = \sum_{k=1}^{\Delta(G)} V_k x^k$

= No of vertices having degree $2 \times x^2$ +

No of vertices having degree $3 \times x^3$ +

No of vertices having degree $n+2 \times x^{n+2}$

$= 4nx^2 + (2n^2 - 4n)x^3 + 2n\, x^{n+2}$.

*3.2.3. Some Structural Properties of $(S_n^0 \circ P_n) n \ge 3$.*

| Properties Graphs | No. of Vertex | No. of Edges | Maximum Degree | Minimum Degree | Vertex Polynomial |
|---|---|---|---|---|---|
| Path Graph | n | n-1 | 2 | 1 | $2x+(n-2)x^2$ |
| Crown Graph | 2n | $n^2$-n | n-1 | n-1 | $(n^2 - n)x^{n-1}$ |
| $(S_n^0 \circ P_n)$ | 2n(n+1) | $5n^2 - 3n$ | 2n-1 | 2 | $4nx^2 + (2n^2 - 4n)x^3 + (2n)x^{n+}$ |

## 4. CORONA PRODUCT OF COMPLETE BIPARTITE GRAPH WITH PATH GRAPH

*4.1. b-chromatic number on Corona Product of Complete Bipartite Graph with Path Graph*

*4.1.1. Theorem*

For any n ≥ 3, $\varphi[K_{mn} \circ P_n] = \begin{cases} 2n & m = n \\ 2n+1 & m > n \\ 2n-1 & m < n \end{cases}$

Proof: Let $K_{mn}$ be any complete bipartite graph with vertices, V = $\{v_1, v_2, \ldots, v_n\}$ and $V' = \{v'_1, v'_2, \ldots, v'_n\}$ i.e. $V(K_{mn})$ = V U $V'$. Let the edges $K_{mn}$ of be $E(K_{mn}) = \{e_j : 1 \le j \le n^2\}$ where $e_j$ is the edge connecting $v_i$ and $v'_j$.

Let $P_n$ be ant path graph of length n-1 with n-vertices. $V(p'_n) = \{u_{ij} : 1 \le i \le 2n, 1 \le l \le n, 1 \le j \le n\}$ and $E(P_n)$ be $\{e_{pi} : 2n - 1 \le i \le n-1\}$

By the definition of corona graph each vertex in $K_{m,n}$ is adjacent to every vertex copy of $P_n$, i.e. vertices of $V(K_{mn} \circ P_n) = V(K_{mn})\ UV(P_n)$.

Let the edges of $K_{mn} \circ P_n$ be $E[K_{m,n} \circ P_n] = E(K_{m,n})$ U $E(P_n)$U $\{e_i : n^2 + 1 \le i \le 5n^2 - 2n\}$, for m =n, $E[K_{m,n} \circ P_n] = E(K_{m,n})$ U $E(P_n)$U $\{e_i : n^2 + 1 \le i \le 5n^2 - 5n + 1\}$, for m < n, $E[K_{m,n} \circ P_n] = E(K_{m,n})$ U $E(P_n)$U $\{e_i : n^2 + 1 \le i \le 5n^2 + n - 1\}$, for m > n.

Consider the color class C = $\{c_1, c_2, , c_3, \ldots, c_n, c_{n+1}, c_{n+2}, \ldots, c_{2n+1}\}$ to color the vertices of $(K_{m,n} \circ P_n)$. The proof follows from the following cases.

Case (i) m=n

Consider the color class $C'_1$ = $\{c_1, c_2, , c_3, \ldots, c_n, c_{n+1}, c_{n+2}, \ldots, c_{2n}\}$ to color the vertices of $K(_{m,n} \circ P_n), m = n$. Assign the colors $c_1, c_2, , c_3, \ldots, c_n$ to $v_1, v_2, \ldots, v_n$, $i.e.\ v'_i$ 's and $c_{n+1}, c_{n+2}, \ldots, c_m$ to $v'_j$ 's , j = 1,2,3,...,m respectively.

From the figure we assure that, each $v'_i$ 's are adjacent to every $v'_j$ 's for and vice versa. Hence both $v'_i$ 's and $v'_j$ 's earns its adjacent color. To make the above coloring to be b-chromatic proper coloring of $V(p'_n)$ by corresponding non-adjacent vertices of its $v_i$'s or $v'_j$'s respectively,and the remaining vertices are colored properly by the colors in the color class. Thus each color has the neighbor in the every other color class. Thus, $\varphi[K_{m,n} \circ P_n]$ = 2n.

Let us assume that $\varphi[(K_{m,n} \circ P_n] > 2n$, say $\varphi[K_{m,n} \circ P_n] = 2n+1$. The graph $[K_{m,n} \circ P_n]$ must requires 2n+2 vertices of degree 2n+1, all with distinct color and each must have adjacent with all of the other color class which is not possible, since maximum degree of $K_{m,n} \circ P_n$ is 2n, hence at least one color class does not have the color dominating vertex, which contradicts the definition of b-coloring. Hence, $\varphi[K_{m,n} \circ P_n]$ not equal to 2n+1, must be less than 2n+1 i.e. $\varphi[K_{m,n} \circ P_n] = 2n$ . Thus, for any n ≥3, the b-chromatic number of corona graph of complete bipartite graph with path graph is 2n for each m = n.

Case (ii) m>n

Consider the color class $C'_2$ = $\{c_1, c_2, , c_3, \ldots, c_n, c_{n+1}, c_{n+2}, \ldots, c_{2n+1}\}$ to color the vertices of $K(_{m,n} \circ P_n), m < n$. Assign the colors $c_1, c_2, , c_3, \ldots, c_n$ to $v_1, v_2, \ldots, v_n$, i.e. $v'_i$ 's and $c_{n+1}, c_{n+2}, \ldots, c_{2n+1}$ to $v'_j$ 's , j = 1,2,3,...,m respectively.

The remaining proof of the theorem follows immediately from case (i). Hence $\varphi[K_{m,n} \circ P_n] = 2n+1, m > n$.

Case (iii) m<n

Consider the color class $C'_2$ = $\{c_1, c_2, , c_3, \ldots, c_n, c_{n+1}, c_{n+2}, \ldots, c_{2n-1}\}$ to color the vertices of $K(_{m,n} \circ P_n), m < n$. Assign the colors $c_1, c_2, , c_3, \ldots, c_n$ to $v_1, v_2, \ldots, v_n$, i.e. $v'_i$ 's and $c_{n+1}, c_{n+2}, \ldots, c_{2n-1}$ to $v'_j$ 's , j = 1,2,3,...,m respectively.

The remaining proof of the theorem follows immediately from case (i). Hence $\varphi[K_{m,n} \circ P_n] = 2n-1, m < n$. Hence the proof.

*4.1.1. Illustration Corona Product of Complete Bipartite Graph with Path Graph*

*4.1.2. Theorem*

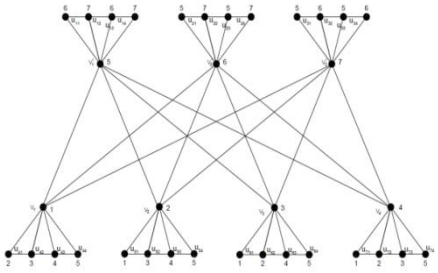
For any m, n ≥ 3, $q[(K_{m,n} \circ P_n)] = 2n^2 + 3mn - m - n$.

Proof: $q[(S_n^0 \circ P_n]$ = Number of edges in $K_{m,n}$ + 2n x Number of edges in Fan graph $F_n$

= mn+ (m+n) (2n-1)

= mn+2mn-m+2$n^2$ − n .

= 2$n^2$ + 3mn − m − n.



$\varphi[K_{3,4} \circ P_4] = 7$

*4.1.3. Theorem*

For any m, n ≥ 3, the vertex polynomial of be( $K_{m,n} \circ P_n$) $4nx^2 + (2n^2 - 4n)x^3 + 2nx^{2n}$, m=n.

Proof: V( $K_{m,n} \circ P_n$; x) = $\sum_{k=1}^{\Delta(G)} V_k x^k$

= No of vertices having degree 2× $x^2$ +

No of vertices having degree 3× $x^3$ +

No of vertices having degree 2n× $x^{2n}$+

= $4nx^2 + (2n^2 - 4n)x^3 + 2n\, x^{n+2}$.

*4.1.4. Theorem*

For any m, n ≥ 3, the vertex polynomial of be( $K_{m,n} \circ P_n$) $4nx^2 + (2n^2 - 4n)x^3 + 2nx^{2n}$, m > n.

Proof: V( $K_{m,n} \circ P_n$; x) = $\sum_{k=1}^{\Delta(G)} V_k x^k$

= No of vertices having degree 2× $x^2$ +

No of vertices having degree 3× $x^3$ +

No of vertices having degree 2n-1× $x^{2n+1}$

$=(4n-2)x^2 + (2n^2 - 3n - 2)x^3 + (2n+1)x^{2n+1}$ .

*4.4.5. Some Structural Properties of ( $K_{m,n} \circ P_n$), n ≥ 3.*

| Properties Graphs | Number of Vertex | Number of Edges | Maximum Degree | Minimum Degree | Vertex Polynomial |
|---|---|---|---|---|---|
| Path Graph | n | n-1 | 2 | 1 | 2x+(n-2)$x^2$ |
| Complete Bipartite Graph | m+n | $n^2$ | max{m,n} | min{m,n} | $(2n)x^n$ |
| ($K_{m,n} \circ P_n$) m = n | $2n^2$ + 2n | $5n^2$ − 2n | 2n | 2 | $4nx^2 + (2n^2 - 4n)x^3 + 2nx^{2n}$ |
| ($K_{m,n} \circ P_n$) m < n | $2n^2$ +n-1 | $5n^2$ −5n+1 | 2n | 2 | $(4n-2)x^2 + (2n^2 - 5n + 2)x^3 + nx^{2n-1} + (n - 1)x^{2n}$ |
| ($K_{m,n} \circ P_n$) m > n | $2n^2$ +3n+1 | $5n^2$ +n-1 | 2n+1 | 2 | $(4n+2)x^2 + (2n^2 - 3n - 2)x^3 + (2n+1)x^{2n+1}$ |

**5. CONCLUSION**

In this paper we operated the graph operation corona product on crown graph and complete bipartite graph with path graph, we get corona product of crown graph with path graph and corona product of complete bipartite graph with path graph and also we find its b-chromatic number and some of its structural properties.

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# ON $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ AND $\widetilde{\alpha\delta}^{\theta\#}\mathcal{A}$ IN TOPOLOGICAL SPACES

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**ABSTRACT**

In (Devi *et al*., 2012), the authors introduced the notion of $\alpha\delta$-closed sets and investigated its fundamental properties. In this paper, we investigate some more properties of this type of closed spaces.

**Keywords:** $\widetilde{\alpha\delta}^{\theta\#}$-convergence and $\widetilde{\alpha\delta}^{\theta\#}$-adherence.

## 1. INTRODUCTION

Generalized open sets play a very important role in General Topology and they are now the research topics of many topologists worldwide. Indeed a significant theme in General Topology and Real Analysis concerns the variously modified forms of continuity, separation axioms etc. by utilizing generalized open sets and the idea of grills on a topological space was first introduced by Choquet. The concept of grills has shown to be a powerful supporting and useful tool like nets and filters, for getting a deeper insight into further studying some topological notions such as proximity spaces, closure spaces and the theory of compactifications and extension problems of different kinds.

Throughout the present paper, spaces $X$ and $Y$ always mean topological spaces. Let $X$ be a topological space and $A$ a subset of $X$. For a subset $A$ of a topological space $(X, \tau)$, $cl(A)$ and $int(A)$denote the closure of $A$ and the interior of $A$, respectively. A subset $A$ is said to be regular open (resp. regular closed) if $A = int(cl(A))$ (resp. $A = cl(int(A))$, The $\delta$-interior of a subset $A$ of $X$ is the union of all regular open sets of $X$ contained in $A$ and is denoted by $Int_\delta(A)$.The subset $A$ is called $\delta$-open if $A = Int_\delta(A)$, i.e., a set is $\delta$-open if it is the union of regular open sets. The complement of a $\delta$-open set is called $\delta$ -closed. Alternatively, a set$A \subset (X, \tau)$ is called $\delta$-closed if $A = cl_\delta(A)$, where $cl_\delta(A) = \{x/x \in U \in \tau \Rightarrow int(cl(A)) \cap A \neq \varphi$. The family of all $\delta$-open (resp. $\delta$-closed) sets in $X$ is denoted by $\delta O(X)$ (resp. $\delta C(X)$).

A subset $A$ of X is called semiopen (Kokilavani and Basker, 2012d) (resp. $\alpha$-open (Roy and Mukherjee, 2009), $\delta$-semiopen) if $A \subset cl(int(A))$ (resp.$A \subset int(cl(int(A)))$, $A \subset cl(Int_\delta(A))$) and the complement of a semiopen(resp. $\alpha$-open, $\delta$-semiopen) are called semiclosed(resp. $\alpha$-closed, $\delta$-semiclosed). The intersection of all semiclosed (resp. $\alpha$-closed, $\delta$-semiclosed) sets containing $A$ is called the semi-closure(resp. $\alpha$-closure, $\delta$-semiclosure) of A and is denoted by $scl(A)$(resp.$\alpha cl(A)$, $\delta\text{-}scl(A)$). Dually, semi-interior(resp. $\alpha$-interior, $\delta$-semi-nterior) of $A$ is defined to be the union of all semiopen (resp. $\alpha$-open,$\delta$-semiopen) sets contained in $A$ and is denoted by $sint(A)$(resp.$\alpha int(A)$, $\delta\text{-}sint(A)$). Note that $\delta\text{-}scl(A) = A \cup int(cl_\delta(A))$ and $\delta\text{-}sint(A) = A \cup cl(Int_\delta(A))$.In (Devi *et al*., 2012), the authors introduced the notion of $\alpha\delta$-closedspaces and investigated its fundamental properties. In this paper, we investigate some more properties of this type of closed spaces.

Before entering to our work, we recall the following definitions, which are useful in the sequel.

**Definition 1.1.** (Devi *et al*., 2012) A subset $A$ of a space $X$ is said to be

(a) An $\alpha$-generalized closed ($\alpha g$-closed) set if $\alpha cl(A) \subseteq U$whenever $A \subseteq U$ and $U$ is $\alpha$-open in $(X, \tau)$.

(b) A $\alpha\delta$-closed set if $cl_\delta(A) \subseteq U$whenever $A \subseteq U$ and $U$ is $\alpha g$-open in $(X, \tau)$.

## 2. $\widetilde{\alpha\delta}^{\theta\#}$-CONVERGENCE AND $\widetilde{\alpha\delta}^{\theta\#}$-ADHERENCE

**Definition 2.1.** (Choquet, 1947) A grill $\mathcal{G}$on a topological space $(X, \tau)$is defined to be a collection of nonempty subsets of $X$such that $(i)\ A \in G$ and $A \subset B \subset X \Rightarrow B \in G$ and $(ii)\ A, B \subset X$and $A \cup B \in G \Rightarrow A \in G\ or\ B \in G$.

**Definition 2.2.** (Choquet, 1947) If $\mathcal{G}$is a grill (or a filter) on a space $(X, \tau)$, then the section of $\mathcal{G}$, denoted by $sec\,\mathcal{G}$, is given by $sec\,\mathcal{G} = \{A \subseteq X: A \cap G \neq \varphi\ , for\ all\ G \in \mathcal{G}\}$.

**Definition 2.3.** A grill $\mathcal{G}$ on a topological space $(X, \tau)$ is said to be an:

(a) $\widetilde{\alpha\delta}^{\theta\#}$-adhere (briefly. $\widetilde{\alpha\delta}^{\theta\#}\mathcal{A}$ ) at $x \in X$ if for each $U \in \alpha\delta O(x)$ and each $G \in \mathcal{G}$,$\alpha\delta_{Cl}(U) \cap G \neq \varphi$,

(b) $\widetilde{\alpha\delta}^{\theta\#}$-converge (briefly. $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ ) to a point $x \in X$ if for each $U \in \alpha\delta O(x)$, there is some $G \in \mathcal{G}$ such that $G \subseteq \alpha\delta_{Cl}(U)$ (in this case we shall also say that $\mathcal{G}$ is $\widetilde{\alpha\delta}^{\theta\#}$-convergent to $x$).

**Remark 2.4.** A grill $\mathcal{G}$ is $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ to a point $x \in X$ if and only if $\mathcal{G}$contains the collection $\{\alpha\delta_{Cl}(U) : U \in \alpha\delta O(x)\}$.

**Definition 2.5.** A filter $\mathcal{F}$on a space $(X, \tau)$ is said to $\widetilde{\alpha\delta}^{\theta\#}\mathcal{A}x \in X$ ($\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ to $x \in X$) if for each $F \in \mathcal{F}$and each $U \in \alpha\delta O(x)$, $F \cap \alpha\delta_{Cl}(U) \neq \varphi$ (resp. to each $U \in \alpha\delta O(x)$, there corresponds $F \in \mathcal{F}$such that $F \subseteq \alpha\delta_{Cl}(U)$.

We note at this stage that unlike the case of filters, the notion of $\widetilde{\alpha\delta}^{\theta\#}\mathcal{A}$ of a grill is strictly stronger than that of $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$. In fact, we have

**Theorem 2.6.** If a grill $\mathcal{G}$on a space$(X, \tau)$, $\widetilde{\alpha\delta}^{\theta\#}\mathcal{A}$ at some point $x \in X$, then $\mathcal{G}$ is $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ to $x$.

**Proof.** Let a grill $\mathcal{G}$ on $(X, \tau)$, $\widetilde{\alpha\delta}^{\theta\#}\mathcal{A}$ at $x \in X$. Then for each $U \in \alpha\delta O(x)$ and each $G \in \mathcal{G}$, $\alpha\delta_{Cl}(U) \cap G \neq \varphi$ so that $\alpha\delta_{Cl}(U) \in sec\,\mathcal{G}$,for each $U \in \alpha\delta O(x)$,and hence $X - \alpha\delta_{Cl}(U) \notin \mathcal{G}$. Then $\alpha\delta_{Cl}(U) \in \mathcal{G}$(as $\mathcal{G}$ is a grill and $X \in \mathcal{G}$), for each $U \in \alpha\delta O(x)$. Hence $\mathcal{G}$ must $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ to $x$.

The following example shows that a $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ grill need not $\widetilde{\alpha\delta}^{\theta\#}\mathcal{A}$ at any point of the space even if the space is finite.

**Example 2.7.** Let $X = \{a, b, c\}$ and $\tau = \{\varphi, X, \{a\}, \{b\}, \{a, b\}, \{a, c\}\}$ It is easy to verify that $(X, \tau)$ is a topological space such that $\alpha\delta O(X, x) = \tau$. Let $\mathcal{G} = \{\{b\}, \{a, b\}, \{b, c\}, X\}$. Then $\mathcal{G}$ is $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ but not $\widetilde{\alpha\delta}^{\theta\#}\mathcal{A}$.

**Remark 2.8.** Let $X$ be a topological space. Then for any $x \in X$, we adopt the following notation:

$\mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x) = \{A \subseteq X : x \in \widetilde{\alpha\delta}^{\theta\#}cl(A)\}$,

$sec\,\mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x) = \{A \subseteq X : A \cap G \neq \varphi\ , for\ all\ G \in \mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x)\}$.

In the next two theorems, we characterize the $\widetilde{\alpha\delta}^{\theta\#}\mathcal{A}$ and $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ of grills in terms of the above notations.

**Theorem 2.9.** A grill $\mathcal{G}$ on a space $(X, \tau)$, $\widetilde{\alpha\delta}^{\theta\#}\mathcal{A}$ to a point $x \in X$ if and only if $\mathcal{G} \subseteq \mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x)$.

**Proof.** A grill $\mathcal{G}$ on a space $(X, \tau)$. $\widetilde{\alpha\delta}^{\theta\#}\mathcal{A}$ at $x \in X$

$\Rightarrow \alpha\delta_{Cl}(U) \cap G \neq \varphi\ for\ all\ U \in \alpha\delta O(x)\ and\ all\ G \in \mathcal{G}$

$\Rightarrow x \in \widetilde{\alpha\delta}^{\theta\#}cl(G), for\ all\ G \in \mathcal{G}$

$\Rightarrow G \in \mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x), for\ all\ G \in \mathcal{G}$

$\Rightarrow \mathcal{G} \subseteq \mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x)$.

Conversely, let $\mathcal{G} \subseteq \mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x)$. Then for all $G \in \mathcal{G}$, $x \in \widetilde{\alpha\delta}^{\theta\#}cl(G)$, so that for all $U \in \alpha\delta O(x)$ and for all $G \in \mathcal{G}$, $\alpha\delta_{Cl}(U) \cap G \neq \varphi$. Hence $\mathcal{G}$ is $\widetilde{\alpha\delta}^{\theta\#}\mathcal{A}$ at $x$.

**Theorem 2.10.** A grill $\mathcal{G}$ on topological space $(X, \tau)$ is $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ to apoint $x$ of $X$ if and only if $\mathcal{G} \subseteq sec\,\mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x)$.

**Proof.** Let $\mathcal{G}$ be a grill on $X$, $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ to $x \in X$. Then for each $U \in \alpha\delta O(x)$, there exists $G \in \mathcal{G}$ such that $G \subseteq \alpha\delta_{Cl}(U)$, and hence $\alpha\delta_{Cl}(U) \in \mathcal{G}$ for each $U \in \alpha\delta O(x)$. Now, $B \in sec\,\mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x)$.

$\Rightarrow X - B \notin \mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x) \Rightarrow$ there exists $U \in \alpha\delta O(x)\ such\ that\ \alpha\delta_{Cl}(U) \cap (X - B) = \varphi \Rightarrow \alpha\delta_{Cl}(U) \subseteq B, where\ U \in \alpha\delta O(x) \Rightarrow B \in G$.

Conversely, let if possible, $\mathcal{G}$ not a $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ to $x$. Then for some $U \in \alpha\delta O(x)$, $\alpha\delta_{Cl}(U) \notin \mathcal{G}$ and hence $\alpha\delta_{Cl}(U) \notin sec\,\mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x)$. Thus for some $A \in \mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x)$, $A \cap \alpha\delta_{Cl}(U) = \varphi$. But $A \in \mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x)$

$\Rightarrow x \in \widetilde{\alpha\delta}^{\theta\#}cl(A)$.

$\Rightarrow \alpha\delta_{Cl}(U) \cap A \neq \varphi$. which is a contradiction.

**Theorem 2.11.** A grill $\mathcal{G}$ on a topological space $(X, \tau)$, $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ to a point $x$ of $(X, \tau)$if and only if $sec\,\mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x) \subseteq \mathcal{G}$.

**Proof.** Let $\mathcal{G}$ be a grill on a topological space $(X, \tau)$, $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ to a point $x \in X$. Then for each $U \in \alpha\delta O(x)$ there exists $G \in \mathcal{G}$ such that $G \subseteq \alpha\delta_{Cl}(U)$, and hence $\alpha\delta_{Cl}(U) \in G$ for each $U \in \alpha\delta O(x)$. Now, $B \in sec\,\mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x) \Rightarrow X \setminus B \notin \mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}$, $x \Rightarrow x \notin \alpha\delta\theta Cl U \Rightarrow$ there exists $U \in \alpha\delta O x$ such that $\alpha\delta Cl U \cap (X \setminus B) = \varphi \Rightarrow \alpha\delta Cl U \subseteq$ B, where $U \in \alpha\delta O x \Rightarrow$ B $\in$ G. Conversely, let if possible, $\mathcal{G}$ not to $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ to $x$. Then for some $U \in \alpha\delta O(x)$, $\alpha\delta\theta_{Cl}(U) \notin \mathcal{G}$ and hence $\alpha\delta\theta_{Cl}(U) \notin sec\,\mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x)$. Thus for some $A \in \mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x)$, $A \cap \alpha\delta_{Cl}(U) = \varphi$. But $A \in \mathcal{G}(\widetilde{\alpha\delta}^{\theta\#}, x) \Rightarrow x \in \alpha\delta\theta_{Cl}(A) \Rightarrow \alpha\delta_{Cl}(U) \cap$ U $\neq \varphi$.

## 3. $\alpha\delta$-CLOSEDNESS AND GRILLS

**Definition 3.1** A non empty subset $A$ of a topological space $X$ is called $\alpha\delta$-closed relative to $X$ if for every

cover $\mathcal{U}$ of $A$ by $\alpha\delta$-open sets of $X$, there exists a finite subset $\mathcal{U}_0$ of $\mathcal{U}$ such that $A \subseteq \cup\{\alpha\delta_{Cl}(U): U \in \mathcal{U}_0\}$. If, in addition, $A = X$, then $X$is called a $\alpha\delta$-closed space.

**Theorem 3.2.**For a topological space$X$, the following statements are equivalent:

(a) $X$ is $\alpha\delta$-closed;

(b) Every maximal filter base $\widetilde{\alpha\delta}^{\theta\#}\mathcal{C}$ to some point of $X$;

(c) Every filter base $\widetilde{\alpha\delta}^{\theta\#}$-adhere to some point of $X$;

(d) For every family $\{V_\alpha: \alpha \in I\}$ of $\alpha\delta$- closed sets that $\cap\{V_i: i \in I\} = \varphi$, there exists a finite subset $I_0$ of $I$ such that $\cap\{\alpha\delta_{int}(V_i): i \in I_0\}$.

**Proof.** $(a) \Rightarrow (b)$: Let $\mathcal{F}$ be a maximal filter base on $X$. Suppose that $\mathcal{F}$ does not $\alpha\delta$-converge to any point of $X$. Since $\mathcal{F}$ is maximal, $\mathcal{F}$ does not $\alpha\delta$-$\theta$-accumulate at any point of $X$. For each $x \in X$, there exist $F_x \in \mathcal{F}$ and $V_X \in \alpha\delta O(X,x)$ such that $\alpha\delta_{cl}(V_X) \cap F_x = \varphi$. The family$\{V_X: x \in X\}$ is a cover of $X$ by $\alpha\delta$-open sets of $X$. By $(a)$, there exists a finite number of points $x_1, x_2, x_3 \ldots x_n$ of $X$ such that $X = \cup\{\alpha\delta_{cl}(V_{x_i}): i = 1,2,\ldots,n\}$. Since $\mathcal{F}$ is a filter base on $X$, there exists $F_0 \in \mathcal{F}$ such that $F_0 \subseteq \cap\{F_{x_i}: i = 1,2,\ldots,n\}$.Therefore, we obtain $F_0 = \varphi$. This is a contradiction.

$(b) \Rightarrow (c)$: Let $\mathcal{F}$ be any filter base on X. Then, there exists a maximal filter base $\mathcal{F}_0$such that $\mathcal{F} \subseteq \mathcal{F}_0$. By $(b)$, $\mathcal{F}_0$ $\alpha\delta$-$\theta$-converges to some point $x \in X$. For every $F \in \mathcal{F}$and every $V \in \alpha\delta O(X,x)$, there exists $F_0 \in \mathcal{F}_0$such that $F_0 \subseteq \alpha\delta_{cl}(V)$; hence $\varphi \neq F_0 \cap F \subseteq \alpha\delta_{cl}(V) \cap F$. This shows that $\mathcal{F}$ $\alpha\delta$-$\theta$-accumulates at $x$.

$(c) \Rightarrow (d)$:Let$\{V_\alpha: \alpha \in I\}$ be any family of $\alpha\delta$-closed subsets of $X$ such that $\cap\{V_\alpha: \alpha \in I\} = \varphi$. Let $\Gamma(I)$ denote the ideal of all finite subsets of $A$. Assume that $\cap\{\alpha\delta_{Int}(V_\alpha): \alpha \in I\} = \varphi$ for every $I \in \Gamma(I)$. Then, the family $\mathcal{F} = \{\bigcap_{\alpha \in I} \alpha\delta_{Int}(V_\alpha): I \in \Gamma(I)\}$ is a filter base on $X$. By $(c)$, $\mathcal{F}$ $\alpha\delta$-$\theta$-accumulates at some point $x \in X$. Since $\{X\backslash V_\alpha: \alpha \in I\}$ is a cover of $X$, $x \in X\backslash V_{\alpha 0}$ for some $V_{\alpha 0} \in I$. Therefore, we obtain $X\backslash V_{\alpha 0} \in \alpha\delta O(X,x)$, $\alpha\delta_{Int}(V_{\alpha 0}) \in \mathcal{F}$ and $\alpha\delta_{Cl}(V_{\alpha 0}) \cap \alpha\delta_{Int}(V_{\alpha 0}) = \varphi$, which is a contradiction.

$(d) \Rightarrow (a)$: Let $\{V_\alpha: \alpha \in I\}$ be a cover of $X$ by $\alpha\delta$-open sets. Then $\{X\backslash V_\alpha: \alpha \in I\}$ is a family of $\alpha\delta$-closed subsets of $X$ such that $\cap\{X\backslash V_\alpha: \alpha \in I\} = \varphi$. By$(d)$, there exists a finite subset $I_0$ of $I$ such that $\cap\{\alpha\delta_{Int}(X\backslash V_\alpha): \alpha \in I_0\} = \varphi$ hence $X = \cup\{\alpha\delta_{Cl}(V_\alpha): \alpha \in I_0\}$. This shows that $X$ is $\alpha\delta$-closed.

**Theorem 3.3.**A topological space $X$ is $\alpha\delta$-closed if and only if every grill on $X$ is $\widetilde{\alpha\delta}^{\theta\#}$-convergent in $X$.

**Proof** Let $\mathcal{G}$ be any grill on a $\alpha\delta$-closed space $X$. Then by Theorem 2.6, $sec\,\mathcal{G}$ is a filter on $X$. Let $B \in sec\,\mathcal{G}$, then $X\backslash B \notin \mathcal{G}$ and hence $B \in \mathcal{G}$(as $\mathcal{G}$is a grill). Thus $sec\,\mathcal{G} \subseteq \mathcal{G}$. Then by Theorem 2.6$(b)$, there exists an ultrafilter $\mathcal{U}$ on $X$ such that $sec\,\mathcal{G} \subseteq \mathcal{U} \subseteq \mathcal{G}$. Now as $X$ is $\alpha\delta$-closed, in view of Theorem 3.2, the ultrafilter $\mathcal{U}$is$\widetilde{\alpha\delta}^{\theta\#}$-convergent to some point $x \in X$. Then for each $U \in \alpha\delta O(X,x)$, there exists $F \in \mathcal{U}$ such that $F \subseteq \alpha\delta_{Cl}(U)$. Consequently, $\alpha\delta_{Cl}(U) \in \mathcal{U} \subseteq \mathcal{G}$, That is $\alpha\delta_{Cl}(U) \in \mathcal{G}$, for each $U \in \alpha\delta O(X,x)$. Hence $\mathcal{G}$ is $\widetilde{\alpha\delta}^{\theta\#}$-convergent to $x$. Conversely, let every grill on $X$ be $\widetilde{\alpha\delta}^{\theta\#}$-convergent to some point of $X$. By virtue of Theorem 3.2 it is enough to show that every ultrafilter on $X$is $\widetilde{\alpha\delta}^{\theta\#}$-converges in $X$, which is immediate from the fact that an ultrafilter on $X$is also a grill on $X$.

**Theorem 3.4.** A topological space $X$is $\alpha\delta$-closed relative to $X$if and only if every grill $\mathcal{G}$ on $X$ with $A \in \mathcal{G}$, $\widetilde{\alpha\delta}^{\theta\#}$-converges to a point in $A$.

**Proof.** Let $A$ be $\alpha\delta$-closed relative to $X$and $\mathcal{G}$ a grill on $X$ satisfying $A \in \mathcal{G}$ such that $\mathcal{G}$ does not $\widetilde{\alpha\delta}^{\theta\#}$-converge to any $a \in A$. Then to each $a \in A$, there corresponds some $U_a \in \alpha\delta O(X,a)$ such that $\alpha\delta_{Cl}(U_a) \notin \mathcal{G}$. Now $\{U_\alpha: \alpha \in A\}$ is a cover of $A$ by $\alpha\delta$-open sets of $X$. Then $A \subseteq \bigcup_{i=1}^{n} \alpha\delta_{Cl}(U_{a_i}) = U$(say) for some positive integer $n$. Since $\mathcal{G}$ is a grill, $U \notin \mathcal{G}$; hence $A \notin \mathcal{G}$, which is a contradiction.

Conversely, let$A$ be not $\alpha\delta$-closed relative to $X$. Then for some cover $\mathcal{U} = \{U_\alpha: \alpha \in A\}$ of $A$ by $\alpha\delta$-open sets of

$X, \mathcal{F} = \{A\backslash \bigcup_{\alpha \in I_0} \alpha\delta_{Cl}(U_\alpha): I_0\ is\ finite\ subset\ of\ I\}$ is a filterbase on $X$. Then the family $\mathcal{F}$can be extended to an ultrafilter $\mathcal{F}^*$on $X$. Then $\mathcal{F}^*$is a grill on $X$ with $A \in \mathcal{F}^*$(as each $F$ of $\mathcal{F}$is a subset of $A$). Now for each $x \in A$, there must exists $\beta \in I$ such that $x \in U_\beta$, as $U$ is a cover of $A$. Then for any $G \in \mathcal{F}^*$, $G \cap (A\backslash\alpha\delta_{Cl}(U_\beta) \neq \varphi$, so that $G \supset \alpha\delta_{Cl}(U_\beta)$for all $G \in \mathcal{G}$. Hence $\mathcal{F}^*$, cannot $\widetilde{\alpha\delta}^{\theta\#}$-converge to any point of $A$. The contradiction proves the desired result.

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# FUZZY SHORTEST ROUTE ALGORITHM FOR TELEPHONE LINE CONNECTION USING THE LC-MST ALGORITHM

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**ABSTRACT**

In computer science, there are many algorithms that finds a minimum spanning tree for a connected weighted undirected fuzzy graph. The minimum length (or cost) spanning tree problem is one of the nicest and simplest problems in network optimization, and it has a wide variety of applications. The problem is to find a minimum cost (or length) spanning tree in G. Applications include the design of various types of distribution networks in which the nodes represent cities, centers etc.; and edges represent communication links (fiber glass phone lines, data transmission lines, cable TV lines, etc.), high voltage power transmission lines, natural gas or crude oil pipelines, water pipelines, highways, etc. The objective is to design a network that connects all the nodes using the minimum length of cable or pipe or other resource in this paper we find the solution to the problem is to minimize the amount of new telephone line connection using matrix algorithm with fuzzy graph.

**Keywords**: Spanning tree, minimum spanning tree, fuzzy graph, Matrix algorithm.

## 1. INTRODUCTION

A minimum cost of the fuzzy spanning tree is spanning tree, but it has weight or length associated with the edges and total weight of the tree is minimum. A fuzzy tree for that graph would be a subset of those paths that has no cycles but still connects to every vertex. There might be several spanning trees possible. A minimum fuzzy tree would be one with the lowest total cost. A less obvious application is that the minimum fuzzy spanning tree can be used to approximately solve the traveling salesman problem.

In this paper, we find the solution for the problem, that (A.V.V.M. Sri Pushpam College, (Autonomous), Poondi, Thanjavur District, South India) needs to connect updated intercom lines connecting all the departments using a fuzzy shortest route algorithm. The problem is to minimize the amount of new line using matrix Algorithm with fuzzy graph.

## 2. DEFINITION

*Definition 2.1.:* A *fuzzy graph* with V as the underlying set is a pair G: (A, Γ) where A: V --▯ [0,1] is a fuzzy subset, Γ : VxV ------> [0,1] is a fuzzy relation on the fuzzy subset A, such that $\Gamma(u,v) \leq A(u) \cap A(v)$ for all $u,v \in V$.

*Definition 2.2.:* A fuzzy Hamiltonian circuit is a circuit that visits every vertex in a fuzzy graph once with no repeats, being a fuzzy Hamiltonian circuits must start and end at the same vertex.

*Definition 2.3.:* A fuzzy Hamiltonian path is a path that passes through each of the vertices in a fuzzy graph exactly once [Hassan, 2012].

*Definition 2.4.:* A fuzzy spanning tree is a fuzzy tree which covers all the vertices of a fuzzy graph, [Antony et al, 2013].

NOTE 2.1: Fuzzy tress has no circuits, and it is fine to have vertices

## 3. THE LC-MST ALGORITHM

The aim of the LC-MST algorithm is to find a least-cost tree of a given network. The idea of the algorithm is to read the distance matrix (weight matrix) of a given network and construct a preferred link matrix that contains the set of least-cost links to construct the least-cost minimum spanning tree.

*3.1. Algorithm: Least-Cost Minimum Spanning Tree*

Step 1: Input the distance matrix $D = [d_{ij}]_{nxn}$ for the weighted graph G(V, E), where V is the set of vertices and E is the set of edges.

Step 2: For all i, j, find the least-cost element (preferred link) in each column j and set the other elements to zero.

Step 3: Construct the preferred link matrix (PLM) by using step 2.

Step 4: Construct the nodes-set matrix (NSM) by using PLM matrix constructed in step 3 (each element in this matrix contains the node-pairs that correspond to the preferred link in PLM).

Step 5: Combining the node-pairs in step 4 to construct the candidates spanning tree.

Step 6: If there are any duplicating node-pairs, keep one of them, and if there is a set of node-pairs, construct a cycle, remove the one that has the largest cost.

Step 7: Output the least-cost minimum spanning tree.

| - | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $x_6$ | $x_7$ | $x_8$ | $x_9$ | $x_{10}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $x_1$ | - | 0.37 | 0.1 | 0.22 | 0.07 | 0.17 | 0.25 | 0.28 | 0.24 | 0.35 |
| $x_2$ | 0.37 | - | 0.25 | 0.16 | 0.5 | 0.19 | 0.07 | 0.1 | 0.13 | 0.01 |
| $x_3$ | 0.1 | 0.25 | - | 0.12 | 0.27 | 0.12 | 0.09 | 0.16 | 0.13 | 0.24 |
| $x_4$ | 0.22 | 0.16 | 0.12 | - | 0.43 | 0.03 | 0.04 | 0.08 | 0.02 | 0.15 |
| $x_5$ | 0.07 | 0.5 | 0.27 | 0.43 | - | 0.45 | 0.47 | 0.34 | 0.38 | 0.42 |
| $x_6$ | 0.17 | 0.19 | 0.12 | 0.03 | 0.45 | - | 0.06 | 0.11 | 0.06 | 0.18 |
| $x_7$ | 0.25 | 0.07 | 0.09 | 0.04 | 0.47 | 0.06 | - | 0.11 | 0.08 | 0.11 |
| $x_8$ | 0.28 | 0.1 | 0.16 | 0.08 | 0.34 | 0.11 | 0.11 | - | 0.03 | 0.05 |
| $x_9$ | 0.24 | 0.13 | 0.13 | 0.02 | 0.38 | 0.06 | 0.08 | 0.03 | - | 0.11 |
| $x_{10}$ | 0.35 | 0.01 | 0.24 | 0.15 | 0.42 | 0.18 | 0.11 | 0.05 | 0.11 | - |

**Fig. 2.1. Distance matrix**

| - | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $x_6$ | $x_7$ | $x_8$ | $x_9$ | $x_{10}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $x_1$ | - | 0.37 | 0.1 | 0.22 | 0.07 | 0.17 | 0.25 | 0.28 | 0.24 | 0.35 |
| $x_2$ | 0.37 | - | 0.25 | 0.16 | 0.5 | 0.19 | 0.07 | 0.1 | 0.13 | 0.01 |
| $x_3$ | 0.1 | 0.25 | - | 0.12 | 0.27 | 0.12 | 0.09 | 0.16 | 0.13 | 0.24 |
| $x_4$ | 0.22 | 0.16 | 0.12 | - | 0.43 | 0.03 | 0.04 | 0.08 | 0.02 | 0.15 |
| $x_5$ | 0.07 | 0.5 | 0.27 | 0.43 | - | 0.45 | 0.47 | 0.34 | 0.38 | 0.42 |
| $x_6$ | 0.17 | 0.19 | 0.12 | 0.03 | 0.45 | - | 0.06 | 0.11 | 0.06 | 0.18 |
| $x_7$ | 0.25 | 0.07 | 0.09 | 0.04 | 0.47 | 0.06 | - | 0.11 | 0.08 | 0.11 |
| $x_8$ | 0.28 | 0.1 | 0.16 | 0.08 | 0.34 | 0.11 | 0.11 | - | 0.03 | 0.05 |
| $x_9$ | 0.24 | 0.13 | 0.13 | 0.02 | 0.38 | 0.06 | 0.08 | 0.03 | - | 0.11 |
| $x_{10}$ | 0.35 | 0.01 | 0.24 | 0.15 | 0.42 | 0.18 | 0.11 | 0.05 | 0.11 | - |

**Fig. 2.2. PLM**

| - | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $x_6$ | $x_7$ | $x_8$ | $x_9$ | $x_{10}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| $x_1$ | - | 0 | 0 | 0 | $(x_1,x_5)$ | 0 | 0 | 0 | 0 | 0 |
| $x_2$ | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | $(x_2,x_{10})$ |
| $x_3$ | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $x_4$ | 0 | 0 | 0 | - | 0 | $(x_4,x_6)$ | $(x_4,x_7)$ | 0 | $(x_4,x_9)$ | 0 |
| $x_5$ | $(x_5,x_{1)}$ | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 |
| $x_6$ | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 |
| $x_7$ | 0 | 0 | $(x_7,x_3)$ | 0 | 0 | 0 | - | 0 | 0 | 0 |
| $x_8$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 |
| $x_9$ | 0 | 0 | 0 | $(x_9,x_4)$ | 0 | 0 | 0 | $(x_9,x_8)$ | - | 0 |
| $x_{10}$ | 0 | $(x_{10},x_2)$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - |

**Fig. 2.3. NSM**

Example: In this example we applied the matrix algorithm to plan and connect an efficient fuzzy route telephone line connection for the problem (Nirmala and Uma, 2012). Consider each department as vertex such as $x_1$ –office room, $x_2$-mathematics, $x_3$ – economics, $x_4$ – History, $x_5$ – Computer Science, $x_6$ – Library, $x_7$– Physics, $x_8$ – Chemistry, $x_9$ – Botany and $x_{10}$ – Physical education. The distance between them are represented as fuzzy weights matrix shown in the fig.3.8.

In this section, we find the solution for the below matrix the table is taken from (Nirmala and Uma, 2012) needs to connect updated intercom lines connecting all the departments exactly once. The problem is to minimize the amount of new line using Matrix Algorithm with fuzzy graph. The step by step procedure is given below.

The Preferred link matrix PLM (least-cost link matrix) can be constructed from the distance matrix as shown in Fig 2.2.

The corresponding nodes-set matrix NSM is constructed as shown in Fig.2.3.

The set of node-pairs that construct the candidate spanning tree is: $=\{(x_2,x_{10})+(x_4,x_9)+(x_8,x_9)+(x_4,x_6)+(x_4,x_7)+(x_1,x_5)+(x_3,x_7)\}$.

The length of the cable

$=\{(x_2,x_{10})+(x_4,x_9)+(x_8,x_9)+(x_4,x_6)+(x_4,x_7)+(x_1,x_5)+(x_3,x_7)\}$

$= 0.01+0.07+0.02+0.04+0.09+0.02+0.03$

$= 0.28.$

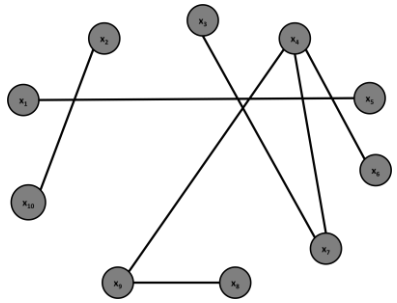

**Fig. 2.4. The least cost minimum spanning tree**

## 4. CONCLUSION

In this paper we apply the Least-Cost Minimum Spanning Tree for the problem that connecting distances to plan and visit an efficient fuzzy spanning tree route for the intercom land line (phone) to reach it all the department exactly once. So we conclude that Least-Cost Minimum Spanning Tree is the best to adopt for these types of problems.

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# ASSESSMENT OF ECOLOGICAL STATUS OF ECONOMICALLY IMPORTANT PLANTS IN UDHAYAGIRI HILLS, NAGARCOIL

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## ABSTRACT

The present ecological investigation was carried out in the understorey of tropical moist deciduous forest of Udhayagiri fort hills, Kanyakumari, Tamil Nadu. A total number of 171 species were documented in the understory of the study area and among them 163 species were recognized as economically important. The secured value of ecological attribute, importance value index (IVI) indicates that the species like *Tephrosia purpurea, Clerodendron infortunatum Acalypa indica*, *Aerva lanata*, *Asystasia gangetica*, *Belpharis maderaptensis*, *Cleome viscosa, Dodonia viscose, Glycosmis pentaphylla, Leucas aspera*, *Limnophila indica, Martynia annua, Oldenlandia* umbellate, *Pavetta indica*, *Phyllanthus amarus* and *Rhynchosia minima* are well established in the study area. On the other hand, 55 plant species are considered to be ecologically weaker in the community. Hence priorities must be given to these species for natural regeneration and hence their conservation as well.

**Keywords:** Ecological status, Udhayagiri hills**,** Importance value index**.**

## 1. INTRODUCTION

Western Ghats is among the ecologically richest of India, next to the Himalaya in the diversity of its biological species (Gadgil, 1984). It encompasses many types of ecosystems such as tropical wet evergreen forests, dry deciduous forests, moist deciduous forests, thorny scrub jungles and the fragile montane shoals with associated grasslands (Champion and Seth, 1968). Among the different types of vegetations in the Western Ghats, The present study area, Udhayagiri Hills is dominated by the tropical moist deciduous forests. A large number of herbs, shrubs and climbers is commonly occupying in the under storey of the study area. Udhayagiri Hills under semi - arid climatic condition in many parts hold more number of economically and medicinally important plants due to the presence of diverse secondary metabolites. However, works on phytosociological analysis in the understory of this region have been limited. Hence, the present ecological investigation was carried out to enlist economically important plants and to assess their ecological position through phytosociological analysis in the understory of the study area.

## 2. MATERIALS AND METHODS

### *2.1. Study area*

The present study area, Udhayagiri fort hills is situated in the Kanyakumari district of Tamil Nadu and lies at a distance of 14 km from the town of Nagercoil. The Udhayagiri covers a huge area of 22.50 hectares which is surrounded by isolated hills. The elevation of the study area is 97m above msl. The geographical location of Udhayagiri fort hills lies between 8° -14' 38.4 N attitude and 77°- 19' 55.2 E longitude.

### *2.2. Experimental methods*

Phytosociological analysis was carried out during the rainy month of September, 2013 in the understory of the study forest, Udhayagiri hills. At the time of sampling, 50 random quadrats each with the size of $1m^2$ were laid to encount the species and their individuals. The quantitative characters such as frequency, density, abundance, relative frequency, relative density, relative dominance and importance value index were calculated according to the following formulae proposed by Cottam and Curtis (1956):

$$\text{Frequency (\%)} = \frac{\text{Number of quadrats in which the species present}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Density} = \frac{\text{Total number of individuals of the species in all quadrats}}{\text{Total number of quadrats studied}}$$

$$\text{Abundance} = \frac{\text{Total number of individuals of the species in all quadrats}}{\text{Number of quadrats of occurrence of the species}}$$

Since most of the stems are cylindrical, the basal area was calculated by using the formula:

$$\text{Basal area} = \pi r^2$$

Where, π = 3.14 and 'r' is the radius of the stem at the point of emergence.

Relative frequency, relative density, and relative dominance were calculated from the following formulae:

$$\text{Relative frequency (\%)} = \frac{\text{Number of occurence of the species}}{\text{Number of occurence of all species}} \text{ X } 100$$

$$\text{Relative density (\%)} = \frac{\text{Number of individuals of the species}}{\text{Number of individuals of all species}} \text{ X } 100$$

$$\text{Relative dominance (\%)} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all species}} \text{ X } 100$$

Importance value Index (IVI) is the sum of quantities of relative frequency, relative density and relative dominance expressed per 300.

## 3. RESULTS AND DISCUSSION

A total number of 171 species were documented in the understory of the study area and among them 163 were recognized as economically important (Table 1). This may be explained that the study area has favourable microclimate for better growth and development of more number of species and also potential habitat for the plants of economic importance. Puri *et at* (1989) stated that the continuous availability of moisture in the soils of shoals in Western Ghats enables the appearance of more number species. Despite the presence of suitable microclimate, the constituent species in the understory of shoals in Western Ghats showed wide variation in distribution level, population size and basal area between them (Padmavathy, 2005).

In the present study, the ecological position for highly and poorly established plants alone is highlighted in terms of expressing their frequency, density, basal area and importance value index (Table 2). The dicot species such as *Acalypa indica*, *Asystasia gangetica*, *Cleome viscose, Leucas aspera*, *Phyllanthus amarus* and *Sida cardata* showed maximum frequency value of 100% in the community and certain other herbaceous species viz., *Aerva lanata*, *Belpharis maderaptensis*, *Mollugo pentaphylla*, *Oldenlandia umbellate*, *Stylosantus hamate* and *Tephrosia purpurea* also showed higher distribution (around 85% frequency value) during rainy month of September. The higher seed output and greater reproductive potential exist in these species may be the possible reasons for this fact (Usher, 1991).

Many species in the understory of the study area like *Amaranthus spinnosus, Amaranthus virigidis*, *Barleria buxifolia*, *Biophytum sensitivum, Croton zeylanicus*, *Crotalaria pallida*, *Curculigo orchioides*, *Plumbago zeylanica* and *Rauvolfia serpentina* have exhibited poor distribution. The external factors like topography, soil conditions and the biotic disturbance and some intrinsic factors like dispersal mechanism, longevity of seeds, duration of dormancy and germination efficiency are some of the environmental variables generally determine the degree of distribution of any plant species (Belsky, 1988).

The plant species such as *Tephrosia purpurea, Acalypa indica*, *Aerva lanata*, *Asystasia gangetica*, *Belpharis maderaptensis*, *Cleome viscosa, Clerodendron infortunatum, Leucas aspera*, *Phyllanthus amarus*, *Sida cardata*, *Mollugo pentaphylla* and *Oldenlandia umbellata* were present in the study area with higher densities. This may be due to the presence of continuous wetness, a favourable factor for the better growth of these species in the soil of moist deciduous forest (Saxena, 1991). On the other hand, many species like *Rauvolfia serpentina, Cardiospermum halicacabum* and *Borreria articularis, Andrographis paniculata*, *Boerhavia diffusa, Blainviella acmella*, *Cleome rutidesperma*, *Cleome rutidesperma, Croton zeylanicus*, *Desmodium illinoensis*, *Rungia repens*, *Sida cordifolia, Barleria cuspidata*, *Aerva lanata*, *Amaranthus virgatus*, *Clitoria ternate*, *Corchorus aestuans* and *Croton bonplandiam*, *Belpharis maderaptensis, Gymnema sylvestre, Heydyotis peterita*, *Ocimum americanum, Ludwigia octovalvis* etc., have always present with low densities in the study area. The poor reproductive potential with less seed output and weaker competitive ability may lead the species with low density in the communities (Chandrasakaran and Swamy, 1995).

The basal cover of certain plant species such as *Tephrosia purpurea, Clerodendron infortunatum*, *Acalypa indica* and *Pavetta indica* was greater in the understory of studied forest. Among them, due to shrubby habit two species namely *Clerodendron infortunatum* and *Pavetta indica* were occupied higher basal cover in comparison to other constituent species. This feature may lead to the occupation of higher basal cover in the communities. The lower basal cover attained by many species such as *Aerva javanica, Alternanthera sessilis*, *Asparagus racemosus*, *Centella asiatica*, *Clitoria ternate*, *Desmodium adscendens*, *D. triflorum*, *Evolvulus alsinoides*, E. *nummularis*, *Indigofera hirsuta, I. glandulosa, Justicia gluca,* and *Oldenlandia corymbosa* might be due to their poor ecological characters like lower density and less basal area per individual.

**Table 1. The constituent species in the study area, Udhayagiri hills with their ecological status and economic importance.**

| S. No. | Species | Ecological status | Parts used | Medicinal/Other economic importance | Mode of administration |
|---|---|---|---|---|---|
| 1 | *Abrus pulchellus* | Common | Leaves | Cure fever, cough, cold | Juice |
| 2 | *Abulition indicum* (L.). Sw | Common | Root | Piles | Extract |
| 3 | *Acalypha indica* L. | Common | Leaves | Headache, wounds, itching | Juice, paste |
| 4 | *Acanthospermum hispidum* DC. | Common | Root | Jaundice | Decoction |
| 5 | *Achyranthus aspera* Linn. | Common | spike | Poisonous insect bites. | Paste |
| 6 | *Aerva javanica* | Common | Whole plant | Swelling | Decoction |
| 7 | *Aerva lanata* (L.) Juss.ex.Shut. | Common | Root | Piles | Paste |
| 8 | *Alternanthera pungens* Kunth. | Common | Whole plant | Gonorrhea | Decoction |
| 9 | *Alternanthera tenella* | Common | Inflorescences | Earache | Ash |
| 10 | *Amaranthus spinosus* L. | Common | Whole plant | Thorns | Paste |
| 11 | *Amaranthus viridis* Linn. | Common | Leaves, root | Scorpion sting, diuretic, laxative, retention of urine, treat gonorrhea | Decoction, paste |
| 12 | *Andrographis echioides* (Burm.f.) Nees | Common | Leaf | Head ache | Paste |
| 13 | *Andrographis paniculata* (Burn.F) Wall.ex.Nees. | Common | Root, leaves | Fever, liver complaints and jaundice | Decoction, paste |
| 14 | *Asparagus racemosus* Willd.(L.) | Common | Root tubers | Kidney stone, week end immunity | Powder, paste |
| 15 | *Asystasia gangetica*. (L.) T. Anderson in Thwaittes. | Common | Whole plant | Rheumatism | Juice |
| 16 | *Barleria buxifolia* (L.) | Common | Leaves | Viral fever, urinary affection, stomach disorders | Juice |
| 17 | *Barleria cuspidate* | Common | Leaves, flower | Viral fever | Decoction |
| 18 | *Barleria lupulina* | Rare, endemic | Leaves | Urinary tract infection | Juice |
| 19 | *Belpharis maderaptensis* (L.) B. Heyne. Ex. Roth. Nov. | Common | Leaves | Bone fracture | Paste |
| 20 | *Biophytum sensitivum* | Common | Leaves, roots | Bite poisoning, wound | Paste |
| 21 | *Blainviella acmella* | Common | Leaves | Alcohol deaddiction | Juice |
| 22 | *Boerhavia diffusa* L. | Common | Root | Asthma, sugar in urine | Decoction, juice |
| 23 | *Borreria latifolia* | Common | Leaves, stem | Body pain | Crushed |
| 24 | *Bryophyllum pinnatum* (lam) oken. Alleg | Common | Leaves | Dysentery cuts and wounds, head ache. | Juice, paste |
| 25 | *Cardiospermum halicacabum* L. | Common | Leaves | Cough piles, arthritis, joint pains, skin diseases | Decoction |
| 27 | *Celosia argentea* L. | Common | Whole plant | Urinary stones | Decoction |

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|---|---|---|---|---|---|
| 28 | *Centella asiatica* (Linn) Urban. | Common | Whole plant | Typhoid | Juice |
| 29 | *Cheilocostus specious* | Endangered | Root | Head ache, diarrhea, stop vomiting | Powder |
| 30 | *Chromolaena oderata* (L.) King & Robi | Common | Whole plant | Wounds and rashes | Paste |
| 31 | *Cleome aspera* | Endemic | - | - | - |
| 32 | *Cleome gynandra* L. | Common | Leaf | Wounds, fever | Paste, decoction |
| 33 | *Cleome monophylla* | Endemic | Leaves, root | Vomit | Powder |
| 34 | *Cleome rutidesperma* | Common | Whole plant | To relief general sickness and uneasiness of the body | Infusion |
| 35 | *Cleome viscosa* L. | Common | Leaves | Earache, wound | Juice, paste |
| 36 | *Clerodendram infortunatum* auct. Non L. | Common | Leaves | Tumors, hair growth, wounds and fungal infection. | Paste |
| 37 | *Clitoria ternata* L. | Common | Whole plant | Snake bite, cause abortion | Extract |
| 38 | *Commelina benghalensis* Linn. | Common | Whole plant | Leprosy, jaundice | Paste, juice |
| 39 | *Corchorus aestuans* L.Syst. Nat | Common | Leaves | Head ache | Poultice |
| 40 | *Corchorus olitorius* L. | Vulnerable | Seed | Stomach ache | Powder |
| 41 | *Crotalaria mysorensis* Roth. | Common | Leaf, fruit | Stomach ache and stomach ulcer | Paste |
| 42 | *Crotalaria pallid* | Common | Seed, leaf, whole plant | Skin diseases, ring worm, itches, stomach pain | Paste, decoction |
| 43 | *Crotalaria verrucosa* L. | Common | Leaves | Skin allergies | Extract |
| 44 | *Croton bonplandiam* Bail. | Rare, endemic | Latex | Bleeding and venereal sores, headache | Juice |
| 45 | *Croton hirtus* | Common | - | - | - |
| 46 | *Croton zeylanicus* | Common | Bark | Stomachache | Juice |
| 47 | *Cuphea hyrsopifolia* | Common | Leaves | Cold | Infusion |
| 48 | *Curculigo orchioides* Gaertn. | Common | Root | Ulcer, treat asthma, piles, jaundice, diarrhea, and gonorrhea | Juice |
| 49 | *Cyanotis axilaris* | Common | Whole plant | Rheumatism, joint pain | Decoction |
| 50 | *Cyanotis tuberose* | Common | Tubers | Relief cough | Eaten |
| 51 | *Cynodon doctylon* (L.) Pers Panicum Dactylon Linn. | Common | Whole plant | Diuretic | Extract |
| 52 | *Cyperus rotundus* L. | Common | Tuber | Stomach ache | Paste |
| 53 | *Cyrtococcum patens* | Common | - | - | - |
| 54 | *Datura metal* L. | Common | Leaves | Asthma, chronic ulcer | Juice |
| 55 | *Desmodium adscendens* | Common | Leaves | Wounds, venereal sores | Powder |
| 56 | *Desmodium illinoensis* | Common | Leaves | Itches | Boiled |
| 57 | *Desmodium triflorum* (Linn.) Dc. | Common | Leaves, root | Diarrhea, cough, asthma | Paste, juice |
| 58 | *Dodonaea viscosa* (L.) Jacq | Common | Leaves | Tooth ache | Juice |

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|---|---|---|---|---|---|
| 59 | *Ecbolium viride* acut. Non (Frossk) Alston. | Common | Leaves, root | Jaundice, rheumatism | Decoction |
| 60 | *Echinochloa colona* (L.) Link. | Common | - | - | - |
| 61 | *Eclipta prostrate* L. | Common | Leaves | Jaundice | Decoction |
| 62 | *Emilia sonchifolia* | Common | Root | Diarrhea | Juice |
| 63 | *Euphorbia hirta* Linn. | Common | Leaves | Blood in urine, pita aggravation | Paste |
| 64 | *Euphorbia serpens* Kunth | Common | - | - | - |
| 65 | *Euphorbia thymifolia* | Common | Whole plant | Gastric problem | Extract |
| 66 | *Evolvulus alsinoides* L. | Common | Whole plant | Leucoderma, hair growth | Paste |
| 67 | *Evolvulus nummularis* (L.) L. | Common | Whole plant | Edema of legs | Tied |
| 68 | *Glycosmis pentaphylla* (Retz.) DC | Endangered | Leaf | Jaundice | Powder |
| 69 | *Gomphrena serrata* | Common | Flowers | Baby gripe cough, diabetes and cooling | Boiled |
| 70 | *Gymnema sylvestre* (Retz.) R. Br.ex.schutt. | Common | Root, leaf | Poison bites, diabetes | Powder |
| 71 | *Hedyotis diffusa* | Common | Whole plant | Cold | Juice |
| 72 | *Hedyotis pterita* | Common | Root | Ulcer | Juice |
| 73 | *Heliotropium indicum* L. | Vulnerable | Leaves | Snake bite, scorpion bite | Juice |
| 74 | *Hemidesmus indicus* (L) R. Br. In Aiton | Common | Root | Leucoderma, abdominal tumors, eruptions of tongue of children | Paste, decoction, powder |
| 75 | *Hibiscus micranthus* L.F. | Common | Root | Head ache | Paste |
| 76 | *Hibiscus surattensis* L. | Common | Leaves, stem | Venereal sores, arthritis | Infusion |
| 77 | *Hibiscus* vitifolius | Common | Whole plant | Breast to cure mastitis (maruti ubale) | Paste |
| 78 | *Hybanthus enneaspermus* L. | Common | Root | Body pain | Paste |
| 79 | *Hygrophila auriculata* | Common | Root | Edema patients | Powdered |
| 80 | *Hyptis suaveolens* (L.) Poit. Ann. | Common | Root, leaf | Malaria fever, bleeding from nose cuts and wounds | Decoction. Powder, juice |
| 81 | *Imperata cylindrica* L. | Rare, endemic | Root | Fever | Infusion |
| 82 | *Indigofera asplanthoides* Vahl ex DC. | Common | Whole plant | Skin diseases | Ash |
| 83 | *Indigofera glandulosa* Wendl | Common | Fruit | Stomach ache | Powder |
| 84 | *Indigofera hirsute* L. | Common | Whole plant | Asthma, whooping cough | Juice |
| 85 | *Indigofera uniflora* Buch. Ham.ex Roxb. | Common | Leaf | Skin diseases | Paste |
| 86 | *Ipomoea carnea* Jaqc | Common | Leaves | Hardened pimples | Crushed |
| 87 | *Ipomoea obscura* (L.) Ker Gawler | Common | Leaf | Snake bite | Juice |
| 88 | *Justicia adhatoda* | Common | Root | Asthma and fever | Extract |

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|---|---|---|---|---|---|
| 89 | *Justicia gluca* Rott | Common | Leaves | Back ache | Juice |
| 90 | *Justicia simplex* D. Don. | Common | Leaves | Strengthening of bones | Extract |
| 91 | *Justicia tranquebariensis* L.f. | Common | Leaves | Jaundice. Skin aliments | Juice, paste |
| 92 | *Kyllinga odorata* | Common | Root, leaf | Diarrhea | Poultice |
| 93 | *Lagascea mollis* Cav | Common | Whole plant | Chest and throat to cure cold | Paste |
| 94 | *Lantana camera* Linn. | Common | Leaves | Measles and chicken pox, malarial fever, ring | Decoction, paste |
| 95 | *Leucas aspera* (Wild). Link, Enum. | Common | Leaf, flower | Itch scabies, blockage of nose, head ache | Paste |
| 96 | *Leucas grandis* | Common | Flower | Alleviate fever | Paste |
| 97 | *Linderina crustacea* | Common | Leaves | Ring worm | Paste |
| 98 | *Lindernia ciliate* | Common | Leaves, whole plant | Ring worm, clear stomach | Paste, juice |
| 99 | *Ludwigia octovalvis* (Jacq.) Raven. | Common | Whole plant | Fungal infection of toes | Paste |
| 100 | *Ludwigia peruviana* | Common | Leaves | Urine problem of children | Decoction |
| 101 | *Malvastrum coromandelianum* (L.) Garcke | Common | Leaves | Wounds and dysentery | Decoction |
| 102 | *Martynia annua* | Common | Root, leaves | Snake bite, epilepsy, tuberculosis | Decoction, juice |
| 103 | *Melhania hamiltoiana* | Common | Leaves | Dysentery, wounds | Decoction |
| 104 | *Melochia corchorifolia* L. | Common | Leaves | Stomach disorders | Decoction |
| 105 | *Merremia tridentate* (L.) Hallier | Common | Leaf, root | Growth of the hair, diabetes | Paste, decoction |
| 106 | *Microstachys chamaelea* | Common | Whole plant | Head ache | Paste |
| 107 | *Mimosa pudica* L. | Common | Root | Whylous urine, veterinary | Decoction, paste |
| 108 | *Mollugo pentaphylla* L. | Common | Leaf | Cooling purpose, urinary troubles | Boil, juice |
| 109 | *Naregamia alata* Wight & Arn | Common | Whole plant, root | Itch and contagious skin diseases and dysentery | Extract, decoction |
| 110 | *Ocimum americanum* L. | Rare, endemic | Leaf | Cuts and wounds | Juice |
| 111 | *Ocimum basilicum* L. | Common | Leaf | Acne vulgarism, pimples, earache, nasal congestion | Juice |
| 112 | *Ocimum gratissimum* L. | Endemic | Leaves | Cough, fever, nasal catarrh | Infusion |
| 113 | *Ocimum tenuiflorum* | Common | Whole plant, leaf | Leucoderma, common fever, cold and cough | Paste, decoction, juice |
| 114 | *Oldenlandia corymbosa* L. | Common | Whole plant | Liver trouble, urinary disorder in children, jaundice, fever and bilious infection. | Juice |
| 115 | *Oldenlandia umbellate* L. | Common | Leaf, root | Asthma, bronchitis | Extract, paste |
| 116 | *Orthosiphon thymiflorus* (Roth) Sleesen, Reinwandtia | Common | Leaves | Skin eruption | Juice |
| 117 | *Osbeckia aspera* | Common | - | - | - |
| 118 | *Pavetta indica* L. | Common | Root, leaves | Urinary diseases, ulcerated nose | Decoction |

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|---|---|---|---|---|---|
| 119 | *Pedalium murex* L. | Common | Leaves | Gonorrhea | Juice |
| 120 | *Pergularia daemia* Forssk. | Common | Leaf | Head ache and asthma | Paste |
| 121 | *Peristrophe paniculate* (Forsk). Burm. | Common | Fruit | Eye problem | Juice |
| 122 | *Persicaria hydropiper* L. | Common | Leaves | Cold and cough | Infusion |
| 123 | *Phryma laptostachya* | Common | Root | Skin diseases | Paste, infusion |
| 124 | *Phyla nodiflora* (L.)Greene. | Endemic | Leaves | Leucorrhoea, dandruff | Powder, paste |
| 125 | *Phyllanthus amarus* Schumach & Thonn. | Common | Whole plant, root | Skin diseases, body heat, fever, jaundice | Paste |
| 126 | *Phyllanthus debilis* Klein ex willed. | Common | Leaves | Sickle cell anemia | Juice |
| 127 | *Phyllanthus maderrasptensis* L. | Common | Fruits | Teeth diseases | Powder |
| 128 | *Phyllanthus myrtifolius* | Common | Root | Jaundice | Paste |
| 129 | *Phyllanthus virgatus* G.Forest.FI. | Common | Leaves | Eye diseases | Juice |
| 130 | *Physalis minima* L. | Common | Leaf | Stomach to cure boils | Juice |
| 131 | *Plumbago zeylanica* Linn. | Common | Roots | Fever, skin diseases, diuretic, rheumatism and dyspepsia. | Powder |
| 132 | *Polycarpaea corymbosa* (L.) Lam. | Common | Leaf | Jaundice | Paste |
| 133 | *polygala chinensis* | Common | Leaves | Stopping mother feeding | Paste |
| 134 | *Portulaca quadrifida* | Common | Leaves | Swellings erysipelas, burns, scalds | Paste |
| 135 | *Psuedarthria viscida* (L) Wight & Arn. | Common | Root | Asthma, fever, diarrhea, worms, piles | Juice |
| 136 | *Rauvolfia serpentine* (Linn.)Benth.ex Kurz | Endangered | Root, rhizome, leaves | Dysentery | Decoction, powdered |
| 137 | *Rhinacanthus nasutus* (L.) Kurz. J.Asiat | Endemic | Leaf, root | Snake and skin diseases. | paste |
| 138 | *Rhynchosia minima* (L.) DC. | Common | Whole plant | Delivery for body care | Juice |
| 139 | *Rulliea prostrate* | Common | Whole plant | Diabetes | Infusion |
| 140 | *Rulliea tuberosa* L. | Common | Leaves | Asthma, sinking of ribs | Juice |
| 141 | *Rungia repens* (L.) Nees. | Endemic | Whole plant | Bronchitis, fever | Decoction |
| 142 | *Scoparia dulcis* Linn. | Common | Seed, leaf | Kidney stone, common fever, throat sore | Powder and decoction |
| 26 | *Senna absus* | Endemic | Leaves, seeds | Cough, ringworm, skin diseases | Juice and paste |
| 143 | *Senna occidentalis* | Common | Seed, leaf, root | Skin disease, head bone fractures | Paste |
| 144 | *Senna uniflora* | Common | Leaves | Wounds, cure eczema | Poultice |
| 145 | *Sida acuta* Burm F.FI. | Common | Leaves | Wounds | Paste |
| 146 | *Sida cordata* (Burm.f.) Borss.Waalk. | Common | Roots | Nervous, urinary diseases | Infusion |

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|---|---|---|---|---|---|
| 147 | *Sida cordifolia* L. | Common | Root | Refrigerant | Paste |
| 148 | *Solanum melongena* | Common | Seeds, leaves | Cold, cough, phlegm accumulation, gum infection, tooth ache. | Powder |
| 149 | *Solanum torvum* Swartz | Common | Fruit | Anemia, chest congestion cough, cold. | Paste |
| 150 | *Solanum virginianum* | Common | Fruits, whole plant | Cough, asthma, tooth ache, chest pain | Decoction, juice |
| 151 | *Spermacoce articularis* | Common | Whole plant | Head ache | Decoction |
| 152 | *Spermacoce hispida* | Common | Root | Urinary infection, headache, internal heat | Decoction |
| 153 | *Spermacoce ocymoides* Burm.F | Common | Leaves | Diarrhea and dysentery | Infusion |
| 154 | *Spermacoce pusilla* | Common | Roots | Urinary infection, headache, internal heat | Decoction |
| 155 | *Stashytropheta jamaicensis* (L.) Vahl.Enum. | Common | Whole plant | Stomach pains | Decoction |
| 156 | *Stylosanthus fruticosa* | Common | Whole plant | Febrifuge | Infusion |
| 157 | *Stylosantus hamata* | Common | Whole plant | Diarrhea and cold | Juice |
| 158 | *Synederella nodiflora* (L). Gaertn.Fruct.Sem. | Common | Leaves | Itch scabies | Juice |
| 159 | *Tephrosia purpurea* (L.) Pers. | Common | Root, flower | Dyspepsia, eye inflammation | Decoction, juice |
| 160 | *Trianthema portulacastrum* Linn | Common | Leaf | Urinary troubles | Juice |
| 161 | *Tribulus terrestris* Linn | Common | Fruit, whole plants | Urinary problem, kidney stones, stomach ache | Powder, extract |
| 162 | *Trichodesmum indicum* (L.) R.Br | Common | Leaf, root | Scabies, swelling of joints | Paste, powder |
| 163 | *Tridax procumbens* L. | Common | Leaves | Head ache, cuts, wounds | Juice, paste |
| 164 | *Triumfetta rhomboidea* Jacq. Enum. Sy st. | Common | Roots | Bone fracture | Paste |
| 165 | *Urena lobata* Linn. | Common | Root | Body edema | Paste |
| 166 | *Urena sinuate* | Common | Root | Urinary disease | Decoction |
| 167 | *Vernonia cineriea* (L.) Less.Linnaea. | Common | Whole plant | Wounds | Paste |
| 168 | *Vigna triblobata* (L.)Verde. | Rare | Root | Till the person vomits in snake bite | Powder |
| 169 | *Waltheria indicum* L. | Vulnerable | Roots, leaves | Washing wounds | Decoction |
| 170 | *Xanthium stumarium* | Common | Leaves | Infection fingers | Paste |
| 171 | *Zorina diphylla* (L.) Pers. | Common | Whole plant | Breast to cure mastitis (maruti ubale) | Paste |

*Ahmedullah, M. and Nayar, M.P. (1987); Nayar, M.P. and Sastry, A. R. K. (1987- 1990); Maheshwari, J.K. (2000);
* Anonymous (1940-1976); Singh S. K. (2004); Viswanathan, M.B. (2004).

**Table 2. Number of individuals in 50 quadrats (1 x 1m each) and quantitative characters such as frequency, density, abundance, basal area, relative frequency, relative density, relative dominance and IVI of constituent species in the study forest during the rainy month of September 2013.**

| S. No. | Species | 2013 SEP | Frequency % | Density (indi./m2) | Abundance | Basel area (sq.mm/50quad.) | Relative frequency (%) | Relative density (%) | Relative dominance (%) | IVI |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *Abrus pulchellus* | 42(29) | 58 | 0.84 | 1.45 | 2.41 | 0.86 | 0.96 | 0.16 | 1.98 |
| 2 | *Abulition indicum* | 32(25) | 50 | 0.64 | 1.28 | 8.61 | 0.74 | 0.73 | 0.57 | 2.04 |
| 3 | *Acalypa indica* | 61(50) | 100 | 1.22 | 1.22 | 42.84 | 1.49 | 1.39 | 2.81 | 5.69 |
| 4 | *Acanthospermum hispidum* | 29(15) | 30 | 0.58 | 1.93 | 3.74 | 0.45 | 0.66 | 0.25 | 1.35 |
| 5 | *Achyranthus aspera* | 40(29) | 58 | 0.8 | 1.38 | 4.08 | 0.86 | 0.91 | 0.27 | 2.04 |
| 6 | *Aerva javanica* | 19(10) | 20 | 0.38 | 1.90 | 0.27 | 0.30 | 0.43 | 0.02 | 0.75 |
| 7 | *Aerva lanata* | 70(49) | 98 | 1.4 | 1.43 | 4.01 | 1.46 | 1.60 | 0.26 | 3.32 |
| 8 | *Alternanthera pungens* | 20(15) | 30 | 0.4 | 1.33 | 2.58 | 0.45 | 0.46 | 0.17 | 1.07 |
| 9 | *Alternanthera tenella* | 17(15) | 30 | 0.34 | 1.13 | 0.68 | 0.45 | 0.39 | 0.04 | 0.88 |
| 10 | *Amaranthus spinnosus* | 15(10) | 20 | 0.3 | 1.50 | 4.04 | 0.30 | 0.34 | 0.26 | 0.90 |
| 11 | *Amaranthus virigidis* | 16(12) | 24 | 0.32 | 1.33 | 3.08 | 0.36 | 0.36 | 0.20 | 0.92 |
| 12 | *Andrographis echoides* | 20(15) | 30 | 0.4 | 1.33 | 3.85 | 0.45 | 0.46 | 0.25 | 1.16 |
| 13 | *Andrographis paniculata* | 12(9) | 18 | 0.24 | 1.33 | 6.19 | 0.27 | 0.27 | 0.41 | 0.95 |
| 14 | *Asparagus racemosus* | 14(10) | 20 | 0.28 | 1.40 | 0.09 | 0.30 | 0.32 | 0.01 | 0.62 |
| 15 | *Asystasia gangetica* | 62(50) | 100 | 1.24 | 1.24 | 2.47 | 1.49 | 1.41 | 0.16 | 3.06 |
| 16 | *Barleria cuspidata* | 19(13) | 22 | 0.32 | 1.45 | 14.68 | 0.33 | 0.36 | 0.96 | 1.66 |
| 17 | *Barleria buxifolia* | 16(11) | 26 | 0.38 | 1.46 | 14.64 | 0.39 | 0.43 | 0.96 | 1.78 |
| 18 | *Barleria lupulina* | 26(19) | 38 | 0.52 | 1.37 | 18.26 | 0.57 | 0.59 | 1.20 | 2.36 |
| 19 | *Belpharis maderaptensis* | 69(49) | 98 | 1.38 | 1.41 | 5.38 | 1.46 | 1.57 | 0.35 | 3.39 |
| 20 | *Biophytum sensitivum* | 9(7) | 14 | 0.18 | 1.29 | 2.06 | 0.21 | 0.21 | 0.14 | 0.55 |
| 21 | *Blainviella acmella* | 15(11) | 22 | 0.3 | 1.36 | 7.74 | 0.33 | 0.34 | 0.51 | 1.18 |
| 22 | *Boerhavia diffusa* | 18(13) | 26 | 0.36 | 1.38 | 1.83 | 0.39 | 0.41 | 0.12 | 0.92 |
| 23 | *Borreria latifolia* | 20(17) | 34 | 0.4 | 1.18 | 8.15 | 0.51 | 0.46 | 0.54 | 1.50 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 24 | *Bryophyllum pinnatum* | 20(16) | 32 | 0.4 | 1.25 | 16.85 | 0.48 | 0.46 | 1.11 | 2.04 |
| 25 | *Cardiospermum halicabum* | 15(10) | 20 | 0.3 | 1.50 | 3.44 | 0.30 | 0.34 | 0.23 | 0.87 |
| 26 | *Cassia absus* | 27(25) | 50 | 0.54 | 1.08 | 2.11 | 0.74 | 0.62 | 0.14 | 1.50 |
| 27 | *Celosia argentea* | 18(15) | 30 | 0.36 | 1.20 | 5.62 | 0.45 | 0.41 | 0.37 | 1.23 |
| 28 | *Centella asiatica* | 15(13) | 26 | 0.3 | 1.15 | 0.10 | 0.39 | 0.34 | 0.01 | 0.74 |
| 29 | *Cheilocostus speciosus* | 16(13) | 26 | 0.32 | 1.23 | 14.68 | 0.39 | 0.36 | 0.96 | 1.72 |
| 30 | *Chromolaena oderata* | 14(12) | 24 | 0.28 | 1.17 | 8.05 | 0.36 | 0.32 | 0.53 | 1.20 |
| 31 | *Cleome aspera* | 20(11) | 22 | 0.4 | 1.82 | 4.59 | 0.33 | 0.46 | 0.30 | 1.08 |
| 32 | *Cleome gynandra* | 25(15) | 30 | 0.5 | 1.67 | 14.37 | 0.45 | 0.57 | 0.94 | 1.96 |
| 33 | *Cleome monophylla* | 19(12) | 24 | 0.38 | 1.58 | 5.93 | 0.36 | 0.43 | 0.39 | 1.18 |
| 34 | *Cleome rutidesperma* | 18(13) | 26 | 0.36 | 1.38 | 6.45 | 0.39 | 0.41 | 0.42 | 1.22 |
| 35 | *Cleome viscose* | 65(50) | 100 | 1.3 | 1.30 | 37.36 | 1.49 | 1.48 | 2.45 | 5.42 |
| 36 | *Clerodendran infortunatum* | 72(48) | 96 | 1.44 | 1.50 | 60.65 | 1.43 | 1.64 | 3.98 | 7.05 |
| 37 | *Clitoria ternate* | 13(11) | 22 | 0.26 | 1.18 | 0.19 | 0.33 | 0.30 | 0.01 | 0.64 |
| 38 | *Commelina benghalensis* | 15(10) | 20 | 0.3 | 1.50 | 1.93 | 0.30 | 0.34 | 0.13 | 0.77 |
| 39 | *Corchorus aestuans* | 15(13) | 26 | 0.3 | 1.15 | 1.93 | 0.39 | 0.34 | 0.13 | 0.86 |
| 40 | *Corchorus olitorius* | 25(23) | 46 | 0.5 | 1.09 | 10.19 | 0.68 | 0.57 | 0.67 | 1.92 |
| 41 | *Crotalaria mysorensis* | 12(11) | 22 | 0.24 | 1.09 | 10.11 | 0.33 | 0.27 | 0.66 | 1.26 |
| 42 | *Crotalaria pallida* | 16(12) | 24 | 0.32 | 1.33 | 17.22 | 0.36 | 0.36 | 1.13 | 1.85 |
| 43 | *Crotalaria verrucosa* | 25(19) | 38 | 0.5 | 1.32 | 14.37 | 0.57 | 0.57 | 0.94 | 2.08 |
| 44 | *Croton bonplandianum* | 12(9) | 18 | 0.24 | 1.33 | 5.52 | 0.27 | 0.27 | 0.36 | 0.90 |
| 45 | *Croton hirtus* | 13(9) | 18 | 0.26 | 1.44 | 7.47 | 0.27 | 0.30 | 0.49 | 1.05 |
| 46 | *Croton zeylanicus* | 9(7) | 14 | 0.18 | 1.29 | 4.64 | 0.21 | 0.21 | 0.30 | 0.72 |
| 47 | *Cuphea hyrsopifolia* | 19(15) | 30 | 0.38 | 1.27 | 2.45 | 0.45 | 0.43 | 0.16 | 1.04 |
| 48 | *Curculigo orchioides* | 10(8) | 16 | 0.2 | 1.25 | 7.71 | 0.24 | 0.23 | 0.51 | 0.97 |
| 49 | *Cyanotis axillaries* | 13(9) | 18 | 0.26 | 1.44 | 1.32 | 0.27 | 0.30 | 0.09 | 0.65 |
| 50 | *Cyanotis tuberose* | 18(14) | 28 | 0.36 | 1.29 | 1.40 | 0.42 | 0.41 | 0.09 | 0.92 |
| 51 | *Cynodon doctylon* | 34(19) | 38 | 0.68 | 1.79 | 1.95 | 0.57 | 0.78 | 0.13 | 1.47 |
| 52 | *Cyperus rotundus* | 35(26) | 52 | 0.7 | 1.35 | 2.73 | 0.77 | 0.80 | 0.18 | 1.75 |
| 53 | *Cyrtococcum patens* | 28(25) | 50 | 0.56 | 1.12 | 6.42 | 0.74 | 0.64 | 0.42 | 1.80 |
| 54 | *Datura metal* | 19(12) | 24 | 0.38 | 1.58 | 18.91 | 0.36 | 0.43 | 1.24 | 2.03 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 55 | *Desmodium adscendens* | 19(17) | 34 | 0.38 | 1.12 | 0.27 | 0.51 | 0.43 | 0.02 | 0.96 |
| 56 | *Desmodium illinoensis* | 15(12) | 24 | 0.3 | 1.25 | 4.04 | 0.36 | 0.34 | 0.26 | 0.96 |
| 57 | *Desmodium triflorum* | 17(12) | 24 | 0.34 | 1.42 | 0.24 | 0.36 | 0.39 | 0.02 | 0.76 |
| 58 | *Dodonia viscose* | 30(26) | 52 | 0.6 | 1.15 | 25.27 | 0.77 | 0.68 | 1.66 | 3.12 |
| 59 | *Echinochloa colona* | 25(22) | 44 | 0.5 | 1.14 | 12.90 | 0.65 | 0.57 | 0.85 | 2.07 |
| 60 | *Eclipta prostrate* | 17(14) | 28 | 0.34 | 1.21 | 9.77 | 0.42 | 0.39 | 0.64 | 1.45 |
| 61 | *Ecobolium viride* | 18(15) | 30 | 0.36 | 1.20 | 6.45 | 0.45 | 0.41 | 0.42 | 1.28 |
| 62 | *Emila sonchifolia* | 25(20) | 40 | 0.5 | 1.25 | 5.73 | 0.60 | 0.57 | 0.38 | 1.54 |
| 63 | *Euphorbia hirta* | 16(13) | 26 | 0.32 | 1.23 | 6.52 | 0.39 | 0.36 | 0.43 | 1.18 |
| 64 | *Euphorbia serpens* | 26(23) | 46 | 0.52 | 1.13 | 2.03 | 0.68 | 0.59 | 0.13 | 1.41 |
| 65 | *Euphorbia thymifolia* | 29(17) | 34 | 0.58 | 1.71 | 7.80 | 0.51 | 0.66 | 0.51 | 1.68 |
| 66 | *Evolvulus alsinoides* | 15(12) | 24 | 0.3 | 1.25 | 0.38 | 0.36 | 0.34 | 0.03 | 0.72 |
| 67 | *Evolvulus nummularis* | 13(10) | 20 | 0.26 | 1.30 | 0.33 | 0.30 | 0.30 | 0.02 | 0.62 |
| 68 | *Glycosmis pentaphylla* | 30(25) | 50 | 0.6 | 1.20 | 29.86 | 0.74 | 0.68 | 1.96 | 3.39 |
| 69 | *Gomphrena serata* | 26(23) | 46 | 0.52 | 1.13 | 2.03 | 0.68 | 0.59 | 0.13 | 1.41 |
| 70 | *Gymnema sylvestre* | 16(9) | 18 | 0.32 | 1.78 | 11.24 | 0.27 | 0.36 | 0.74 | 1.37 |
| 71 | *Hedyotis diffusa* | 19(15) | 30 | 0.38 | 1.27 | 8.74 | 0.45 | 0.43 | 0.57 | 1.45 |
| 72 | *Hedyotis pterita* | 14(10) | 20 | 0.28 | 1.40 | 5.71 | 0.30 | 0.32 | 0.37 | 0.99 |
| 73 | *Helitrophihum indicum* | 29(23) | 46 | 0.58 | 1.26 | 24.43 | 0.68 | 0.66 | 1.60 | 2.95 |
| 74 | *Hemidesmus indicus* | 19(14) | 28 | 0.38 | 1.36 | 3.66 | 0.42 | 0.43 | 0.24 | 1.09 |
| 75 | *Hibiscus micranthus* | 13(9) | 18 | 0.26 | 1.44 | 5.98 | 0.27 | 0.30 | 0.39 | 0.96 |
| 76 | *Hibiscus surrattensis* | 16(12) | 24 | 0.32 | 1.33 | 9.20 | 0.36 | 0.36 | 0.60 | 1.33 |
| 77 | *Hibiscus vitifolius* | 15(12) | 24 | 0.3 | 1.25 | 4.04 | 0.36 | 0.34 | 0.26 | 0.96 |
| 78 | *Hybanthus ennaespermum* | 13(10) | 20 | 0.26 | 1.30 | 1.68 | 0.30 | 0.30 | 0.11 | 0.70 |
| 79 | *Hygrophila auriculata* | 28(25) | 50 | 0.56 | 1.12 | 6.42 | 0.74 | 0.64 | 0.42 | 1.80 |
| 80 | *Hyptis suvaledens* | 25(17) | 34 | 0.5 | 1.47 | 14.37 | 0.51 | 0.57 | 0.94 | 2.02 |
| 81 | *Imperata cylindrical* | 29(18) | 36 | 0.58 | 1.61 | 24.43 | 0.54 | 0.66 | 1.60 | 2.80 |
| 82 | *Indigofera asplanthoides* | 32(27) | 54 | 0.64 | 1.19 | 1.83 | 0.80 | 0.73 | 0.12 | 1.65 |
| 83 | *Indigofera glandulosa* | 20(9) | 18 | 0.4 | 2.22 | 1.15 | 0.27 | 0.46 | 0.08 | 0.80 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 84 | *Indigofera hirsute* | 29(25) | 50 | 0.58 | 1.16 | 0.74 | 0.74 | 0.66 | 0.05 | 1.45 |
| 85 | *Indigofera uniflora* | 29(17) | 34 | 0.58 | 1.71 | 0.42 | 0.51 | 0.66 | 0.03 | 1.19 |
| 86 | *Ipomea carnea* | 13(8) | 16 | 0.26 | 1.63 | 1.32 | 0.24 | 0.30 | 0.09 | 0.62 |
| 87 | *Ipomea obscura* | 22(16) | 32 | 0.44 | 1.38 | 1.72 | 0.48 | 0.50 | 0.11 | 1.09 |
| 88 | *Justicia adothoda* | 12(8) | 16 | 0.24 | 1.50 | 12.92 | 0.24 | 0.27 | 0.85 | 1.36 |
| 89 | *Justicia gluca* | 32(26) | 52 | 0.64 | 1.23 | 6.17 | 0.77 | 0.73 | 0.40 | 1.91 |
| 90 | *Justicia simplex* | 18(13) | 26 | 0.36 | 1.38 | 1.03 | 0.39 | 0.41 | 0.07 | 0.87 |
| 91 | *Justicia tranquebariensis* | 26(20) | 40 | 0.52 | 1.30 | 1.49 | 0.60 | 0.59 | 0.10 | 1.29 |
| 92 | *Kyllinga odorata* | 29(19) | 38 | 0.58 | 1.53 | 0.74 | 0.57 | 0.66 | 0.05 | 1.28 |
| 93 | *Lagascea mollis* | 26(20) | 40 | 0.52 | 1.30 | 2.65 | 0.60 | 0.59 | 0.17 | 1.36 |
| 94 | *Lanata camera* | 20(15) | 30 | 0.4 | 1.33 | 19.90 | 0.45 | 0.46 | 1.31 | 2.21 |
| 95 | *Leucas aspera* | 55(50) | 100 | 1.1 | 1.10 | 14.80 | 1.49 | 1.25 | 0.97 | 3.71 |
| 96 | *Leucasgrandis* | 19(14) | 28 | 0.38 | 1.36 | 7.75 | 0.42 | 0.43 | 0.51 | 1.36 |
| 97 | *Linderina ciliate* | 19(15) | 30 | 0.38 | 1.27 | 3.66 | 0.45 | 0.43 | 0.24 | 1.12 |
| 98 | *Linderina crustacea* | 26(20) | 40 | 0.52 | 1.30 | 3.35 | 0.60 | 0.59 | 0.22 | 1.41 |
| 99 | *Ludwigia octovalis* | 14(12) | 24 | 0.28 | 1.17 | 1.81 | 0.36 | 0.32 | 0.12 | 0.79 |
| 100 | *Ludwigia peruviana* | 16(10) | 20 | 0.32 | 1.60 | 2.06 | 0.30 | 0.36 | 0.14 | 0.80 |
| 101 | *Malvastrum coromandelianum* | 17(12) | 24 | 0.34 | 1.42 | 6.09 | 0.36 | 0.39 | 0.40 | 1.14 |
| 102 | *Martynia annua* | 39(30) | 60 | 0.78 | 1.30 | 38.81 | 0.89 | 0.89 | 2.55 | 4.33 |
| 103 | *Melhania hamiltoniana* | 29(25) | 50 | 0.58 | 1.16 | 0.42 | 0.74 | 0.66 | 0.03 | 1.43 |
| 104 | *Melochia corehorifolia* | 45(36) | 72 | 0.9 | 1.25 | 12.11 | 1.07 | 1.03 | 0.79 | 2.89 |
| 105 | *Merremia tridentate* | 30(26) | 52 | 0.6 | 1.15 | 1.72 | 0.77 | 0.68 | 0.11 | 1.57 |
| 106 | *Microstachys chamaelea* | 17(12) | 24 | 0.34 | 1.42 | 1.33 | 0.36 | 0.39 | 0.09 | 0.83 |
| 107 | *Mimosa pudica* | 27(19) | 38 | 0.54 | 1.42 | 6.19 | 0.57 | 0.62 | 0.41 | 1.59 |
| 108 | *Mollugo pentaphylla* | 50(38) | 76 | 1 | 1.32 | 3.90 | 1.13 | 1.14 | 0.26 | 2.53 |
| 109 | *Naregama alata* | 20(16) | 32 | 0.4 | 1.25 | 6.24 | 0.48 | 0.46 | 0.41 | 1.34 |
| 110 | *Ocimum americanum* | 19(14) | 28 | 0.38 | 1.36 | 13.34 | 0.42 | 0.43 | 0.88 | 1.73 |
| 111 | *Ocimum basilicum* | 20(15) | 30 | 0.4 | 1.33 | 19.90 | 0.45 | 0.46 | 1.31 | 2.21 |
| 112 | *Ocimum gratissimum* | 22(14) | 28 | 0.44 | 1.57 | 15.45 | 0.42 | 0.50 | 1.01 | 1.93 |
| 113 | *Ocimum tenuiflorum* | 25(20) | 40 | 0.5 | 1.25 | 6.73 | 0.60 | 0.57 | 0.44 | 1.61 |
| 114 | *Oldenlandia corymbosa* | 23(21) | 42 | 0.46 | 1.10 | 0.33 | 0.63 | 0.52 | 0.02 | 1.17 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 115 | *Oldenlandia umbellate* | 65(46) | 92 | 1.3 | 1.41 | 6.62 | 1.37 | 1.48 | 0.43 | 3.29 |
| 116 | *Orthosiphon thymiflorus* | 23(19) | 38 | 0.46 | 1.21 | 19.37 | 0.57 | 0.52 | 1.27 | 2.36 |
| 117 | *Osbeckia aspera* | 39(35) | 70 | 0.78 | 1.11 | 10.50 | 1.04 | 0.89 | 0.69 | 2.62 |
| 118 | *Pavetta indica* | 46(28) | 56 | 0.92 | 1.64 | 42.19 | 0.83 | 1.05 | 2.77 | 4.65 |
| 119 | *Pedalium muxex* | 45(35) | 70 | 0.9 | 1.29 | 18.34 | 1.04 | 1.03 | 1.20 | 3.27 |
| 120 | *Pergularia daemia* | 30(26) | 52 | 0.6 | 1.15 | 6.88 | 0.77 | 0.68 | 0.45 | 1.91 |
| 121 | *Peristrophe paniculata* | 32(29) | 58 | 0.64 | 1.10 | 1.83 | 0.86 | 0.73 | 0.12 | 1.71 |
| 122 | *Persicaria hydropiper* | 29(23) | 46 | 0.58 | 1.26 | 5.59 | 0.68 | 0.66 | 0.37 | 1.71 |
| 123 | *Phryma laptostachya* | 23(19) | 38 | 0.46 | 1.21 | 1.79 | 0.57 | 0.52 | 0.12 | 1.21 |
| 124 | *Phyla nodiflora* | 15(12) | 24 | 0.3 | 1.25 | 1.17 | 0.36 | 0.34 | 0.08 | 0.78 |
| 125 | *Phyllanthus amarus* | 60(50) | 100 | 1.2 | 1.20 | 7.74 | 1.49 | 1.37 | 0.51 | 3.36 |
| 126 | *Phyllanthus debilis* | 25(23) | 46 | 0.5 | 1.09 | 3.22 | 0.68 | 0.57 | 0.21 | 1.47 |
| 127 | *Phyllanthus maderraptensis* | 23(20) | 40 | 0.46 | 1.15 | 2.34 | 0.60 | 0.52 | 0.15 | 1.27 |
| 128 | *Phyllanthus myrtifolius* | 39(31) | 62 | 0.78 | 1.26 | 3.97 | 0.92 | 0.89 | 0.26 | 2.07 |
| 129 | *Phyllanthus virgatus* | 28(21) | 42 | 0.56 | 1.33 | 1.11 | 0.63 | 0.64 | 0.07 | 1.34 |
| 130 | *Physalis minima* | 30(25) | 50 | 0.6 | 1.20 | 3.06 | 0.74 | 0.68 | 0.20 | 1.63 |
| 131 | *Plumbago zeylanica* | 19(15) | 30 | 0.38 | 1.27 | 2.45 | 0.45 | 0.43 | 0.16 | 1.04 |
| 132 | *Polycarpaea corrymbosa* | 32(29) | 58 | 0.64 | 1.10 | 7.34 | 0.86 | 0.73 | 0.48 | 2.07 |
| 133 | *Polygala chinensis* | 20(16) | 32 | 0.4 | 1.25 | 1.15 | 0.48 | 0.46 | 0.08 | 1.01 |
| 134 | *Portulaca quadrifida* | 29(26) | 52 | 0.58 | 1.12 | 24.43 | 0.77 | 0.66 | 1.60 | 3.04 |
| 135 | *Psuedathria viscid* | 35(27) | 54 | 0.7 | 1.30 | 3.57 | 0.80 | 0.80 | 0.23 | 1.84 |
| 136 | *Rauvolfia serpentine* | 9(7) | 14 | 0.18 | 1.29 | 2.06 | 0.21 | 0.21 | 0.14 | 0.55 |
| 137 | *Rhinacanthus nasutus* | 20(15) | 30 | 0.4 | 1.33 | 16.85 | 0.45 | 0.46 | 1.11 | 2.01 |
| 138 | *Rhynchosia minima* | 35(30) | 60 | 0.7 | 1.17 | 24.58 | 0.89 | 0.80 | 1.61 | 3.30 |
| 139 | *Rulliea prostrate* | 35(29) | 58 | 0.7 | 1.21 | 16.11 | 0.86 | 0.80 | 1.06 | 2.72 |
| 140 | *Rulliea tuberose* | 19(17) | 34 | 0.38 | 1.12 | 10.92 | 0.51 | 0.43 | 0.72 | 1.66 |
| 141 | *Rungia repens* | 15(11) | 22 | 0.3 | 1.36 | 2.89 | 0.33 | 0.34 | 0.19 | 0.86 |
| 142 | *Scoparia dulcis* | 29(20) | 40 | 0.58 | 1.45 | 20.36 | 0.60 | 0.66 | 1.34 | 2.59 |
| 143 | *Senna uniflora* | 12(10) | 32 | 0.4 | 1.25 | 10.32 | 0.48 | 0.46 | 0.68 | 1.61 |
| 144 | *Senna oxidentalis* | 20(16) | 20 | 0.24 | 1.20 | 4.30 | 0.30 | 0.27 | 0.28 | 0.85 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 145 | *Sida acuta* | 15(10) | 20 | 0.3 | 1.50 | 1.93 | 0.30 | 0.34 | 0.13 | 0.77 |
| 146 | *Sida cardata* | 59(50) | 100 | 1.18 | 1.18 | 2.35 | 1.49 | 1.35 | 0.15 | 2.99 |
| 147 | *Sida cordifolia* | 15(12) | 24 | 0.3 | 1.25 | 12.64 | 0.36 | 0.34 | 0.83 | 1.53 |
| 148 | *Solanum melongena* | 16(10) | 20 | 0.32 | 1.60 | 5.73 | 0.30 | 0.36 | 0.38 | 1.04 |
| 149 | *Solanum torvum* | 20(13) | 26 | 0.4 | 1.54 | 11.50 | 0.39 | 0.46 | 0.75 | 1.60 |
| 150 | *Solanum virginianum* | 25(19) | 38 | 0.5 | 1.32 | 11.50 | 0.57 | 0.57 | 0.76 | 1.89 |
| 151 | *Spermacoce articularis* | 17(13) | 26 | 0.34 | 1.31 | 1.73 | 0.39 | 0.39 | 0.11 | 0.89 |
| 152 | *Spermacoce hispida* | 22(19) | 50 | 0.64 | 1.28 | 3.26 | 0.74 | 0.73 | 0.21 | 1.69 |
| 153 | *Spermacoce ocymoides* | 15(10) | 38 | 0.44 | 1.16 | 2.84 | 0.57 | 0.50 | 0.19 | 1.25 |
| 154 | *Spermacoce pusilla* | 32(25) | 20 | 0.3 | 1.50 | 1.93 | 0.30 | 0.34 | 0.13 | 0.77 |
| 155 | *Stashytropheta jamensia* | 29(19) | 38 | 0.58 | 1.53 | 26.60 | 0.57 | 0.66 | 1.75 | 2.97 |
| 156 | *Stylosanthus fruticona* | 19(15) | 30 | 0.38 | 1.27 | 2.45 | 0.45 | 0.43 | 0.16 | 1.04 |
| 157 | *Stylosantus hamate* | 46(39) | 78 | 0.92 | 1.18 | 4.69 | 1.16 | 1.05 | 0.31 | 2.52 |
| 158 | *Syndrella nodiflora* | 19(13) | 26 | 0.38 | 1.46 | 5.11 | 0.39 | 0.43 | 0.34 | 1.16 |
| 159 | *Tephrosia purpurea* | 77(48) | 96 | 1.54 | 1.60 | 82.89 | 1.43 | 1.76 | 5.44 | 8.62 |
| 160 | *Trianthema portulacastrum* | 29(22) | 44 | 0.58 | 1.32 | 16.67 | 0.65 | 0.66 | 1.09 | 2.41 |
| 161 | *Tribulus terrestrus* | 29(19) | 38 | 0.58 | 1.53 | 7.80 | 0.57 | 0.66 | 0.51 | 1.74 |
| 162 | *Trichodesmium indicum* | 35(29) | 58 | 0.7 | 1.21 | 18.06 | 0.86 | 0.80 | 1.19 | 2.85 |
| 163 | *Tridax procumbens* | 30(27) | 54 | 0.6 | 1.11 | 23.12 | 0.80 | 0.68 | 1.52 | 3.01 |
| 164 | *Triumfetta rhomboids* | 29(21) | 42 | 0.58 | 1.38 | 14.96 | 0.63 | 0.66 | 0.98 | 2.27 |
| 165 | *Urena lobata* | 29(23) | 46 | 0.58 | 1.26 | 7.80 | 0.68 | 0.66 | 0.51 | 1.86 |
| 166 | *Urena sinuate* | 27(22) | 44 | 0.54 | 1.23 | 11.01 | 0.65 | 0.62 | 0.72 | 1.99 |
| 167 | *Vernonia cineria* | 35(27) | 54 | 0.7 | 1.30 | 8.03 | 0.80 | 0.80 | 0.53 | 2.13 |
| 168 | *Vigna trilobata* | 30(26) | 52 | 0.6 | 1.15 | 9.36 | 0.77 | 0.68 | 0.61 | 2.07 |
| 169 | *Waltheria indica* | 25(18) | 36 | 0.5 | 1.39 | 10.19 | 0.54 | 0.57 | 0.67 | 1.77 |
| 170 | *Xanthium stumarium* | 26(21) | 42 | 0.52 | 1.24 | 21.90 | 0.63 | 0.59 | 1.44 | 2.66 |
| 171 | *Zorina diphylla* | 20(15) | 30 | 0.4 | 1.33 | 4.59 | 0.45 | 0.46 | 0.30 | 1.20 |
| | **Total** | | **6720** | **87.68** | **227.34** | **1523.65** | **100.00** | **100.00** | **100.00** | **300.00** |

The higher IVI contributed by many species like *Tephrosia purpurea, Clerodendron infortunatum Acalypa indica*, *Aerva lanata*, *Asystasia gangetica*, *Belpharis maderaptensis*, *Cleome viscosa, Dodonia viscose, Glycosmis pentaphylla, Leucas aspera*, *Limnophila indica, Martynia annua, Oldenlandia* umbellate, *Pavetta indica*, *Phyllanthus amarus* and *Rhynchosia minima* in the present study area indicates their stronger perpetuation and higher functional role in the ecosystem.

Many species like *Alteranthera pungens*, *Amaranthus spinosus*, *Desmodium illinoensis, Evolvulus nummularis, Hybanthus enneaspermus*, *Justicia simplex*, *Ocimum basilicum*, *Plumbago zeylanica*, *Phyla nodiflora*, *Rauvolfia serpentine*, *Rungia repens*, *Solanum melongena, Acanthospermum hispidum, Aerva javanica, Amaranthus viridis*, *A. spinosus, Andrographis paniculata*, *Asparagus racemosus*, *Barleria buxifolia, B.lupulina, B. mysorensis, Biophytum sensitivum, Blainvilla trinervia, Borreria articularis, Boerhavia diffusa*, *Senna occidentalis, Cardiospermum halicabum, Centella asiatica*, *Chromolaena oderata, Cleome aspera, C. tetrandra, C. rutidesperma, Clitoria ternate*, *Commelina benghalensis*, *Corchorus aestuans, Croton hirtus, C. bonplandiam*, *C. sparsiflorus*, *Curculigo orchioides*, *Cyanotis axillaris*, *Cyanotis tuberosa, Desmodium adscendens*, *Desmodium triflorum*, *Evolvulus alsinoides*, *Ecobolium viride, Euphorbia hirta, Heydyotis peterita, Hibiscus vitifolius*, *H. micranthus*, *Indigofera glandulosa, Ipomea carnea, Justicia gluca, Ludwigia octovalvis, L. Peruviana, Phyllanthus virgatus, Sebastiana chamaelea, Sida acuta, Spermacoce articularis* and *S. hispida* were weaker in ecological attributes and secured poor IVI in the communities of studied forest. In addition to less fitness, the killing of young individuals by frost in winter may be ascribed as reason for this fact (Agarwal *et al.,* 1961). Hence it is suggested that priority must be given to these species for conservation by employing proper macro micro propagation techniques.

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# INDUCTION OF CALLOGENESIS AND SHOOT REGENERATION OF A MEDICINAL PLANT SPECIES *PERISTROPHE BICALYCULATA* (RETZ.) NEES.

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## ABSTRACT

In the present study, protocol for callus induction and regeneration for the medicinal plant species, *Peristrophe bicalyculata* (Retz.)Nees has been developed by using leaf explants. Young apical leaf explant was used for callus induction on MS medium containing BAP and NAA at 2`0 and 0.8 $mgl^{-1}$ respectively showed maximum callus induction (80%). The amount of callus responded for shoot formation (81%) was obtained in the MS medium containing BAP (2.0 $mgl^{-1}$) and $GA_3$ (0.3$mgl^{-1}$).The elongated shoots were rooted on half strength medium supplemented with IBA (2.0 $mgl^{-1}$) and IAA (0.2 $mgl^{-1}$) for shoots rooted. Regenerated plantlet were successfully acclimatized and hardened off inside the culture and then transferred to green house with better survival rate.

**Keywords:** *Peristrophe bicalyculata*, MS medium, multiple shooting, Acclimatization.

## 1. INTRODUCTION

The world has a very rich biodiversity of woody plants, many of which are medicinally important. Because of the use in medicine, woody plants require rapid and reliable methods of propagation. The conventional methods of propagation such as cuttings, graftings and layering are very slow. The rapid loss of rooting ability with age of woody plants makes them difficult to propagate. So, they require alternative method. Plant propagation by tissue culture is the possible approach to overcome the problem.

*Peristrophe bicalyculata* (Retz.)Nees belonging to the family Acanthaceae, having lot of medicinal properties. The plant is used on blood pressure, kidney, liver functions and skin related problems. It is also used as an antidote for snake poison when macerated in an infusion of rice, and as an insect repellant (Dwivedi, 2008). The ethanol extract of the plant has been reported to exhibit analgesic, anti-inflammatory and antibacterial properties (Chopra, 1959; Dwivedi, 2002). Although undocumented, the plant is used in South West Nigeria in the treatment of hypertension and other cardiovascular diseases. The essential oil shows tuberculostatic activity *in vitro*. Ayurvedic pharmacopoeia of India recommends the dried root in insomnia and for fear- psychosis in children. Leaves of the plant were used traditionally as analgesic, antipyretic, anti-inflammatory, sedative, stomachic, anticancer, fertility, diuretics and diarrhoea.

To date, there has been no report on *in vitro* regeneration of *P. bicalyculata*. Herein, we described the optimization of culture conditions and plant growth regulators required for callus initiation, shoot regeneration and rooting of plantlets from immature leaflets of *P. bicalyculata*.

## 2. MATERIALS AND METHODS

Leaf segments from young and healthy branches of *P. bicalyculata* were used as explants. They were collected from pot cultured individuals maintained in a mist chamber. For surface sterilization, the collected immature leaves were washed with tap water twice and then treated with 5 % tween–20 solutions for 5 min followed by rinsing in tap water. To eliminate fungal contamination, explants were further treated with 5 % antibiotics (Amphicillin and Rifampicin) for 30 min followed by 3 rinses in sterile double distilled water. Further, surface sterilization was carried out by dipping the explants in 0.1% $HgCl_2$ for 3 min followed by 3-4 rinses in sterile double distilled water.

### *2.1. Media and culture condition*

Murashige and Skoog (MS) (1962), medium containing 3 % sucrose solidified with 1 % agar (tissue culture grade, Himedia, India) was used. The pH of the medium was adjusted to 5.6-5.8 prior to the addition of agar before autoclaving at $121^0$ C for 15 min. All the culture bottles were kept in culture chamber at 25± $2^0$ C under 16/8 hr (light/dark) photoperiod with a light intensity of 2000 lux

supplied by cool white fluorescent tubes and with 60-65% relative humidity.

*2.2. Callus induction medium*

The explants were transferred to culture bottles containing 25 ml MS medium supplemented with different concentrations and combinations of BAP and NAA for callus induction.

*2.3. Shoot induction medium*

MS medium containing different concentrations and combinations of BAP (0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 mg/l) and $GA_3$at 0.3 mg/l was used for shooting attributes.

*2.4. Rooting of elongated shoots and acclimatization*

After proper shoot induction, the plantlets were carefully removed from the medium and washed with sterilize double distilled water properly, so as to avoid any trace of medium on roots. *In vitro* regenerated shoots (5-6 cm long) were excised and transferred onto the rooting media containing half strength MS medium supplemented with IBA and IAA for rooting. After proper root formation, these rooted plantlets were transferred to hardening medium composed by garden soil, sand and vermicompost in different proportion and maintained in greenhouse condition to know the survivability rate.

*2.5. Statistical Analysis*

All the experiment was done at least twice using triplicate. The data was statistically processed and means were compared using Duncan's Multiple Range Test ($P$<0.05).

**3. RESULTS AND DISCUSSION**

Calli formation was observed in leaf explants after 25 days. The best response of callus (80%) was observed in the MS medium supplemented with cytokinin BAP (2.0 $mgl^{-1}$) and auxin, NAA (0.8 $mgl^{-1}$) (Table 1). The result is supported by Thambiraj & Paulsamy (2012).Further studies were carried out for shoot regeneration capacity of the callus. Shoots were initiated from the callus obtained leaf explants. The best result of shooting (81%) was observed on the MS medium fortified with BAP (2.0 $mgl^{-1}$) and $GA_3$ (0.3 $mgl^{-1}$). The maximum number of multiple shoots 11.77 shoots/callus & shoot length (6.3 cm) were produced in the same concentrations and combinations of growth regulators (Table 2). The superiority of BAP over the other cytokinins on shoot bud production and proliferation of shoots has been reported for several medicinal and aromatic plant species by Jebakumar & Jayabalan, 2000; Hussain & Anis, 2006; Raja *et al*., 2008; Faisal & Anis, 2003.

Induction of rooting is an important step for *in vitro* plant propagation. Excised shoots were inoculated on MS medium with IBA and IAA for proper root development. The rooting responses were summarized in Table 3. Maximum rooting (78%), number of roots (9.78 roots/ shoot) & root length (6.6 cm) was observed on the MS medium supplemented with IBA and IAA at 2.0 & 0.2 $mgl^{-1}$ respectively (Table 3). These findings are in agreement with those reported by Sujatha & Reddy, 1998; Ahn *et al*., 2007; Alam *et al*., 2010 and Ramanathan *et al*., 2011.

After the development of roots, the plantlets were taken out from the culture bottles and washed with sterilized distilled water to remove adhering agar medium, so that the chance of contamination could be stopped. Then these juvenile plantlets were transferred to the hardening medium containing garden soil, sand and vermicompost (1:1:1 ratio by volume) where the leaf callus derived plantlets survivability rate was higher 76% (Table 4). Admixture of all these three components may offer condusive environment by providing proper nutrients, adequate aeration and required minerals respectively to the plantlets.

**Table 1. Effect of growth regulators on callus induction from leaf explants of the species, *Peristrophe bicalyculata.***

| Growth regulators (mg/l) | | | | Days required for callus formation after inoculation | Callus formation (%) |
|---|---|---|---|---|---|
| **BAP** | **2,4-D** | **NAA** | **Kn** | **Leaf Explant** | **Leaf Explant** |
| 0.5 | 0.0 | 0.0 | 0.0 | 18 | $35.25^{a} \pm 1.63$ |
| 1.0 | 0.0 | 0.0 | 0.0 | 19 | $47.76^{c} \pm 0.82$ |
| 1.5 | 0.0 | 0.0 | 0.0 | 17 | $56.86^{e} \pm 1.63$ |
| 2.0 | 0.0 | 0.0 | 0.0 | 20 | $64.35^{g} \pm 2.45$ |
| 2.5 | 0.0 | 0.0 | 0.0 | 21 | $70.53^{i} \pm 0.82$ |

| | | | | | |
|---|---|---|---|---|---|
| 3.0 | 0.0 | 0.0 | 0.0 | 19 | 60.84$^{f}$ ± 0.82 |
| 0.0 | 0.5 | 0.4 | 0.0 | 16 | 46.57$^{c}$ ± 1.63 |
| 0.0 | 1.0 | 0.4 | 0.0 | 15 | 54.37$^{e}$ ± 1.63 |
| 0.0 | 1.5 | 0.4 | 0.0 | 20 | 61.36$^{f}$ ± 0.82 |
| 0.0 | 2.0 | 0.4 | 0.0 | 23 | 69.58$^{i}$ ± 1.63 |
| 0.0 | 2.5 | 0.4 | 0.0 | 16 | 37.97$^{a}$ ± 1.63 |
| 0.5 | 0.0 | 0.2 | 0.0 | 15 | 59.00$^{cd}$ ± 0.82 |
| 1.0 | 0.0 | 0.4 | 0.0 | 16 | 67.35$^{e}$ ± 1.63 |
| 1.5 | 0.0 | 0.6 | 0.0 | 21 | 75.35$^{i}$ ± 0.82 |
| 2.0 | 0.0 | 0.8 | 0.0 | 25 | 80.13$^{j}$ ± 1.63 |
| 2.5 | 0.0 | 1.0 | 0.0 | 21 | 72.25$^{h}$ ± 1.63 |
| 3.0 | 0.0 | 1.2 | 0.0 | 18 | 52.87$^{b}$ ± 1.63 |
| 0.0 | 0.3 | 0.0 | 0.2 | 15 | 46.48$^{c}$ ± 1.63 |
| 0.0 | 0.6 | 0.0 | 0.4 | 17 | 51.59$^{d}$ ± 0.82 |
| 0.0 | 0.9 | 0.0 | 0.6 | 16 | 55.32$^{e}$ ± 1.63 |
| 0.0 | 1.2 | 0.0 | 0.8 | 18 | 60.21$^{f}$ ± 0.82 |
| 0.0 | 1.5 | 0.0 | 1.0 | 14 | 49.00$^{cd}$ ± 0.82 |

Means in columns followed by different letter (s) are significant to each other at 5% level according to DMRT.

**Table 2. Effect of different concentrations of growth regulators on shoot initiation, shoot number and shoot length after the subculturing of leaf derived callus of the species, *Peristrophe bicalyculata.***

| Growth regulators (mg/l) | | | | Culture response (%) | No. of shoots/callus | Shoot length (cm) |
|---|---|---|---|---|---|---|
| **BAP** | **NAA** | **$GA_3$** | **IAA** | | | |
| 0.3 | 0.0 | 0.0 | 0.0 | 53.23$^{d}$ ± 0.82 | 3.14$^{ab}$ ± 0.82 | 2.5$^{ab}$ ± 0.82 |
| 0.3 | 0.0 | 0.0 | 0.0 | 62.64$^{hi}$ ± 0.82 | 5.74$^{bcd}$ ± 0.82 | 3.8$^{abc}$ ± 1.63 |
| 0.3 | 0.0 | 0.0 | 0.0 | 65.78$^{j}$ ± 1.63 | 7.98$^{def}$ ± 1.63 | 4.0$^{abc}$ ± 1.63 |
| 0.3 | 0.0 | 0.0 | 0.0 | 58.37$^{fg}$ ± 0.82 | 4.00$^{abc}$ ± 1.63 | 5.2$^{bc}$ ± 0.82 |
| 0.3 | 0.0 | 0.0 | 0.0 | 60.64$^{gh}$ ± 1.63 | 9.38$^{fgh}$ ± 1.63 | 4.6$^{abc}$ ± 0.82 |
| 0.3 | 0.0 | 0.0 | 0.0 | 70.53$^{kl}$ ± 1.63 | 9.64$^{fgh}$ ± 0.82 | 5.7$^{c}$ ± 1.63 |
| 0.5 | 0.0 | 0.3 | 0.0 | 69.27$^{k}$ ± 0.82 | 8.75$^{hi}$ ± 1.63 | 4.3$^{abc}$ ± 0.82 |
| 1.0 | 0.0 | 0.3 | 0.0 | 75.00$^{m}$ ± 1.63 | 9.35$^{ghi}$ ± 0.82 | 3.9$^{abc}$ ± 0.82 |
| 1.5 | 0.0 | 0.3 | 0.0 | 77.58$^{n}$ ± 0.82 | 10.17$^{i}$ ± 0.82 | 5.0$^{c}$ ± 1.63 |
| 2.0 | 0.0 | 0.3 | 0.0 | 81.58$^{n}$ ± 0.82 | 11.77$^{i}$ ± 0.82 | 6.3$^{c}$ ± 1.63 |
| 2.5 | 0.0 | 0.3 | 0.0 | 75.96$^{b}$ ± 1.63 | 9.98$^{efg}$ ± 0.82 | 5.7$^{abc}$ ± 0.82 |
| 3.0 | 0.0 | 0.3 | 0.0 | 50.36$^{a}$ ± 1.63 | 5.32$^{bcd}$ ± 0.82 | 2.5$^{ab}$ ± 0.82 |
| 0.0 | 0.5 | 0.0 | 0.0 | 55.26$^{de}$ ± 0.82 | 6.41$^{ghi}$ ± 0.82 | 3.5$^{abc}$ ± 1.63 |
| 0.0 | 0.5 | 0.0 | 0.0 | 41.12$^{a}$ ± 0.82 | 5.67$^{fgh}$ ± 0.82 | 4.9$^{bc}$ ± 0.82 |
| 0.0 | 0.5 | 0.0 | 0.0 | 49.11$^{c}$ ± 0.82 | 6.52$^{cde}$ ± 1.63 | 5.3$^{bc}$ ± 1.63 |
| 0.0 | 0.5 | 0.0 | 0.0 | 58.85$^{fg}$ ± 1.63 | 3.43$^{ab}$ ± 1.63 | 4.7$^{abc}$ ± 1.63 |
| 0.0 | 0.5 | 0.0 | 0.0 | 64.26$^{ij}$ ± 0.82 | 5.28$^{bcd}$ ± 0.82 | 3.3$^{abc}$ ± 0.82 |
| 0.0 | 0.5 | 0.0 | 0.0 | 72.16$^{l}$ ± 1.63 | 7.47$^{efg}$ ± 1.63 | 2.8$^{ab}$ ± 0.82 |
| 0.5 | 0.0 | 0.0 | 0.2 | 43.49$^{d}$ ± 0.82 | 3.90$^{def}$ ± 0.82 | 2.0$^{abc}$ ± 0.82 |
| 1.0 | 0.0 | 0.0 | 0.2 | 28.00$^{k}$ ± 1.63 | 1.38$^{ghi}$ ± 0.82 | 1.9$^{a}$ ± 0.82 |
| 1.5 | 0.0 | 0.0 | 0.2 | 57.45$^{ef}$ ± 1.63 | 4.15$^{abc}$ ± 1.63 | 3.4$^{abc}$ ± 0.82 |
| 2.0 | 0.0 | 0.0 | 0.2 | 62.75$^{hi}$ ± 0.82 | 2.47$^{a}$ ± 0.82 | 3.5$^{abc}$ ± 1.63 |
| 2.5 | 0.0 | 0.0 | 0.2 | 59.32$^{fg}$ ± 0.82 | 3.74$^{ab}$ ± 1.63 | 2.0$^{a}$ ± 0.82 |
| 3.0 | 0.0 | 0.0 | 0.2 | 55.21$^{ij}$ ± 1.63 | 6.00$^{fgh}$ ± 0.82 | 2.5$^{ab}$ ± 0.82 |

Means in columns followed by different letter (s) are significant to each other at 5% level according to DMRT.

**Table 3. Effect of different concentrations of growth regulators on root number, rooting percentage and root length after the subculturing of leaf callus derived *in vitro* produced shoots of the species, *Peristrophe bicalyculata.***

| Growth regulators (mg/l) | | | Shoots rooted (%) | No. of roots/shoot | Root length (cm) |
|---|---|---|---|---|---|
| IBA | IAA | NAA | | | |
| 0.5 | 0.2 | 0.0 | $60.30^{j} \pm 0.41$ | $6.67^{abc} \pm 0.82$ | $5.4^{a-d} \pm 0.82$ |
| 1.0 | 0.2 | 0.0 | $68.25^{k} \pm 0.82$ | $7.39^{def} \pm 1.63$ | $5.9^{ef} \pm 0.82$ |
| 1.5 | 0.2 | 0.0 | $76.29^{m} \pm 0.41$ | $8.81^{f} \pm 1.63$ | $6.0^{f} \pm 1.63$ |
| 2.0 | 0.2 | 0.0 | $78.65^{l} \pm 0.82$ | $9.78^{ef} \pm 0.41$ | $6.6^{ef} \pm 1.63$ |
| 2.5 | 0.2 | 0.0 | $62.54^{h} \pm 1.63$ | $4.98^{abc} \pm 0.82$ | $4.8^{de} \pm 0.41$ |
| 3.0 | 0.2 | 0.0 | $48.45^{g} \pm 0.82$ | $3.00^{ab} \pm 0.82$ | $3.2^{a-d} \pm 0.16$ |
| 0.5 | 0.0 | 0.3 | $19.65^{e} \pm 0.41$ | $2.26^{bcd} \pm 1.63$ | $1.1^{bcd} \pm 0.82$ |
| 1.0 | 0.0 | 0.3 | $25.32^{d} \pm 0.82$ | $3.19^{ab} \pm 1.63$ | $3.9^{a-d} \pm 0.33$ |
| 1.5 | 0.0 | 0.3 | $35.54^{c} \pm 1.63$ | $4.64^{abc} \pm 0.82$ | $2.8^{abc} \pm 0.49$ |
| 2.0 | 0.0 | 0.3 | $39.24^{b} \pm 0.82$ | $4.38^{abc} \pm 0.33$ | $3.5^{a-d} \pm 0.41$ |
| 2.5 | 0.0 | 0.3 | $45.17^{a} \pm 0.41$ | $2.59^{a} \pm 0.82$ | $2.6^{ab} \pm 0.82$ |
| 3.0 | 0.0 | 0.3 | $50.98^{a} \pm 0.82$ | $3.38^{ab} \pm 0.82$ | $2.2^{a} \pm 0.16$ |
| 0.5 | 0.0 | 0.0 | $34.87^{c} \pm 0.82$ | $3.29^{ab} \pm 1.63$ | $3.8^{a-d} \pm 0.82$ |
| 1.0 | 0.0 | 0.0 | $45.67^{f} \pm 0.82$ | $5.48^{bcd} \pm 0.49$ | $2.9^{abc} \pm 0.82$ |
| 1.5 | 0.0 | 0.0 | $52.54^{h} \pm 1.63$ | $6.76^{cde} \pm 1.63$ | $4.1^{bcd} \pm 0.82$ |
| 2.0 | 0.0 | 0.0 | $51.87^{h} \pm 0.82$ | $5.53^{bcd} \pm 0.82$ | $4.5^{cde} \pm 0.41$ |
| 2.5 | 0.0 | 0.0 | $48.88^{g} \pm 0.41$ | $4.68^{abc} \pm 0.82$ | $3.2^{a-d} \pm 0.33$ |
| 3.0 | 0.0 | 0.0 | $55.34^{i} \pm 0.82$ | $5.58^{bcd} \pm 0.82$ | $4.8^{de} \pm 0.24$ |

Means in columns followed by different letter (s) are significant to each other at 5% level according to DMRT.

**Table 4. Effect of different composition of hardening medium on survivability rate of leaf callus derived *in vitro* rooted plantlets of the species, *Peristrophe bicalyculata.***

| Hardening medium composition (V/V) | No. of plantlets under hardening | No. of plantlets survived | Survivability (%) |
|---|---|---|---|
| Red soil + sand (1:1) | 50 | 24 | $42^{a} \pm 0.82$ |
| Garden soil + sand + vermicompost (1:1:1) | 50 | 41 | $76^{d} \pm 0.41$ |
| Decomposed coir waste + perlite + compost (1:1:1) | 50 | 35 | $71^{c} \pm 1.63$ |
| Vermicompost + soil (1:1) | 50 | 33 | $64^{b} \pm 0.65$ |
| Red soil + sand + vermicompost (1:1:1) | 50 | 25 | $50^{a} \pm 0.82$ |

Means in column followed by different letter (s) are significant to each other at 5% level according to DMRT.

From the above study, it is concluded that multiple shoot and root cultures of *Peristrophe bicalyculata* were established from leaf explants on MS medium supplemented with combination of hormones. This protocol has potential for large-scale micropropagation and application in molecular plant breeding research programs.

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# STUDY OF ORCHIDS DIVERSITY IN KOLLI HILLS, EASTERN GHATS, TAMIL NADU.

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## ABSTRACT

The present paper deals with the diversity of orchids in kolli hills. In past years above 70 sps of Orchids distributed in kolli hills.(Karuppasamy et al., 2009). But currently 42 species are dominant over in this area. Among this habitats Epiphytic 52.38% of Orchids contributed higher percentage followedby Terrestrial 42.86% and Lithophytic 4.76%. Epiphytic Orchids are highly trophical and sub-trophical in distributed. Most of orchids like *Eris, bulbophyllum keitense* and *Habineria* are in extinct stage because of deforestation and utilization. In this stage conservation of Orchids is most important. The collected orchids are listed below according to their alphabetical order.

**Keyword**: Kolli hills, Orchids, distribution, deforestation, conservation.

## 1. INTRODUCTION

Orchid are the second largest group of flowering plant comprising about 788genera and 18,500 sps (Mabberley, 1997) they are distributed throughout the world, except the hot deserts and Antartica. In India they are represented by 190genera and 1300species. Based on their varying habits, Orchids are classified into Saprophytic, Terrestrials, Epiphytic and Lithophytic. The number of flowering plant taxa represented approximately in the Eastern Ghats to be about 3500.

While, it is generally accepted today that the conservation of all biodiversity should be the goal. Understanding the natural distribution of plants (floristic studies) is central to conserving biodiversity and managing ecosystems for long term viability and sustainability (Ali Mohammad Asadi, 2009).

In this prospective the study was conceived to understand the Orchid diversity of Kolli hills of Eastern Ghats.

## 2. MATERIALS AND METHODS

### *2.1. Study area*

Kolli hills of Eastern Ghats lies in Namakkal district, tamilnadu is well known for its biological diversity. It has a total area of 490 $km^2$.kolli hills flanked Namakkal taluk on the South, and South West. Rasipuram on the North and North East, Attur taluk is on the north east and Trichy district in the east. The altitude ranges from 400-1400m rising to 1450m Kuzhivalavu.($11^0$10'-$11^0$27'N and $78^0$18'-$78^0$30' E.) the vegetation of Kolli hills is of mixed deciduous and evergreen types. The temperature ranges from $12^0$C-$25^0$C and the annual rainfall from 1200 to 1400mm. Kolli hills is called as Chaturagiri or Square hills contain of high raising peaks and ravines slopes are quite steep forming several narrow and deep valleys and in some places rising abruptly from plains and generally steep near ridges. So that the edge of the plateau is sharply defined. Along the slopes and foot hills the soil is red sandy-loam with rich in limestone and elements. Many of the areas of the hill are under mining for bauxite.

Kolli hills drained by two rivers, Vasisthanadhi and Swetanadhi. Swetanadhi originates from kolli hills and drains the Northern side of Salem district. Vasisthanadhi is called as Pearer and originates from Aranuttmalai, turns eastwards and which is an irrigation resource to Attur taluk.

### *2.2. Field survey*

Periodical field survey was conducted during the year 2011-2014 for collection of Orchids. Frequent field trips were made in all flowering seasons in those years. The study was based on field work and taxonomical examination of orchids.

## 3. RESULT AND DISCUSSION

In kolli hills, Orchids are beings to appear from 500m elevation onwards. Apart from climatic condition altitude play vital role for the distribution of Orchids. In the present study about 42 species belonging to 28 genus (Table 1) Orchids were collected and identified. During the course of survey maximum of Orchids were recorded in Kuzhivazhavu shola followed by Nachiyar kovil.

**Table 1. Enumeration of Orchids in Kolli hills.**

| S.No. | Botanical name | Habitat | Types of vegetation | Floral period |
|---|---|---|---|---|
| 1 | *Acampe praemorsa* (Roxb.) Blatt. | Epiphyte | MD,SEG | Jan-Mar |
| 2 | *Acanthephippium bicolor* Lindl. | Terrestrial | Shola | Apr-June |
| 3 | *Arides ringens* (Lindl.)Fishcer | Epiphytic | EG, SEG | June-July |
| 4 | *Anoectochilus elatus* Lindl. | Terrestrial | EG, Shola | June-Sept |
| 5 | *Bulbophyllum kaitense* Reichb.f. | Epiphytic | SEG- MD | Sept |
| 6 | *Bulbophyllum neilgherrense* Wight | Epiphyte | EG-SEG | Feb-Mar |
| 7 | *Calanthe triplicata* (Willem) Ames | Terrestrial | EG,SEG,Shola | July-Sept |
| 8 | *Coelogyne breviscapa* Lindl. | Epiphytic | EG | Feb-Mar |
| 9 | *Coelgyne odorratissima* | Terrestrial | EG,Shola | Feb-Mar |
| 10 | *Chysoglossum maculatum* (Thw.) Hook.f. | Terrestrial | Shola | Feb-Mar, Dec-Jan |
| 11 | *Dendrobium aquem* Lindl. | Epiphytic | EG,SEG | Sept-Oct |
| 12 | *Dendrobium herbaceum* Lindl. | Epiphyte | EG | Mar-July |
| 13 | *Dendrobium heterocarpum* Well. ex Lindl | Epiphyte | EG,Shola | Apr-June |
| 14 | *Diplocentrum recurvum* Lindl. | Epiphyte | EG | May-June, July-Aug |
| 15 | *Disperis neilgherrensis* Wight. | Terrestria | Shila | Aug-Sept |
| 16 | *Eria pauciflora* Wight | Epiphyte | EG | Aug-Sept |
| 17 | *Eria polystachya* A.Rich | Terrestrial | Shola | Oct-Nov |
| 18 | *Eria reticosa* Wight | Epiphyte | EG | July-Aug |
| 19 | *Eulophia graminea* Lindl. | Terrestrial | MD | Sept-Oct |
| 20 | *Flickingeria nodosa* (Dalz.)Seidenf. | Epiphyte | MD | July-Sept |
| 21 | *Geodorum densiflorum* (Lam.)Schltr. | Terrestrial | DD,MD,SEG | Aug-Sept |
| 22 | *Habinaria longocorniculata* Graham | Terresrial | SEG,MD | Aug-Sept |
| 23 | *Habinaria longicornu* Lindl. | Terresrial | MD | Aug-Sept |
| 24 | *Habinaria rariflora* A.Rich | Terrestrial | EG,SEG | Aug-Sept |
| 25 | *Habinaria virusens* | Terrestrial | Grass lands | Aug-Sept |
| 26 | *Liparis walkeriae* Graham. | Terrestrial | EG | July-Aug |
| 27 | *Luisia birchea* Bl. | Epiphyte | EG | July-Aug |
| 28 | *Luisia zeylanica* Lindl. | Epiphyte | EG | May- July |
| 29 | *Malaxis rheedii* Sw. | Terrestrial | EG,SEG,MD | Aug-Sept |
| 30 | *Nervilia plicata* (Andr.) Schltr. | Terrestrial | EG,SEG | Aug-Sept |
| 31 | *Oberonia brunoniana* Wight. | Epiphyte | EG,SEG | Sept-Oct |
| 32 | *Oberonia denticulate* Wight. | Epiphyte | EG,SEG | July-oct |
| 33 | *Oberonia proudlockii* King & Prantl | Epiphyte | EG,SEG | May-Aug |
| 34 | *Oberonia santapaui* Kapadia. | Epiphyte | EG | July-oct |
| 35 | *Papillanthe subulta* (koeing) Garay | Epiphyte | EG | Mar-Apr |
| 36 | *Peristylus goodyeroids* (D.Don.) Lindl. | Terrestrial | SED,MD | Feb-Mar |
| 37 | *Polystachya concreta* (jacq.) Garay & Sweet | Epiphyte | EG,Shola | July-Aug |
| 38 | *Srihookera latifolia* | Epiphyte | EG,Shola | July-Aug |
| 39 | *Tropidia angulosa* (Lindl.) Bl | Terrestrial | EG,SEG | Aug-Sept |
| 40 | *Vanda spathulata* (L) Spreng. | Epiphyte | MD | June-Sept |
| 41 | *Vanda tessellata* (Roxb.) Hook. ex G.Don. | Epiphyte | DD | Sept-Oct |
| 42 | *Zexuine longilabris* (lindi.) Benth. ex Hook.f. | Terrestrial | Shola | May-Aug |

EG - Ever Green, SEG - Semi Ever Green, MD - Moist Deciduous, DD - Dry Deciduous.

Among this habitats Epiphytic 52.38% of Orchids contributed higher percentage followed by Terrestrial 42.86% and Lithophytic 4.76 %.(Table 2). Epiphytic Orchids are highly trophical and sub-trophical in distributed.

**Table 2. Habitat percentage.**

| S.No | Habitat | % of occurrence |
|---|---|---|
| 1 | Epiphytic | 52.38 |
| 2 | Lithophytic | 4.76 |
| 3 | Terrestrial | 42.86 |

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# ETHNOMEDICINAL APPROACHES FOR TREATING VARIOUS DISEASE BY IRULA TRIBALS, KONBANUR VILLAGE, ANAIKATTI HILLS,THE WESTERN GHATS, COIMBATORE DISTRICT

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## ABSTRACT

Ethno-medicine means the medical practices for the treatment of ethnic or aborigine people for their health care needs. Indigenous traditional Knowledge is an integral part of the culture and history of a local community. It is evolved through years of regular experimentation on the day to day life and available resources surrounded by the community. The present paper documented 85 ethno-medicinal plants of Konbanur village, Anaikatti, Coimbatore district, the Western Ghats, Tamil Nadu belonging to 48 families were used by the Irula tribals for various diseases and food. The conventional ethno medicinal plants were mostly used for different inflammation, cough and cold, leucoderma, different skin diseases, ulcers and leprosy. The medicinal plants used by the Irula tribal traditional users of Konbanur village, Anaikatty hills are arranged alphabetically followed by botanical name, family, local name and medicinal uses.

**Keywords**: Ethnomedicine, Irula tribals, Anaikatti hills.

## 1. INTRODUCTION

India is endowed with a variety of natural resources. All along the West coast the Western Ghats are sprawling. The entire Western Ghats is known for its biodiversity, richness and endemism of different species. India harbours about 15% (3000 – 3500) out of 20,000 medicinal plants of the world. About 90% of these are found growing wild in different climatic regions of the country. The tribal and rural populations of India are, to a large extent, dependent on medicinal plants not only to meet their own healthcare needs by self-medication, but also for their livestock.The Western Ghats is richly credited with varied kind of vegetation and unimaginable topographical features. There are about 2,000 plant species that has been found to possess the medicinal value, in all the four systems of indigenous medicine, viz, Ayurveda, Unani, Siddha, and Homeopathy. Irulas are a small tribal community that is part of the Dravidian language group that is spoken in South-Eastern India. They are recognized as a Scheduled Tribe (ST) by the Government of India (Sasi *et al.,* 2011; Ragupathy and Newmaster, 2009). The Irulas are the Dravidian inhabitants and one among the 36 sub-tribal communities in Tamil Nadu that holds the population about 26,000 Irulas living in Tamil Nadu, out of the total population of 558 lakh in the state (Department of Tribal Welfare of Tamil Nadu, Statistic table, July 2006), which is less than 0.5 % of the entire state's population (Census of India, 1991 and 2001). The study area Konbanur village, Anaikatti (11°6'N, 76°45'E). is occupied 250 acres site constitutes a part of the large two square kilometers catchment area. Two hill slopes, northern and southern, also form a part of NBR park. The hills elevate to a height of 80 to 120 metres from the valleys (Fig. 1).

## 2. MATERIALS AND METHODS

Each and every ethnobotanical work has various activities. They are field trip, observations, identification retrieving the medicinal properties and mode of preparation of drug from the plants by Irula tribal community.

The present work is the outcome of intensive field studies undertaken in hamlet inhabited by Irulas community. Explorative field trips were regularly made once in a month of the study area to all habitants to elicit information on medicinal plant used to treat various ailments. Folklore medico botanical investigations were carried out according to the method adopted by Schultes (1960, 1962); Jain (1989) and Martin (1995). Fieldwork is the most significant aspect in this type of study. Extensive field trips were conducted to remote rural settlements. From each village, two or three local herbal healers were interviewed to elicit first hand information in respect of the plant/plant product curing various diseases. The voucher specimen plants collected were identified with the help of Flora of Presidency of

Madras by Gamble (1936) and Flora of Tamilnadu and Carnatic by Mathew (1983).

The medicinal plants collected in this way are tabulated. They are documented, both family and genus are arranged according to the alphabetical order. The botanical names followed by author citation and synonyms of the plant species, local name of the plant species also provided. Most of the plants are used as a medicine rest of them served as an edible plants.

## 3. RESULTS AND DISCUSSION

The present study was carried out in the Konbanur village of Anaikatti hills, the Western Ghats, Coimbatore District. Fieldwork is the most significant aspect in this type of study. Extensive field trips were conducted to remote rural settlements. From each village, two or three local herbal healers were interviewed to elicit first hand information in respect of the plant/plant product curing various diseases. In Table 1, data obtained from the field survey are presented. In this study 85 plant species belonging to 48 families have been recorded. Many plant species belonging to families of Solanaceae, Asteraceae and Amarandhaceae are frequently used (Table 2). The informations collected from this study are in agreement with the previous reports (Pushpangadan and Atal, 1984, Kala, 2005; Jain and Shrivastava, 2001; Ayyanar and Ignacimuthu, 2005; Sandhya *et al*., 2006; Ignacimuthu *et al.,* 2006). For common ailments such as fevers, stomach ache and respiratory disorders, skin diseases, joint pains, hair loss, dysentery, diarrhea, snakebite, jaundice and malaria more number of medication were used. On the other hand, few were used to complicated problems such as heart diseases, kidney disorders skin diseases, cancer and diabetes. The knowledge informants were taken to the field and information on medicinal plants was recorded. The informants were asked to explain therapies of the diseases and to list plants they employ (Table 3-5). In this investigation, there are 20species belonging to 17 families and 18 Genera were reported by the local practice for the treatment of common heart diseases (Table 3).Among them, 17families represents atleast single species each. Nearly 20 species, they are using for the treatment of common stomach problems which belonging into 12 families and 20 Genera (Table 4) and The Irula communities of the study area selectively used around 15 families with their 19 plant species especially for the treatment of kidney disorders which is belonging into (Table 5) Amarandhaceae, Asclepiadaceae, Cucurbitaceae, Lamiaceae, Fabaceae, Malvaceae, Menispermaceae and Nyctaginaceae etc.,

For each plant species complete documentation of folklore medicinal information including medicinal property, their vernacular names, family, parts of used, uses and their identified phytochemical compounds was recorded (Martin, 1995).

The most important aspect of the Irula tribal medicine is that fresh plant material is used for the preparation of medicine. Alternatively, if the fresh plant parts are not available, dried plant materials are used. For this reason several plants served as edible food and alternative remedy to cure a more than single diseases. From this study it is clear that Irula tribal possess innate ability to discern the character of plants and exploit the plant resources to meet their health care needs.

**Fig. I. Location of the study area.**

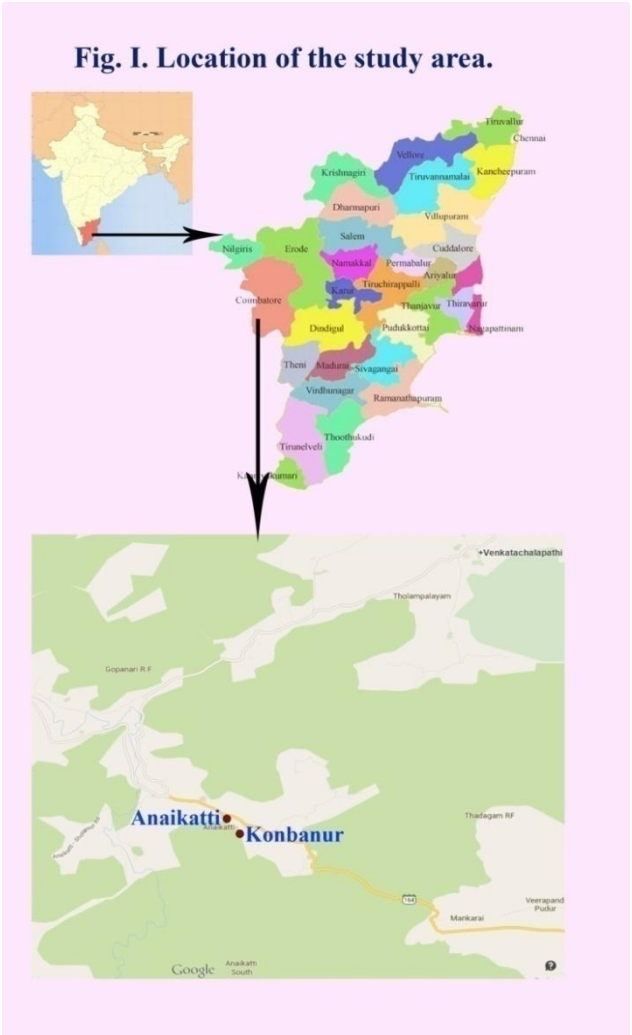

**Table 1. List of Ethnomedicinal plants used by Irula tribal in study area.**

| S.No | Botanical Name | Family | Vernacular Name | Parts used ,Mode of Preparation, Ethno medicinal uses and some other plants used as ingredients |
|---|---|---|---|---|
| 1 | *Abelmoschusesculandus*L. | Malvaceae | Bhendhi | Protect from asthma and diabetes |
| 2 | *Abrusprecatorius*L. | Fabaceae | Rosary pea, Ratti | Used in stomach pains and diarrhea |
| 3 | *Abutilonindicum*Linn. | Malvaceae | Thuthi | Protect from Piles and Pulmonary tuberculosis |
| 4 | *Achyranthesaspera*Linn. | Amaranthaceae | Chirchitta | Useful in treatment of Vomiting, Cough, Dysentery |
| 5 | *Aconitum heterophyllum*L. | Fabaceae | Athividayam | Extracts used for treating Snakebite, Fever |
| 6 | *Acoruscalamus*L. | Acoraceae | Vasambu | Rhizome used for cough & fever. Leaf used for Diuretic |
| 7 | *Adina cordifolia*(Roxb.) | Rubiaceae | Kadami | Medicine for Stomach-ache, cold cough, fever |
| 8 | *Aeglemarmelos*(L.) Correa | Rutaceae | Vilvam | Fruits used for Dysentery |
| 9 | *Aervalanata* L. | Amarandhaceae | Kanpulai | Leaf juice cure kidneystone |
| 10 | *Ageratumconyzoides*L. | Asteraceae | Chick weed | Treating for stomach pain and antifungal disease |
| 11 | *Allium ceba* L. | Liliaceae | Onion | To relieve congestions especially in lungs & bronchial tract. |
| 12 | *Allium sativum* L. | Liliaceae | Garlic | To lower blood pressure and cholesterol. |
| 13 | *Amarandhuscaudatus*L. | Amarandhaceae | Cirukeerai | Avoid diarrhea done by its powder |
| 14 | *Amaranthusspinosus*L. | Amaranthaceae | Mullu | Leaf juice used for Diuretic & Digestion |
| 15 | *Andrographispaniculata*(Burm.f.) | Acanthaceae | Siriyanangai | Leaf paste mixed with milk internally taken for snake bite |
| 16 | *Aristolochia bracteolate* Lam. | Aristolochiaceae | Aaduthinnapaalai | Leaf Paste used externally on the wound of snake bite |
| 17 | *Artocarpusheterophyllus*Lam. | Moraceae | Palamaram | Leaf juice used for taken internally for ulcer |
| 18 | *Basella alba* L. | Basellaceae | Kodipasalai | Leaves boiled in water and taken internally to cure piles |
| 19 | *Boerhaaviadiffusa*L. | Nyctaginaceae | Mukkurttaikkoti | Taken for treatment of abdominal pain,tumors |
| 20 | *Bryophyllumpinnatum* (Lam.)oken | Crassulaceae | Malaikali | Cure kidney stone and Cough |
| 21 | *Burberis vulgaris* Linn. | Berberidaceae | Jaundice barberry | Fruit used to reinforce the heart and liver |
| 22 | *Caesalpiniapulcherrima*Linn. | Fabaceae | Peacock Flower | Focusing the diseases like asthma, malaria, kidney stone |
| 23 | *Caeselpiniabonduc (L.)* Roxb. | Caesalpinaceae | Kazhichikai | Seed used for Fever. Leaf juice used for diabetics |
| 24 | *Camellia sinensis* (L.) Kuntze | Berberidaceae | Tea plant | Tea used for cancer, heart disease, liver disease |
| 25 | *Canna indica*L. | Scitaminaceae | Kalvazhai | Root juice are used for diuretic & digestion |

| | | | | |
|---|---|---|---|---|
| 26 | *Canthiumcoromandelicum*(Burm.f) Alston | Rubiaceae | Bellakarai | Roots & Leaves paste used for Diuretic |
| 27 | *Capparissepiaria*L. | Violaceae | Thottichedi | Root & Leaves are pasted with lemon juice and are applied topically to treat swellings. |
| 28 | *Cappariszeylanica*L. | Capparaceae | Kevisi | Leaves juice used for Immuno stimulant anti-inflammatory |
| 29 | *Carallumabicolour*Ramach, S. Joseph, H. A. John & C. Sofia | Asclepiadaceae | Kattalae | Plant extract used for Weight loss |
| 30 | *Caralluma umbellate*Haw. | Asclepiadaceae | Chirukalli | Whole plant roasted for a few minutes and roasted paste applied for indigestion |
| 31 | *Carica papaya* Linn. | Caricaceae | Papaya | Cures Abdominal disorders, Amenorrhoea, Atherosclerosis |
| 32 | *Cassia occidentalis*(L) | Fabaceae | Ponnavarai | Works as an antibacterial, antifungal, antimalarial |
| 33 | *Celosia argentia*L. | Verbenaceae | Kozhikontai | Curing infant fever and Chronic cough |
| 34 | *Cissampelospareira*L. | Menispermaceae | Ponmusutai | Treatment of urinary tract |
| 35 | *Cocciniagrandis*(L.) J.Viogt | Cucurbitaceae | Koovaikodi | Treating diseases of urinary tract infection, skin diseases, Hypoglycaemic |
| 36 | *Coleus aromaticus*benth. | Lamiaceae | Karpuravalli | Working against Anti-tumor and Cholera |
| 37 | *Coleus forskohlii* (willd.)Briq | Lamiaceae | Marunthukoorkankizanku | Treating intestinal disorders, asthma |
| 38 | *Commiphora mukul* (Jacq.)Eng | Burseraceae | Guggul | oleo-gum-resin used in treatment of nervous diseases, leprosy |
| 39 | *Cordiadichotoma*G. Forst. | Boraginaceae | Karadisellai | Seed extract used for Anti-inflammatory |
| 40 | *Crataegus oxyacantha* Linn. | Rosaceae | Hawthorn | To reduce cardiac and cerebral damage, when ischemia |
| 41 | *Crocus sativus* Linn. | Iridaceae | Saffron | Stamens are used for curing heart disease |
| 42 | *Curcuma longa* Linn. | Zingiberaceae | Turmeric | Use in cardiovascular diseaseand gastrointestinal disorders |
| 43 | *Cyphomandrabetacea*(Cav.) Miers | Solanaceae | Maraththakkali | Fruits used for diuretic, cough and cold |
| 44 | *Daturastramonium*L. | Solanaceae | Unmatta | Relieve the diseases urinary retention and ulcer |
| 45 | *Digitalis lanata*Linn. | Scrophulariaceae | Wooly foxglove | Used to relive from heart diseases and asthma |
| 46 | *Dioscoreaoppositifolia*L. | Dioscoreaceae | Chinese yam | Leaves paste is used as antiseptic for ulcers |
| 47 | *Diplocylospalmatus*(L.) Jeffrey | Cucurbitaceae | Sivalingakkodi | Fruits juice used in body pain |
| 48 | *Dolichosbiflorus*L. | Fabaceae | Kulattha | Lowering the level of blood sugar |
| 49 | *Drynariaquercifolia*(L.) J.Sm. | Polypodiaceae | Mudavattukizhangu | Rhizome juice are taken internally for body pain |
| 50 | *Emblica officinalis*Gaertn. | Euphorbiaceae | *Indian gooseberry* | Treatment of jaundice, dyspepsia and cough |
| 51 | *Erigeron Canadensis* L. | Asteraceae | Horseweed | Helps for curing Blood clotting &rheumatic |

| | | | | |
|---|---|---|---|---|
| | | | | complaints |
| 52 | *Gloriosasuperba*L. | Liliaceae | Kanvalipoo | Rhizome paste is applied treat wounds. |
| 53 | *Glycosmispentaphylla*(Retz.) Dc. | Rutaceae | Melaekulukki | Used for cough, rheumatism, anemia and jaundice. |
| 54 | *Gompherna serrate* L. | Amarandhaceae | Arasan con todo | Cures the Kidney problems and live disorders |
| 55 | *Guizotiaabyssinica*(L.f.) Cass. | Asteraceae | Malaiellu | Treatment for Stomach ache |
| 56 | *Hemidesmusindicus* L. | Asclepiadaceae | Nanari | Refrigerant and for kidney and urinary disorders |
| 57 | *Inula racemosa* HOOK. F | Asteraceae | Sunspear | Roots are powerful biological activity. |
| 58 | *Jatrophamultifida*L. | Euphorbiaceae | Churakkalli | Protects fromStomach ache, burn |
| 59 | *Justiciaadhatoda*L. | Acanthaceae | Aadhatodai | Leaf juice from this plant used for cough, fever and diarrhea |
| 60 | *Kalanchoepinnata*L. | Crassulaceae | Ranakalli | Medicine for curing kidney diseases |
| 61 | *Lagenariasiceraria* L. | Cucurbitaceae | Surakkai | Treating diseases like Diabetic,Doarrhea and digestive problem |
| 62 | *Madhucalongifolia*(Koenig) | Sapotaceae | Iluppai | Medicine for diabetes, Painkiller, Skin diseases |
| 63 | *Matricarrecutita*L. | Asteraceae | Chamomile | Cures the digestive problems and acts as an anti-inflammatory, anti-spasmodic. |
| 64 | *Momordicacharantia*L. | Cucurbitaceae | Pakkrkai | Cure kidney stone. |
| 65 | *Moringa oleifera* L. | Moringaceae | Murungai | Stabilize blood pressure and make strengthen |
| 66 | *Nelumbo nucifera* Gaertn | Nymphaeaceae | Indian Lotus | Treatment of diarrhea, tissue inflammation and haemostasis |
| 67 | *Pachygoneovata (*Poir.) Diels | Menispermaceae | Perungkaattukodi | Seeds powder used for Snake bites |
| 68 | *Pergulariadaemia*(Forsk) Chiv | Asclepiadaceae | Veliparuthi | Treating the diseases like malarial intermittent fevers, toothaches |
| 69 | *Phyllandhusniruri* L. | Phyllandhaceae | Keezhanelli | Brain tumor andJaundice |
| 70 | *Piper longum* L. | Piperaceae | Long pepper | Therapeutic agent for Alzheimer disease, Anti-stress |
| 71 | *Psidium guajava* L. | Myrtaceae | Guava | Rich in antioxidant properties |
| 72 | *Punica granatum* L. | Puniacaceae | Pomegranate, | Focusing on treatment of diabetics and prevention of cancer, cardiovascular disease |
| 73 | *Ricinuscommunis*L. | Euphorbiaceae | Castor | Protect liver damage from certain poisons |
| 74 | *Riveahypocrateriformis*Choisy | Convolulaceae | Mustae | Leaves paste used for diarrhea |
| 75 | *Scillahyacinthina*(Roth) Macbr. | Liliaceae | Kattuvengayam | Paste made from bulb applied externally for body pain |
| 76 | *Scopariadulcis* L. | Scrophuraliaceae | Sarkaraivempu | Cure kidney stone. |
| 77 | *Solanumnigrum*L. | Solanaceae | Makoi | Having antiulcer properties cures stomach diseases |
| 78 | *Solanumrudepannum*Dunal | Solanaceae | Toothuvalai | Leaf juice is taken orally for cough and fever |

| | | | | |
|---|---|---|---|---|
| 79 | *Strychnospotatorum*L.f. | Loganiaceae | Sillakottai | The whole plants used for Urinary & Kidney |
| 80 | *Terminaliaarjuna*W. & A. | Combretaceae | White Marudah | Protects the heart, strengthens circulation |
| 81 | *Terminaliachebula*Retz. | Combretaceae | Haritaki | Works as anAntioxidant,Antibacterial, |
| 82 | *Tribulusterrestis* L. | Zygophyllaceae | Nerunji | Protects the liver and kidney |
| 83 | *Withaniasomnifera*Dunal | Solanaceae | Winter cherry | Increases hemoglobin content in the blood |
| 84 | *Zingiberofficinale*Roscoe. | Zingiberaceae | Ginger | Useful in fighting heart disease, cancer |
| 85 | *Zizphus jujube* (L.) | Rhamnaceae | Ber | Increase physical stamina and cures the liver disorders |

**Table 2. List of families with number of species in study area.**

| S.No | Name of the Family | No. of species present in each family | S.No | Name of the Family | No. of species present in each family |
|---|---|---|---|---|---|
| 1 | Acanthaceae | 2 | 25 | Malvaceae | 2 |
| 2 | Acoraceae | 1 | 26 | Menispermaceae | 2 |
| 3 | Amarandhaceae | 5 | 27 | Moraceae | 1 |
| 4 | Aristolochiaceae | 1 | 28 | Moringaceae | 1 |
| 5 | Asclepiadaceae | 4 | 29 | Myrtaceae | 1 |
| 6 | Asteraceae | 5 | 30 | Nyctaginaceae | 1 |
| 7 | Basellaceae | 1 | 31 | Nymphaeaceae | 1 |
| 8 | Berberidaceae | 1 | 32 | Phyllandhaceae | 1 |
| 9 | Boraginaceae | 1 | 33 | Piperaceae | 1 |
| 10 | Burseraceae | 1 | 34 | Polypodiaceae | 1 |
| 11 | Caesalpinaceae | 1 | 35 | Puniacaceae | 1 |
| 12 | Capparaceae | 1 | 36 | Rhamnaceae | 4 |
| 13 | Caricaceae | 1 | 37 | Rosaceae | 1 |
| 14 | Combretaceae | 2 | 38 | Rubiaceae | 2 |
| 15 | Convolulaceae | 1 | 39 | Rutaceae | 2 |
| 16 | Crassulaceae | 2 | 40 | Sapotaceae | 1 |
| 17 | Cucurbitaceae | 4 | 41 | Scitaminaceae | 1 |
| 18 | Dioscoreaceae | 1 | 42 | Scrophulariaceae | 2 |
| 19 | Euphorbiaceae | 3 | 43 | Solanaceae | 5 |
| 20 | Fabaceae | 2 | 44 | Theaceae | 1 |
| 21 | Iridaceae | 1 | 45 | Verbenaceae | 1 |
| 22 | Lamiaceae | 2 | 46 | Violaceae | 1 |
| 23 | Liliaceae | 4 | 47 | Zingiberaceae | 2 |
| 24 | Loganiaceae | 1 | 48 | Zygophyllaceae | 1 |

**Table 3. List of medicinal plants used by Irula tribal for the treatment of heart diseases.**

| S.No | Botanical Name | Common name | Name of the Family | Parts used | Chemical Constituents |
|---|---|---|---|---|---|
| 1 | *Allium ceba* L. | Onion | Liliaceae | Bulb & Leaves | Sulphur compounds(Ajoene, allyl sulfides, and vinyldithiins), quercetin& Allicin(diallyl disulphide oxide) |
| 2 | *Allium sativum* L. | Garlic | Liliaceae | Bulb | Sulphur compounds,(Ajoene, allyl sulfides, and vinyldithiins)&Allicin |
| 3 | *Burberis vulgaris*Linn. | Jaundice barberry | Berberidaceae | Bark & Root | Berberine |
| 4 | *Camellia sinensis* (L.) Kuntze | Tea plant | Theaceae | Leaves & Leaf buds | Epicatechin (EC),Epigallocatechin (EGC), Epicatechin-3-gallate (ECG), and Epigallocatechin-3-gallate (EGCG) |
| 5 | *Coleus forskohlii*(willd.)Briq | Marunthu koorkankizanku | Lamiaceae | Tuberous root | Forskohlin,Arjunic acid |
| 6 | *Commiphora mukul*(Jacq.)Eng. | Guggul | Burseraceae | Gum &Resin | Guggulsterones,Z–guggulsterone, Guggulipids |
| 7 | *Crataegus oxyacantha*Linn. | Hawthorn | Rosaceae | Berries, Leaves &Flowers | Oligomeric proanthocyanidins, Catechin, Quercetin,Epicatechin |
| 8 | *Crocus sativus* Linn. | Saffron | Iridaceae | Stigmas | Crocetin, Picrocrocin |
| 9 | *Curcuma longa Linn.* | Turmeric | Zingiberaceae | Rhizome | Curcumin(diferuloylmethane) C3 |
| 10 | *Digitalis lanata*Linn. | Grecin foxglove | Scrophulariaceae | Leaves | Cardiac glycosides |
| 11 | *Emblica officinalis*Gaertn. | *Amalaki, amla* | Euphorbiaceae | Fruit | Vitamin C, Gallic acid, Emblicanin A,B |
| 12 | *Inularacemosa* HOOK. F | Indian elecampane | Asteraceae | Root& Rhizome | Alantolactone, isoalantolactone |
| 13 | *Nelumbo nucifera* Gaertn | Indian Lotus | Nymphaeaceae | Flowers &Rhizome | Quercetin,Luteolin |
| 14 | *Piper longum* L. | Long pepper,Thippali | Piperaceae | Fruit& Root | Piperlongumine |
| 15 | *Psidium guajava* L. | Guava | Myrtaceae | Fruit &Leaves | Quercetin, Lycopene,vitamin C |
| 16 | *Punica granatum* L. | Pomegranate | Puniacaceae | Fruits& flowers | Hexahydroxydiphenic acid,Gallic acid, quercetin, Punicic acid. |
| 17 | *Terminaliaarjuna*W. & A. | Maruthamaram | Combretaceae | Bark | Arjunolic acid,Arjunic acid, Glycosides, Gallic acid, oligomeric proanthocyanidins |
| 18 | *Terminaliachebula*Retz. | Haritaki | Combretaceae | Fruit, Bark &seed | Pentacyclictriterpenes, vasicine & vasicinone,Ellagic acid,chebulic acid |
| 19 | *Withaniasomnifera*Dunal | Winter cherry, Ashwagandha | Solanaceae | Tuber &Root | Withaferin A |
| 20 | *Zingiberofficinale*Roscoe. | Ginger | Zingiberaceae | Root | Galanolactone |

**Table 4. List of medicinal plants used by Irula tribal for the treatment of stomach disorders.**

| S.No. | Botanical name | Name of the family | Common name | Part used | chemical constitution |
|---|---|---|---|---|---|
| 1 | *Abrusprecatorius*L. | Fabaceae | Kuntrymani | Seed | 2,3-diphospho-d-glyceric Acid |
| 2 | *Achyranthesaspera*Linn. | Amaranthaceae | Chirchitta | whole plant | C-glycosides |
| 3 | *Aconitum heterophyllum*L. | Fabaceae | Athividayam | whole plant | Heterophylline,Hetisine |
| 4 | *Adina cordifolia(Roxb.)* | Rubiaceae | Kadami | leaf, flower | Rhamnopyranosyl |
| 5 | *Ageratum conyzoides*L | Asteraceae | Chick weed | whole plant | Leucoanthocyanins |
| 6 | *Caesalpiniapulcherrima* Linn. | Fabaceae | Peacock Flower | Leaf | Terpinene |
| 7 | *Carica papaya* Linn | Caricaceae | Papaya | fruit, seed | cardiac glycosides |
| 8 | *Cassia occidentalis*(L) | Fabaceae | Ponnavarai | roots, leaves and seeds | Chrysophanol 1 |
| 9 | *Cocciniagrandis*(L.)J.Viogt | Cucurbitaceae | Koovaikodi | leaves | Cephaoandrins |
| 10 | *Daturastramonium*L. | Solanaceae | Unmatta | Seed | 7-hydroxy apoatropine |
| 11 | *Dioscoreaoppositifolia*L. | Dioscoreaceae | Chinese yam | tuber, flower, leaf | Cardiac glycoside |
| 12 | *Erigeron canadensis*L. | Asteraceae | Horseweed | aerial parts of plant | β-Caryophyllene |
| 13 | *Guizotiaabyssinica*(L.f.) Cass. | Asteraceae | Malaiellu | seeds | Campesterol |
| 14 | *Jatrophamultifida*L. | Euphorbiaceae | Churakkalli | Whole plant | Fraxidin |
| 15 | *Madhucalongifolia*(Koenig) | Sapotaceae | Iluppai | Flower, leaves, bark & seeds | Stigmasterol |
| 16 | *Matricariarecutita*L. | Asteraceae | wild chamomile. | Flowers | Chamazulene |
| 17 | *Pergulariadaemia*(Forsk) Chiv | Asclepiadaceae | Veliparuthi | aerial parts | Hentriacontane |
| 18 | *Ricinuscommunis*L. | Euphorbiaceae | Castor | Seed | N-demethylricinine |
| 19 | *Solanumnigrum L* | Solanaceae | manatthakkali | whole plant | gallic acid |
| 20 | *Zizphusjujuba*(L.) | Rhamnaceae | Ber | Fruit | Stigmasterol |

**Table 5. List of medicinal plants used by Irula tribal for the treatment of kidney disorders.**

| S.No | Botanical Name | Family | Common Name | Parts used | Chemical constitution |
|---|---|---|---|---|---|
| 1 | *Abutilon indicum* Linn. | Malvaceae | Thuthi | Leaf | Ethylacetate, Chloroform, Methanolic, Aphrodisiac, Laxative, Mucilage |
| 2 | *Aervalanata* L. | Amarandhaceae | Kanpulai | Root, leaf | β-Sitosterol, α-amyrin,betulin, Hentriacontane, Sitosterylpalmitate, D-glucoside, Glycosides, Rhamnogalactoside |
| 3 | *Abelmoschusesculandus* L. | Malvaceae | Vendai | Fruit | Saponins, Glycosides, linoleic, linolenic ,oleic acid, squalene |
| 4 | *Amarandhuscaudatus* L. | Amarandhaceae | Cirukeerai | Root. | β-carotene.Triterpenoids, Saponins, Glycosides, linoleic, linolenic ,oleic acid, squalene |
| 5 | *Boerhaaviadiffusa* L. | Nyctaginaceae | Mukkurttaik koti | Root | phlobaphenes and ursolic acid |
| 6 | *Bryophyllumpinnatum*(Lam.)oken | Crassulaceae | Malaikali | Leaves | β-D-glucopyranoside , nundecanyl, flavanoids ,flavones, falvans, flavanones, isoflavonoids, chalcones, |
| 7 | *Coleus aromaticus*Benth | Lamiaceae | Karpuravalli | Leaves | Oleanolic acid, 2,3- dihydroxyoleanolic acid, Crategolic acid, Ursolic acid, Pomolic acid, ssEuscaphic acid, |
| 8 | *Celosia argentia* L. | Verbenaceae | Kozhikontai | Seed, root | , 6-methoxygenkwanin,quercetin, Chrysoeriol, Luteolin, Apigenin, Flavanoneeriodyctol, Flavanol |
| 9 | *Cissampelospareira* L. | Menispermaceae | Ponmusutai. | Leaf, root | 7, 12-dimethylbenz(a)anthracene (DMBA),polycyclic aromatic hydrocarbon (PAH), peroxides, |
| 10 | *Clerodendrumserratum* L. | Lamiaceae | Thalunarai | Leaf | calcium, magnesium ,uric acid, carbohydrates |
| 11 | *Dolichosbiflorus* L. | Fabaceae | Kollu | Root | petroleum ether, Alcohol, Calcium chloride dehydrate, Sodium oxalate, Disodium hydrogen phosphate |
| 12 | *Gompherna serrate* L. | Amarandhaceae | Arasan con todo | Whole plant | sulphur, chlorine, potassium, calcium, chromium , manganese, cobalt, Nickel, copper, Zinc |
| 13 | *Hemidesmusindicus* L. | Asclepiadaceae | Nanari | Root | 4-hydroxy-3-methoxy-cinnamic acid, 4-hydroxybenzoic acid, p-hydroxycinnamic |
| 14 | *Lagenariasiceraria* (L.) | Cucurbitaceae | Surakkai | Fruit | α- and β-amyrins, calcium albumin and alanin transaminase, β-D-glucopyranoside |
| 15 | *Moringa oleifera* L. | Moringaceae | Murungai | Root | alkaloids, moriginine, bacteriocide, spirochin, vitamins |
| 16 | *Momordicacharantia*L. | Cucurbitaceae | Pakarkai | Leaves | Alkaloid, glycosides, reducing sugar, saponin |
| 17 | *Phyllandhusniruri* (L.) | Phyllandhaceae | Keezhanelli | Root | Alkaloid, glycosides, reducing sugar, saponin phosphatase |
| 18 | *Scopariadulcis* (L.) | Scrophuraliaceae | Sarkaraivempu | Root, shoot | Calcium chloride, sodium oxalate, calcium chloride. |
| 19 | *Tribulusterrestis* L. | Zygophyllaceae | Nerunji | Whole plant | Peroxide,malondialdehyde,ethanalic,protein,carboxinyl,catalase glutathione, dithiobis, nitrobenzoic acid |

## 4. CONCLUSION

In the present investigation, a total of 85 species of medicinal plants distributed among 80 genera belonging to 48 families were identified at Konbanur village, Anaikatti hills, the Western Ghats, Coimbatore district**.** In this survey Amarandaceae, Asteraceae and Solanaceae family species served as a food and Asclepiadaceae, Combretaceae, Rhamnaceae and Liliaceae, Euphorbiaceae and etc., families are utilized for various ailments. It is clearly indicates that there is wide usage of local flora by the Irulars community in study area.

This rural area is an important source of traditional medicines. More information may be explored from the peoples residing in the remote villages in this district. The traditional healers are the main source of knowledge on medicinal plants. This knowledge has been transmitted orally from generation to generation; however it seems that it is vanishing from the modern society since younger people are not interested to carry on this tradition. It is also observed that some traditional plants in that area are fast eroding. The conservation efforts are needed by plantation and protection of these plants with maximum participation of local people.

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# UTILIZATION AND CONSERVATION OF FLORA IN THE HOME GARDENS OF SOME RESIDENTIAL AREAS, COIMBATORE

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## ABSTRACT

Home garden can serve as an important source of both food and cash income for vulnerable households. The objectives of this study were to documenting the flora of the home gardens, obtaining their frequency and to categorize the plants into medicinal/other economically important species according to their utility value in 10 different residential areas of Coimbatore city. The home garden surveys revealed that totally 90 species, were enlisted in the sampled areas and of them the higher species richness of 26 were found in Vadavalli residential area. Overall 47 families were recorded, among them Acanthaceae and Apocyanaceae were more dominant families in the study sites. In the species content 72 were recognized as medicinally important and 18 as ornamental. It was further known that the residents of middle class earned sizeable income through vegetables in addition to fulfilling their day to day need while the residents of upper class highly preferring ornamental species. Few species like *Saraca indica,* the endemics are well protected by cultivation in homegardens. Thus the present study presumes that home gardens satisfy various household needs and conserve medicinally valuable species.

**Keywords:** Home gardens, residential areas, Coimbatore, frequency.

## 1. INTRODUCTION

Home gardens are species-rich agroforestry systems maintained on the basis of choice, needs and importance of plants. It is a traditional land use practice around a homestead where several plant species are maintained by members of the house hold and their products are intended to be an economically consumption (Shrestha *et al*., 2001). Compared to other agricultural or horticultural ecosystems, home gardens are having rich species content and well suited for *ex situ* conservation of many rare/endangered species, besides fruit and timber trees. Home garden structure also varies from place to place according to the local physical environment, ecological characteristics, socioeconomic and cultural factors (Abdoellah, 1990; Kumar and Nair, 2004).

Coimbatore is the leading industrial city in southern India. The industrial areas, educational institutions and residential areas are maintaining home gardens almost in all parts of the city. Generally, greens and other vegetable crops are maintained to meet the demand of day to day life. However, many upper economic class people and educated people maintained their home gardens with many ornamental plants and some plants of red listed categories also. Despite the well establishment of home gardens no taxonomical and ecological studies have been made so far in Coimbatore city. To address this lacuna, the present study has been carried out in 10 houses which spread all over the Coimbatore city in different locations and aimed to document the flora of the home gardens, calculating their frequency and to categorize the plants based on their utility value.

## 2. MATERIALS AND METHODS

### *2.1. Sampling places*

A total number of 10 home gardens with different sizes located in the places *viz.,* R.S. Puram, Race course, G.N. Mills, Viswasapuram, Ganapathy, Vadavalli, Manikarapalayam, Mettupalayam, Nava India and Saravanampatti were selected for the present study in Coimbatore city. The home gardens selected were explored for the plant species for the informations on habit, family, parts used and medicinal/other economic uses. The degree of distribution of various plant species among the home gardens was determined as per the following formula:

$$\text{Frequency (\%)} = \frac{\text{Number of home gardens in which the species present}}{\text{Total number of home gardens sampled}} \text{ X } 100$$

The medicinal and other economic uses of the plant species present in the home gardens of sampling places were documented on the basis of

personal interview with the respective gardener of the institutions, local public and the owners of the residential homes and by available literature. The red listed and endemic plants were enlisted according to Ahmedullah and Nair (1987).

## 3. RESULTS AND DISCUSSION

For the present study, all over the city of Coimbatore, 10 home gardens in 10 different residential areas have been selected to enumerate the species taxonomically and to evaluate ecologically (Table 1 and Fig. 1). The sizes of the home gardens sampled were also varied much between ca. 25m$^2$ and 225m$^2$. In this range most of the home gardens were within the global inventory range of other tropical home gardens (Fernandez and Nair, 1986). The number of species and their numerical strength were not in accordance with the size of the home gardens studied in Coimbatore city. Studies of home gardens in Mexico (Rico Gray *et al*., 1991) and Indonesia (Abdoellah *et al.,* 2006) indicated that the number of species or individuals is not related to home garden size. The species richness was noted to be varied between the home gardens studied. The higher species richness of 26 was present in the home garden of Vadavalli residential area. On the other hand, the lower species richness of 11 was noted in the residential areas of R.S. Puram.

Altogether, 90 plant species belongs to different life forms were noted to be present in the studied home gardens. A higher number of 46 species (51.1%) were in the form of herbs followed by the shrubs with 26 species (28.9%), trees with 14 species (15.6%) and climbers with 4 species (4.4%) (Table 1). This may be due to the need and individual option. The most grown herbs in the gardens are mainly for the purpose of supplying requirements to their day to day life as vegetables, greens and medicinal plants.

In addition to higher species diversity, the diversity of families was noted to be most noteworthy (Table 2). A total number of 47 families with the contribution of 90 species were present in the home gardens. The family, Acanthaceae contributed the higher number of 7 species (7.8%) followed by the family, Apocyanaceae with 6 species (6.7%) and Asteraceae, Amaranthaceae and Solanaceae with 5 species (5.6%) each to the communities of home gardens. The remaining families have contributed 1, 2 or 3 species only to home garden communities. It indicates the diverse utility of the plant resources particularly the preferences towards medicinal uses (Kumar *et al.,* 1994). The high floristic diversity is perhaps the reflection of the potential of home gardens to serve as repositories of genetic diversity as well (Esquivel and Hammer, 1992). Kabir and Webb (2008) also reported the predominance of herbs and trees in the home gardens of south western Bangladesh.

The degree of distribution of the various enumerated plant species was very low and it was ranging between 10 and 50% only (Table 1). The species namely, *Adenium obesum, Anthurium spathyiphyllum, Aloe vera, Ficus benjamina, Plumbago auriculata* and *Plumeria rubra* have registered 50% frequency which indicates that these species have distributed comparatively in higher number of home gardens (Fig. 2). Other species have recorded below 50% frequency and hence these species have restricted distribution in few home gardens only. The total number of individuals maintained for the constituent species in the home gardens was widely varied (Table 1 and Figs. 3 and 4). Pandey *et al*. (2006) also reported the lower distribution level of many home garden plants in South Andaman and he explained that the selective cultivation of species with the home gardens is mainly due to the utility value of the species. The endemic plant species, *Saraca indica* was represented by only one individual at Ganapathy residential area. It ensures the expansion of the geographical area for this species. Similarly, the species such as *Artocarpus heterophyllus, Dracaena* sp., *Ficus benghalensis, Hamelia patens, Jasminum grandiflorum, J. sambac, Momordica charantia, Musa paradisiaca, Sansevieria roxburghiana, Saraca indica, Thunbergia mysorensis* and *Taxus wallichiana* have also been represented by only one individual (Fig. 4).

The economic importance including the medicinal uses of the various plant species present in the sampled home gardens of Coimbatore city is presented in Table 2. In the account of 90 species, 72 (80%) were recognized as medicinally important and 18 (20%) as ornamentals. The medicinal uses of the plant species are multidimensional. A greater number of 16 species are used to treat inflammation related diseases, 13 species prescribed for skin problems, 10 species are suggested for diabetics and 8 species are used for anticancer. Ecological and socioeconomic factors, including geographic location, climate, water availability, garden size and history, agricultural policy, market needs, food cultivars and house hold preferences influence the species diversity and utilization of the product of traditional home gardens (Gajaseni and Gajaseni, 1999; Trinh *et al.,* 2003).

**Table 1. Number of individuals of constituent plant species and their frequency in the sampled home gardens of Coimbatore city.**

| S.No. | Name of the species | Habit | Home gardens* | | | | | | | | | | Frequency (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| 1. | *Acalypha wilkesiana* Hort. | Shrub | - | - | - | - | - | - | 10 | - | - | - | 10 |
| 2. | *Adenium obesum* (Forsk.) Roem. et Schult. | Shrub | - | 2 | - | - | 3 | 4 | - | 5 | - | 3 | 50 |
| 3. | *Anthurium spathiphyllum* Schott. | Herb | - | - | 3 | 5 | 3 | 2 | 3 | - | - | - | 50 |
| 4. | *Allamanda cathartica* L. | Shrub | - | 2 | - | - | | - | 3 | - | - | - | 20 |
| 5. | *Aloe vera* (L.) Burm.f. | Succulent herb | 2 | 5 | 6 | 4 | - | - | 3 | - | - | - | 50 |
| 6. | *Aphelandra squarrosa* Nees. | Herb | - | - | - | - | - | - | 7 | - | - | - | 10 |
| 7. | *Aralia* sp. L. | Herb | - | - | - | - | - | - | - | 5 | - | - | 10 |
| 8. | *Arcotis frutescens* L. | Shrub | - | - | - | - | 6 | - | - | - | - | - | 10 |
| 9. | *Arctotis hirsuta* (Harv.) Beauverd. | Herb | - | - | - | - | - | - | - | - | - | 12 | 10 |
| 10. | *Argyranthemum frutescens* L. | Herb | - | - | - | - | 94 | - | - | - | - | - | 10 |
| 11. | *Araucaria excelsa* R.Br. | Tree | - | - | - | - | - | - | 3 | - | - | - | 10 |
| 12. | *Achyranthes aspera* L. | Herb | - | - | 20 | - | - | - | - | 15 | - | - | 20 |
| 13. | *Amaranthus spinosus* L. | Herb | - | - | - | - | - | - | - | 34 | - | - | 10 |
| 14. | *A. caudatus* L. | Herb | - | - | - | - | - | - | - | 31 | - | - | 10 |
| 15. | *Azardica indica* A. Juss. | Tree | - | - | - | - | - | 1 | - | - | - | 1 | 20 |
| 16. | *Artocarpus heterophyllus* Frost. | Tree | - | - | - | - | - | 1 | - | - | - | - | 10 |
| 17. | *Barleria grandis* Hochst. ex Nees. | Herb | - | - | - | - | - | - | - | - | 12 | - | 10 |
| 18. | *Bougainvillea glabra* Choisy. | Creeper | - | - | - | 6 | - | - | - | - | - | - | 10 |
| 19. | *Callistemon citrinus* (Curtis) Skeels. | Shrub | - | - | - | 2 | - | - | - | - | - | - | 10 |
| 20. | *Calliandra cyanometroides* Bedd. | Herb | 17 | - | - | - | - | - | - | 12 | - | - | 20 |
| 21. | *Campsis radicans* Seem. | Herb | - | - | 12 | 9 | - | - | - | - | - | - | 20 |
| 22. | *Capsicum annuum* L. | Shrub | - | - | - | 5 | - | - | - | - | - | - | 10 |
| 23. | *Catharanthus roseus* L. | Sub shrub | - | 21 | - | - | - | - | 14 | - | - | - | 20 |
| 24. | *Celosia cristata* L. | Shrub | - | - | - | - | - | 5 | - | - | - | 1 | 20 |
| 25. | *Cereus pterogonus* Lem. | Herb | - | - | - | - | - | 4 | - | - | - | - | 10 |
| 26. | *Cestrum nocturnum* L. | Herb | - | 50 | 43 | - | - | - | - | - | - | - | 20 |
| 27. | *Chlorophytum variegatum* Ker. | Herb | - | - | 2 | - | 1 | 2 | - | - | 8 | - | 40 |
| 28. | *Chrysanthemum carinatum* L. | Herb | - | - | - | - | - | - | 6 | - | - | 3 | 20 |
| 29. | *C. odoratum* L. | Herb | - | - | 64 | 82 | - | - | - | - | - | 41 | 30 |
| 30. | *Clitoria ternatea* L. | Herb | - | - | - | - | 19 | - | - | - | - | - | 10 |
| 31. | *Clerodendrum thomsoniae* Balf. | Shrub | - | - | - | - | - | 5 | - | - | - | - | 10 |

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| 32. | *Coleus aromaticus* Benth. | Herb | - | - | - | - | - | 15 | 12 | 5 | - | - | 30 |
| 33. | *Cordyline stricta* L. | Herb | - | - | 5 | - | - | - | - | - | - | - | 10 |
| 34. | *Cosmos bipinnatus* Cav. | Herb | - | - | 74 | - | - | - | 50 | - | - | - | 20 |
| 35. | *Crassula* sp. L. | Herb | - | - | - | - | - | - | 10 | - | 13 | 5 | 30 |
| 36. | *Crossandra infundibuliformis* L. Salib. | Herb | - | - | - | - | - | - | - | - | - | 10 | 10 |
| 37. | *Cucumis pepo* DC. | Climber | - | - | - | - | - | 5 | - | - | - | - | 10 |
| 38. | *Curcuma longa* L. | Herb | - | 3 | - | - | - | 3 | - | - | - | 5 | 30 |
| 39. | *Calotropis gigantea* R.Br. | Shrub | 2 | - | - | - | - | - | - | 1 | - | - | 20 |
| 40. | *Carica papaya* L. | Tree | - | - | - | 1 | - | - | - | 1 | - | - | 20 |
| 41. | *Coriandrum sativum* L. | Herb | - | - | 24 | - | - | - | - | - | - | - | 10 |
| 42. | *Cardiospermum halicacabum* L. | Herb | - | 3 | - | - | - | - | - | - | - | - | 10 |
| 43. | *Cycas siamensis* Miq. | Tree | - | - | - | - | - | 2 | - | - | - | 1 | 20 |
| 44. | *Dracaena* sp. Lam. | Shrub | 1 | - | - | - | - | - | - | - | - | - | 10 |
| 45. | *Duranta repens* L. | Shrub | - | - | - | - | 2 | - | - | - | - | - | 10 |
| 46. | *Damascus carota* Nayeem Ket. | Herb | - | - | - | - | 11 | 6 | 3 | - | - | - | 30 |
| 47. | *Euphorbia pulcherrima* Willd. ex Klotz. | Shrub | - | 10 | - | - | - | - | - | - | - | - | 10 |
| 48. | *Ficus benghalensis* L. | Tree | - | 1 | - | - | - | - | - | - | - | - | 10 |
| 49. | *F. benjamina* L. | Tree | 6 | - | - | 8 | 4 | 2 | - | - | - | 2 | 50 |
| 50. | *F. microspora* Wight. | Tree | - | 2 | - | - | - | - | - | - | 2 | 4 | 30 |
| 51. | *Geranium domesticum* Roxb. | Herb | 9 | - | - | - | - | - | - | - | - | - | 10 |
| 52. | *Gomphrena globosa* Jacq. | Herb | 105 | 95 | - | - | - | - | - | - | - | - | 20 |
| 53. | *Grevillea robusta* A. Cunn. ex R.Br. | Shrub | - | - | - | - | 4 | 2 | - | - | - | - | 20 |
| 54. | *Hamelia patens* Jacq. | Shrub | - | - | - | - | 1 | - | - | - | - | - | 10 |
| 55. | *Hibiscus rosa sinensis* L. | Shrub | - | - | - | - | 2 | 1 | - | - | 5 | - | 30 |
| 56. | *H. syriacus* L. | Shrub | - | 1 | - | 1 | - | - | - | - | - | - | 20 |
| 57. | *Inga cyanocetroides* L. | Shrub | 1 | - | - | - | - | 2 | - | - | - | 2 | 30 |
| 58. | *Ixora coccinea* L. | Shrub | - | - | 2 | - | - | - | - | - | - | - | 10 |
| 59. | *Jacquemontia pentantha* Choisy. | Herb | - | - | 29 | - | 48 | - | - | - | - | - | 20 |
| 60. | *Jasminum grandiflorum* L. | Herb | 1 | - | - | - | - | - | - | - | - | - | 10 |
| 61. | *J. sambac* Ait. | Herb | - | - | - | - | - | - | - | 1 | - | - | 10 |
| 62. | *Kalanchoe fentchokoi* Adans. | Herb | - | - | - | - | - | - | - | - | - | 10 | 10 |
| 63. | *Lablab purpureus* (L) Sweet. | Vine | - | - | - | 2 | 8 | - | - | - | 4 | 3 | 40 |
| 64. | *Lawsonia inermis* L. | Tree | - | - | - | - | - | 1 | 1 | - | - | - | 20 |
| 65. | *Mangifera indica* L. | Tree | - | - | - | - | - | 1 | - | - | 1 | - | 20 |
| 66. | *Miranda leucophyllum* Harts. | Tree | - | - | 12 | - | - | - | - | - | - | - | 10 |
| 67. | *Momordica charantia* L. | Herb | - | - | - | - | 1 | - | - | - | - | - | 10 |

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| 68. | *Musa paradisiaca* L. | Tree | - | 1 | - | - | - | - | - | - | - | - | 10 |
| 69. | *Nephrolepis* sp. Schot. | Herb | - | - | - | - | - | - | - | 8 | - | - | 10 |
| 70. | *N. tuberosa* Bory ex Willd. | Herb | 1 | - | - | - | - | - | - | - | - | 1 | 20 |
| 71. | *Nerium oleander* L. | Shrub | - | - | - | - | 1 | - | 2 | - | - | - | 20 |
| 72. | *Nymphaea pubescens* Wild. | Succulent herb | 5 | 3 | - | - | 2 | - | - | - | - | - | 30 |
| 73. | *Ocimum basilicum* L. | Herb | - | - | - | - | - | - | - | - | 4 | - | 10 |
| 74. | *Plumbago auriculata* Lam. | Herb | 2 | - | - | - | - | 2 | 2 | - | 11 | 3 | 50 |
| 75. | *Plumeria rubra* L. | Shrub | - | 1 | - | 2 | - | 1 | 1 | - | 1 | - | 50 |
| 76. | *Piper betle* L. | Creeper | - | - | - | - | - | - | 38 | - | - | - | 10 |
| 77. | *Ravenala madagascariensis* Sonn. | Herb | - | - | 1 | - | - | - | - | - | - | 1 | 20 |
| 78. | *Rosa* sp. W. | Shrub | - | - | - | 3 | - | - | - | - | - | 4 | 20 |
| 79. | *Salvinia officinalis* L. | Herb | - | - | - | - | - | 2 | - | - | 1 | - | 20 |
| 80. | *Sansevieria roxburghiana* Schult. | Herb | - | 1 | - | - | - | - | - | - | - | - | 10 |
| 81. | *Solanum xanthocarpum* Sch and wend. | Herb | 2 | 3 | - | - | - | - | - | - | - | - | 20 |
| 82. | *S. melongena* Pr. | Herb | - | - | - | 2 | - | - | - | - | - | - | 10 |
| 83. | *S. lycopersicum* L. | Herb | - | - | - | - | 3 | - | - | - | - | - | 10 |
| 84. | *Saraca indica* L. | Tree | - | - | - | - | 1 | - | - | - | - | - | 10 |
| 85. | *Thuja occidentalis* L. | Shrub | - | - | - | - | 2 | - | 3 | 2 | 1 | - | 40 |
| 86. | *Thunbergia erecta* Roxb. | Shrub | - | - | - | - | - | 10 | - | - | - | - | 10 |
| 87. | *T. mysorensis* T.and Roxb. | Shrub | - | - | - | - | - | 1 | - | - | - | - | 10 |
| 88. | *Tabernaemontana divaricata* R.Br. ex Roem. & Schult. | Shrub | - | - | - | - | - | 1 | - | 2 | - | - | 20 |
| 89. | *Taxus wallichiana* L. | Tree | - | - | - | - | - | - | - | 1 | - | - | 10 |
| 90. | *Zephyranthes carinata* L. | Herb | - | - | - | - | - | 16 | - | - | - | - | 10 |

* 1. R.S. Puram; 2. Race course; 3. G.N. Mills; 4. Viswasapuram; 5. Ganapathy; 6. Vadavalli; 7. Manikarapalayam; 8. Mettupalayam; 9. Nava India; 10. Saravanampatti.

**Table 2. The included family useful part, medicinal and other economic uses of various plant species in the home gardens of Coimbatore city.**

| S.No. | Name of the species | Family | Parts used | Medicinal/Other economic uses |
|---|---|---|---|---|
| 1. | *Acalypha wilkesiana* | Acanthaceae | Leaf | The extract of the flower inhibits the ovarian function and stimulate the uterine. Roots are used in the treatment of diabetics, antipyretic, abortifacient, demulcent and useful to relieve chest pain. |
| 2. | *Adenium obesum* | Apocynaceae | Bark and sap | The plant sap and bark are used as remedy for bone dislocation, rheumatism, sprains, paralysis, swellings and skin infections. |
| 3. | *Anthurium spathiphyllum* | Araceae | Whole plant | Cleans indoor air of many environmental contaminants, including benzene, formaldehyde and other pollutants. |
| 4. | *Allamanda* | Apocynaceae | Flower | Flower has been used to treat liver tumors, jaundice, splenomegaly and malaria. |

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| | *cathartica* | | | |
| 5. | *Aloe vera* | Liliaceae | Leaf | It is a remedy for coughs, wounds, ulcers, gastritis, diabetics, cancer, arthritis, immune-system deficiencies and many other conditions when taken internally. |
| 6. | *Aphelandra squarrosa* | Acanthaceae | - | Ornamental plant |
| 7. | *Aralia* sp. | Araliaceae | - | Ornamental plant |
| 8. | *Arcotis frutescens* | Asteraceae | Whole plant | Plants used to treat of opportunistic fungal infections in HIV/AIDS patients. |
| 9. | *Arctotis hirsuta* | Acanthaceae | - | Ornamental plant |
| 10. | *Argyranthemum frutescens* | Asteraceae | Flower and leaf | Flower in tonics as an ophthalmic and purgative, fresh or dried flowering heads are normally used in the treatment of rheumatism, arthritis, liver and kidney disorders, as a blood purifier, etc. Daisy leaves cures mouth ulcers. |
| 11. | *Araucaria excelsa* | Araucariaceae | Leaf | It reduces the bacterial contaminants. |
| 12. | *Achyranthes aspera* | Amaranthaceae | Leaf and seed | It is used to improve appetite and to cure various types of gastric disorders. It is useful in haemorrhoids. Leaves and seeds are emetic, hydrophobia, carminative, resolve swelling, digestive and expel phlegm. |
| 13. | *Amaranthus spinosus* | Amaranthaceae | Leaf | Plant is used as a digestive, laxative, diuretic, stomachic, antipyretic, to improve appetite, biliousness, blood diseases, burning sensation, leprosy, bronchitis, piles and leucorrhea. The boiled leaves and root are given to children as a laxative. |
| 14. | *A. caudatus* | Amaranthaceae | Leaf, stem and root | The roots are used to cure kidney stones. The leaves used to cure cuts, leprosy, boils, burns and fever. Decoction of the stem used to treat jaundice. |
| 15. | *Artocarpus heterophyllus* | Meliaceae | Whole plant | Leaves, bark, flowers, fruits, seed, gum, oil and neem cake are used to have antiallergenic, antidermatic, antifeedent, antifungal, antiinflammatory, antipyorrhoeic, antiscabic, cardiac, diuretic, insecticidal, larvicidal, nematicidal, spermicidal and other biological activities. |
| 16. | *Azardirachta indica* | Moraceae | Leaf and fruit | The leaves are useful in fever, ulcers, boils, wounds, skin diseases, antidiarrhoeal, analgesic and as immuno modulator. The ripe fruits are sweet cooling, laxative, aphrodisiac and tonic. The seeds used for diuretic, aphrodisiac and constipation. |
| 17. | *Barleria grandis* | Acanthaceae | Leaf | Leaf extract treats for hepatic disorders, gastrointestinal disorders, skin disorders, snake bites, cuts and wounds, sexually transmitted diseases, pain, fever, respiratory tract disorders, paralysis, diabetics, rheumatoid arthritis, impotency and bone fractures. |
| 18. | *Bougainvillea glabra* | Nyctaginaceae | Flower | The leaves used for a variety of disorders such as diarrhoea, stomach ulcers, cough and hepatitis. A decoction of dried stems and flowers used as treatment for low blood pressure. |
| 19. | *Callistemon citrinus* | Myrtaceae | Leaf | It is used to treat hemorrhoids. |
| 20. | *Calliandra cyanometroides* | Myrtaceae | | Ornamental plant |
| 21. | *Campsis radicans* | Bignoniaceae | Leaf | Leaf extract having antiinflammatory, antibacterial and antifungal properties. It is used as syrups, infusions, typhoid, anaemia, malaria and headache. |

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| 22. | *Capsicum annuum* | Solanaceae | Fruit | It is used as carminative, appetizer and cure stomachic. Externally, it is used as a counter irritant and also in the treatment of rheumatism and neuralgia. |
| 23. | *Catharanthus roseus* | Apocynaceae | Whole plant | Minimizing the adverse effects of chemotherapy, caricinogenic agents and controls bacterial, fungal and viral infections. |
| 24. | *Celosia cristata* | Amaranthaceae | Leaf flower and seed | It is used for the treatment of diarrhoea, piles, bleeding nose, disinfectant, inflammation, haematological and gynaecologic disorders. |
| 25. | *Cereus pterogonus* | Cactaceae | - | Ornamental plant |
| 26. | *Cestrum nocturnum* | Solanaceae | Leaf | Leaves are used for their pharmacological significance in burns and swellings. It is also used for treating epilepsy and as stupefying charm medicine. It is used to prevent malaria. |
| 27. | *Chlorophytum variegatum* | Liliaceae | - | Ornamental plant |
| 28. | *Chrysanthemum carinatum* | Asteraceae | Flower | The leaves are used medicinally to cure influenza symptoms, liver and menstrual disorders and have antiinflammatory and antispasmodic properties. |
| 29. | *C. odoratum* | Asteraceae | Flower | Flowers are used for antihypertensive, serotonin antagonist, anticancer, antispasmodic, antioxidative and antimicrobial activities. It prevent cancer and lower blood pressure as well as improve the digestive system in human. |
| 30. | *Clitoria ternatea* | Fabaceae | Whole plant | The herb is effective in curing fever and acts as asthma and bronchitis etc. A paste of the whole plant can be applied over the infected area and decoction of the plants is very effective in cleaning the wound. |
| 31. | *Clerodendrum thomsoniae* | Verbenaceae | Leaf and flower | Leaf aqueous extract is traditionally used by people to alleviate symptoms of diabetics, obesity and hypertension. |
| 32. | *Coleus aromaticus* | Lamiaceae | Leaf | The leaves are used for the treatment of cough, throat infection and nasal congestion. |
| 33. | *Cordyline stricta* | Asparagaceae | Leaf | It is used to treat dysentery and skin diseases. It breaks fever and headache. The leaves consumed as greens. |
| 34. | *Cosmos bipinnatus* | Asteraceae | Flower and leaf | Leaves are used for fever, flue, cough, asthma, digestive troubles, piles, diabetics, urinary diseases, male sexual diseases, gynecological diseases antiinflammatory, ear diseases, skin diseases and miscellaneous uses. |
| 35. | *Crassula* sp. | Crassulaceae | - | Ornamental plant |
| 36. | *Crossandra infundibuliformis* | Acanthaceae | Leaf and latex | In is used to treat infectious diseases while simultaneously mitigating many of the side effects. |
| 37. | *Cucumis pepo* | Cucurbitaceae | Leaf, fruit and seed | Seeds are used as a diuretic. Leaves are used as a painkiller, a treatment for nausea, and a boost to haemoglobin content of the blood. The fruit is used for cooling and astringent to the bowels, increases appetite, cures leprosy and purifies the blood. |
| 38. | *Curcuma longa* | Zingiberaceae | Rhizome | A fresh juice is commonly used in many skin conditions, including eczema, chicken pox, shingles, allergy, and scabies. The active compound curcumin have antiinflammatory, antioxidant, antitumour and antiviral activities. |
| 39. | *Calotropis gigantea* | Asclepiadaceae | Leaf and | The powdered root is used to treat bronchitis, asthma, leprosy, eczema, |

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| | | | latex | elephantiasis while the latex is used to treat vertigo, baldness, hair loss, toothache, intermittent fevers, rheumatoid/joint swellings and paralysis. |
| 40. | *Carica papaya* | Caricaceae | Leaf, fruit and root | It increase appetite, ease menstrual pain, meat tenderizer and relieve nausea |
| 41. | *Coriandrum sativum* | Apiaceae | Seed, root and leaf | The seeds were included in a host of prescriptions for fever, diarrhoea, vomiting, indigestion as in stomach and carminative. Leaves are given for biliousness, intestinal irritations, heartburn, thirst and nausea. Volatile oil is carminative. |
| 42. | *Cardiospermum halicacabum* | Sapindaceae | Leaf and fruit | The tender shoots are used as a diuretic, stomachic and rubefacient. It is used in rheumatism, lumbago, nervous diseases and as a demulcent in arthritis and in dropsy. |
| 43. | *Cycas siamensis* | Cycadaceae | - | Ornamental plant. |
| 44. | *Dracaena* sp. | Asparagaceae | Fruit | The fruits are used in the treatment of malarial and kill intestinal worms. |
| 45. | *Duranta repens* | Verbenaceae | Leaf and fruit | The roots are stimulant for indolent ulcer. Different parts of the carrot have been used in medicine for the treatment of kidney dysfunction, asthma, dropsy, inflammation, leprosy etc. |
| 46. | *Damascus carota* | Apiaceae | Leaf and latex | The latex is used as a pain reliever, antibacterial agent, emetic and remedies for skin warts and toothache. |
| 47. | *Euphorbia pulcherrima* | Euphorbiaceae | Leaf and bark | Decoction of the bracts and flowers are taken as galactagogue by nursing women to increase milk flow. The leaves are applied as poultice and used as emeto cathartic causing vomiting and bowel movement. |
| 48. | *Ficus benghalensis* | Moraceae | Leaf | It is used for the treatment of skin diseases and enlargement of liver. |
| 49. | *F. benjamina* | Moraceae | Leaf, bark and root | It is used for the treatment of certain skin disorders, stomachic and antidysentery. Leaf, bark and fruits are used as antiinflammatory, antinociceptive, antipyretic and cytotoxic activity. |
| 50. | *F. microspora* | Moraceae | Leaf and bark | It has been used for intestinal problems, wounds and respiratory ailment. Oil is considered a relaxant in aroma therapy. |
| 51. | *Geranium domesticum* | Geraniaceae | Seed and leaf | Ornamental plant |
| 52. | *Gomphrena globosa* | Amaranthaceae | Leaf and flower | It is used for bronchial asthma, acute and chronic bronchitis, chin cough, haemoptysis of pulmonary tuberculosis, dizziness, blurring of vision, dysentery, whooping cough and headache. |
| 53. | *Grevillea robusta* | Proteaceae | - | Ornamental plant |
| 54. | *Hamelia patens* | Rubiaceae | Leaf and flower | It regulates menstruation and stimulate blood circulation. The flower extract has been traditionally used for liver disorders, high blood pressure and as an aphrodisiac. Young leaves and flowers are used in the case of headache. |
| 55. | *Hibiscus rosasinensis* | Malvaceae | Flower, root and leaf | It is used in antiinflammatory and ingredients for cosmetics. |
| 56. | *H. syriacus* | Malvaceae | Leaf and | It cures skin diseases. |

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| | | | flower | |
| 57. | *Inga cyanometroides* | Fabaceae | Leaf | It is used for hepatic disorder, cancer, microbial infection, antioxidant, pain and inflammation. The flowers were used for the treatment of cancer, leucorrhoea, dysentery, dysmenorrhoea, haemoptysis and hypertension. |
| 58. | *Ixora coccinea* | Rubiaceae | Leaf, root and flower | The leaves are used as an emetic in cases of poisoning. The roots are bitter, acrid and are useful for external application in ringworm and herpes infestations and are recommended for ophthalmopathy, ulcerative stomatitis, leprosy and wounds. |
| 59. | *Jacquemontia pentantha* | Convolvulaceae | - | Ornamental plant |
| 60. | *Jasminum grandiflorum* | Oleaceae | Leaf and root | Leaves are used in the treatment of leprosy, skin disease, ulcers, wounds and corns. |
| 61. | *J. sambac* | Oleaceae | Leaf, flower and root | The plant is used for cooling, skin disorders, leprosy, ulcers, in cases of insanity, weakness of sight and affections of mouth and opium for gangrenous ulcers of the gums. |
| 62. | *Kalanchoe fentchokoi* | Rubiaceae | - | Ornamental plant |
| 63. | *Lablab purpureus* | Fabaceae | Leaf | It has antioxidant, anticancer, antiviral and antiinflammatory activities. |
| 64. | *Lawsonia inermis* | Myrtaceae | Stem bark, root and leaf | It is used as a traditional medicine to treat varies ailments such as rheumatoid arthritis, headache, ulcers, diarrhoea, leprosy fever, leucorrhoea, diabetics, hepatoprotective and colouring agent. |
| 65. | *Mangifera indica* | Anacardiaceae | Fruit and leaf | Fruit is proposed as nutritional supplement (antioxidant) and an anti-inflammatory, analgesic and immunomodulatory treatment to prevent disease progress or increase the patient's quality of life in gastric and dermatological disorders, AIDS, cancer and asthma. Root bark is a bitter aromatic, and used for diarrhoea and leucorrhea. |
| 66. | *Miranda leucophyllum* | Scrophulariaceae | - | Ornamental plant. |
| 67. | *Momordica charantia* | Cucurbitaceae | Leaf, Fruit and root | Leaves are used for ulcers and as a bitter digestive aid for intestinal gas, bloating, stomachache, and sluggish digestion. Fruit pulp, leaf juice and seeds are used for antihelimintic. Leaf act as galactogogue and root is astringent. |
| 68. | *Moringa oleofera* | Musaceae | Whole plant | Unripe bananas and plantain fruits are astringent and used to treat diarrhoea. The leaves are used for cough and bronchitis. The roots can arrest hemoptysis, strongly astringent and anthelmintic properties. |
| 69. | *Nephrolepis* sp. | Nephrolepidaceae | - | Ornamental plant. |
| 70. | *N. tuberosa* | Nephrolepidaceae | Whole plant | It is used as healing agents in inflammation, leucorrhoea, piles and as antidote. It possesses antiviral, antibacteral, antiparasitic effects, anti-inflammatory, antiulcer and antioxidant activity and used as diuretic. |
| 71. | *Nerium oleander* | Apocynaceae | Flower, leaf, root and | The flower used as blood purifier and also used in the treatment of jaundice of diabetics, cancer, inflammation and eye disorders. |

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| | | | stem | |
| 72. | *Nymphaea pubescens* | Nympheaceae | Leaf | Both the leaves and the essential oils are used for culinary and medicinal purpose. |
| 73. | *Ocimum basilicum* | Lamiaceae | Leaf | It cures cold, cough. |
| 74. | *Plumbago auriculata* | Plumbaginaceae | Root and leaf | The latex has been used for the treatment of itches, swellings, fevers, inflammations, arthritis and constipation. The root is used to cure abscesses, dysentery, syphilis and cough. |
| 75. | *Plumeria rubra* | Apocynaceae | Root, bark and latex | The fruits are used in the treatment and prevention of cancer, cardiovascular disease, diabetics, dental conditions, erectile dysfunction, bacterial infections, antibiotic resistance and ultraviolet radiation induced skin damage. |
| 76. | *Piper betle* | Piperaceae | Leaf | It cures cold and cough. |
| 77. | *Ravenala madagascariensis* | Strelitziaceae | Leaf | Leaves are used for metrorrhagia, hemoptysis, large intestine hemorrhage, rheumatic arthritis and gynecologic disease. |
| 78. | *Rosa* sp. | Rosaceae | Flower | It has been used for maintaining health, boosting immune system function, various therapies and remission of cancer. |
| 79. | *Salvinia officinalis* | Lamiaceae | Leaf | The leaf sap is applied directly to sores, cuts and grazes and treatment for abdominal pains, ear ache, diarrhoea and hemorrhoids. |
| 80. | *Sansevieria roxburghiana* | Asparagaceae | Flower | Paste of leaves can be applied to relieve pains. Seeds act as expectorant in cough and asthma. The roots are expectorant and diuretic, useful in the treatment of catarrhal fever, coughs, asthma and chest pain |
| 81. | *Solanum xanthocarpum* | Solanaceae | Leaf and root | They are used for inflammatory, antioxidant, anti-allergic, hepatoprotective, and anticarcinogenic activities. |
| 82. | *S. melongena* | Solanaceae | Fruit and leaf | Decoction of leaf is used to cure diabetics, leprosy, gonorrhea, cholera, bronchits, dysentery asthenia and haemorrhoids. |
| 83. | *S. lycopersicum* . | Solanaceae | Fruit | It is used in women related problems, such as leucorrhoea, menorrhagia, dysfunctional uterine bleeding and bleeding hemorrhoids. |
| 84. | *Saraca indica* | Caesalpiniaceae | Leaf | It cures the diseases of eyes cold conjunctivitis, bleeding piles and bronchitis. |
| 85. | *Thuja occidentalis* | Cupressaceae | Leaf | The essential oil within the plant has been used for cleaners, disinfectants, hair reparations, insecticides, liniment, room sprays and soft soaps. Twigs to make teas and to relieve constipation and headache. It is externally applied tincture or ointment for the treatment of warts and ringworms. |
| 86. | *Thunbergia erecta* | Acanthaceae | - | Ornamental plant |
| 87. | *T. mysorensis* | Acanthaceae | - | Ornamental plant |
| 88. | *Tabernaemontana divaricata* | Apocynaceae | Leaf | Ornamental plant |
| 89. | *Taxus wallichiana* | Taxaceae | Leaf and bark | The stem bark is used as a anticancer. This species is also used as fuel wood by the local communities. |
| 90. | *Zephyranthes carinata* | Amaryllidaceae | Flower | Ornamental plant |

R.S. Puram | Race course | G.N. Mills

Viswasapuram | Ganapathy | Vadavalli

Maniyakarampalayam | Mettupalayam | Nava India

Saravanampatti

**Fig. 1. The sampled home gardens of Coimbatore city.**

*Anthurium spathiphyllum* | *Plumbago auriculata* | *Plumeria rubra*

**Fig. 2. The species of higher degree of distribution among the home gardens.**

*Argyranthemum frutescens* | *Chrysanthemum odoratum* | *Gomphrena globosa*

**Fig. 3. Some species of relatively high density.**

*Artocarpus heterophyllus* | *Saraca indica* | *Dracaena* sp.

**Fig. 4. Certain species of relatively low density.**

Although, the proportion of species used for different purposes vary, in general traditional home gardens contribute sustainably towards meeting the basic subsistence needs of their owners for product and services such as food including vegetables and fruits, medicines, forage, shade and ornamental (Alburquerque *et al.,* 2003). Presently many home gardens show a shift from subsistence oriented agriculture to market (Peyre *et al.,* 2006).

The study concludes that the home garden ensure crop diversification, provide diversified products though low in amount but nutritious in nature, conserve plant genetic resources and evolutionary processes in the Coimbatore city.

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# PRELIMINARY PHYTOCHEMICAL INVESTIGATION ON *TYLOPHORA SUBRAMANII* HENRY (APOCYNACEAE) – AN ENDEMIC MEDICINAL PLANT SPECIES OF SOUTHERN INDIA

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## ABSTRACT

*Tylophora subramanii* is used as traditional and folklore medicines for treating various diseases like fever, cold, cough, diarrhea, ulcer, external tumor, cut wounds and headache among the tribal belts of southern Western Ghats. In the present investigation carried out the ethnobotanical uses among the hill inhabitants of Western Ghats and preliminary screening of phytochemicals from various parts of the plant with different solvent extracts. The study revealed that various traditional uses of plant species for local ailments and the presence of various secondary metabolites such as alkaloids, flavonoids, phenols, terpenoids, tannins, glycosides and these components may have supported the medicinal properties of the plant species.

**Keywords**: *Tylophora subramanii*, endemic medicinal plant, ethnobotanical, alkaloids, flavonoids.

## 1. INTRODUCTION

*Tylophora* R.Br. is a pantropical genus distributed in tropical and subtropical Asia, Africa, India to Australia about 60 species (Tseng and Chao, 2011). In India, it is represented by 21 species and two varieties (Jagtap and Singh, 1999). *Tylophora subramanii* is a native plant of southern India commonly found in evergreen forest areas of Theni, Tirunelveli and Kanyakumari districts of Tamilnadu up to 1200 m elevation. It is a slender branched climber with smooth pubescent bark. Leaves, watery latex and root part of the plant has been used for treating various local health care systems. The gens *Tylophora* have been used for treating various diseases like asthma, leucorrhea, dysentery, fever and headache. Root of this genus is acrid and is said to be emetic (Karuppusamy, 2007). The plant is used to cure nervous disorders among Kani tribe community of Agastiyamalai hills in Tamilnadu. The plant is having watery latex in all over the body to have a number of secondary metabolites and high hydrocarbon content. The fruits and leaves of the plant have possessed the antioxidant capacity due to the presence of secondary metabolites. There are no phytochemical reports available so far this endemic medicinal plant species. Hence the present study aimed to carry out the preliminary phytochemical screening of various parts of *T. subramanii*.

## 2. MATERIALS AND METHODS

### *2.1. Collection, identification and preparation of plant material*

Fresh leaves, stem bark and young fruits of *T. subramanii* were collected from Megamalai Wildlife Sanctuary of Theni district, Tamilnadu (Fig.1). Preliminary identification was done with the help of local Flora (Gamble, 1957) and confirmation of the identification was compared with authentic specimen deposited in the Botanical Survey of India, Southern Circle, Coimbatore, Tamilnadu. The voucher specimen (Karuppusamy, 852) is deposited in the herbarium of the Department of Botany, The Madura College Madurai, Tamilnadu. The fresh plant parts separately air-dried, powered and then stored in dry sealed glass bottles until use.

### *2.2. Extraction of plant material*

Plant powders were separately subjected to extraction with various solvents such as Ethanol, Chloroform, Hexane and water using Soxhlet's apparatus with continuous reflux for 8 hours at $70^0$C temperature. Further extracts were distilled off and concentrate to a syrupy consistency and then evaporated to dryness. The dried extract were weighed and prepared the 1% sample solution with respective solvents.

*2.3. Phytochemical screening*

Preliminary qualitative phytochemical screening was carried out with the following methods.

Alkaloids: 2 ml of test solution added with 2 N hydrochloric acid, aqueous layer formed was decanted and to that added few drops of Mayer's reagent. The creamy precipitate obtained in the bottom indicates the presence of alkaloids (Harborne, 1973).

Flavonoids: 2 ml of test solution, added alcohol and a bit of magnesium salt. Then a few drops of concentrated hydrochloric acid was added and boiled gently for 5 minutes (Edeoga *et al*., 2005).

Steriods: 1 ml of the extract was dissolved in 10 ml of chloroform and equal volume of concentrated sulphuric acid was added by the sides of the test tube. The upper layer turns red and sulphuric acid layer showed yellow with green fluorescence. This indicated the presence of steroids (Trease and Evans, 1996).

Terpenoids: 2 ml of extract was added to 2 ml of acetic anhydride and concentration of H2SO4. Formation of blue, green rings indicates the presence of terpenoids (Kolawole *et al*., 2006).

Triterpenoids: 2 ml of test solution, added a piece of tin and 2 drops of thionyl chloride. The result was observed (Kolawole *et al*., 2006).

Tannins: 2 ml of extract was added to few drops of 1% lead acetate. A yellowish precipitate indicated the presence of tannins (Boham and Kocipal-Abyazan, 1974).

Saponins: 5 ml of extract was mixed with 20 ml of distilled water and then agitated in a graduated cylinder for 15 minutes. Formation of foam indicates the presence of saponins Smolenski *et al*., 1974)

Phenols: 2 ml of aqueous extract is added to 2 ml of 2N Hcl and ammonia. The appearance of

pink-red turns blue-violet indicates the presence of phenols (Harborne, 1973).

Coumarins: 3 ml of 10% NaOH was added to 2 ml of aqueous extract formation of yellow colour indicates the presence of coumarins (Harborne, 1973).

Glycosides: 5ml of diluted sulphuric acid was added in extracts in a test tube and boiled for fifteen minutes in a water bath. It was then cooled and neutralized with 20% potassium hydroxides solution. A mixture of 10ml of equal parts of Fehling's solution were added and boiled for five minutes. A more dense red precipitate indicates the presence of glycosides (Harborne, 1973).

## 3. RESULTS AND DISCUSSION

The present investigation on the preliminary phytochemical screening of *T. subramanii* with various extracts of different parts summarized in table 1. Stem bark (Fig. 1) and leaves are having more number of secondary metabolites such as alkaloids, flavonoids, phenols, terpenoids and glycosides. Steroids, saponins and coumarins are obtained negative results in this plant species. Fruit extracts showed the less number of secondary metabolites in all four kinds ofextracts. Among the phytochemicals, alkaloids, flavonoids, phenols and glycosides are abundant in stem bark and leaves which are showing strong results in ethanol extracts.Terpenoids and triterpenoids are weakly present in hexane extracts of leaves and stem bark. Aqueous extracts showed the less number of metabolites and very weak results (Table 1). Ethanol is a good solvent system for extraction of secondary metabolites, the present result is also proved that many metabolites extracted and resulted in ethanol extracts. Chloroform extracts have shown a moderate number of phytochemicals from selected plant parts of *T. subramanii*.

**Fig. 1. *Tylophora subramanii* Henry**


a) Flowering twig; b) Inflorescence; c) Follicle

**Table 1. Qualitative phytochemical screening of different parts of *Tylophora subramanii* with various solvents extracts.**

| Phytochemical | Solvent extracts | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ethanol | | | Chloroform | | | Hexane | | | Aqueous | | |
| | L | SB | F | L | SB | F | L | SB | F | L | SB | F |
| Alkaloids | +++ | +++ | ++ | + | ++ | + | - | - | - | + | + | - |
| Flavonoids | ++ | +++ | + | - | + | + | - | - | - | - | - | - |
| Phenols | +++ | ++ | + | ++ | + | - | - | - | - | + | + | + |
| Steroids | - | + | + | - | - | - | - | - | - | - | - | - |
| Terpenoids | + | - | - | - | - | - | + | ++ | + | - | - | - |
| Triterpenoids | - | - | - | - | - | - | + | + | + | - | - | - |
| Tannins | + | ++ | + | + | + | - | - | - | - | - | + | - |
| Saponins | - | - | - | - | - | - | - | - | - | - | - | - |
| Coumarins | - | - | - | - | - | - | - | - | - | - | - | - |
| Glycosides | +++ | +++ | ++ | ++ | +++ | + | + | + | - | + | + | + |

+++ abundant; ++ moderately present: + weakly present; ---- absent
L- Leaf; SB – Stem bark; F- Flower.

The medicinal value of the plant lies in some chemical substances that have a definite physiological action on the human body. The most important bioactive compounds of the plant are alkaloids, flavonoids, phenols and glycosides. The leaves and stem bark showed a good supply of useful compounds of alkaloids, flavonoids and glycosides. The strong presence of flavonoids in leaves and stem barks may have supported the antioxidant potential of the plant species. The pharmacological properties of the *T. indica*, a closely related species were already reviewed its potential for curing asthma and allergic reactions (Rani *et al*., 2015). Possible detection of alkaloids, glycosides, terpenoids, flavonoids, steroids, tannins and reducing sugars in related species such as *Tylophora indica* (Kumar, 2011) and *Tylophora pauciflora* (Starlin *et al*., 2012).

The pharmacological activities of a given plant are associated with the type and nature of secondary metabolites present in them. The need for phytochemical screening has become imperative, since many plants accumulate biologically active substances in various parts and tissues. Phytochemical screening of *T. subramanii* revealed the possible presence of alkaloids, flavonoids and glycosides. Typical alkaloids often have marked pharmacological effects, when administered to man and other animals. The plant has potential source of flavonoids and glycosides would be chance of exploration of anti-inflammatory and antioxidant properties.

The plant species studied here can be used as a potential source of useful drugs. It also justifies the folklore medicinal use and the claims about the therapeutic values of this plant as a curative agent. Therefore, further study needed for isolation, identification, purification, characterization, and structural elucidation of bioactive compounds of *T. subramanii* that wound be obtained with pharmacological and clinical trials, the compounds leads a promising therapeutic agent.

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# ALGAL DISTRIBUTION AND ITS ABUNDANCE IN PUTHALAM SALTWORKS, KANYAKUMARI DISTRICT, TAMIL NADU

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**ABSTRACT**

Saltworks are important wetlands and exposed to wide range of environmental stress and perturbations. Fluctuations of salinity, brine chemistry and nutrient status leads to variation in microalgal population. The typical saltworks Sri Sankara Allom, Puthalam was chosen for the study. The investigation was aimed to list out the microalgae and calculates their abundance. The work was done in different seasons (I, II, III and IV) of the study period (March 2009 to February 2010). The reservoir pond showed major variation among micro algal species but it was low in condenser pond. Only two micro algal species were observed in crystallizer pond. A gradual reduction in number of micro algal species was observed with an increase in salinity. With regard to crystallizer, Dunaliella was the dominant one throughout the study period.

**Keywords:** Abundance, condenser, crystallizer, microalgae, reservoir, saltworks.

## 1. INTRODUCTION

Saltpans are one of the hypersaline extreme environments. Among halophilic microorganisms, bacteria, cyanobacteria, green algae, fungi and diatoms are abundant in saltpans (Das Sarma and Arora, 2002) and form a biological pad (Zhiling and Guangyu, 2009). They withstand extreme saline conditions and regulate the osmotic pressure, thereby resisting the denaturing effects of salt in their environment (Kerkar, 2004).

In Kanyakumari District eight saltpan industries are involved in the salt production process. In these, the typical tropical saltworks Sri Sankara Allom Salt Factory, Puthalam, Kanyakumari District in South Tamil Nadu is situated between Manakudy seacoast and Puthalam village. This allom was the first to use sub-soil brine for salt production. The total area of this salt work is 24.88 ha. It is situated 13 km south east of Nagercoil and 5 km north of Kanyakumari at 8° 04' N latitude and 77° 68' east longitude. This is one of the best salt producing area in Kanyakumari District and also contains rich plankton community. The aim of this work is to list out the microalgae present in the various ponds of saltworks and also calculate the abundance of phytoplankton.

## 2. MATERIALS AND METHODS

### *2.1. Algal sampling and analysis*

For the study, the microalgae and its abundance (%) were studied throughout the study period. The investigation period (March 2009 to February 2010) was divided into four seasons viz. summer (March, April and May), autumn (June, July and August), spring (September, October and November) and winter (December, January and February). The collection was made in early morning. A circular hand net of ½ m length with 15 cm mouth diameter of a mesh size of 2 µ was used for the collection of phytoplankton samples by filtering 100 litres of water. Then the filtrate was put into clean labeled plastic container and also fixed in Lugol's iodine soon after the collection for further analysis. The fixed samples were transferred to the laboratory and kept undisturbed until analysis. Drop method was applied for counting and identification of phytoplankton species from different samples (APHA, 1992). The cell number was determined by direct counting under a compound microscope. Then they were identified, based on standard monographs (Venkataraman, 1939; Prescott, 1962; Desikachary, 1986). Name, systematic position and the abundance of the microalgae (declared as % abundance/unit area) were tabulated.

## 3. RESULTS

The abundance of phytoplankton showed fluctuation during different seasons of the study period. In general, the reservoir pond showed the higher average population more than the other studied (condenser and crystallizer) ponds.

During the present study a gradual reduction in number of microalgal species were

observed with an increase in salinity. Totally 18 different genera of phytoplankton were identified in the reservoir pond (Table 1). Among these Bacillariophyta contributed more number of genera (7 numbers) followed by Cyanophyta (6 numbers), Chlorophyta (3 numbers) and Dinophyta (2 numbers) (Tables 2 and 3). It is clearly evident and notable that microalgal species like *Nitzschia* was recorded only in season II, *Cosinodiscus* in season III, *Chroococcus* in season I and *Peridinium* in season IV. But *Gleocapsa* and *Exuviella* were recorded in season III and IV. And also it is a point of consideration.

**Table 1. Distribution of algal species identified and its abundance (%) in the reservoir pond of Puthalam saltworks during March 2009 to Feb. 2010.**

| S. No. | Name | Systematic position | | Abundance (%) | | | |
|---|---|---|---|---|---|---|---|
| | | Order | Division | Season I | Season II | Season III | Season IV |
| 1. | *Pleurosigma* sp. | Naviculales | Bacillariophyta | 45.62 | 7.11 | 17.72 | 56.73 |
| 2. | *Navicula* sp. | Naviculales | Bacillariophyta | 0.55 | 14.50 | 15.82 | 7.24 |
| 3. | *Cyclotella* sp. | Centrales | Bacillariophyta | 0.52 | 2.87 | 2.94 | 4.51 |
| 4. | *Pinnularia* sp. | Naviculales | Bacillariophyta | 0.34 | 0.95 | 2.77 | -- |
| 5. | *Amphora* sp. | Naviculales | Bacillariophyta | 0.09 | 0.96 | 4.93 | 0.85 |
| 6. | *Nitzschia* sp. | Nitzschiales | Bacillariophyta | -- | 2.19 | -- | -- |
| 7. | *Coscinodiscus* sp. | Coscinodiseales | Bacillariophyta | -- | -- | 1.31 | -- |
| 8. | *Dunaliella* sp. | Volvocales | Chlorophyta | 41.86 | 20.52 | 21.0 | 5.64 |
| 9. | *Chlorella* sp. | Chlorellales | Chlorophyta | 3.07 | 0.96 | 1.64 | 6.86 |
| 10. | *Closterium* sp. | Desmidiales | Chlorophyta | 0.14 | 0.41 | -- | 0.75 |
| 11. | *Oscillatoria* sp. | Nostocales | Cyanophyta | 7.35 | 26.40 | 26.53 | 10.72 |
| 12. | *Spirulina* sp. | Nostocales | Cyanophyta | 0.06 | 0.42 | 3.80 | 0.85 |
| 13. | *Lyngbya* sp. | Nostocales | Cyanophyta | 0.34 | 22.71 | -- | 4.33 |
| 14. | *Anabaena* sp. | Nostocales | Cyanophyta | -- | 0.54 | 1.38 | 0.09 |
| 15. | *Gloeocapsa* sp. | Chroococales | Cyanophyta | -- | -- | 0.09 | 1.03 |
| 16. | *Chroococcus* sp. | Chroococales | Cyanophyta | 0.06 | -- | -- | -- |
| 17. | *Exuviella* sp. | Gleodinales | Dinophyta | -- | -- | 0.08 | 0.47 |
| 18. | *Peridinium* sp. | Peridiniales | Dinophyta | -- | -- | -- | 0.65 |

Each value is a mean of four data; -- Absent

**Table 2. List of microalgae and its abundance (%) in the condenser pond of Puthalam saltworks during March 2009 to February 2010.**

| S. No | Name | Systematic position | | Abundance (%) | | | |
|---|---|---|---|---|---|---|---|
| | | Order | Division | Season I | Season II | Season III | Season IV |
| 1. | *Pleurosigma* sp. | Naviculales | Bacillariophyta | 2.23 | 4.98 | 1.20 | 4.93 |
| 2. | *Navicula* sp. | Naviculales | Bacillariophyta | -- | -- | 0.31 | 0.70 |
| 3. | *Pinnularia* sp. | Naviculales | Bacillariophyta | 0.04 | -- | 0.12 | -- |
| 4. | *Dunaliella* sp. | Volvocales | Chlorophyta | 79.10 | 14.94 | 98.05 | 90.14 |
| 5. | *Synechococcus* sp. | Synechococcales | Cyanophyta | 18.30 | 78.16 | 0.03 | 1.76 |
| 6. | *Chroococcus* sp. | Chroococales | Cyanophyta | 0.32 | 2.04 | 0.28 | -- |
| 7. | *Peridinium* sp. | Peridiniales | Dinophyta | -- | -- | -- | 2.46 |

Each value is a mean of four data; -- Absent

**Table 3. Phytoplankton and its abundance (%) in the crystallizer pond of Puthalam saltworks during March 2009 to February 2010.**

| S. No. | Name | Systematic position | | Abundance (%) | | | |
|---|---|---|---|---|---|---|---|
| | | Order | Division | Season I | Season II | Season III | Season IV |
| 1. | *Dunaliella* sp. | Volvocales | Chlorophyta | 96.21 | 98.73 | 98.96 | 99.37 |
| 2. | *Chroococcus* sp. | Chroococales | Cyanophyta | 3.79 | 1.27 | 1.04 | 0.63 |

Each value is a mean of four data

Only seven genera from three divisions were identified in the condenser pond. *Dunaliella* was dominant in all the seasons except season II. At the same time, *Synechococcus* had dominated only in season II. *Peridinium*, one of the members of Dinophyta was recorded only in season IV which is a notable fact. In the crystallizer pond only two genera were found in one in each of the divisions Chlorophyta and Cyanophyta. *Dunaliella* was the dominant one in all the seasons during the study and registered the abundance of 96.21 (season I), 98.73 (season II), 98.96 (season III) and 99.37 % (season IV) respectively. The another species *Chroococcus* showed the lowest abundance of 3.79, 1.27, 1.04 and 0.63% in the seasons.

The population size of different groups and species of phytoplankton at various ponds during different seasons were highly variable. Higher abundance of phytoplankton in all ponds was recorded during season IV.

## 4. DISCUSSION

The population density estimated in reservoir pond of Puthalam saltworks showed the major variation among microalgal species. Examination of phytoplankton population revealed that the density of phytoplankton varied in relation to salinity. Salinity showed a significant relation with Bacillariophyceae and Cyanophyceae which was abundant in low salinity ponds followed by Chlorophyta and Dinophyta. These results are agreement with the results of Reginald (2003).

Diatoms were abundant and most frequently encountered in the microscopic survey of this study. The cyanobacterial species occupied the second dominant position. It was in accordance with the findings of Oren (2009) and Khan *et al*. (2009).

In the reservoir pond, among the most abundant microalgae identified were species of the genera *Pleurosigma*, *Navicula*, *Cyclotella*, *Amphora*, *Dunaliella*, *Chlorella*, *Oscillatoria* and *Spirulina*. Although Bacillariophyta were dominant in respect to species numbers, Cyanophyta and Chlorophyta type phytoplankton were registered in terms of population density (Elif and Arif, 2010). Blooming of phytoplankton occur in season II induced by changes in temperature and nutrients supply during summer.

The salinity was higher in the condenser pond than the reservoir and also condenser pond receives brine from the reservoir. The population density and species abundance were very low in the condenser pond of Puthalam saltworks. The presence of *Pleurosigma*, *Navicula*, *Dunaliella* and *Chroococcus* throughout the study period indicates that they can tolerate wide fluctuations in salinity.

One organism that is the cyanobacterium *Synechococcus* was present in the condenser pond which was not observed in reservoir pond and crystallizer pond throughout the study period. It is a slime producing algae grow and reproduce best in intermediate salinities (Oren, 2000) but they do not survive in crystallizers. *Synechococcus* and *Dunaliella* species are the key organisms in condenser pond and common in most solar saltworks. *Dunaliella* species could tolerant extreme high salinity and they become the dominant species.

Increased salinity in the crystallizer ponds has eliminated some non-tolerant species. There are only two micro algal species (*Dunaliella* and *Chroococcus*) were noticed even in the crystallizer pond. The chlorophycean member *Dunaliella* species was present in all ponds and constituted the bulk of phytoplankton in the crystallizer ponds. The same effect in Thamaraikulam saltworks of Kanyakumari District, South Tamil Nadu was observed in the past by Reginald (2003). According to Davis (2009) the algal species of *Dunaliella* remain alive in high salinity and gradually change colour to bright orange-red, enlarge, become spherical and accumulate glycerol and beta carotene.

From these observations, the present study of surveying in Puthalam saltworks gives an idea about microalgal population, provide first hand knowledge about the co-existence of various phytoplankton to the peculiar environment offered by the solar saltpan, evaluate their interaction among themselves and provide useful information regarding their nature in various salinities of the ponds in order to survive for quality salt production. Another important fact learned through this study was, most of the marine algae prefer shelf-shade for its survival in salinity.

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# GLOBAL WARMING AND ITS IMPACT ON COLACHEL ESTUARY, KANYAKUMARI DISTRICT, TAMIL NADU.

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## ABSTRACT

The outcome of global warming in the form tsunami brought drastic changes in our ecosystems. With a view to understand the ill effects of global warming, an attempt was made to focus attention on the shift in diversity of phytoplanktons in the Colachel estuary.

**Keywords:** Estuary, fluctuations, retting, stress, Tamilnadu.

## 1. INTRODUCTION

On 26th December 2004, tectonic disturbances happened in the java,Sumatra islands with an intensity of a round 9.3 in the Richter scales extend to the southern Indian Ocean basin. The changes caused by the tsunami along the Tamilnadu coast was discussed by Jayakumar *et al*. (2005).This has brought vast changes in our aquatic ecosystem and resulted in large scale depletion of flora and fauna.

An estuary is a partly enclosed coastal body of water which is opened to the open sea and within which sea water is measurably diluted with fresh water derived from land drainage (Pitchard, 1967). These ecosystems with an unstable environments spread to an expanse of about two million hectares in India (Kurian, 1975). Being influenced by river flow and tidal water currents they have wide fluctuations in hydro dynamic and biological characteristics (Balusamy, 1988). Estuary serves as a potential breeding site for many of the important species of fin fishes and shell fishes (Achuthankutty *et al*., 1981) and prawn (Jayabalan *et al*., 1980). The occurrence of recent tsunami waves have created an extensive dredging in estuaries affected local tidal currents regimes which influence the movement and distribution of sediments and turbidity plums resulting in stress, remobilization of metals and minerals impacted microalgae.

Some fishes were being an extensive dredging in estuaries affected local tidal currents regimes which influence the movement and distribution of sediments and turbidity plums resulting in stress, remobilization of metals and minerals impacted microalgae. Some fishes were being forced out of their habitats. The hindrance to the fish habitats caused a disruption of the local food chain resulting in reduced fish catch.

## 2. MATERIALS AND METHODS

### *2.1. Study area*

The Colachel estuary is situated in Kanyakumari at the south of Tamil Nadu.it is a minor estuary. It originates from the Vellimalai hills about 25km north west of Nagercoil and transverses 22 km before it joins the Arabian sea at Colachel and forms the estuary when it crosses the rice paddies it receives the agricultural run-off which contains the fertilizers and pesticide effluents along these retting fields are found along the estuaries.

### *2.2. Methodology*

Phytoplankton samples were collected using no.3 plankton net (bolting silk mesh size 48 µm) during early hours of the day and transferred to 1 liter polythene bottle with a few drops of 5% formalin as preservative. The phytoplankton were allowed to settle to the bottom for 24 hours and identified using standard monographs of Desikachary (1959) and Santhanam *et al*., 1987 and compared with the pre tsunami reports.

The fishery resources of water bodies are greatly influenced by the availability of primary producers, the phytoplankton with a view to find out the impact of tsunami on fish production; survey physical observation and personal enquiry were conducted. The resource depletion was enlisted.

## 3. RESULTS AND DISCUSSION

The estuary chosen for the present study is used for various purposes for domestic and agricultural purposes; people rely mainly on estuarine water sudden perturbation like tsunami can alter the state and contents of water both

qualitatively and quantitatively. Diversity of phytoplankton acts as an index to assess the fertility of water mass as they are efficient primary producers and constitute a major food source for higher trophic level. The phytoplankton observed from colachel estuary ranged from primitive Cyanophyceae to Bacillariophyceae (Vasantha, 2004). In the present study 36 species were observed i.e 4 genera of Chlorophyceae, 5 genera of Cyanophyceae, 5 members of Dinophyceae, 3 members of Euglenophyceae,19 genera Bacillariophyceae (Table 1). 17 algal species were found decreased in the post tsunami period and all other genera were found increased.

**Table 1. Phytoplankton identified in the water samples collected in the selected estuary during post and pre-Tsunamic periods.**

| Class | Name of the phytoplankton | Species composition | |
|---|---|---|---|
| | | Pre-tsunami | Post tsunami |
| Chlorophyceae | *Chlorella marina* | +++ | + |
| | *Closterium sp* | ++ | ++++ |
| | *Spirogyra sp* * | +++ | ++++++ |
| | *Volvox sp* | +++++ | ++ |
| Cyanophycea | *Oedogonium sp** | +++ | +++++++ |
| | *Oscillatoria sp** | +++++ | ++++++++ |
| | *Nostoc sp* | ++ | +++++ |
| | *Anabaena sp* | +++++++ | +++ |
| | *Gloeocapsa sp** | +++ | +++++++ |
| Dinophyceae | *Ceratium furca** | ++ | ++++++++ |
| | *Peridinium conicum* | ++++++ | ++ |
| | *P .granii* | ++ | +++ |
| | *Noctiluca sp.* | ++++++++ | ++ |
| | *Gymnodinium sp.** | + | +++++ |
| Euglenophyceae | *Euglena acus** | ++++++++ | +++ |
| | *Phacus longicauda* | +++ | +++++ |
| | *Lepocinclis ovam** | ++ | +++++++ |
| Bacillariophyceae | *Asterionella sp* * | + | ++++ |
| | *Diatoma sp* | +++ | ++ |
| | *Fragilaria sp* * | + | +++++ |
| | *Melosira sulcata* | ++++++ | +++ |
| | *Navicula granulate* | +++ | ++ |
| | *Pleurosigma normenii* | ++++++ | ++ |
| | *Gyrosigma balticum* * | ++ | +++++ |
| | *Rhizosolenia robusta* | + | ++++ |
| | *Bacillaria paradoxa* | ++++ | ++ |
| | *Coscinodiscus centralis* * | + | +++++ |
| | *Ditylum brightwelli* | ++++++ | +++++ |
| | *Eucampia zoodiacus* | ++++++ | ++ |
| | *Synedra ulna* | ++ | ++++ |
| | *Schroederella delicatula** | ++ | +++++ |
| | *Tricerattium favus** | + | +++++ |
| | *Hemidiscus hardmannianus** | ++ | +++++ |
| | *Rhizosolenia setigera** | + | +++++ |
| | *R .alata** | +++ | ++++++ |
| | *R .cylindricus* | +++ | +++++ |

Source: primary data * = increase in number

The temperature and plankton production are positively correlated .The microbial community exhibited marked variation in their dominance and diversity and these changes are due to different effects of changing physical, chemical and biological factors on individual species (Legendre and Legendre, 1978). Diatoms and in flagellates were the predominant forms throughout the year a reported earlier in many of the Indian estuaries.(Sivakumar, 1982, Ashokan, 1987, Ramesh *et al.*,1992, Tiwari and Nair, 1993 ,Katti *et al*, 2002). In response to alterations in weather and seasonal oscillations in hydrography microalgal diversity may vary (Walting *et al*., 1979, Karentz and Smayda, 1984). Their growth, abundance and dispersal are determined by environmental parameters such as transparency, temperature, salinity, nutrients in particular nitrates, phosphates and silicates (Satpathy, 1996) light penetration (Jegatheesan, 1986 and Vasantha, 2004) salinity (Neelakantan, 1988) and circulation patterns (Smayda, 1978). During the pre-tsunami period microalgae supported diverse communities of small benthic invertebrates such as polychaetes and amphipods, isocapods, decapods, oligochaetes, foraminifera, ostracods and mollusks (Vasantha, 2004) which form part of the local fish production cycle.

**Table 2. Depletion in fish catch after Tsunami in Colachel estuary.**

| Common name | English name |
|---|---|
| Mullukendai | White carp |
| Naichaalay | Herring oil sardine |
| Kuthippu kare | Big jawed jumper |
| Kalral | Lobsters |
| Velameen | Snapper |
| Oolavaalai | Ribbon fish |
| Chunnampoovaalai | Cutlass fish |

The fish catch in Arabian Sea near Colahel estuary has been affected severely in the post tsunami period. Discharge of industrial wastes in several forms such as solid, liquid and gases to the environment causes several problems and it ultimately results in global climatic change. Coir retting, a process of decomposition of coconut husk by the action of bacteria is a common practice in nearby this estuary. During this process the retting liquor is discharged directly into the estuarine water and it causes an adverse change in the resident communities of the habitat composition.

The tsunami that hit the shores of Tamilnadu on 26th December, 2004 was a catastrophe. It not only killed thousands of people but also changed the coast line of Tamilnadu in several areas. After the tsunami, the realization has set in that the destruction of the coastal mangrove forest and other natural vegetation was the main reason for the havoc caused. This has spurred many measures to protect the coast lines with natural barriers and prevent such occurrences in the future.

The results of the study indicate that if there is no increase in thermal tolerance capacity, depletion would become an annual or bi annual event for almost all fishes. The tsunami episodes have definite impact on fish habitats, plankton diversity and reduced local and regional fishery production. Hence there is a need to keep the people aware about global warming and to have a better understanding of this estuary for optimum utilization of water and biological resources.

The global temperature will continue to increase and in order to minimize the effects all individuals, governments and NGOs have come forward to take control measures. Emerging economics such as India which is rich in biodiversity due to immense variety of climate conditions coupled with ecological habitats should take steps against greenhouse gas emission. The benefits we are getting from the innumerable natural resources should be passed to the grand children of their children also. Man is the beneficiary and biodiversity is the benefactor. In the absence of benefactor the beneficiary cannot exist. Man should not forget this basic fact.

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# EFFECT OF *EXACUM WIGHTIANUM* ARN., AN ENDEMIC MEDICINAL PLANT ON THE ANTI DIABETIC ACTIVITY

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## ABSTRACT

The study revealed the antidiabetic activity of the ethanol extract of *Exacum wightianum* Arn. (Gentianaceae) in streptozotocin induced diabetic rats. The pilot studies were carried after oral administration at doses of 100, 200, 500 and 1000 mg/kg b.wt. in sub-acute study. In diabetic induced rats fed with the extract at 100 and 200 mg/kg body b.wt. The fasting plasma glucose levels were reduced to near normal body and liver weight were found to be increased. Whereas blood glucose, protein, albumin and creatinine levels were estimated after two weeks. The extract significantly inhibited the induction of albuminuria, proteinemia and uremia. The present study clearly indicated a significant antidiabetic activity with the ethanol extract of *E. wightianum* supports the traditional usage of the plant by Ayurvedic physicians for the control of diabetes. The extract could be useful in preventing the incidence of long term complications of diabetes mellitus.

**Keywords**: Albuminuria, *Exacum wightianum,* Proteinemia, Streptozotocin and Creatinine.

## 1. INTRODUCTION

Diabetes, as one of the most common global diseases, affects approximately 200 million individuals worldwide and approximately 300 million people worldwide are at risk of diabetes (McCune and Johns, 2002). There are two types of diabetes: type 1 and type 2. In type 1 diabetes insulin deficiency originated from allergic reactions in genetically susceptible people that eventually destroy the pancreatic β- cells producing insulin. Type 1 diabetics are insulin dependent. Type 2 diabetes is the most common form of diabetes accounting for 90% of cases worldwide. Patients with type 2 diabetes are not dependent to use insulin. It is found that the main factor to improve vascular diseases seen in type 2 diabetics is a decreased plasma antioxidant level (Kelble, 2005). The approach to the management of type 2 diabetes is based on weight management and life-style modification. In modern medicine, no satisfactory effective therapy is still available to cure the diabetes mellitus. Now-a-days insulin therapy is encouraged for the management of diabetes mellitus, but there are several drawbacks like insulin resistance. The herb *Exacum wightianum* Arn. belongs to the family Gentianaceae. It has a long history of use in Ayurvedic medicine (the traditional medicine of India). It is extensively used as bitter tonic and febrifuge in the Ayurvedic system of medicine (Sharma, 1993). The extract has long been used in folk medicine for the treatment of hepatitis, cholecystitis, pneumonia, malaria, dysentery and spasm; whereas the recent investigations have shown that some xanthones possess a marked hypoglycemic activity when administered to rats. In the present investigation the effect of ethanolic extract of *E. wightianum* were studied on streptozotocin- induced diabetic male Wistar albino rats.

## 2. MATERIALS AND METHODS

### *2.1. Collection of plant material*

All aerial parts and roots of *Exacum wightianum* (Gentianaceae) was collected during blooming season August, 2010 from Naduvattam, Uthagamamdalam, the Nilgiri Hills, Western Ghats, Southern India, Tamil Nadu. The plant was identified and authenticated by a plant taxonomist, Mr. M. Murugesan, Scientist, SACON, Coimbatore.

### *2.2. Preparation of extract*

500 g of shade dried and pulverized whole plant powder of *E. wightianum* was defatted with petroleum ether and the residue was then re-extracted with ethanol by using soxhlet apparatus. This extract was stored at 4ºC and used for further studies.

*2.3. Experimental Animal*

Male Wistar Albino rats weighing 180-250 g were obtained from Agricultural University, Animal house lab, Trissur, Kerala. All the animals were maintained in polycarbonated cages in an animal room with 12 h light/12 h dark cycle at temperature of 22 ±2ºC and humidity of 45-60%. They were fed with commercial pelleted rats chow and free access water during the entire period of experiment. The experiments were performed according to ethical guidelines for the investigation of experimental pain in conscious animals (659/02/a/CPCSEA).

*2.4. Induction of experimental diabetes*

Diabetes was induced by administering intraperitonial injection of a freshly prepared solution of Streptozotocin monohydrate dissolved in 0.1 M cold citrate buffer (pH 4.5) to the overnight fasted rats (Sekar *et al.,* 1990) and the STZ solution is made cold using cold citrate buffer immediately before administration. The drug induced hypoglycemia in all rats was controlled by treating 5% glucose solution. The blood glucose above 250 mg/dl on the third day after injection was considered as diabetic rats. At this time the treatment was started on the fifth day after injection and considered as first day of treatment.

*2.5. Experimental design*

The streptozotocin induced rats were divided into five groups each contains five numbers of rats. Group I served as normal rats without any treatment, Group II served as diabetic control rats. Group III diabetic rats given glibenclamide (600 µg/kg b.wt.).Group IV served as diabetic rats given ethanolic extract of *E. wightianum* (100 mg/kg b.wt.).Group V served as diabetic rats given ethanolic extract of *E. wightianum* (200 mg/kg b.wt.). At the end of the experiment all the animals were deprived of food overnight, anesthetized and sacrificed by cervical dislocation. Blood was collected in heparinised tubes and used for the further estimation of biochemical studies.

*2.6. Toxicity study*

*E. wightianum* ethanolic extract was orally administrated at a concentration of 250,500,750 and 1000 mg/kg body weight/ day for a period of 14 days. The toxic effects were measured by body weight and morphological changes.

*2.7. Estimation of Insulin, Blood glucose, Urea and Creatinine*

The blood glucose level was estimated by the method of O-toludine by Sasaki *et al.* (1972), Insulin was estimated by radio immuno assay kit purchased from stat Diagnostics, Mumbai, India (Anderson *et al.,* 1993). Urea level was assayed according to the method of Varley (2012) and Creatinine level was estimated by Owen *et al*., (1954).

*2.8. Statistical analysis*

All data were expressed as means ± S.E. Significant differences among the groups were determined by one-way analysis of variance using the DMRT statistical analysis program. Statistical significance was considered at $p<0.05$.

**3. RESULTS**

The ethanol extract of *E. wightianum* was administrated orally to rats at the doses of 100, 200, 500 and 1000 mg/kg b.wt. and the mean death rats were observed. The results showed that numbers of deaths of rats were observed at the different dose levels. There was no morphological change like respiratory distress, hair loss, restlessness, convulsions, laxative, coma, weight loss etc. There was no lethality or any toxic reactions found at any of the doses selected till the end of treatment period (Table 1). Table 2 shows the effect of *E. wightianum* extract on the body weight and organ weight in normal and streptozotocin induced diabetic rats. A significant weight loss was observed in the diabetic control group (Group II). The body weight and organ weight were increased in the *E. wightianum* extract treated groups IV and V at two concentrations 100 and 200 mg/kg b.wt. A significant improvement was observed in the group III treated with the standard drug, glibenclamide (Fig.1 a,b). The table 3 shows the effects of *E. wightianum* ethanol extract administered on streptozotocin induced diabetes for 14 days drug treatment. *E. wightianum* ethanol extract at the doses of 100 and 200 mg/kg b.wt. treatment significantly decreased the blood glucose level in streptozotocin induced diabetes rats (Group II). There was a significant elevation in blood glucose level with significant decrease in serum insulin levels in streptozotocin diabetic rats, compared with normal rats. Administration of *E. wightianum* extracts 100 and 200 mg/kg b.wt. and glibenclamide treated group III bring blood glucose and serum insulin towards normal levels. The effect of *E. wightianum* extracts 200 mg/kg b.wt. was significantly better than 100 mg/kg b.wt. The

administration of *E. wightianum* extract and glibenclamide showed a significant effect in lowering blood glucose and increasing serum insulin. In the diabetic control group II, the levels of serum creatinine was found to be increased in comparison with control. Treatment with *E. wightianum* extract significantly prevented the streptozotocin induced creatinine level. The diabetic rats administrated with *E. wightianum* extract at 100 and 200 mg/Kg b.wt. and glibenclamide at the dose of 600µg/Kg b.wt., daily orally for 14 days consequently orally by 1GC altered the values of insulin, glucose and creatinine when compare to control. The levels of the urea in streptozotocin diabetic rats were significantly higher than the control. When these diabetic rats treated with two concentrations of extracts (100 and 200 mg/kg b.wt.) decreased the levels when compare to group II (Fig.2-5).

## 4. DISCUSSION

Gallagher *et al*., (2003) studied the ability to inhibit glucose diffusion using same in vitro method. They reported that agrimony and avocado represented the most inhibitory effect on glucose diffusion [more than 60%] and mushrooms, coriander, eucalyptus, juniper, lucerne, mistletoe decreased significantly (ranged 6–48%) and elder, nettle extracts did not significantly decrease glucose diffusion. In the present study, the ethanol extract of *E. wightianum* effectively decreased the blood glucose in streptozotocin-induced diabetic rats, which is even better than glibenclamide. The results of the present study indicate that *E. wightianum* extract brought back the body weight, liver weight, glucose, insulin, protein and antioxidant. Aqueous extract of *Punica granatum* has brought decreased body weight of diabetic rats to normal (Khalil, 2004). The ability of this extract to prevent the body weight loss seems to be due to its anti-diabetic activity. Prakasam *et al.,* (2003) have reported that a reduction in body weight was observed in STZ diabetic animals, but when animals were treated with *Casearia esculenta* root extracts, the decrease in the body weight was minimized to almost nil. A significant weight loss was observed in allaxon induced diabetic rats than normal rats, when treated with aqueous extract of *Laportea ovalifolia* and Tolbultamide in streptozotocin induced diabetic rats. The body weight was improved when compared with the untreated diabetic rats (Pari and Saravanan, 2004).

**Table 1. Toxicity studies with *E. wightianum* extract.**

| Group (Dose)* | No of Rats | Death | Dose difference | Mean death | Dose different X Death |
|---|---|---|---|---|---|
| Group I | 5 | 0 | 0 | 0 | 0 |
| Group II | 5 | 0 | 100 | NM | NM |
| Group III | 5 | 0 | 200 | NM | NM |
| Group IV | 5 | 0 | 500 | NM | NM |
| Group V | 5 | 0 | 1000 | NM | NM |

* All treatment given one dose only; NM- No Mortality
Group I : Control rats given normal saline orally by using an intragastric catheter tube (IGC).
Group II : Diabetic rats given *E. wightianum* drug at the dose of 100 mg/ Kg body weight orally by IGC
Group III : Diabetic rats given *E. wightianum* drug at the dose of 200 mg/ Kg body weight , orally by IGC
Group IV: Diabetic rats given *E. wightianum* drug at the dose of 500 mg/ Kg body weight orally by IGC
Group V: Diabetic rats given *E. wightianum* drug at the dose of 1000 mg/ Kg body weight orally by IGC

**Table 2. Effect of treatment for 14 days with extract of *E. wightianum* on body and liver weight of normal, diabatic induced and drug treated adult albino rats.**

| Parameter | Body weight (gm) | Liver weight (gm) |
|---|---|---|
| Group I | 207 ± 8.21 | 7.56 ± 0.15 |
| Group II | 158.53 ± 6.50 | 4.52 ± 0.31 |
| Group III | 190.71± 11.63 | 6.73 ± 0.41 |
| Group IV | 192.13 ± 10.92 | 7.13 ± 0.53 |
| Group V | 197.53 ± 10.47 | 5.76 ± 0.39 |

Each Value is * SEM of 5 animals * $P < 0.05$
Group I: Rats given only saline (by using an intragastric catheter tube (IGC).
Group II: Streptozotocin induced diabetic rats (drug at the dose of 200 mg/ Kg b.wt.)
Group III: Streptozotocin induced diabetic rats treated with glibenclamide at the dose of 60 mg/ Kg b.wt.
Group IV: Streptozotocin induced diabetic rats treated with crude plant extract of *E.wightianum* at the dose of 100 mg/ Kg b.wt. orally for 14 days.
Group V: Streptozotocin induced Diabetic rats treated with crude plant extract of *E.wightianum* at the dose of 200 mg/ Kg b.wt. orally for 14 days.

**Table 3. Effect of treatment for 14 days with extract of *E.wightianum* on the insulin, blood glucose, urea, creatinine levels of normal, diabatic induced and drug treated adult albino rats**

| Parameter | Insulin (MIu/ml) | Bloodglucose (mg/dl) | Urea (mg/dl) | Creatinine (mg/dl) |
|---|---|---|---|---|
| Group I | 19.41±1.41 | 94.21 ± 5.10 | 15.31±1.3 | 0.51±0.01 |
| Group II | 07.41±0.09 | 272.11± 1.42 | 41.61±2.4 | 1.73±0.07 |
| Group III | 10.47±1.08 | 110.34 ± 8.3 | 21.02±1.9 | 0.95±0.02 |
| Group IV | 13.63±1.03 | 105.41 ± 6.4 | 16.63±1.6 | 0.74±0.5 |
| Group V | 18.32±1.45 | 95.32 ± 9.4 | 18.31±1.7 | 0.69±0.4 |

Each Value is * SEM of 5 animals * $P < 0.05$

Group I: Rats given only saline (by using an intragastric catheter tube (IGC).

Group II: Streptozotocin induced diabetic rats (drug at the dose of 200 mg/ Kg body weight)

Group III: : Streptozotocin induced diabetic rats treated with glibenclamide at the dose of 60 mg/ Kg b.wt.

Group IV: Streptozotocin induced diabetic rats treated with crude plant extract of *E.wightianum* at the dose of 100 mg/ Kg b.wt. orally for 14 days.

Group V: Streptozotocin induced diabetic rats treated with crude plant extract of *E.wightianum* at the dose of 200 mg/ Kg b.wt. orally for 14 days.

The administration of Glibenclamide also decreased the levels of urea and creatinine to some extent. Stabilization of serum creatinine and urea levels through administration of the extract *E. wightianum* is further a clear indication of the improvement of the functional status of the liver cells. Our results thus clearly demonstrated that the ethanolic extract of *E. wightianum* has potent antihyperglycemic in STZ induced diabetic rats. Further studies are warranted to isolate and characterize the bioactive antidiabetic principles from this plant, which can therefore be used as an alternative remedy for the treatment of diabetes mellitus and oxidative stress associated diabetic complications.

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# COMPARISON OF VERMICOMPOST AND LEAF MOLD ON THE GROWTH AND YIELD OF *CAPSICUM ANNUUM* L.VAR. *FRUTESCENS* (L.) KUNTZE

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## ABSTRACT

An experiment was conducted to determine the effect of vermicompost on the growth and yield of*Capsicum annuum*var. *frutescens* (Kantharimilagu). Vermicompost is a rich source of vitamins, enzymes, macro and micronutrients which when applied to plants help in efficient growth. The major thrust of this investigation was focused on the growth and yield of *Capsicumannuum*var. *frutescens*using the vermicompost prepared by the earthworm species namely *Eudriluseugeniae*on the biodegradation of Banana waste (*Musa*sps) mixed with cow dung 3:1. The present study has been carried out to evaluate thephysico-chemical characteristics, micronutrients and macronutrients, and also a comparative study was done on the effect of vermicompost on growth parameters namely root length, shoot length, number of leaf and number of flower and length of fruits in *Capsicum annuum*var. *frutescens*. The results of the study revealed that the plants treated withvermicompostshowed C/N ratio increasedin macronutrients (N, P, K, Ca, Na, Mg and C) and micronutrients (Fe, Cu, Mg and Zn) than the plants grown in leaf mold and control.The vermicompost applied plant *(Capsicum annuum*var. *frutescens)* showed increased root and shoot length, number of leaves, number of flowers and length of fruits than the plants which are not treated with vermicompost. Hence based on the various biochemical studies performed it is concluded that this quality of bio solid vermicompost obtained from the degradation of banana wastes by *Eudriluseugeniae* is an effective biofertilizer which would facilitate the increased uptake of the nutrients by the plants resulting in higher growth and yield.

**Keywords:** Biofertilizer, degradation, macro nutrients,vermicompost, yield.

## 1. INTRODUCTION

Vermicomposts are products derived from the accelerated biological degradation of organic wastes by earthworms and microorganisms. Earthworms consume and fragment the organic wastes into finer particles by passing them through a grinding gizzard and derive their nourishment from microorganisms that grow upon them. The process accelerates the rates of decomposition of the organic matter, which in turn alter the physical and chemical properties of the material, leading to a humification effect in which the unstable organic matter is fully oxidized and stabilized (Albanell *et al*., 1988; Orozco *et al*., 1996). The end product, commonly referred to as vermicompost is greatly humified through the fragmentation of the parent organic materials by earthworm sand colonization by microorganisms (Edwards, 1998). From earlier studies also it is evident that vermicompost provides all nutrients in readily available form and also enhances uptake of nutrients by plants. Sreenivas *et al*. (2000) studied the integrated effect of application of fertilizer and vermicompost on soil available Nitrozen (N) in ridge gourd (*Luffa acutangula*). Similarly, the uptake of N, phosphorus (P), potassium (K) and magnesium (Mg) was found to be higher in (*Oryzasativa*) plant when it was applied with vermicompost (Jadhav *et al*., 1997).

## 2. MATERIALS AND METHODS

The present work was carried during the year August 2013 – December 2013, at Marayapuram, Marthandam, K.K. Dist, and Tamil Nadu. To effectively recycle, the locally available banana waste, the earthworm species *Eudriluseugeniae*was used. Culture of *Eudriluseugeniae*species of earthworms were set up using large baskets for the production vermicompost. The basal layer of the vermi-bed comprised of broken bricks followed by a layer of coarse sand in order to ensure proper drainage. A layer of loamy soil was placed at the top. 50 locally collected earthworms are introduced in tothe soil. Fresh cattle dung was scattered over the soil and then it was covered with a dried banana waste. Water was added to the unit in order to keep it moist. The plant waste along with cattle dung was over turned once a week. After 60 days,

vermicompost units were regularized for the harvesting of vermicompost every 20 days.

Leaf mold compost was prepared by using loamy soil, leaf wastes and some dropping of animal waste in the ratio of 3:2:1. Enough water was added at regular intervals. After 30 days, leaf mold compost was ready.

After preparing the media (vermicompost, leaf mold compost) the seeds of *Capsicumannuumfrutescens*are sown on the ordinary soil and watered regularly. After 15 days, selected freshly grown nursery plants are planted in a medium of vermicompost and leaf mold compost separately. The seedlings are watered regularly. A control set up is maintained. The following growth parameters are recorded at harvest (after 15 weeks)

1) Root length
2) Shoot length
3) Number of leaves per plant
4) Number of flowers
5) Number of fruits and
6) Length of fruits

On 15th week, the plants were taken out of the gunny bags and the above listed growth parameters were measured. The physico- chemical parameters such as macro and micro nutrients, pH and electrical conductivity (Jackson, 1973) are analysed.

**3. RESULTS AND DISCUSSION**

The physico-chemical properties of vermi compost, leaf mold compost and control are listed in Table 1. All the physico-chemical parameters except pH increased significantly in pots of vermicompost followed by leafmold compost and control. The content of micro nutrients like Mn – 8 ppm, 6 ppm and 2.03 ppm; Zn – 4.5 ppm, 3.6 ppm and 3.5 ppm; Cu – 1.5 ppm, 1.2 ppm and 0.045 ppm; Fe – 9.9 ppm,9 ppm, 4.3 ppm; Mg 5.2 ppm, 4.1 ppm, 2.44 ppm; Ca-8.5 ppm, 6.2 ppm and 4.09 ppm; K-65%, 55% and 45%; P-8.25%, 6.15% and 0.03%; N-2.2%, 2.01% and 0.6%; C- 3.07%, 1.07% and 0.09% in Vermicompost, leaf mold compost and control respectively (Table 1). pH (7.5) decreased in vermicompost, followed by 7.7 in leaf mold compost and 7.9 in control. Like that electrical conductivity (EC) was 1.40 in vermicompost followed by 1.36 and 1.35 in leaf mold compost, control respectively.

**Table 1. Physico-chemical properties of vermicompost and leaf mold compost.**

| Media | Mn (ppm) | Zn (ppm) | Cu (ppm) | Fe (ppm) | Mg (ppm) | Ca (ppm) | K (%) | P (%) | N (%) | C (%) | pH | EC (mscm-1) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vermi compost | 8 | 4.5 | 1.5 | 9.9 | 5.2 | 8.5 | 65 | 8.25 | 2.2 | 3.01 | 7.5 | 1.40 |
| Leaf mold compost | 6 | 3.6 | 1.2 | 9 | 4.1 | 6.2 | 55 | 6.15 | 2.01 | 1.07 | 7.7 | 1.36 |
| Sterile soil (Control) | 2.03 | 3.5 | 0.045 | 4.3 | 2.44 | 4.09 | 45 | 0.03 | 0.6 | 0.09 | 7.9 | 1.35 |

**Table 2. Effects ofvermicompost and leaf mold on the growth of *Capsicum annuum*L. var. *frutescens* (L.) Kuntze**

| Media | Root Length (cm) | Shoot length (cm) | Number of flowers (cm) | Number of fruits (cm) | Length of fruits (cm) | Number of leaves |
|---|---|---|---|---|---|---|
| Vermicompost | 7.5 | 16 .5 | 15 | 13 | 2.2 | 10 |
| Leaf Mold compost | 9 | 13 | 11 | 6 | 2 | 6 |
| Sterile Soil (Control) | 5.5 | 11 | 9 | 3 | 1.2 | 5 |

Effects of the application of various fertilizers on different morphological parameters such as root length, shoot length, number of leaves, number of flowers, number of fruits and length of fruits were determined after harvesting. All the morphological parameters increased significantly for the plants treated with vermicompost than with leaf mold compost and control. At the harvesting time, the plants treated with vermicompost, leaf mold and control showed the increase in length of roots7.5 cm, 9cm and 5.5cm, shoot length increased 16.5 cm, 13 cm and 11 cm; number of flowers 15, 11 and 9; number of fruits 13, 6 and 3; length of fruits 2.2 cm, 2 cm and 1.2 cm and number of leaves 10, 6 and 5 respectively (Table 2).

The results of the decrease in the pH of soil treated with vermicompost when compared with control,the increased soil electrical conductivity and the increased soil nutrients (nitrogen, phosphorous, potassium, carbon, calcium, magnesium, manganese, copper, zinc and magnesium) are in agreement with the earlier work done by Ismail (2005); Lalitha *et al.,* (2000); Azarmi *et al.,* 2008). Similarly, the result of growth and yield of *C. annuum* with present study increased root length, shoot length, number of leaves, flowers, fruits and length of fruits is in accordance with Marinari *et al.* 2000); Erich *et al.* (2002); Gajalakshmi and Abbasi (2002); Arancon *et al.* (2004); Chamani *et al.* (2008);Hameeda *et al.* (2007); Zaller (2007); Rajbir. (2008).

The decrease in total nitrogen properties in soils without vermicompost is due to larger amount of carbon and nitrogen, in vermicompost and leaf mold compost that could have provided a larger source of nitrogen for mineralization (Arancon *et al.,* 2006). There have been other reports of increase of nitrogen in soil after application of vermicompost (Nethra *et al.,* 1999). In this experiment, the more available potassium probably could have contributed to decrease of soil pH caused from the application of vermicompost. The selective feeding of earthworm on originally rich substances which breakdown during passage through the gut, biological grinding, together with enzymatic influence of finer soil particles are likely to be responsible for increasing the different forms of potassium (Rao *et al.,* 1996). Vermicompostprovides nutrients in more available forms to plants such as phosphates, exchangeable calcium and soluble potassium (Orozco *et al.,* 1996).

Furthermore, the results showed that the available zinc concentration in soil was significantly affected by vermicompost treatments. The total zinc content, pH, organic matter of the soil affects the zinc availability (Alloway, 1993). The soil pH is the most important factor controlling zinc availability, which decreases with the increase of the pH. In this experiment increased zinc was attributed to the pH reduction and the greater organic matter degradation. The earlier findings of Atiyeh (2001) and Maheshwarpa *et al.* (1999) supported the present result of reduction of soil pHwith increase of vermicompost rate in the soil.

The soils amended with vermicompost had significantly higher electrical conductivity (EC) than the control. The soil EC increased with increasing the application rate of vermicompost in soil as reported by Atiyeh *et al.* (2001). The EC of vermicompost depends on the raw materials used for vermicomposting and their ion concentration (Atiyeh, 2002b). The manganese availability in the soil was significantly affected by vermicompost treatments. Also the results revealed that the soil copper concentration did not differ significantly between the treatments.

Length of root, stem, number of leaves, flowers and fruits are maximum in plants treated with vermicompost followed by leaf mold compost and control (Table 2). The maximum number of leaves observed with in vermicompost treated plants can be accounted for by the fact that vermicompost are high in nitrogen which is responsible for rapid plant growth. The plant height observed after harvest was maximum for in vermicompost and leaf mold compost treated plants followed by control. The yield of the fruit per plant in vermicompost treatment was maximum followed by leaf mold compost and control. The increased plant growth in vermicompost than leaf mold compost and control may be due to the impact of microbes in bio-fertilizers (Lalitha *et al.,* 2000; Ansari, 2008 a).

Vermicompost and leaf mold compost are also enriched with certain metabolites and vitamins which enhance the plant growth (Lalitha *et al.,* 2000; Ansari, 2008 a; b). According to Lalitha *et al.,* (2000), application of vermicompost and leaf mold compost has an emphatic effect on plant growth and production. The higher yield due to application of vermicompost may be attributed to the higher level of nutrients along with growth stimulating substances exerted by earthworms into their casts. Tomati *et al.* (1988) clearly stated the influence of microbial, hormones like substances on the plant metabolism, growth and development by vermicompost. The result of the present study goes in agreement with the findings of Aruna and

NassaReoldy (1999) in *Soyabean* and in *Capsicum*sps.

Nazari *et al.* (2008) reported that the application of compost media is an integral element for improving growth, flowering and development of plants. Application of vermicompost in soil increases enzyme activities such as urease, phosphomonoesterase, phosphodiesterase and arylsulphatase (Albiach *et al.,* 2000). Plant growth promoting bacteria directly stimulate the growth by nitrogen fixation, solubilisation of nutrients, antagonizing pathogenic fungi by production of siderophores, chitinase, B-1-3-glucanase, antibiotics and cyanide (Han *et al.,* 2005).

The present study showed a remarkableincrease in root and shoot length in plantstreated with vermicompost. Similar result was reported by Packiaraj and Venkataraman (1991) who found that the addition of coir waste increased the height of rice plants and Liyanage *et al.* (2005) found that the application of coir dust and coconut husk to coconut resulted in greater number and weight of roots.

Hence the present study clearly indicated that the application of vermicompost and leaf moldcompost had a significant influence on various morphological parameters. Addition of vermicompost to soil increased nutrient content in the substrate and gave higher concentrations of P, Ca, Mg, Cu, Mn and Zn in shoot tissues of red clover and cucumber (Sainz *et al.,* 1998). Further, Kumari and UshaKumari, 2002 reported that enriched vermicompost was a better treatment for enhancing the uptake of N, P, K, Ca and Mg by Cowpea. Thus nutrient uptake enhancement aided through vermicompost, increase the growth of plants. Vermicompost are comprised of large amount of humic substances some of the effects of which on plant growth are similar to those of soil-applied plant growth regulators (Muscolo *et al.,* 1999). Aracnon *et al.,* (2006) reported that enhanced availability of plant growth influencing substances produced by microorganisms in vermicompost were factors considered to have contributed to increased fruit yield in peppers. These findings support our observations that vermicompost significantly enhanced the growth of the plants and also increases the microbial diversity of vermicompost applied soil.

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# NUTRITIVE EVALUATION AND PHYTOCHEMICAL COMPOSITION OF UNDERUTILIZED INDIGENOUS EDIBLE FRUITS OF VELLIANGIRI HILLS, COIMBATORE DISTRICT

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## ABSTRACT

The study was aimed to explore the nutritional status of 5 indigenous edible fruits *viz*., *Ziziphus jujuba, Limonia acidissima, Ziziphus oenoplia, Phyllanthus emblica* and *Ficus racemosa* along with their phytochemical profile. Phosphorous content was determined using indophenol blue method; K, Ca, Mg, Fe and Zn contents were determined using atomic absorption spectrophotometer. Qualitative and quantitative estimations were carried out using standard procedures. In the present study, all the investigated samples presented substantial amount of P, Ca, Mg, Fe and Zn content. The qualitative analysis revealed the presence alkaloids, phenols and flavonoids in all the five investigated samples. However, tannins were detected only in *Limonia acidissima* and *Ficus recemosa*; whereas steroids were absent in *Limonia acidissima* and *Phyllanthus emblica.* The quantitative analysis also exhibited appreciable amount of phenolic (47 to 85 mg GAE/g sample) and flavonoid contents (12 to 61 mg RE/g sample). Thus the study confirmes that wild edible fruits investigated are a promising source of essential nutrients such as P, K, Ca, Zn, Mg and Fe. Phytochemical study also confirmed the presence of the adequate quantities of secondary metabolites of medicinal importance thus exemplifies therapeutic values.

**Keywords:** Edible fruits, nutritive evaluation, phytochemcial contents.

## 1. INTRODUCTION

Plants have been of great importance due to their nutritive value and continue to be a major source of medicine. 30 to 40% of today's conventional drugs employed in herbal supplements as botanicals, nutraceuticals, drugs are emerged from the curative properties of various plant species. Caloric requirements to meet the demand are also comparatively high. Therefore, plant materials form a major portion of the diet and so evaluation of their nutritive value is very important.

Many wild fruits notably Amla, Harida, Bel, Elephant apple have been exploited from wild for centuries across Indian subcontinent on account of its food and medicinal properties. The therapeutic efficacy of many indigenous plants for various diseases has been described by traditional herbal medicinal practitioners. Some wild plants have been identified to have better nutritional value than the cultivated ones. As a result, in recent years, a growing interest has been emerged to evaluate various wild edible plants for their nutritional features. The medicinal importance of fruit is due to the presence of some bioactive components such as alkaloids, glycosides, resins, volatile oils, gums, tannins, etc.

The wild edible species are gathered mostly for home consumption mainly by forest dwellers, tribal and marginalized rural communities. But information on edibility and therapeutic properties of wild fruits is scanty and data on their nutritional composition is also negligible. Therefore, the present study was adressed to explores the nutritional status of five indigenous edible fruits *viz*., *Ziziphus jujuba, Limonia acidissima, Ziziphus oenoplia, Phyllanthus emblica* and *Ficus racemosa* along with their phytochemical profiles such as phenolics, tannins and flavonoids.

## 2. MATERIALS AND METHODS

### *2.1. Sample collection and preparation*

Wild edible fruits of *Ziziphus jujuba, Limonia acidissima, Ziziphus oenoplia, Phyllanthus emblica* and *Ficus racemosa* were collected during the month of November- December, 2014 from Velliangiri hills, Poondi, Coimbatore. The authenticity of the selected plant species were confirmed by comparing with the reference specimens preserved at Botanical Survey of India, Southern Circle, Coimbatore. The fruits from respective species were cleaned, washed with copious amount of distilled water, shade dried, chopped into bits, and coarsely powdered in a Willy mill to 60 mesh.

*2.2. Preparation of crude plant extracts*

50g of coarsely powdered plant samples were subjected to ethanol (w/v) extraction at a controlled temperature using soxhlet apparatus. The extracts were concentrated to dryness under reduced pressure using rotary vacuum evaporator (supervac R-185, India), lyophilized to remove traces of water molecules and were stored at -20$^{o}$C for further studies.

*2.3. Sample analysis*

Phosphorus(P) was determined by Indophenol blue method; while, Potassium (K), Calcium (Ca), Magnesium (Mg), Iron (Fe) and Zinc (Zn) contents were determined using atomic absorption spectrophotometer (Biricik and Baroglu, 2006; Kazankaya *et al.,* 2008).

*2.4. Qualitative analysis of the extracts*

The concentrated extracts were subjected to qualitative tests for the identification of various phytochemical constituents *viz*., alkaloids, phenols, flavonoids, tannins and steroids as per standard procedures (Harborne, 1984; Trease and Evans, 1989; Sofowora, 1993).

*2.5. Quantification of non-enzymic antioxidants*

*2.5.1. Total phenolics and tannins*

The total phenolic content of the plant extracts were determined using Folin-Ciocalteu reagent according to the method described by Siddhuraju and Becker (2003). In this method, 20 µg of the extract (dissolved in the respective solvent) was taken in a test tube and made upto the volume of 1.0 ml with distilled water. Then 0.5ml of freshly prepared Folin-Ciocalteu phenol reagent (1:1) with water and 2.5ml of 20% sodium carbonate solution were added sequentially in each tube. The mixtures were agitated and left in dark at laboratory temperature for 40 min for the development of colour. The absorbance was recorded at 725nm against the reagent blank using spectrophotometer (Shimadzu-UV-160 Japan). A calibration curve of gallic acid was constructed, and linearity was observed in the range of 10-50µg/ml. Using the standard curve, the total phenol content of the extract was calculated and expressed as Gallic Acid Equivalents (GAE mg/g extract). Using the same extract, tannin content was estimated after treatment with polyvinyl polypyrrolidone (PVPP) as described by Siddhuraju and Manian (2007). 100mg of PVPP was weighed in a 100x12 mm test tube and to this, 1ml distilled water and 1ml of tannin containing phenolic extract was added. The contents were vortexed and kept at 4$^{o}$C for 15 mins. Then the sample was centrifuged (5000rpm for 10 mins at laboratory temperature) and the supernatant was collected. This supernatant has only simple phenolics other than tannins (the tannins would have been precipitated along with the PVPP). The phenolic content of the supernatant was measured as monitored above and expressed as the content of free phenolics on a dry matter basis. From the above results, the tannin content of the extract was calculated as follows:

Tannin = Total phenolic - Free phenolics

*2.5.2. Total flavonoid content*

The total flavonoid content was determined spectrophotometrically using the method adopted by Zhishen *et al.*(1999). 0.5ml of appropriately diluted extract solution was mixed with 2ml of distilled water and subsequently with 0.15ml of 5% sodium nitrate solution and maintained for 6mins. Then, 0.15 ml of 10% aluminium chloride solution was added and allowed to stand for 6mins, and finally 2 ml of 4% sodium hydroxide solution was added. Final volume of the content was made upto 5 ml with distilled water and were mixed thoroughly. After 15mins of incubation at laboratory temperature, the absorbance was determined against blank at 510nm. The total flavonoid content was determined using a standard curve with rutin. The mean of the three values were expressed as milligrams of rutin equivalents (mg RE/g extract) on a dry weight basis.

## 3. RESULTS

The elemental mineral contents of five different wild edible fruits such as *Ziziphus jujuba, Limonia acidissima, Ziziphus oenoplia, Phyllanthus emblica* and *Ficus racemosa* were attempted and depicted in Table 1. Results revealed that Potassium (K), Iron (Fe), Calcium (Ca), Magnesium (Mg), Phosphorus (P) and Zinc (Zn) contents varied widely between plant samples analyzed. In the present study, potassium content ranged between 0.012 and 0.278 mg/g dried sample. However, among the samples investigated, *Ficus racemosa* (0.278mg/g) fruit registered high levels of potassium content followed by *Limonia acidissima* fruit (0.185mg/g); on the other hand, *Ziziphus jujuba* fruit (0.012mg/g) recorded very low content of potassium (Table 1).

Concentration of calcium in various wild edible fruit samples were analysed and presented in Table 1. It was in the range of 0.096 and 0.176 mg/g. *Phyllanthus emblica* (0.0176mg/g) fruit contained

the highest levels of calcium content followed by *Ziziphus jujuba* (0.151mg/g) and *Ficus racemosa* (0.119mg/g) fruit; whereas *Limonia acidissima* fruit (0.096 mg/g) displayed very low content of calcium. Similarly in all the wild edible fruits tested, *Ziziphus oenoplia* fruit (0.192 mg/g) displayed relatively higher amount of magnesium followed by *Phyllanthus emblica* fruit (0.154 mg/g); while *Ficus racemosa* fruit (0.09 mg/g) and *Ziziphus jujuba* fruit (0.039 mg/g) broadly arrayed very low values.

The iron content of 5 different wild edible fruit samples *viz*., *Ziziphus jujuba, Limonia acidissima, Ziziphus oenoplia, Phyllanthus emblica* and *Ficus racemosa* were examined and their results were presented in Table 1. Obviously, it was observed that all the samples investigated displayed remarkably appreciable amount of their contents (Table 1). Additionally, *Ziziphus jujuba* (7.11 mg/g) followed by *Phyllanthus emblica* (4.26 mg/g) and *Ficus racemosa* (2.68 mg/g) fruits were found to have markedly higher amount of their contents than that of the other said samples investigated.

**Table 1. Proximate composition of wild edible fruits.**

| S.No. | Sample | Potassium (K) mg/g | Calcium (Ca) mg/g | Magnesium (Mg), mg/g | Iron (Fe) mg/g | Zinc (Zn) mg/g | Phosphorus (P) mg/g |
|---|---|---|---|---|---|---|---|
| 1 | *Ziziphus jujuba* | 0.012 | 0.151 | 0.039 | 7.11 | 0.105 | 0.049 |
| 2 | *Limonia acidissima* | 0.185 | 0.096 | 0.147 | 0.32 | 0.072 | 0.054 |
| 3 | *Ziziphus oenoplia* | 0.023 | 0.103 | 0.192 | 0.823 | 0.067 | 0.025 |
| 4 | *Phyllanthus emblica* | 0.104 | 0.176 | 0.154 | 4.26 | 0.056 | 0.019 |
| 5 | *Ficus racemosa* | 0.278 | 0.119 | 0.090 | 2.68 | 0.126 | 0.095 |

**Table 2. Qualitative phytochemical analysis of wild edible fruits.**

| S.No. | Sample | Secondary metabolites | | | | | |
|---|---|---|---|---|---|---|---|
| | | Alkaloids | Tannins | Phenols | Flavonoids | Steroids | Terpenoids |
| 1 | *Ziziphus jujuba* | +++ | - | +++ | +++ | + | - |
| 2 | *Limonia acidissima* | +++ | + | +++ | ++ | - | +++ |
| 3 | *Ziziphus oenoplia* | ++ | - | ++ | - | + | ++ |
| 4 | *Phyllanthus emblica* | +++ | - | +++ | ++ | - | ++ |
| 5 | *Ficus racemosa* | +++ | + | ++ | +++ | ++ | ++ |

+++ indicate high degree of presence, ++ indicate moderate degree of presence, + indicate low degree of presence and - Indicate the absence.

**Table 3. Phenolic, tannins and total flavonoid contents of wild edible fruits.**

| S.No. | Sample | Total phenolics (mg GAE/g sample) | Tannins (mg GAE/g sample) | Total Flavonoids (mg RE/g sample) |
|---|---|---|---|---|
| 1 | *Ziziphus jujuba* | 47 | 15 | 41 |
| 2 | *Limonia acidissima* | 52 | 19 | 61 |
| 3 | *Ziziphus oenoplia* | 65 | 16 | 45 |
| 4 | *Phyllanthus emblica* | 72 | 19 | 33 |
| 5 | *Ficus racemosa* | 85 | 32 | 12 |

GAE – Gallic Acid Equivalents; RE – Rutin Equivalents

In the present study, the zinc content for the 5 different wild edible fruits were determined and presented in Table 1. However among the samples analyzed, *Ficus racemosa* (0.126 mg/g) and *Ziziphus jujuba* (0.015 mg/g) fruits unveiled higher contents. On the other hand, *Phyllanthus emblica* (0.056 mg/g) fruit displayed very low content of Zinc. Similarly among the samples examined, *Ficus racemosa* (0.095 mg/g) exhibited substantial amount of phosphorous content followed by *Limonia acidissima* (0.054 mg/g) fruit. In contrast, *Phyllanthus emblica* (0.019 mg/g) fruit determined significantly very low content of Phosphorus (Table 1).

*3.1. Preliminary qualitative phytochemical analysis*

In the present study, the presence of various secondary metabolites such as alkaloids, tannins, flavonoids, phenols, steroids and terpenoids in wild edible fruits of *Ziziphus jujuba, Limonia acidissima, Ziziphus oenoplia, Phyllanthus emblica* and *Ficus racemosa* were attempted and presented in Table 2. The study revealed that among the samples examined, *Ziziphus jujuba, Limonia acidissima, Ziziphus oenoplia, Phyllanthus emblica* and *Ficus racemosa* fruit registered the presence of a variety of secondary metabolites such as phenols, alkaloids, flavonoids and terpenoids with high degree of prevalence (Table 2). While comparatively very low levels of tannins were detected in *Limonia acidissima* and *Ficus racemosa*; whereas in case of *Ziziphus jujuba, Ziziphus oenoplia* and *Phyllanthus emblica* fruit, tannins were not detected. On the other hand, steroids were present only in trace amount in the investigated samples (Table 2) and it was absent in *Limonia acidissima* and *Phyllanthus emblica* fruit.

*3.2. Quantification of Phenolics, Tannins and Flavonoids*

Using Folin-Ciocalteu's reagent, amount of total phenolic constituents for the wild edible fruits viz., *Ziziphus jujuba, Limonia acidissima, Ziziphus oenoplia, Phyllanthus emblica* and *Ficus racemosa* were estimated and presented in Table 3. The amount of total phenolic and tannin contents were varied widely between 47 mg GAE/g and 85 mg GAE/g sample, respectively. In particular, *Ficus racemosa* (85 mg GAE/g sample ) and *Phyllanthus emblica* (72 mg GAE/g samples) fruits exhibited appreciable amount of polyphenolic contents. Similarly, the total phenolic content varied considerably between 12 mg GAE/g and 61 mg GAE/g of dried samples. Among the investigated samples, *Limonia acidissima* registered high flavonoid contents(61 mg RE/g of dried sample) followed by *Ziziphus oenoplia* fruit (45mg RE/g of dried sample). Whereas, *Ficus racemosa* fruit (12 mg RE/g of dried sample), registered minimal levels of total flavonoid contents being detected under the experimental conditions tested.

**4. DISCUSSION**

Wild edible fruits offer tremendous application as they can be used as food and medicines besides their key ecological roles. It represents one of the world's greatest untapped resources of nutrition and palatable food of the future. They generally possess most of the attributes of nutritious food as they contain many essential nutrients and antioxidants in good quantity. Therefore proximate and nutrient analysis of wild edible fruits play a crucial role in assessing their nutritional significance. As various medicinal plant species are also used as food along with their medicinal benefits, evaluating their nutritional significance can help to understand the worth of these plant resources.

Despite such claims, in the present investigation, an attempt has been made to explore underutilized indigenous edible fruits of Velliangiri hills for their nutritive and phytochemical evaluation. In the present study, the average values of the nutritive elements present in various edible fruits were presented in Table 1. The results of the nutritional profile of wild edible fruits viz., *Ziziphus jujuba, Limonia acidissima, Ziziphus oenoplia, Phyllanthus emblica* and *Ficus racemosa* revealed that alll the samples investigated determined high calories of nutritive value (Table 1) and thus are considered as an excellent source for human consumption.

In elemental compositional analysis, among the samples investigated, *Ficus racemosa* fruit is considered as a good source of nutrition as they possess high content of K, Zn and P (Table 1). Similarly, the fruits of *Ziziphus jujuba* and *Ziziphus oenoplia* also registered high content of Fe and Mg.

Anandakumar *et al.* (2009) reported that the presence of secondary metabolites like alkaloids, phenols, flavonoids, steroids, glycosides and saponins in plants is the basic character for their medicinal properties. The species with high content of alkaloids and flavonoids generally indicate that they are medicinally important for the treatment of diuretic, antispasmodic, antiseptic and antidote actions (Jeeshna *et al.,* 2010). High phenolic content generally have antibacterial and antiviral activities. Flavonoids, on the other hand are potent water-soluble antioxidant and free radical scavengers which prevent oxidative cell damage and have strong anticancer activity (Paulsamy and Jeeshna, 2011). Considering the above facts, the presence of all these compounds in the investigated sampes (Table 2), thus justifies its medicinal claims. The difference in chemical contents of fruits observed in this study could be due to genetic differences (Beyhan *et al.,* 2011).

Phenolic compounds are an important group of secondary metabolites, which are synthesized by plants for protection against predators. In the present study, the contents of total

phenolics and tannin contents varied widely between 47mg GAE/g and 85 mg GAE/g sample; 15 mg GAE/g and 32 mg GAE/g respectively. The observed variation might be due to the marked difference in the qualitative and quantitative composition of phenolic compounds and their conjugates present in these extracts. However among the samples investigated, *Ficus racemosa* fruit registered substantial amount of active compounds which might offer a good source of nutritional antioxidant defence against reactive oxygen species involved in the initiation of deleterious free radical reaction (Thenmozhi *et al.,* 2012).

Flavonoids, the most wide spread group of natural compounds occur naturally in a wide range of plant species. They are phenolic derivative present in substantial amount in plants. In the present study, the total flavonoid content varied considerably between 12mgRE/g and 61mgRE/g of dried sample. Food derived flavonoids, especially flavonols (kaempferol and quercetin) are widely occurring flavonoids are known to possess multiple biological functions such as antioxidant, antiartherogenic, antiallergic, cardioprotecive and vasodialatory effects (Thenmozhi *et al.,* 2012).

## 5. CONCLUSION

Based on the active profile exposed, *Ziziphus jujuba, Limonia acidissima, Ziziphus oenoplia, Phyllanthus emblica* and *Ficus racemosa* have revealed that these plants are a good source of nutrients and can be used as a substrates deficient in either of these nutrients. The study also confirmed the therapeutic value and furthermore its folklore medicinal value in the presence of adequate amount of secondary metabolites such as phenolics, tannins, sterols, flavonoids and terpenoids. The present investigation has opened up a new arena of using this wild edible fruits with nutraceutical perspective in the field of drug development. Therefore, assessment of antioxidant properties might be a fruitful approach for advocating them in the field of nutraceuticals and therapy.

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# ANTIMICROBIAL EFFICACY OF THE FOLKLORE MEDICINAL PLANT, *ACACIA CAESIA* (L.) WILD

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## ABSTRACT

Leaf extracts of the folklore plant species, *Acacia caesia* L. by using three alcoholic solvents *viz;* petroleum ether, ethyl acetate and methanol were tested against ten human pathogenic bacteria *viz*., *Pseudomonas aeruginosa, P. stutzeri, Escherichia coli, Micrococcus* sp., *Lactobacillus* sp*., Servatia* sp., *Moraxetta* sp., *Bacillus subtilis*, *B. thuriengensis*, and *Klebsiella pneumoniae* and ten human pathogenic fungi *viz., Aspergillus niger, A. flavus, A.baumannii, Fusarium oxysporum, F. solani, Mucor rouxii, Alternaria alternata, Candida albicans, Cladosporium* sp. and *Rhizopus* sp*.* for assessing the antimicrobial properties by adapting disc diffusion method. The results of the study revealed that all extracts showed varied degree of antimicrobial activity against the tested pathogens. However, the ethyl acetate extracts exhibited higher inhibition zone (15.73 mm) against the bacterium, *Bacillus subtilis* and the fungus, *Mucor rouxii* (20.67 mm). These results support the therapeutic importance of the species, *Acacia caesia* in curing infectious diseases and encourage the extensive use of this species in health care practices.

**Keywords:** Medicinal plant, *Acacia caesia*, Antimicrobial activity, Microorganisms.

## 1. INTRODUCTION

Located in a tropical belt, India is endowed with a rich wealth of fauna and flora with inumerous medicinal plants. These plants have made a good contribution to the development of ancient Indian Materia Medica. One of the earliest treatises on Indian medicine, the Charaka Samhita (1000 B.C), records the use of over 340 drugs of vegetable origin (Pullaih, 2006). Most of these continue to be gathered from wild plants to meet the demand of the medical profession. India, in particular, has a big scope for the development of the pharmaceutical and phytochemical industry. Traditionally different parts of several medicinal plants or their extracts are used in treatment of various diseases in India (Balakrishnan *et al.,* 2006). Among them, many species of *Acacia* are found to have diverse photochemical compounds of medicinal properties (Lee *et al.,* 2000; Readel *et al.,* 2001; Seo *et al.,* 2002; Sathishkumar *et al.,* 2009). *Acacia caesia* L. belongs to the family, Mimosaceae is one such folklore plant used in traditional system of medicine in Coimbatore district of Tamil Nadu, India. It is an armed woody shrub occurring throughout the tropical and sub-tropical regions of India (Krishnamurthy, 1993). This plant species has been used as a folk remedy for the treatment of skin diseases, asthma, bronchitis, scabies, cold, menstrual disorders and antiseptic also. The leaves of this plant are used as vegetable and the powdered bark and pod are used as substitute for soap and their decoctions as lice killer (Thammanna, 1990). Woody branches of this species are used as tooth brushes by tribal folk and the shrub is used as fuel wood. However, no published works are available for the antimicrobial property of leaf part of this plant. Hence in the present study, an attempt has been made to focus the plant in this angle and hence to assess its therapeutic potency.

## 2. MATERIALS AND METHODS

### *2.1. Plant material*

Fresh leaf parts were collected from the population of *A. caesia* present in the Maruthamalai Hills of Coimbatore District and washed under running tap water, air dried and then homogenized to fine powder and stored in air tight bottles.

### *2.2. Preparation of extracts*

250g air-dried leaf powder was subjected to 250ml of methanol in soxhlet extraction for 8 hours (50-85$^0$C). The extracts were concentrated to dryness in a flask evaporator under reduced pressure and controlled temperature (50-60$^0$C) to yield crude residue, which was then stored in refrigerator. To obtain petroleum ether and ethyl acetate extracts, the same method as used to obtain methanol extract was adopted.

### *2.3. Media used*

Freshly prepared nutrient agar medium and PDA medium were used for the culture of bacteria and fungi respectively.

*2.4. Microorganisms*

*In vitro* antimicrobial activity was examined for the chemical extracts of leaf part of the study plant, against ten bacterial species which include the gram positive strains *viz*., *Micrococcus* sp., *Lactobacillus* sp., *Bacillus subtilis*, *B. thuriengensis* and gram negative strains *viz., Pseudomonas aeruginosa, P. stutzeri, Escherichia coli, Klebsiella pneumoniae, Servatia* sp. and *Moraxetta* sp. and fungal species *viz., Aspergillus niger, A. flavus, A. baumannii*, *Fusarium oxysporum, F. solani, Mucor rouxii, Alternaria alternata, Candida albicans, Cladosporium* sp. and *Rhizopus* sp*.* All these microorganisms were obtained from the Department of Microbiology, Tamil Nadu Agricultural University, Coimbatore. All the microorganisms were maintained at $4^0$C on nutrient agar slants (for bacteria) and PDA slants (for fungi) until further use.

*2.5. Antimicrobial assay*

The alcoholic extracts were tested for their effect against the growth of pathogenic bacteria and fungi by disc diffusion method (Bauer *et al.,* 1966). Both the organisms, bacteria and fungi tested were inoculated into nutrient agar and PDA media respectively. After an incubation period of 24 hrs at a temperature of 35°C, three or four colonies isolated from these media were inoculated into 4ml of nutrient broth and incubated for 2 hrs at 35°C. The cultures were adjusted with sterile saline solution to obtain turbidity. Petri dishes containing Muller-Hinton agar medium and PDA medium were streaked with these microbial suspensions of bacteria and fungi respectively. Disks of 6mm diameter were impregnated with the extracts of petroleum ether, methanol and ethyl acetate separately. Tetracycline is used as positive control. After equilibrium at 4°C, the plates were incubated overnight at 37°C and the diameter of any resulting zones of inhibition was measured. Each experiment was repeated at least three times.

## 3. RESULTS AND DISCUSSION

The antibacterial activity of the all the alcoholic leaf extracts of the study species, *Acacia caesia* generally showed inhibitory activity against the growth of *Bacillus thuringiensis* and *Lactobacillus* sp. However, towards *Pseudomonas aeruginosa, P. stutzeri, Escherichia coli, Micrococcus* sp., *Serratia* sp., *Moraxetta* sp., *Bacillus subtilis* and *Klebsiella pneumoniae,* all these extracts showed activity with less pronounced manner (Table 1). It is explained that the different phytochemicals like steroids, cardiac glycosides, anthraquinone, flavonoids and phenolics extracted by different solvents may be responsible for their antibacterial effects (Tambekar and Khante, 2010). Further, the ethyl acetate extract has determined to have highest inhibitory activity (15.73 mm diameter inhibitory zone) against the bacterium, *Bacillus subtilis* (gram positive) and (14.83 mm diameter inhibitory zone) against the bacterium, *B. thuringiensis* followed by the methanol extract against the bacterium, *Escherichia coli,* (gram negative) (12.43 mm diameter inhibitory zone). It indicates the presence of effective active principle compounds in the ethyl acetate and methanol extracts of leaf part of *A. caesia* to suppress both gram negative and gram positive bacteria. It has been observed further that the ethyl acetate extracts showed significantly higher inhibitory activity against the colonial growth of *Bacillus subtilis* and *B. thuringiensis* than that of the commercially available antibiotic, tetracycline. This fact shows the higher therapeutic potential of ethyl acetate extract of the study species. The petroleum ether extract has comparatively less activity against most of the tested pathogens. It may be attributed to the presence of respective active compounds with insufficient quantities in this crude extract (Taylor *et al.,* 2001).

The antifungal activity of various alcoholic leaf extracts of the study species, *Acacia caesia* against the ten studied fungal species is given in Table 2. The results of the study report that the ethyl acetate extract has the highest inhibitory activity (20.67 mm diameter inhibitory zone) against the fungus, *Mucor rouxii*. The petroleum ether and methanol extracts were also found to be better with respect to inhibitory function against the two fungal species, *Mucor rouxii* and *Rhizopus* sp*.* (17.73 and 16.75 mm diameter inhibitory zone respectively).

This fact indicats the existence of strong antifungal activity of leaf part of the study species, *A. caesia* and hence its effective healing property against the infectious diseases. The variation in antifungal activity across the extracts studied may be due to the polarity of the solvents used. Significantly higher inhibitory activity of ethyl acetate extract is nearly to the commercially available antibiotic tetracycline against the fungus, *Mucor rouxii* observed shows the superior healingness of leaf part of *A. caesia.* Proper isolation and purification of active compounds by using ethyl acetate solvent would ensure the therapeutic value of this folklore medicinal plant when it will be used commercially.

**Table 1. Antibacterial activity of certain alcoholic leaf extracts of the species, *Acacia caesia*.**

| Plant extract | Diameter of zone inhibition (mm) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Gram positive bacteria | | | | Gram negative bacteria | | | | | |
| | BS | BT | MC sp. | L sp. | KP | EC | PS | PA | S sp. | M sp |
| Standard* | 8.53 ± 0.56 | 8.33 ± 0.35 | 22.43 ± 0.40 | 24.03 ± 0.45 | 15.43 ± 0.44 | 30.43 ± 0.40 | 12.73 ± 0.46 | 26.61 ± 0.54 | 14.93 ±0.31 | 8.87 ±0.42 |
| Petroleum ether | - | 12.76 ± 0.62 | - | 8.07 ±0.55 | - | - | - | - | - | - |
| Ethyl acetate | 15.73 ± 0.70 | 14.83 ± 0.80 | - | 8.03 ± 0.44 | 8.03 ± 0.15 | 12.17 ±0.35 | 7.76 ±0.70 | - | - | - |
| Methanol | - | 9.07 ± 0.21 | 9.07 ± 0.46 | 7.43 ±0.59 | 11.93 ± 0.40 | 12.43 ± 0.45 | 8.03 ±0.25 | 8.73 ± 0.67 | 9.03 ±0.25 | 12.07 ±0.40 |

BS - *Bacillus subtilis;* BT - *B. thuringiensis;* MC sp. - *Micrococcus* sp.; L sp. - *Lactobacillus* sp.; KP - *Klebsiella pneumoniae;* EC - *E. coli;* PS - *Pseudomonas stutzeri;* PA - *P. aeruginosa;* S sp. - *Serratia* sp.; *M sp.* - *Moraxetta* sp.
* Tetracycline

**Table 2. Antifungal activity of certain alcoholic leaf extracts of the species, *Acacia caesia*.**

| Plant extract | Diameter of zone inhibition (mm) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | AN | AF | AB | FO | FS | MR | AA | CA | C sp. | R sp. |
| Standard * | 35.23 ± 0.59 | 38.17 ± 0.67 | 33.63 ± 0.65 | 32.73 ±0.67 | 25.73 ± 0.67 | 27.63 ±0.57 | 30.67 ± 0.59 | 16.03 ± 0.15 | 13.67 ± 0.65 | 36.67 ± 0.59 |
| Petroleum ether | 8.23 ± 0.49 | - | - | - | 8.13 ±0.70 | 17.73 ±0.67 | - | - | - | - |
| Ethyl acetate | 15.73 ±0.67 | 12.67 ± 0.61 | 10.77 ± 0.70 | 12.77 ±0.71 | 10.67 ± 0.65 | 20.67 ±0.61 | 10.73 ±0.67 | 10.76 ± 0.80 | - | 12.67 ±0.59 |
| Methanol | 14.77 ± 0.70 | 9.17 ± 0.38 | 10.83 ± 0.80 | 10.67 ± 0.65 | - | 15.70 ±0.66 | 8.67 ±0.65 | 8.27 ± 0.55 | 8.03 ±0.91 | 16..75 ±0.73 |

AN - *Aspergillus niger;* AF - *A. flavus;* AB - *A. baumanii;* FO - *Fusarium oxysporum;* FS - *F. solani;* MR - *Mucor rouxii;* AA - *Alternaria alternate;* CA - *Candida albicans;* C sp. - *Cladosporium* sp.; R sp. - *Rhizopus* sp.
* Tetracycline

The overall study on antimicrobial activity reports that the study species contains adequate variety of active compounds to reduce or check the growth of microbial colonies. It confirms the therapeutic value and hence the traditional usage of the leaf part of the study species, *A. caesia* against various ailments. Further, the alcoholic extracts of leaf part of this plant in general and ethyl acetate and methanol extracts in particular are suggested for the therapy of infectious diseases caused by pathogens and further studies are recommended to purify the active compounds for the formulation of new drugs, while go for commercialization.

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# ALLELOPATHIC POTENTIAL OF WEED SPEICES *AGERATUM CONYZOIDES* L. AND *CLEOME VISCOSA* L. ON GERMINATION AND GROWTH OF *SESAMUM INDICUM L.*

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## ABSTRACT

Various concentrations (5%, 10%, 15% and 20%) of aqueous extracts prepared from two weed species namely *Ageratum conyzoides* L. and *Cleome viscosa* L. and used for the present experiments to determine their allelopathic potential on growth and developmental changes on *sesame* (*Sesamum indicum* L.*)*. The weed extracts showed an inhibitory effect on germination percentage, root and shoot growth, and fresh and dry weight of *sesame* seedlings. The extracts of *A.conyzoides* had more inhibitory effect at 20%concentration,than that of *C.viscosa* on growth parameters of *sesame*.

**Keywords:** Allelopathic potential, *Ageratum conyzoides, Cleome viscosa*, Sesame.

## 1. INTRODUCTION

Allelopathy generally refers to the detrimental effects of higher plants of one species (the donor) on the germination, growth or development of plants of another species (the recipient) (Narwal, 1994). Molisch (1937) coined the term allelopathy from two Greek words, where allelon means 'to each other' and pathos means 'to suffer'. In natural or man managed agro-ecosystems, neighboring plants may interact with the growth and development of other species. Muller (1969) suggested the term interference for the overall influence of one plant (including microorganisms) on another. In agro ecosystems, several weeds, crops, agroforestry trees and fruit trees have been shown to exert allelopathic influence on the crops, thus affecting their germination and growth adversely (Kohli *et al.,* 1998). Allelopathy plays a key role both in natural and managed ecosystems. Eventhough allelopathy includes both positive and negative effects of one plant on the other; most of the studies seem to focus only on its deleterious impacts alone.

In agriculture, the inhibitory effect of weed species on germination and growth of crops has been attributed to phytotoxic chemicals released from the leaf litter and roots. Further, Rice (1974) observed that many species of weeds produce toxins that are inhibitory to other weeds, crops and often to themselves**.** The regular irrigation to the crop fields and natural rain, which are leachates the inhibitory substances of weed biomass in the root zone of crops impairs the germination and growth of cereals, millets and other crops (Jha and Sen,1985). If the weed parts containing water soluble allelochemicals, it is likely that crop seedlings would be subjected to growth inhibition.The objectives of this research were to assess the impact of two weed species *Ageratum conyzoides* L. and *Cleome viscosa* L. on growth and development of sesame (*Sesamum indicum* L.) under green house study.

## 2. MATERIALS AND METHODS

The preparation of aqueous weed extracts and germination studies were followed as per the methods of Padhy *et al.* (2000) and Bhatt and Chauhan (2000).The collected fully matured weed species of *Ageratum conyzoides* L. and *Cleome viscosa* L. were air dried, ground to fine powder and extracted in water. Twenty grams of ground weed material was soaked in one litre of distilled water and kept 48 hours at room temperature with occasional shaking. The infusion was decanted and filtered through three layers of Whatman No.1 filter paper. From this weed extracts (20%) further dilutions of 15,10 and 5% were prepared with distilled water. The selected seeds of sesame cv.TKM-1 were surface sterilized with 0.03% formalin solution for 20 min. and then washed thoroughly with distilled water (DW). For the germination study 15 seeds were sown in earthen pots(15cm x 30cm) filled with 3.5kg of normal garden soil. Equal quantity of weed extracts/DW was irrigated to all the pots on 0,3, 6, 9, 12 and 15 days after seed sown. Each treatment including control was replicated five times. The number of seeds germinated in each treatment was counted daily up to $10^{th}$ day after sowing, and germination percentage was calculated. The emergence of radicle was taken as criteria for germination. Five seedlings

from each replicate was selected for recording the morphological parameters such as length of shoot and root, fresh and dry weight on 15th day after sowing.The mean data was statistically analysed by ANOVA at P<0.5%.

## 3. RESULTS AND DISCUSSION

Aqueous weed extracts of *A. conyzoides* and *C. viscosa* caused a significant inhibition on the germination of sesame seeds over control. The intensity of inhibition differed depending upon the concentration and weed species. As the concentration of the weed extracts increased the degree of inhibition on germination percentage was increased (Table 1). The extracts of both the weed species significantly affected the germination percentage of sesame more at their higher concentration (20%) and the effect was more intense by the extracts of *A.conyzoides* than *C.viscosa*. The reduction on the shoot and root length and biomass content of sesame seedlings (Table 2) was more by *A.conyzoides* than *C.viscosa* extract treatments. As the concentration increased, the seedling growth and seedling fresh and dry weight decreased. Similar results were obtained by Alsaadawi and Salih (2009), in which, they reported the root exudates of *C. rotundus* significantly reduced the root and shoot growth of tomato and cucumber plants. The reduction in the seedling growth and biomass production may be due to imbalance in water uptake or osmotic balance of the tissues for germination and growth by the allelochemical toxicity of the extracts (Blum *et al.,*1999).

**Table 1. Aqueous extracts of *A. conyzoides and C. viscosa* on seed germination and seedling length (cm/plant) of sesame.**

| Concentrations (%) | Germination % | | *A. conyzoides* | | *C. viscosa* | |
|---|---|---|---|---|---|---|
| | *A. conyzoides* | *C. viscosa* | Root length | Shoot length | Root length | Shoot length |
| Control | 98 | 96 | 13.3 | 8.0 | 13.3 | 8.0 |
| 5 | 84 (-14.3) | 86 (-11.6) | 12.8 (-3.7) | 7.5 (-6.2) | 13.0 (-2.2) | 7.3 (-3.9) |
| 10 | 74 (-24.5) | 75 (-21.8) | 10.7 (-19.5) | 7.0 (-12.5) | 11.0 (-17.3) | 6.8 (-10.5) |
| 15 | 60 (-38.7) | 62 (-35.4) | 8.8 (-33.8) | 5.0 (-37.5) | 9.0 (-32.3) | 5.4 (-29.0) |
| 20 | 54 (-45) | 58 (-39.5) | 4.7 (-64.6) | 3.5 (-56.2) | 5.0 (-62.4) | 3.6 (-52.6) |
| Average | 63 | 66 | 10.06 | 6.02 | 10.26 | 6.22 |
| F | 196.6897 | | RL-915.90, SL.263-84 | | | |

Data in parenthesis indicates % increase (+), decrease (-) over control.

**Table 2. Aqueous weed extracts of *A. conyzoides and C. viscosa* on the fresh and dry weight (mg/plant) of *sesame.***

| Concentrations (%) | *A. conyzoides* | | *C. viscosa* | |
|---|---|---|---|---|
| | Fr.Wt | Dry wt. | Fr.Wt | Dry wt. |
| Control | 80 | 18 | 80 | 22 |
| 5 | 74 (-7.5) | 15 (16.6) | 76 (-5.0) | 19 (-13.6) |
| 10 | 68 (-15.0) | 13.5 (-25) | 70 (-12.5) | 17 (-22.7) |
| 15 | 55 (-31.2) | 11 (-38.8) | 60 (-25.0) | 14 (-36.3) |
| 20 | 40 (-50) | 9.5 (-47.2) | 45 (-43.7) | 12 (-45.4) |
| Average | 63.4 | 16.8 | 66.2 | 13.4 |
| F | FW-77.87; DW-2.15 | | | |

Data in parenthesis indicates % increase (+), decrease (-) over control.

The fresh and dry weight decreased when increasing the concentrations (10%, 15%, 20%) of weed extracts. The result of Drost and Doll, (1980) favors the present findings, where the plant residues and tuber extracts of yellow nutsedge (*Cyperus esculentus* L.) inhibited the germination and growth of corn (*Zea mays* L.) and soybeans (*Glycine max* (L.) Merr.). Present results are also similar to the findings of Channappagoudar *et al.,(*2005).They reported that the extracts of *Cyperus rotundus* and *Commelina bengalensis* had an inhibitory effect on the germination, seedling length of wheat, green gram and soybean. The higher concentration of leaf, new shoot and old shoot extracts of *Tinospora cordifolia* inhibited the germination of *Sesamum orientala* and *Eleusine coacana.(*Bhupendra Singh *et al*.,2009).Asif Tanveer *et al*.,(2010) recorded the weed *Euphorbia helioscopia* caused an inhibition on growth and development of three crops *i.e.,* wheat, chickpea and lentil. The inhibitory effects may be due to the presence of higher amounts of growth inhibitory substances in the tuber extracts that were released during extraction.

The differential degree of inhibitory (5,10, 15 and 20%) effect on the growth of *sesame* may be due to the presence of allelochemicals at different concentration of both weed extracts. Verma *et al.,* (2002) found the extracts of *Cyperus rotundus* adversely inhibited the seed germination, seedling growth and biomass production of *Brassica* and tomato. Jeyasrinivas *et al.,*(2006) reported that the higher concentrations of *Trianthimum portulacastrum, Cyanodon doctylon* and *C.rotundus* leaf leachates inhibited the seed germination,shoot length, root length and drymatter production of pearmillet, cowpea, sesamum and cucumber. These results are coinciding with our present results. Many of the allelochemicals are water soluble substances released into the environment through leaching, root exudation, volatilization and decomposition of plant residues and are affected by several environmental factors (Reigosa *et al.* 1999). Akobundu (1987) listed factors such as soil temperature, soil moisture regime, alternate wetting and drying of soil, soil nitrate level among others as those that affect seed germination. These results are supported by the findings of Oke (1988) that siam weed extract inhibited the germination of seeds of cowpea, soybean and tridax.

Present findings are also agree with the results of Hussain *et al.,*(1992). They reported that *Imperata cylnidrica* reduced the early growth, fresh and dry weight of lentil. JaiKnox *et al*.,(2010) reported that *Cassia occidentalis*, *Rumex dentatus*, *Calotropis procera* and *Withania somnifera* inhibited germination and growth of *Parthenium hysterophorus.* The presence of inhibitory chemicals in higher concentrations of the extract might be the reason for differential behaviour of the extracts and causing maximum reduction in growth of the seedlings. Phytotoxicity of allelochemicals present in the weed extracts might be caused synergistic activity on the germination and growth of sesame seedlings rather than single chemical. The statistically observed significances are evident for the inhibitory effects of *A.conyzoides and C.viscosa* on the growth of sesame. The studies are further to be extended in field level experiments for exploring the impact of residues of *A.conyzoides and C.viscosa* on growth and yield attributes of sesame..

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# ALLELOPATHIC POTENTIAL OF *CYPERUS ROTUNDUS* L. *AND CYNODAN DACTYLON* L. ON GERMINATION AND GROWTH RESPONSES OF SOME RICE CULTIVARS

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## ABSTRACT

Weeds are enemies to the crop plants and have harmful effects on agricultural crops due to several factors such as competition for space, light and nutrients and allelopathy. In the present study,various concentrations (0,5,10,15,20 and 25%) of whole plant aqueous extractsof weeds, *Cyperus rotundus*L.*(* Purple nut sedge) and *Cynodan dactylon*(L.) Pers. (Bermuda grass) were tested for assessing their allelopathic potential on seed germination and seedling growth of some rice (*Oryza sativa* L.) cultivars i.e.ADT-36,BPT-5204 and IR-20 using pot culture experiments. The experimental results revealed that all the concentrations of both the weed extracts had inhibition on germination percentage, seedling length, number of,dry weight and chlorophyll contents of 15 day old seedlings of all the three rice cultivars and the inhibitory effect of the extracts was concentration dependent. However, at 5% of *C. rotundus* and10% of *C. dactylon* extracts did not affect seed germination of IR-20 . Among the rice cultivars,the higher degree of growth inhibition was observed in ADT-36followed by BPT-5204 and IR-20 . The weed *C.rotundus*exhibited more intense on growth suppression of rice cultivars than*C.dactylon.*

**Keywords:** Allelopathic potential, *Cyperus rotundus, Cynodan dactylon*, rice cultivars.

## 1. INTRODUCTION

Allelopathy is an important mechanism of plant interference by the addition of plant-produced phytotoxins to the plant environment. Many of the phytotoxic substances suspected of causing germination and growth inhibition have been identified from plant tissues and soil (Whittaker and Fenny, 1971). Allelopathy is of two types, one is true allelopathy and other is functional allelopathy. The true allelopathy is the release of substances that are toxic in the form in which they are produced in the plant. Functional allelopathy is the release of substances that are toxic or a result of transformation by micro-organism (Wittekar, 1999). According to Muller (1969) the term allelopathy refers to the overall influence of one plant on another, due to the chemical compounds being added to the environment. The phenomenon of allelopathy has reviewed a wide attention in the past three decades in India. Of the total annual loss of agricultural produce due to various pests in India, weeds account for 45%, insects 30%, diseases 20% and other pests, 5% (Rao, 1983). In crops field, weeds and crops mutually infer of each other, which may reduce the growth of one or both species.

Allelopathy can be the most effective form of interference during the juvenile stages of the susceptible plants and allelopathic interactions play a major role in the determining the distributions of plants in nature and yield of different crops(Fisher, 1980).Hence, in the present investigation an attempt has been made to study the allelopathic effect of *Cyperusrotundus L.* and *Cynodan dactylon* L. on seed germination and seedling growth of some rice (*Oryza sativa* L.) cultivars ie.ADT-36,BPT-5204 and IR-20.

## 2. MATERIALS AND METHODS

The preparation of aqueous weed extracts and germination studies were followed as per the methods of Padhy *et al.* (2000) and Bhatt and Chauhan (2000).The collected fully matured whole parts of *Cyperus rotundus L.* and *Cynodan dactylon* L. were air dried, ground to fine powder and extracted in water. Twenty grams of ground weed material was soaked in one liter of distilled water and kept 48 hours at room temperature with occasional shaking. The infusion was decanted and filtered through three layers of Whatman No.1 filter paper. From this weed extracts (20%) further dilutions of 15,10 and 5% were prepared with distilled water. The seeds of rice cultivars *ie.*ADT-36,BPT-5204 and IR-20were surface sterilized with 0.03% formalin solution for 20 min. and then washed thoroughly with distilled water (DW). For the germination study 15 seeds were sown in earthen pots(15cm x 30cm) filled with 3.5kg of normal garden soil. Equal quantity of weed extracts/DW was irrigated to all

the pots on 0,3, 6, 9, 12 and 15 days after seed sown. Each treatment including control was replicated five times. The number of seeds germinated in each treatment was counted daily up to 7th day after sowing, and germination percentage was calculated. The emergence of radicle was taken as criteria for germination. Five seedlings from each replicate was selected for recording the morphological parameters such as length of shoot and root, dry weight and chlorophyll contents on 15th day after sowing.The mean data was statistically analysed by ANOVA followed by DMRT at P<0.5%.

## 3. RESULTS AND DISCUSSION

*Cyperus rotundus* L. (family Cyperaceae), also known as purple nutsedge or nutgrass, is a common perennial weed with slender, scaly creeping rhizomes, bulbous at the base and arising singly from the tubers which are about 1-3 cm long. The tubers are externally blackish in colour and reddish white inside, with a characteristic odour. The stems grow to about 25 cm tall and the leaves are linear, dark green and grooved on the upper surface. Inflorescences are small, with 2-4 bracts, consisting of tiny flowers with a red-brown husk. The nut is three-angled, oblong-ovate, yellow in colour and black when ripe. *C. rotundus* is indigenous to India, but are now found in tropical, subtropical and temperate regions (Pooley,(1998); Gordon-Gray,(1995)).

*Cynodon dactylon* (Family: Poaceae, Arugampullu in Tamil, Dhub in Hindi, Bermuda grass inEnglish). A creeping herb rooting at the joints withsmooth upward stem. The roots are whitish, tough andcreeping, almost woody with smooth fibers. Leavestapering to a sharp point, ribbed with smooth sheathand hairy stipules. Flowers are purplish arranged in twoclose alternative rows in equally crowed 4 or 5terminal, linear spikes and blooming in the mouth ofAugust to September (Nadkarni, 2000 and Vaidyaratnam, 2003).

Aqueous weed extracts of *C.rotundus*and*C. dactylon*caused a significant inhibition on the germination of riceseeds over control. The intensity of inhibition differed depending upon the concentration, weed species and rice cultivars. As the concentration of the weed extracts increased the degree of inhibition on germination percentage was increasedin all the three rice cultivars (Table 1). The extracts of both the weed species significantly affected the germination percentage of rice cultivars more at their higher concentration (20%) and the effect was more intense by the extracts of *C.rotundus* than*C.dactylon.* The reduction on the germination, seedling length and dry weight (Table 2) was observedmore in ADT-36 followed by BPT-5204 and IR-20. As the concentration increased, the seedling growth and dry weight of rice seedlings decreased. Similar results were obtained by Alsaadawi and Salih (2009), in which, they reported the root exudates of *C. rotundus* significantly reduced the root and shoot growth of tomato and cucumber plants. The result of Drost and Doll, (1980) favors the present findings, where the plant residues and tuber extracts of yellow nutsedge (*Cyperus esculentus* L.) inhibited the germination and growth of corn (*Zea mays* L.) and soybeans (*Glycine max* (L.) Merr.). Present results are also similar to the findings of Channappagoudar*et al.,*(2005),in which, they reported the extracts of *Cyperus rotundus* and *Commelinabengalensis*had an inhibitory effect on the germination, seedling length of wheat, green gram and soybean.Verma *et al.,* (2002) found the extracts of *Cyperus rotundus* adversely inhibited the seed germination, seedling growth and biomass production of *Brassica* and tomato. Jeyasrinivas*et al.,* (2006) reported the higher concentrations of leaf leachates of *Trianthimumportulacastrum, Cyanodondoctylon* and *C.rotundus,* inhibited the seed germination,shoot length, root length and drymatter production of pearmillet, cowpea, sesamum and cucumber.

The reduction in the seedling growth and biomass production may be due to imbalance in water uptake or osmotic balance of the tissues for germination and growth by the allelochemical toxicity of the extracts (Blum *et al.,* 1999).The inhibitory effects may be due to the presence of higher amounts of growth inhibitory substances in the tuber extracts that were released during extraction. The differential degree of inhibitory (5, 10, 15, 20 and 25%) effect on the growth of rice cultivars may be due to the presence of various allelochemicals at different levelin both the weed extracts. Previous phytochemical studies on *C. rotundus* revealed the presence of alkaloids, flavonoids, tannins, starch, glycosides and furochromones, and many novel sesquiterpenoids (Raut *et al*., 2006; EL-Habashy *et al*., 1989; Kapadia *et al.,* 1967; Jeong *et al*., 2000; Sayed *et al*., 2007; Xu*et al*., 2008). The herb *C.dactylon* contains beta sitosterol, beta-carotene, vitamin C, palmitic acid, andtriterpenoids. Alkaloids like ergonovine, ergonovivine, others include ferulic acid, syringic acid, vanillin acid,p-coumaric acid (Ravindra, 2003).

**Table 1. Germination Percentage of rice cultivars exposed to aqueous extracts of *Cyperus rotundus* and *Cynodon dactylon.***

| Extract Concentrations (%) | *C.rotundus* | | | *C.dactylon* | | |
|---|---|---|---|---|---|---|
| | ADT-36 | BPT | IR-20 | ADT-36 | BPT | IR-20 |
| Control | 98.0 - | 96.0 - | 98.0 - | 98.0 - | 96.0 - | 98.0 - |
| 5% | 85.0 (- 13.3) | 86.8 (-9.6) | 91.5 (-6.6) | 89.6 (-8.6) | 89.0 (-7.3) | 94.2 (-3.9) |
| 10% | 72.5 (-26.0) | 74.6 (-22.3) | 82.6 (-15.7) | 80.2 (-18.2) | 83.5 (-13.0) | 85.6 (-12.6) |
| 15% | 60.8 (-38.0.) | 65.0 (-32.3) | 71.5 (-27.0) | 65.3 (-33.4) | 68.5 (-28.5) | 76.2 (-22.2) |
| 20% | 56.0 (-42.8) | 60.5 (-37.0) | 65.3 (-33.3) | 59.2 (-40.0) | 62.5 (-34.8) | 71.5 (27.04) |
| 25% | 44.0 (-55.1) | 47.3 (-50.7) | 59.2 (-40.0) | 50.5 (-48.4) | 58.6 (-39.0) | 63.6 (-35.1) |

*Value in parenthesis indicate the percentage of decrease (-) over control

**Table 2. Root length and shoot length (cm/plant) of rice cultivars exposed to aqueous extracts of *Cyperus rotundus* and *Cynodon dactylon.***

| Extract Concentrations (%) | *C. rotundus* | | | | | | *C. dactylon* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Root length | | | Shoot length | | | Root length | | | Shoot length | | |
| | ADT-36 | BPT | IR-20 | ADT-36 | BPT | IR-20 | ADT-36 | BPT | IR-20 | ADT-36 | BPT | IR-20 |
| Control | 3.3 | 4.0 | 4.3 | 12.5 | 16.0 | 19.8 | 3.3 | 4.0 | 4.3 | 12.5 | 16.0 | 19.8 |
| 5% | 2.85 (-13.6) | 3.49 (-12.7) | 3.87 (-10.0) | 10.86 (-13.1) | 14.43 (-10.0) | 19.38 (-2.2) | 3.04 (-7.9) | 3.68 (-8.0) | 4.1 (-4.6) | 11.44 (-8.4) | 14.96 (-6.5) | 19.62 (-1.0) |
| 10% | 2.59 (-21.5) | 3.25 (-18.7) | 3.76 (-12.5) | 10.00 (-20.0) | 13.47 (-15.8) | 18.35 (-7.3) | 2.72 (-17.5) | 3.46 (-13.5) | 3.89 (-9.5) | 10.39 (-17.2) | 14.19 (-11.3) | 18.74 (-5.3) |
| 15% | 2.19 (-33.6) | 2.72 (-32.0) | 3.21 (-25.3) | 8.37 (-33.0) | 11.55 (-28.1) | 15.86 (-20.0) | 2.29 (-30.6) | 2.96 (-26.0) | 3.44 (-20.0) | 8.93 (-28.6) | 12.41 (-22.4) | 17.12 (-13.5) |
| 20% | 1.78 (-46.1) | 2.25 (-43.7) | 2.75 (-36.0) | 7.02 (-44.0) | 9.42 (-41.1) | 14.22 (-28.1) | 2.02 (-38.8) | 2.52 (-37.0) | 3.33 (-23.2) | 7.65 (-37.5) | 11.18 (-30.1) | 16.26 (-17.8) |
| 25% | 1.48 (-55.1) | 1.87 (-53.2) | 2.39 (-44.4) | 6.27 (-49.8) | 8.73 (-45.4) | 12.01 (-40.0) | 1.66 (-50.0) | 2.32 (-42.0) | 2.72 (-36.7) | 6.63 (-47.0) | 10.33 (-35.3) | 15.69 (-20.8) |

*Value in parenthesis indicate the percentage of decrease (-) over control

**Table 3. Dry weight (g/plant) and Total Chl. Content (mg/g.fr.wt.) of rice cultivars exposed to aqueous extracts of *Cyperus rotundus*and *Cynodon dactylon.***

| Extract Concentrations (%) | *C.rotundus* | | | | | | *C. dactylon* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dry weight | | | Total Chl. | | | Dry weight | | | Total Chl. | | |
| | ADT-36 | BPT | IR-20 | ADT-36 | BPT | IR-20 | ADT-36 | BPT | IR-20 | ADT-36 | BPT | IR-20 |
| Control | 0.55 | 0.72 | 0.93 | 0.963 | 0.989 | 1.152 | 0.55 | 0.72 | 0.93 | 0.963 | 0.989 | 1.152 |
| 5% | 0.41 (-25.4) | 0.67 (-7.0) | 0.87 (-6.4) | 0.845 (-12.6 ) | 0.888 (-10.2) | 0.972 (-15.6) | 0.43 (-21.8) | 0.69 (-8.3) | 0.91 (-2.2) | 0.859 (-10.7) | 0.913 (-5.2) | 0.968 ( -16.0) |
| 10% | 0.38 (-31.0) | 0.58 (-19.4) | 0.75 (-19.3) | 0.768 (-20.2) | 0.818 (-17.3) | 0.944 (-18.1) | 0.38 (-30.0) | 0.62 (-13.8) | 0.82 (-11.5) | 0.832 (-13.6) | 0.868 (-13.4) | 0.957 (-17.0) |
| 15% | 0.26 (-52.7) | 0.54 (-25.0) | 0.74 (-20.4) | 0.619 (-35.7 ) | 0.722 (-27.0) | 0.810 (-30.0) | 0.29 (-47.2) | 0.55 (-23.6) | 0.79 (-15.5) | 0.787 (-18.3) | 0.765 (-22.6) | 0.865 (-25.0) |
| 20% | 0.21 (-61.8) | 0.42 (-41.7) | 0.60 (-35.5) | 0.544 (-43.5) | 0.583 (-41.0) | 0.763 (-33.7) | 0.22 (-60.0) | 0.49 (-32.0) | 0.65 (-30.0) | 0.586 (-40.2) | 0.655 (-36.8) | 0.785 (32.0) |
| 25% | 0.18 (-67.3) | 0.38 (-47.2) | 0.55 (-40.8) | 0.452 (-54.3) | 0.519 (-47.5 ) | 0.611 ( -29.0) | 0.20 (-63.6) | 0.40 (-44.4) | 0.62 (-33.3) | 0.523 (-45.7) | 0.586 ( -40.7) | 0.689 (-40.2) |

*Value in parenthesis indicate the percentage of decrease (-) over control.

Akobundu (1987), listed factors such as soil temperature, soil moisture regime, alternate wetting and drying of soil, soil nitrate level among others as those that affect seed germination. These results are supported by the findings of Oke (1988) that siamweed extract inhibited the germination of seeds of cowpea, soybean and tridax. JaiKnox*et al*.,(2010) reported that *Cassia occidentalis*, *Rumex dentatus*, *Calotropis procera* and *Withaniasomnifera* inhibited germination and growth of *Parthenium hysterophorus.* The presence of inhibitory chemicals in higher concentrations of the extract might be the reason for differential behaviour of the extracts and causing maximum reduction in growth of the seedlings. Phytotoxicity of allelochemicals present in the weed extracts might be caused synergistic activity on the germination and growth of rice seedlings rather than single chemical. The statistically observed significances are evident for the inhibitory effects of *C.ortundus*and*C.dactylon* on the growth of rice cultivars.

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# ALLELOPATHIC EFFECT OF A WEED SPECIES, *CYPERUS ROTUNDUS* L. AND *CLEOME VISCOSA* L. ON GROWTH AND DEVELOPMENT OF BLACK GRAM (*VIGNA MUNGO* (L.) HEPPER.)

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## ABSTRACT

The present study was aimed to investigate the allelopathic influence of two weed species *Cyperus rotundus* L. and *Cleome viscosa* L. against the growth of Black gram (*Vigna mungo* (L.) Hepper). Aqueous extracts (5%, 10%, 25%, 50%, 75% and 100% concentrations) of whole plants of *C. rotundus* and *C. viscosa* were employed to investigate their influence on the germination and seedling growth of the black gram. The aqueous whole plants extracts ( from 5% to 100% concentrations) of *C. rotundus* and *C. viscosa* exhibited an inhibitory effects on all the parameters employed in the germination percentage, root and shoot growth, fresh and dry weight, content of chlorophyll, starch, sugar and protein contents of Black gram over control. The extracts of both the weeds caused a minimum inhibition on germination and seedling growth of Black gram at 5% concentration and the intensity of inhibition increased when increased extract concentrations. The aqueous extracts of *C. rotundus* and *C. viscosa* showed an inhibitory effect on Black gram but their effect was more severe on black gram by the extract treatments of *C. rotundus* than that of *C. viscosa*.

**Keywords**: Allelopathy, *Cyperus rotundus, Cleome viscose, Vigna mungo*

## 1. INTRODUCTION

Allelopathy is an important mechanism of plant interference by the addition of plant-produced phytotoxins to the plant environment. Many of the phytotoxic substances suspected of causing germination and growth inhibition have been identified from plant tissues and soil. These substances are termed allelochemics or allelochemicals (Whittaker and Fenney, 1971). Allelochemicals refer mostly to the secondary metabolites produced by plants and are the by products of primary metabolic processes (Levin, 1976) and they have no physiological function essential for the maintenance of life. Plants produce a large variety of secondary metabolites like phenols, tannins, terpenoids, alkaloids, polyacetylenes, fatty acids and steroids, which have an allelopathic effect on the growth and development of the same plant or neighbouring plants. Considerable knowledge has been obtained concerning the chemicals involved in allelopathy, but much more is needed to answer many critical questions about this phenomenon (Narwal, 1994). One of the most worked out aspects of allelopathy in manipulated ecosystems is its role in agriculture. In this, the effects of weeds on crops, crops on weeds and crops on crops have been invariably emphasized. In addition, the possibility of using allelochemicals as growth regulators and natural pesticides promoted sustainable agriculture (Pellissier, 2000).

Some of the toxic effects of decomposition products on plants are inhibition of seed germination, stunted growth, inhibition of the primary root system and increase in secondary roots, inadequate nutrient absorption, chlorosis, slow maturation and delay or failure of reproduction (Patrick and Koch, 1958; Patrick *et al*., 1964). Toxins from the decomposing crop residues could affect young crop plants sown between the mature plants e.g., in relay cropping or into the stubbles of the preceding crop in multiple sequential cropping (Trenbath, 1976). Quayyam *et al*. (2000) reported that the C*yperus rotundus* aqueous extracts and leachate of leaves and tubers significantly reduced the germination and seedling growth of rice.The study of Challa and Ravindra (1998), revealed that leachate of *Echinochloa colonum* inhibited the germination and seedling growth of onion, radish and knol khol. Hence the present investigation an attempt has been made to determine the allelopathic effect of two weed species *i.e*. *Cyperus rotundus* L. and *Cleome viscosa* L. on the growth of black gram (*Vigna mungo* (L.) Hepper).

## 2. MATERIALS AND METHODS

The weed plants, *Cyperus rotundus* L. and *Cleome viscosa* L. were collected from the crop fields freshly for the experimental study, whenever needed. The entire plants (root and shoot parts) used for the preparation of extracts. The extracts of whole plant were employed to study their effect on

the germination and seedling growth of black gram (*Vigna mungo* (L.) Hepper.). The black gram seeds cv.TMV-1 were procured from Tamil Nadu agricultural University, coimbatore, Aduthurai. Seeds with uniform size, colour and weight were selected and stored in metal tins. All the experiments were conducted in the Department of Botany, Annamalai University.

*2.1. Preparation of aqueous extract*

Fresh plants of two weed plants were washed thoroughly and cut in to small pieces. Each of the chopped 25g samples was ground in a pestle and mortar with distilled water. Aqueous extracts thus obtained were filtered through muslin cloth and the volume was made up-to 100ml with distilled water. From this stock solution 25, 20, 15, 10, 5 and 2% solutions were prepared by adding distilled water. The extracts were stored in a deep freezer until they were used. Distilled water used as a control.

*2.2. Germination study*

The seeds of black gram were steeped in water to determine their viability those that floated were discarded. The viable seeds were sterilized for two minutes in 0.2 % mercuric chloride ($HgCl_2$) solution. The seeds were then thoroughly washed with tap water. The seeds were arranged in sterilized Petri dishes of 10cm diameter lined with filter paper. Each Petri dish was moistened uniformly by different concentrations of weed extracts and the distilled water was used as control. Each experiment was carried out with five replicates. The petrol dishes were covered kept at room temperature (30 ± 2°C) and were opened periodically for proper aeration. Germination percentage was recorded on 5$^{th}$ day while, root and shoot length, fresh and dry weight and pigment contents (Chlorophyll-Arnon, (1949) were recorded on 8$^{th}$ day after treatment.

## 3. RESULTS AND DISCUSSION

The seeds of Black gram started germinating on the third day and the maximum percentage of germination was observed on day 3$^{th}$ after soaking both in the control and in treatments. Aqueous extracts of both *Cyperus rotundus* L. and *Cleome viscosa* L. species caused a significant inhibition on the germination of the two test crops over control. The intensity of inhibition differed depending upon the organ. The extract caused an inhibition of germination and the intensity of inhibition increased as the concentration of the extract increased. The degree of inhibition of germination also increased over control.

The study of Bendall (1975) showed that the root extract of Canada thistle inhibited the germination on *Trifolium subterraneum* seed by 87%. Similar inhibition of seed germination by weed extract was observed by different workers. The inhibitory effect of *Ipomea carnea spp. Fistulosa, Cyperus rotundus, Cynodon dactylon, Echinochloa colonum, Portulaca oleracea* and *Lagasca mollis,* on sorghum, wheat, kidney bean, rice, onion, radish and knol knoll (Jadhav *et al*., 1997; Challa and Ravindra, 1998), clearly supports the present findings. But on the contrary the study of Pope et al. (1985) revealed that the root exudates of *Cynodon dactylon* promoted seed germination in soybean plant. Most of the studies with the whole plant extract exhibited an inhibitory effect on seed germination.Whole plant extract of *Trianthema portulacastrum* inhibited the seed germination on soybean (Umarani and Selvaraj, 1996). This study supports the result of the present findings.

The results on the root and shoot growth of seedlings of Black gram are given in Table 3. The inhibitory effect of weed extracts of *C. rotundus* and *C. viscosa* on root and shoot growth of black gram was similar to their inhibitory effect *on* seed germination as over control. The study of Patil (1994) revealed that the leaf extracts of *Glyricidia maculata* L. inhibited the seedling growth of rice, sorghum, green gram and blackgram. The leaf extract of *Faxinus micrantha* L. inhibited the growth of root and shoot length of *Raphanus sativus, Eleusine coracana, Triticum aestivum* and *Brassica campestris* (Joshi *et al.,* 1996). These studies are in conformity with the present findings. But on the contrary the study of Lovett and Sagar (1978) showed that the aqueous washings of leaves of *Camellina sativa* stimulated the growth of radicles of flax seedlings. Similarly the study of Tripathi *et al.* (1998) showed that the leaf extracts of *Albizia procera, Tectona grandis* and *Acacia nilotica* stimulated root and shoot length in soybean.

The fresh and dry weight of the test crop seedlings were reduced by the weed extract treatments. The degree of inhibition depends on the concentrations of the extracts. The study of Kazinczi *et al.* (1997) revealed that the root residues of *Centaurea cyanus* inhibited (50%) the fresh weight of rape as compared to control.

**Table 1. Effect of aqueous extract of two *weeds* on Seedling growth (cm/plant) of Black gram**

| Concentration of Extract | *Cleome viscosa L Extracts* | | | *Cyperus rotundus L. Extracts* | | |
|---|---|---|---|---|---|---|
| | **Shoot Length (cm)** | **Root Length (cm)** | **Leaf Area ($cm^2$)** | **Shoot Length (cm)** | **Root Length (cm)** | **Leaf Area ($cm^2$)** |
| Control '0' | 20.14 (± 1.00) | 5.22 (±0.26) | 3.80 (± 0.19) | 20.14 (± 1.00) | 5.22 (±0.26) | 3.80 (± 0.19) |
| 5% | 20.00 (± 1.01) | 5.14 (± 0.31) | 3.22 (± 0.20) | 18.02 (± 1.00) | 4.68 (± 0.23) | 2.61 (± 0.18) |
| 10% | 19.52 (± 0.97) | 5.01 (± 0.25) | 3.07 (± 0.15) | 17.80 (± 0.89) | 4.04 (± 0.20) | 2.50 (± 0.12) |
| 25% | 18.55 (± 0.92) | 4.94 (± 0.24) | 2.93 (± 0.14) | 16.95 (± 0.84) | 3.08 (± 0.15) | 2.32 (± 0.11) |
| 50% | 17.20 (± 0.86) | 4.58 (± 0.22) | 2.12 (± 0.10) | 16.50 (± 0.82) | 2.70 (±.0.13) | 1.82 (± 0.09) |
| 75% | 16.76 (± 0.83) | 3.05 (± 0.15) | 2.20 (± 0.11) | 12.52 (± 0.62) | 1.36 (± 0.06) | 0.26 (± 0.01) |
| 100% | 15.90 (± 0.79) | 2.64 (± 0.13) | 0.44 (± 0.02) | 9.02 (± 0.45) | 0.90 (± 0.04) | 0.19 (± 0.00) |

**Table 2. Effect of aqueous extract of two *weeds* onFresh weight ((ug/plant) of Black gram .**

| Concentration of Extract | *Cleome viscosa* L Extracts | | | *Cyperus rotundus L.* Extracts | | |
|---|---|---|---|---|---|---|
| | **Leaf** | **Stem** | **Root** | **Leaf** | **Stem** | **Root** |
| Control | 160 (± 8.00) | 760 (±38.80 | 155 (± 7.75) | 160 (± 8.00) | 760 (±38.80 | 155 (± 7.75) |
| 5% | 155 (± 11.50) | 745 (± 43.25) | 145 (± 9.65) | 125 (± 9.35) | 610 (± 33.25) | 125 (± 8.93) |
| 10% | 145 (± 7.25) | 719 (± 35.95) | 140 (± 7.00) | 126 (± 6.30) | 580 (± 31.10) | 102 (± 5.10) |
| 25% | 118 (± 5.90) | 610 (± 30.50) | 135 (± 6.75) | 109 (± 5.45) | 563 (± 28.15) | 99 (± 4.95) |
| 50% | 90 (± 4.50) | 580 (± 29.00) | 109 (± 5.45) | 70 (± 3.50) | 495 (±.24.75) | 78 (± 3.90) |
| 75% | 75 (± 3.75) | 470 (± 23.50) | 65 (± 3.25) | 59 (± 2.95) | 427 (± 2.35) | 59 (± 2.95) |
| 100% | 45 (± 2.25) | 330 (± 16.50) | 42 (± 4.10) | 25 (± 1.25) | 318 (± 15.90) | 37 (± 1.85) |

**Table 3. Effect of aqueous extract of two weeds on the dry weight (ug/plant) of seedlings of Black gram (The values are mean + SE of 7 samples).**

| Concentration of Extract | *Cleome viscosa* Extracts | | | *Cyperus rotundus* Extracts | | |
|---|---|---|---|---|---|---|
| | **Leaf** | **Stem** | **Root** | **Leaf** | **Stem** | **Root** |
| Control | 41 (± 2.05) | 74 (±3.70) | 33 (± 1.65) | 41 (± 2.05) | 74 (±3.70) | 33 (± 1.65) |
| 5% | 38 (± 2.13) | 69 (± 4.30) | 31 (± 1.85) | 33 (± 1.80) | 42 (± 2.50) | 25 (± 1.60) |
| 10% | 37 (± 1.85) | 68 (± 3.50) | 29 (± 1.60) | 28 (± 1.60) | 38 (± 2.25) | 22 (± 1.40) |
| 25% | 36 (± 1.80) | 66 (± 3.30) | 28 (± 1.40) | 27 (± 1.50) | 36 (± 2.20) | 18 (± 1.25) |

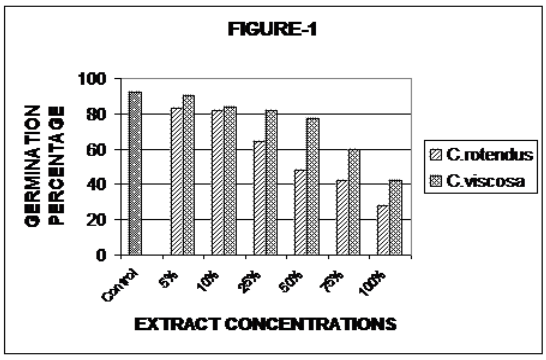
| | | | | | | |
|---|---|---|---|---|---|---|
| 50% | 35 (± 1.75) | 61 (± 3.05) | 25 (± 1.25) | 26 (± 1.40) | 32 (±.2.15) | 16 (± 1.00) |
| 75% | 32 (± 1.60) | 57 (± 2.85) | 22 (± 1.10) | 24 (± 1.30) | 28 (± 1.95) | 15 (± 0.95) |
| 100% | 29 (± 1.45) | 55 (± 2.75) | 17 (± 0.85) | 21 (± 1.05) | 26 (± 1.60) | 13 (± 0.7) |

**Table 4. Effect of aqueous extract of two weeds on chlorophyll contents (ug/g.fr.wt.) of Black gram (The values are mean ± SE of 7 samples).**

| Concentration of Extract | *Cleome viscosa* Extracts | | | *Cyperus rotundus* Extracts | | |
|---|---|---|---|---|---|---|
| | Chl.-a | Chl.-b | Total chl. | Chl.-a | Chl.-b | Total chl. |
| Control | 382 (± 19.10) | 319 (±16.05) | 701 (± 35.05) | 382 (± 19.10) | 319 (±16.05) | 701 (± 35.05) |
| 5% | 371 (± 22.30) | 311 (± 18.05) | 682 (± 40.35) | 265 (± 16.20) | 241 (± 15.95) | 521 (± 32.15) |
| 10% | 364 (± 18.20) | 321 (± 15.95) | 685 (± 34.25) | 251 (± 12.55) | 217 (± 10.85) | 468 (± 23.40) |
| 25% | 331 (± 16.55) | 278 (± 13.90) | 609 (± 30.45) | 224 (± 11.2) | 196 (± 9.80) | 420 (± 21.00) |
| 50% | 302 (± 15.10) | 242 (± 12.10) | 544 (± 27.20) | 188 (± 9.40) | 176 (±.8.80) | 364 (± 18.20) |
| 75% | 284 (± 14.20) | 204 (± 10.20) | 488 (± 24.40) | 179 (± 8.95) | 154 (± 7.70) | 333 (± 16.65) |
| 100% | 252 (± 12.60) | 196 (± 9.80) | 448 (± 22.40) | 152 (± 7.60) | 149 (± 7.45) | 301 (± 15.05) |

The study of Umarani and Selvaraj (1996) reported that the stem and whole plant extract of *Trianthema portulacastrum* reduced the dry matter production on soybean. Beres and Kazinczi (1997) showed that the aqueous shoot extract of *Rumex obtusefolius* and *Asclepias syriaca* reduced the fresh and dry weight of corn. But on the other hand the root leachate of donor soybean with significantly increased the dry matter of receiver soybean (Ramamurthy and Shivashankar, 1995).

**Fig.1. Allelopathic effect of aqueous extract of *Cleome viscosa L.* on seed germination percentage of Black gram**




The allelopathic effect of two weed extracts exhibited a retarding effect on the contents of chlorophyll and carotenoid of black gram. The maximum chlorophyll content (Chl. a, Chl. b and total chlorophyll) was observed in control seedlings when compared to treated one. The chlorophyll content decreased as the concentration of extract increased and a maximum chlorophyll content reduction was observed at 100% treated seedlings of both the weed extracts The inhibitory effect on the chlorophyll contents was more prominent by *Cyperus rotundus* extract treatments than *that of Cleome viscosa* on black gram seedlings. Dube *et al.*(1979) reported that the aqueous extracts of root, stem and leaf of *Parthenium hysterophorus* decreased the chlorophyll production by cotyledons of radish, cabbage and cauliflower. Aqueous shoot and root extracts of *Parthenium hysterophorus* on mulberry (Singhal *et al.,* 1996). *Echinacea angustifolia* crushed extracts of root and shoot on the seedlings of *Lactuca sativa*, *Panicum virgatum* and *Sarobolus heterolepis*, aqueous leaf extracts of bamboo on groundnut (Eyini *et al.,* 1981). Leaf residue of *Parthenium* on *Najas graminea* (Pandey, 1997) aqueous leaf leachates of *Euclyptus globulus* in the leaves of *Costus speciosus* and finger millet (Konar and Kushari, 1995; Padhy et al., 2000),

the leaf and leaflitter extracts of *Quercus glauca* and *Q. lauotrichophora* on wheat, mustard and lantil (Bhatt and Chauhan, 2000) significantly reduced the chlorophyll content of the seedlings. These studies strongly support the present findings.

The following allelochemicals present in the plant organs of *Cyperus rotundus,*they are 1,8-cineole, 4alpha, 5alpha-oxidoeudesm-11-en-3-alpha-ol, Alkaloids, Alpha-cyperone, Alpha-rotunol, Beta-cyperone, Beta-pinene, Beta-rotunol, Beta-selinene, Calcium, Camphene, Copaene, Cyperene, Cyperenone, Cyperol, Cyperolone Cyperotundone D-copadiene, D-epoxyguaiene, D-fructose, D-glucose, Eo, Flavonoids, Gamma-cymene, Isocyperol, Isokobusone, Kobusone, Limonene, Linoleic-acid, Linolenic-acid, Magnesium, Manganese, Mustakone, Myristic-acid, Oleanolic-acid, Oleanolic-acid-3-o-neohesperidoside, Oleic-acid, P-cymol, Patchoulenone, Pectin, Polyphenols, Rotundene, Rotundenol, Rotundone, Selinatriene, Sitosterol, Stearic-acid, Sugeonol, Sugetriol (Seo *et al.,*2007). The pharmacological studies have shown that CV possesses various notable biological activities such as anthelmintic, antimicrobial, analgesic, antiinflammatory, immunomodulatory, antipyretic, psychopharmacological, antidiarrheal, and hepatoprotective activities. A wide variety of phytoprinciples have been isolated from *C.viscosa* (Mali, 2010). The differential degree of inhibitory effect two weed extracts on germination and seedling growth of Black gram may be due to the presence of various inhibitory allelochemicals at different concentrations in weed organs of *C.rotundus*. and *C. viscosa.*

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# ALLELOPATHIC POTENTIAL OF EXTRACTS AND LEACHATES OF *AZADIRACHTA INDICA* A. JUSS LEAVES ON GERMINATION AND GROWTH OF *ELEUSINE CORACANA* (L.) GAERTNER

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## ABSTRACT

Various concentrations (5%, 10%, 15% and 20%) of leaf leachates and leaf extracts prepared from fully senesced fallen and matured leaves of *Azadirachta indica* A. Juss. and used for the present experiments to determine their allelopathic potential on growth and developmental changes on *Eleusine coracana* (L.) Gaertner. Leaf leachates and leaf extracts sowed an inhibitory effect on germination percentage, root and shoot growth, and fresh and dry weight of *E. coracana* seedlings. The leaf extracts had more inhibitory effect at 20%concentration,than that of leaf leachates on morphological parameters of *E. coracana*.

**Keywords:** Allelopathic potential, *Azadirachta indica, Eleusine coracana.*

## 1. INTRODUCTION

Allelopathy generally refers to the detrimental effects of higher plants of one species (the donor) on the germination, growth or development of plants of another species (the recipient) (Narwal, 1994). Molisch (1937) coined the term allelopathy from two Greek words, where allelon means 'to each other' and pathos means 'to suffer'. In natural or man managed agroecosystems, neighbouring plants may interact with the growth and development of other species. Muller (1969) suggested the term interference for the overall influence of one plant (including microorganisms) on another. In agro ecosystems, several weeds, crops, agroforestry trees and fruit trees have been shown to exert allelopathic influence on the crops, thus affecting their germination and growth adversely (Kohli *et al.,* 1998). Allelopathy plays a key role both in natural and managed ecosystems. Eventhough allelopathy includes both positive and negative effects of one plant on the other; most of the studies seem to focus only on its deleterious impacts alone.

Joshi *et al.* (1996) reported that aqueous leaf extracts of *Fraxinus micrantha* inhibited the germination and growth of *Raphanus sativus*, *Eleusine coracana, Triticum aestivum* and *Brassica campestris*. Hussain *et al.* (1991) tested litter extracts of walnut inhibitory effect on germination of maize, turnip and bean. Aqueous extract of leaves and inflorescence of *Acacia tortilis* at four per cent concentration significantly reduced the pearlmillet seed germination, root and shoot length (Saxena and Sharma, 1996).The present study was aimed to determine the influence of aqueous leaf extracts and leaf leachates of *Azadirachta indica* A. Juss. on the seed germination and seedling growth of *Eleusine coracana* (L.) Gaertner.

## 2. MATERIALS AND METHODS

The preparation of dried fresh leaf extracts, leaf leachates and germination studies were followed as per the methods of Padhy *et al.* (2000) and Bhatt and Chauhan (2000).Leaf leachates:Twenty grams of senesced fallen leaves were collected from understory of *Azadirachta indica* A. Juss. tree. These leaves were washed thoroughly with tap water followed by distilled water and soaked in 100 ml – distilled water for 48 hours. The leachates were, filtered and filtrates were considered as 20% concentration. From this leachates (20%) further dilutions of 5, 10, 15% were prepared with distilled water. Leaf Extracts:The collected fully matured fresh leaves of *Azadirachta indica* A. Juss. were air dried, ground to fine powder and extracted in water. Twenty grams of ground leaf material was soaked in one litre of distilled water and kept 48 hours at room temperature with occasional shaking. The infusion was decanted and filtered through three layers of Whatman No.1 filter paper. From this leaf extracts (20%) further dilutions of 15, 10 and 5% were prepared with distilled water. The selected seeds of *Eleusine coracana* were surface sterilized with 0.03% formalin solution for 20 min. and then washed thoroughly with distilled water. For the germination study 25 seeds were placed in sterilized petriplates lined with two layers of filter paper. On the first day 10ml of leaf extracts/Distilled Water was added per treatments on the petri plates. Distilled water served as control. Thereafter to keep the filter paper moist, 10ml leaf extracts/DW was added per plate 6, 9, 12 and 15 days after soaking.

Afterwards the seeds were allowed to germinate in the growth chamber and kept in light intensity of 2 ± 0.4 K. Lux and at 30 ± 2°C till 15 days after seed soaking. Each treatment including control was replicated five times. The number of seeds germinated in each treatment was counted daily up to 10th day after sowing, and germination percentage was calculated. The emergence of radicle was taken as criteria for germination. Five seedlings from each replicate was selected for recording the morphological parameters such as length of shoot and root, fresh and dry weight on 15th day after sowing.

## 3. RESULTS AND DISCUSSION

Aqueous leaf extracts and leaf leachates of *Azadirachta indica* caused a significant inhibition on the germination of *Eleusine coracana* (L ) seeds over control. The intensity of inhibition differed depending upon the concentration. As the concentration of the extracts and leachates increased the degree of inhibition of the germination also increased over control (Table 1). The leaf extracts and leachates affected the germination percentage more at the higher concentration (20%). But the effect was more intense in the treatment of leaf extracts than in aqueous leaf leachates. The extracts and leachates of leaves exhibited both inhibitory (5,10, 15, 20%) effects on the germination of seeds.

**Table 1. Aqueous leaf extracts and leaf leachates of *A. indica* on seed germination and seedling length(cm/plant) of *E. coracana***

| Concentrations | Germination % | | Extracts | | Leachates | |
|---|---|---|---|---|---|---|
| | Extracts | Leachates | Root length | Shoot length | Root length | Shoot length |
| Control | 98 | 96 | 13.3 | 8.0 | 13.3 | 8.0 |
| 5 | 84 (-14.3) | 86 (-11.6) | 12.8 (-3.7) | 7.5 (-6.2) | 13.0 (-2.2) | 7.3 (-3.9) |
| 10 | 74 (-24.5) | 75 (-21.8) | 10.7 (-19.5) | 7.0 (-12.5) | 11.0 (-17.3) | 6.8 (-10.5) |
| 15 | 60 (-38.7) | 62 (-35.4) | 8.8 (-33.8) | 5.0 (-37.5) | 9.0 (-32.3) | 5.4 (-29.0) |
| 20 | 54 (-45) | 58 (-39.5) | 4.7 (-64.6) | 3.5 (-56.2) | 5.0 (-62.4) | 3.6 (-52.6) |
| Average | 63 | 66 | 10.06 | 6.02 | 10.26 | 6.22 |
| F | 196.6897 | | RL-915.90,SL.263-84 | | | |

Data in parenthesis indicates % increase (+), decrease (-) over control.

**Table 2. Aqueous leaf extracts and leaf leachates of *Azadirachta indica* A. Juss on the fresh and dry weight (mg/plant) of *Eleusine coracana* (L.) GAERTNER**

| Concentrations (%) | Extracts | | Leachates | |
|---|---|---|---|---|
| | Fresh Weight | Dry Weight | Fresh Weight | Dry Weight |
| Control | 80 | 18 | 80 | 22 |
| 5 | 74 (-7.5) | 15 (16.6) | 76 (-5.0) | 19 (-13.6) |
| 10 | 68 (-15.0) | 13.5 (-25) | 70 (-12.5) | 17 (-22.7) |
| 15 | 55 (-31.2) | 11 (-38.8) | 60 (-25.0) | 14 (-36.3) |
| 20 | 40 (-50) | 9.5 (-47.2) | 45 (-43.7) | 12 (-45.4) |
| Average | 63.4 | 16.8 | 66.2 | 13.4 |
| F | FW-77.87; DW-2.15 | | | |

Data in parenthesis indicates % increase (+), decrease (-) over control.

Leaf extracts of several tree species are *Grewia oppositifolia*, *Ficus roxburgh* and *Bauhinia variegata* showed a higher rate of inhibition on the germination of maize, cowpea, finger millet and soybean (Kaleta *et al.,* 1996). Similar inhibition of seed germination by leaf extract treatment was reported by different workers. The inhibitory effect of *Acacia tortilis*, *Chromolena odorata, Quercus glauca* and *Quercus leucotrichopora* on the germination of pearlmillet, cowpea, wheat, mustard and lentil (Gill *et al.,* 1993; Bhatt and Chauhan, 2000) clearly supports the present findings.But on the contrary the study of Tripathi *et al.* (1998) revealed that the leaf extracts of *Tectona grandis, Albizia procora* and *Acacia nilotica* stimulated germination in soybean plant

The extracts and leachates of *Azadirachta indica* leaves caused inhibitory effect on the root and shoot length of *Eleusine coracana* (L )over control. Leaf leachates of different allelopathic tree species like, *Terminalia tomentasa, Sapindus emarginatus* and *Azadirachta indica* L. at the higher concentrations inhibit the growth of field crops. But at lower concentrations radicle growth of field crops has been promoted (Jadhav, 2003).

The bark of Tamarind tree showed strong growth inhibition in both radicles and hypocotyls of asparagus, cucumber, lettuce, radish, sesame, tomato and welsh onion (Parvez *et al.,* 2004). The aqueous extract of aerial parts of *Prunus amygdalus* inhibited the growth of root and shoot length on wheat and finger millet (Pande *et al.,* 1998).

The study of Jayakumar *et al.* (1998) showed that the mature trees of *Ficus bengalensis* produce high potential inhibitors, which will inhibit the germination of seed and seedling growth of *Vigna radiata*. Lower concentration (5%) of aqueous extract of Ficus leaf and bark, enhanced the shoot and root length of *Vigna radiata,* but at higher concentration (20%) of both the bark and leaf extract inhibited the germination of seed and reduce the biomass of shoot. These studies are in conformity with the present findings, because leaf leachates and leaf extracts of *Azadirachta indica* showed inhibition on shoot and root growth of *Eleusine coracana* (L ). But on the contrary the study of Tripathi *et al.* (1998) showed the leaf extracts of *Albizia procera, Tactoria grandis* and *Acacia nilotica* stimulated root and shoot length in soybean..

The fresh and dry weight decreased when increasing the concentrations (10%, 15%, 20%) of leaf extracts and leaf leachates. The fresh weight of cucumber and Chinese cabbage seedlings were reduced by 58 and 52% respectively over control by full treatments of mikania leaf extract (Ismail and Kumar, 1996).

The study of Eyini *et al.* (1996) reveled that the leaf extract of *Tephrosia purpurea, Albizzia ammara* and *Delonix regia* inhibited that the biomass on *Zea mays.* The leaf leachates of *Casuarina equisetifolia* reduced the dry weight on rice and cowpea (Jadhav and Gayman, 1995). But the study of Mallik and Watson (1998) showed that the shoot weight of soybean were enhanced by silver nightshade residue. These studies favour the present findings. The differential degree of inhibitory (5, 10, 15 and 20%) effect on the growth of *E.coracana*. may be due to the presence of allelochemicals at different concentration of *Azadirachta indica* in both leaf extracts and leaf leachates

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# IMPACT OF CLIMATE CHANGE ON THE PLANKTONS IN AKKULAM-VELI LAKE, THIRUVANANTHAPURAM DISTRICT

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## ABSTRACT

Hydrobiological studies were carried out in Akkulam – Veli (Thiruvananthapuram District, Kerala, India) estuary for six months (January – June 2008) various studies were conducted to understand the conditions of this dynamic ecosystem. The planton analysis reveals that around 64 species of phytoplankton and 8 species of zooplanktons were observed.

**Keywords**: Phytoplankton, zooplankton, estuary.

## 1. INTRODUCTION

The convincing definition of estuary has been given by Pritchard (1967) : "An estuary is a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with freshwater derived from land drainage". The study area, Akkulam Veli lake is a tourist attraction spot located very close to the capital city of Kerala.

The study focuses attentions on various aspects of the Environmental pollutions The Akkulam-Veli lake situated approximately 5km north west of Thiruvananthapuram between latitudes 8 25' and 8 35' and longitudes 76 50' and 76 58'E, the lake is having an area of <1km surrounded by lateritic hillocks. Serious environmental degradation is being experienced by this system due to municipal waste disposal, eutrophication, excessive tourism load, effluent discharge, developmental activities etc. Two canals, viz the Kulathur canal and Parvathy puthenar join the Veli lake in the northen side. The channankara canal connects the veli lake with kadinamkulam kayal in the north. Seepage of sewage from Muttathara sewage makes the water extremely polluted. Kannamoola canal joins the eastern part of the Akkulam lake. Sewage from the Thiruvananthapuram city and drainage from the suburbans are brought into the lake through the Kannammoola canal. In the vicinity of the lake there are two factories, The English clays ltd. and Travancore Titanium products ltd. The clay factory discharge and its effluents directly to the lake, while the effluent discharged from TTP to the sea finds its way to the lake when the river mouth remains open.Six stations were selected for the study they are Akkulam boat club, central part of the akkulam lake, akkulam side of the bund,central part of lake off clays factory, veli boat club, mouth part of veli lake.

## 2. MATERIALS AND METHODS

Six stations were selected for the study they are Akkulam boat club, Central part of the Akkulam lake, Akkulam side of the bund, Central part of lake off clays factory, Veli boat club, mouth part of Veli lake. The water samples were collected at the last date of every month, for a period of 6 months, starting from January 2008 to june 2008. Standard methodology after Welch (1948) and Jhingran *et al*. (1982), with suitable modifications to suit local availability was used. Procedures adopted are collection, preservation and transportation, washing and Qualitative analysis. The planktons were identified with the help of classical works of Prescott (1954), Desikachary (1959, 1987), Subramanyan (1976) and Santhanam *et al.* (1987).

## 3. RESULTS AND DISCUSSION

This was done for plankton analyses which reveals that around 64 species of phytoplanktons and 8 species of zooplanktons. The higher concentration of Carbondioxide resulted in low ph and high carbonate .The high concentration of Carbondioxide might be due to less photosynthetic activity because of low phytoplankton population and more respiratory acitivity of zooplankton (Bohra, 1977).The findings coincides with Bohras

observation. The station 1 & 2 has maximum number of phytoplankton's compared to other stations where the concentration of carbon dioxide is less. The station 3,4,5 & 6 has maximum number of zooplanktons because of more carbon dioxide in that area. Thus climate change increases photosynthetic rate. The negative side of climate change is loss and degradation of habitat, effect motility of plankton disturb hydrology cycle, increases the level of UV light, pollution etc. So let us join hands with our fellowmen to the restoration of the aquatic ecosystem for our future generation.

Table. 1 . List of phytoplantation species recorded in the month of January 2008 in six different stations.

| Sl. No. | Name of species | Name of the stations | | | | | |
|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI |
| 1. | Acrostichum aureum | | | | | | |
| 2. | Ather nauthera sessils | | | | | x | |
| 3. | Aniseia martini censis | | | | x | x | |
| 4. | Ardisia litteratlis | | | x | | | |
| 5. | Bacopa Monnieri | | | | | | x |
| 6. | Barringtonia racemosa | | | | x | | |
| 7. | Caesalpinia crista | | | | | x | |
| 8. | Caeralpinia nigra | x | | | | | |
| 9. | Calophylleum inophyllum | | | x | x | | x |
| 10. | Ceratralus turgidius | | | | | | |
| 11. | Ceraliera odollam | | | | | | |
| 12. | Chactoposa elegans | | | | | x | x |
| 13. | Chlorella Vulgaris | | | | | x | |
| 14. | Clerodendum inerme | | | x | | x | |
| 15. | Closteriopsis longissima | | | | x | | x |
| 16. | Coscinodiscus reniformis | | | x | x | | |
| 17. | Coscinodiscus reniformis | | | x | x | | x |
| 18. | Crinum definum | | | | | | |
| 19. | Cyperus | x | | | | | |
| 20. | Dalbergia Candanatensis | | | | x | | |
| 21. | Denticula Vantreurckii | | | | | | |
| 22. | Derris scandens | x | | | | x | |
| 23. | Derris trifoliara | | | x | | | x |
| 24. | Dimcosphenia elongate | | | | | | x |
| 25. | Dolechandrone Spathacea | | | x | x | x | x |
| 26. | Kclipta prostrate | | | | | | |
| 27. | Fimbristylis cymosa | | | | | x | |
| 28. | Fimlristylis Ferruginea | | | | | | |
| 29. | Fimhristylis polytrichoides | | | | x | | |
| 30. | Flagellaria indica | | | | | | x |
| 31. | | | | | | x | |
| 32. | Hydrosera triquetra | | | | | | x |
| 33. | Ipomaca campanelats | | | | | x | x |
| 34. | Ipomaca paescapre | | | | | x | |
| 35. | Lagenandra | x | | | | | |
| 36. | Licmophora flabellats | | | | | x | |
| 37. | Licmophora chrenbergii | | | | x | | x |
| 38. | Mariscus Javanicus | | | | | | |
| 39. | Mastogloia descussata | | | x | | x | |
| 40. | Melastoma | | x | | x | | |
| 41. | Morinda citrifolia | | | | | | |
| 42. | Navicula longa | | | x | | x | |
| 43. | Nitzchia longissima | | | | | x | |
| 44. | Nitzchia panduriformis | | | | | | x |
| 45. | Pandanus ododartissimus | | | | | | |
| 46. | Parsonir alboflavascens | | | | | | |
| 47. | Paspalum disticlum | | | | | | |
| 48. | Phacotus | | | x | | x | |
| 49. | Phragnutes Karka | | | x | | | x |
| 50. | Premna Serratifolia | | | x | | x | |
| 51. | Rhizosolenia styliformis | | | | | x | |
| 52. | Samadera indica | x | | | | | |
| 53. | Sauropus bacciformis | | | | | | |
| 54. | Saytonematopsis Kazhyapi | | | | x | | |
| 55. | Scaevola sericea | | | | | x | |
| 56. | Sphenoclea Zeylanica | | | | x | | |
| 57. | Syzygium travancoricum | | | | | | x |
| 58. | Taliparithi tiliaceum | | | x | x | | |
| 59. | Thespesia populnea | | | x | | | |
| 60. | Triceiatium reticulatum | | | | | | |
| 61. | Trichodesmium erythree | | | x | x | x | |
| 62. | Tylophora tetrapetala | | | | | | |
| 63. | Weddia chimensis | | | | | | |
| 64. | Zoysia Matrella | | | | | x | x |

Table. 2 . List of Zooplantations recorded in the month of January 2008 in six different stations.

| Sl. No. | Name of the species | Name of the stations | | | | | |
|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI |
| 1. | Cresin Spp | x | x | | | | |
| 2. | Diphyes Spp | | | | | | |
| 3. | Lalidocera acuta | x | | | | | |
| 4. | Nauplius | | x | | | | |
| 5. | Sagitta Spp. | | | | | | |
| 6. | Mysis | | x | | | | |
| 7. | Lucifer | x | | | | | |
| 8. | Zoea (crab) | | | | | | |

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# HISTOPATHOLOGICAL ALTERNATIONS INDUCED BY THE ACTION OF LAMBDA-CYHALOTHRIN IN *ETROPLUS SURATENSIS* (BLOCH)

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## ABSTRACT

The study of structural damage of organs or tissues is an integral part of pollution toxicology. The present work was conducted to study the effect of the pyrethroid insecticide, lambda-cyhalothrin on the kidney of the pearlspot "*Etroplus suratensis*". The dilation of the kidney tubules, degeneration in kidney tissue, rupture in the collecting tubules and necrosis were observed in the present investigation after lambda-cyhalothrin treatment.

**Keywords:** *E. suratensis,* Kidney, Lambda-cyhalothrin.

## 1. INTRODUCTION

Histopathology is an effective tool to visualize the stress-induced structural changes in cells and tissues. Organisms have tremendous capacity to overcome the environmental stress conditions and thus to maintain the homeostasis. Various chemicals with their varied mode of action in different tissues bring about certain architectural changes ultimately culminating in either death of the organism or making the organism less viable for survival. Kidney plays a vital role in the maintenance of an organism's internal environment, being the key to the regulation of extracellular fluid volume and composition as well as acid–base balance. It is also a target of toxic chemicals, which can disrupt its functions, and cause temporary or permanent derangement of homeostasis. Several authors recorded histopathological changes in the kidney of freshwater fish, *Puntius conchonius* and *Channa punctatus* exposed to organophosphate insecticides diazinon, monocrotophos, dimethoate and elsan respectively (Banerjee and Bhattacharya, 1994; Miller, 2002). The toxicity of such pollutants is assessed by the extent of histopathological damages induced in the test organism and the degree of cell damage is evident in relation to the concentration of pollutants employed. Mortality of fishes occurs due to the pathological lesions caused by pollutants (Iyappan *et al.,* 1998; Tilak *et al.,* 2005).

The present work was conducted to study the effect of the pyrethroid insecticide, lambda-cyhalothrin on the kidney of the pearlspot "*Etroplus suratensis*".

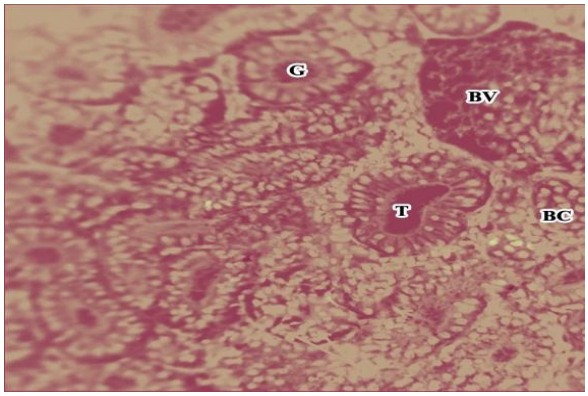
## 2. MATERIALS AND METHODS

Fishes were randomly selected from control and treated groups for histopathological observations by sampling after 60 days of pesticide exposure. The kidney of control and pesticide treated *E. suratensis* fishes were taken out and a histological study was carried out by employing Culling (1974) method.

## 3. RESULTS

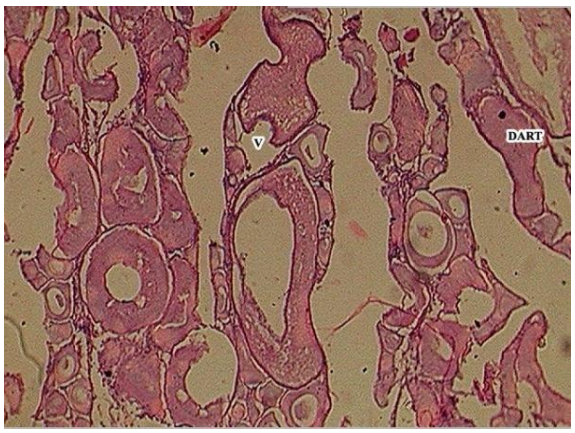
The teleost kidney consists of head and body kidneys. Head kidney is the anterior portion of the kidney and consists of lymphoid tissue. Body kidney is composed of many nephrons and intestitial lymphoid tissue. The interstitial tissue is the major hematopoietic tissue in the body. Each nephron consists of two parts, the glomerulus and the urinary tubule. The bowman's capsule consists of an inner and outer layer of single flattened epithelia. Renal tubules consist of single layer of epithelial cells. Mesangium fills the spaces between the loops of glomerular capillaries (Fig. 1). In lower concentration (0.005 ppm), kidney of *E. suratensis* exposed to lambda-cyhalothrin histological alternations included degeneration and atrophy of renal tubules and vacuolization were observed (Fig. 2). In *E. suratensis* exposed to 0.006 ppm of lambda-cyhalothrin for 60 days, showed the cells of the kidney are destroyed, vacuolization, collapsing glomeruli, congestion of cells and necrosis were noticed (Fig. 3).

**Fig. 1: Section showing the kidney of control *E.suratensis* (400X)**



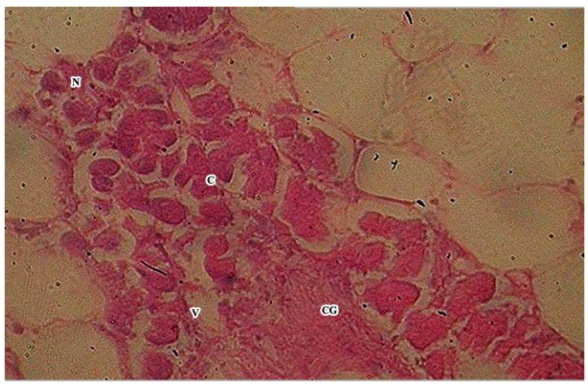

G-Glomerulus BV-Blood vessel T- Tubule BC-Bowman's capsule

**Fig. 2: Section showing the kidney of *E.suratensis* exposed to 0.005 ppm concentration of lambda-cyhalothrin (400X)**



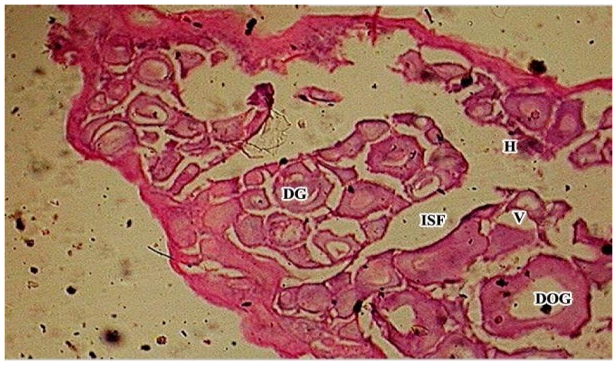

DART – Degeneration and atrophy of renal tubules V-Vacuolized

**Fig. 3: Section showing the kidney of *E.suratensis* exposed to 0.006 ppm concentration of lambda-cyhalothrin (400X)**



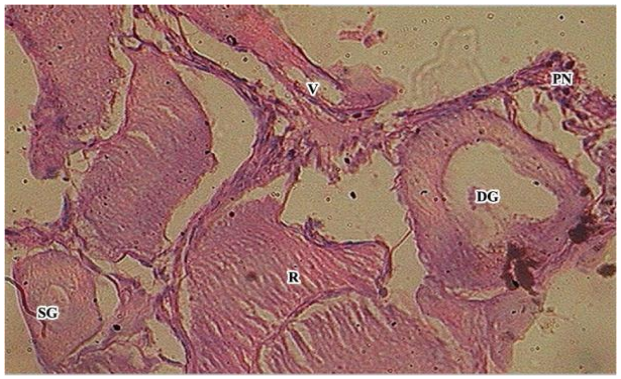

CG-Collapsing glomeruli V-Vacuole N-Necrosis C-Congession of cells

**Fig. 4: Section showing the kidney of *E.suratensis* exposed to 0.008 ppm concentration of lambda-cyhalothrin (400X)**



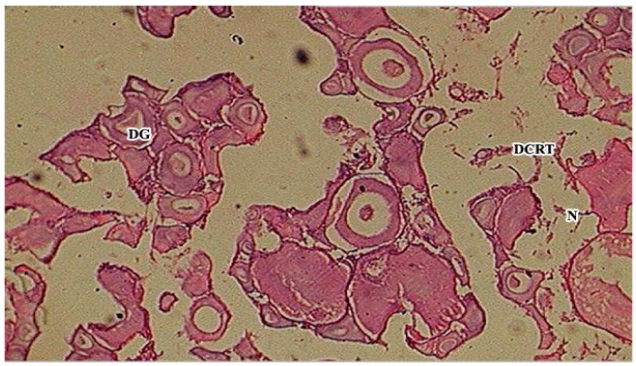

DG – Degeneration in glomerulus DOG-Disorganization of glomerulus V-Vacuolization H-Haemorrhage ISF-Intercellular spaces formation

**Fig. 5: Section showing the kidney of *E.suratensis* exposed to 0.013 ppm concentration of lambda-cyhalothrin (400X)**




SG-Swelling of glomerular cells R-Ruptered cells DG-Damaged glomerulus PN – Pycnotic nuclei, V-Vacuolization

**Fig. 6: Section showing the kidney of *E.suratensis* exposed to 0.026ppm concentration of lambda-cyhalothrin (400X)**




DG – Degeneration in glomerulus N-Necrosis DCRT-Dilation in the capillary tubes of renal tubules.

At middle concentration of lambda-cyhalothrin (0.008 ppm), vacuolization, haemorrhage, intercellular spaces formation, disorganization and degeneration of glomerulus were identified (Fig. 4). The kidney of *E.suratensis* exposed to sub-lethal concentrations of lambda-cyhalothrin (0.013 ppm and 0.026 ppm) histological alternations like swelling of glomerular cells, ruptered of kidney cells, damaged glomerulus, vacuolization, pycnotic nuclei, degeneration of glomerulus, dilation in the capillary tubes of renal tubules and necrosis leading to the complete necrosis were noticed (Figs. 5 and 6).

## 4. DISCUSSION

Kidney is an important organ of excretion and osmoregulation and is highly susceptible to toxic substance because of its high blood supply. In fish, as in higher vertebrates, the kidney performs an important function to maintain the homeostasis. The kidney is one of the first organs to be effected by contaminants in water (Thophon *et al.,* 2003). The major alternations found in the kidney of *E. suratensis* exposed to lambda-cyhalothrin are degeneration and atrophy of renal tubules, vacuolization, collapsing glomeruli, congestion of cells, necrosis, haemorrhage, intercellular spaces formation, disorganization and degeneration of glomerulus, swelling of glomerular cells, damaged glomerulus, pycnotic nuclei and dilation in the capillary tubes of renal tubules. All these changes were brought about by pesticide intoxication because kidney is an important organ for the filtration of blood (Radhakrishnan Nair, 2002). Similar results were reported in the severe necrosis, vacuoles around renal tubule and haemorrhage in histological section of the kidney of *C. mrigala* were observed when it exposed to fenvalerate (Anitha Susan and Tilak, 2003).

Pathological changes have earlier been reported in the kidney of fishes exposed to various pollutants (Banerjee and Bhatacharya, 1994). According to Mohamed (2009) the exposure of fish to pollutants, that is agricultural and industrial chemicals, resulted in several pathological changes in different tissues of fish. Cengiz (2006) observed degeneration in the renal tubule, pycnotic nuclei in the hematopoietic tissue and degeneration of glomerulus. Similar alterations in the kidney have also been reported in Nile Tilapia exposed to ammonia (Benli *et al.,* 2008).

The dilation of the kidney tubules, degeneration in kidney tissue, rupture in the collecting tubules and necrosis as observed in the present investigation after lambda-cyhalothrin treatment have also been reported in various fish exposed to various pollutants (Sukumar and Karpagaganapathy, 1986; Gill *et al*., 1988; Vardhani and Gowri, 2002). According to Dubale and Shah (1981) the process of destruction is a function of dosage and period of exposure and they opined that the renal tubules of kidney are the first to be affected by pesticide stress. Rashatwar and Ilyas (1984) reported the histolopathological changes in kidney to lead to cloudy swelling of renal tubules in *Nemachellus denisoni* acutely exposed to phosphamidon.

In the present study, kidney of the fish often showed vacuolar degeneration (cloudy swelling) in tubules cells, characterized by the hypertrophy of the cells. In more severe cases, the degenerative process leads to tissue necrosis. The necrosis of the renal tubules affects the metabolic activities and promotes metabolic abnormalities in fish (Yokote, 1982). All these changes were brought about by pesticide intoxication because kidney is an important target organ for the filtration of blood. The present study was supported by various authors like King (1962) and Singh and Sahai (1986). Heptachlor also produced abnormality in the kidney tubules in *L. rohita* (Konar, 1970). Nephrotoxic lesion including degenerative changes in tubular epithelium, dilation of tubular lumina proteinaceous or cellular cast within tubular lumina, tubular necrosis, shrinkage of glomeruli, microvacuolar and degeneration was reported by Nestel and Budd (1975).

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# STUDY OF ANTIMICROBIAL ACTIVITY OF SEAWEED

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## ABSTRACT

In this study *Gracilaria edilis*, *sargassam* and *Padina gymnospora* from Raameshwaram sea, Tamil Nadu were collected, identified and tested against various pathogenic bacteria. In Antibacterial assay Acetone shows the maximum number of activity against the Salmonella typi (32mm) length of inhibtions occurred and Acetone shows the minimum activity against *Klebsiella pneumonia* (18mm) of the inhibition level. Under the Antifungal assay Acetone shows the maximum activity against the *penicillium.sp*, (10mm) of the inhibition. Acetone shows the moderate activity against the *Aspergillus niger* (5mm) of inhibition and the minimum activity in candida sp,. (8mm) of inhibition zone level.

**Keywords:** Seaweeds, Antibacterial activity and Antifungal activity

## 1. INTRODUCTION

Seaweeds are a marine algae is a potential source of bioactive substances. Seaweeds have been traditionally used in human and animal nutrition. Seaweeds are rich source of bioactive compounds. Important polysaccharides such as agar, alginates and carrageenans obtained from seaweeds are used in pharmaceutical as well as in the food industries. Although most of the antibiotics found from terrestrial sources are used as therapeutic agents to treat various diseases, the oceans have enormous biodiversity and potential to provide novel compounds with commercial value. Use of antimicrobial drugs has certain limitations due to changing patterns of resistance in pathogens and side effects they produce. These limitations demand for improved pharmacokinetic properties which necessitates continued research for the search of new antimicrobial compounds for the development of drugs.

Hence, the present study the antimicrobial activities of red and brown algae using different solvents were investigated. The presence of nutrients, epithelial debris, and secretions makes the oral cavity a favorable habitat for a great variety of oral bacteria like Streptococci, Lactobacilli,Staphylococci, Cornybacteria, and with a great number of anaerobes, especially Seaweeds are considered as a source of bioactive compounds with cytostatic, antiviral, anti helminthic, antifungal and antibacterial activities. They have also been used to treat some diseases like cancer, arthritis etc. Seaweeds are the renewable living sources which are also used as food, feed and fertilizer in many parts of the world. They have been screened extensively to isolate life saving drugs or biologically active substances all over the world.

### *1.1. Herbivores*

Grazer induced mechanical damage triggers the production of chemicals that acts as feeding detergents or toxins in seaweeds most of the secondary metabolites produced by seaweeds have bacteriological or the antimicrobial compounds derived from seaweeds consists of divers group of bacteriostatic properties. Phillippines as the world's largest seaweed producer by 2011. Production was hit 10 million tones.

### *1.2. Herbalism*

Alginates are commonly used in wound dressing and production of dental moulds. Seaweeds are a source of iodine necessary for thyroid function and to prevent goiter. Tuberculosis, arthritis, colds and influenza tumors.

### *1.3. Fertilizers*

The strong photo synthesis of algae creates a large affinity for nutrients. Such as ammonia, nitrate, phosphate, iron, copper. Reefs and lakes are naturally filtered this way. This filterable process is duplicated in man-made seaweed filters such as algae scrubbers.

Micro algae required more processing to separate it from the water than macro algae does. Macro algae are simply pulled out. Compost for landscaping or means of combating beach erosion through burial in beach dunes ingredient: - Tooth

paste, cosmetics and paints. Sulphated saccharides from both red & green algae have been known to inhibit some DNA & RNA enveloped.

*1.4. Healthy risks*

Rotting seaweeds sources of hydrogen sulphide. A highly toxic gas. It can cause vomiting & diarrhea.

*1.5. Fucus*

Brown, in intertidal zones on rocky shores. Fucus vesiculosus is the scientific name of brown seaweed. Commercially available varieties of marine macro algae are commonly refered to as seaweeds. Macro algae can be classified as green algae (chlorophyta), brown algae (phaeophyta) and red algae (rhodophyta), depending on their nutrient and chemical composition. Red and brown algae are mainly used as human food sources.Seaweeds serve as an important source of bioactive natural substances.

Asia diet for centuries as it contains carotenoids, dietary fibres, proteins, essential fatty acids, vitamins and minerals. Marine algae are exploited mainly for the industrial production of phycocolloids such as agar-agar, alginate and carrageenan, not for health aspects.

## 2. MATERIALS AND METHODS

*2.1. Collection of seaweeds*

The samples of *Grasillariya edilis*, *P. gymnospora* ,Sargassam, Ulva were collected by handpicking at Raameshvaram sea. The collected samples were cleaned well with seawater to remove all the extraneous matter such as epiphytes, sand particles, pebbles and shells and brought to the laboratory in plastic bags. The plastic bags should be sterilized .The samples were then thoroughly washed with freshwater, blotted and spread out at room temperature for drying. Shade dried samples were grounded to fine powder with the use of any mixer grinder. The powdered samples were then stored in refrigerator for further use.

*2.2. Preparation of samples*

The dried seaweed materials were blended into a coarse powder before extraction portions of the powdered samples (3.5 g) and packed in Soxhlet apparatus and extracted successively with acetone for 8 ml of this solvents. The crude extracts were weighed and deep frozen (-20 °C) until tested.

*2.3. Microbial strains*

Bacterial strains used for assay were as following: *Klebsiella pneumoniae, Salmonella* sp.,While fungal strains were *Aspergillus niger, Candida albicans, Penicillium* sp. Microbial strains were obtained from the Department of biotechnology, Kongunadu Arts and Science college coimbatore. The bacterial stock cultures were maintained on Mueller Hinton Agar medium at 4 °C. Fungal cultures were maintained on Potato Dextrose Agar medium at 4°C.

*2.4. Antibacterial assay*

The antimicrobial activities were carried using the agar disc diffusion method Paper disc of 6 mm in diameter was prepared from Whattman No. 1 filter paper. The antibacterial assay using the agar plate method. The bacterial inoculation was grown in nutrient broth overnight and a fixed volume was inoculated into 10 ml aliquots nutrient agar, mixed and then poured over a nutrient agar base in sterile petri dishes; this formed the bacterial lawn. Initially both paper discs and well were used for testing the crude extracts. The paper disc of 6 mm in diameter was soaked in 6 µL of crude extract and placed onto the bacterial lawn after it had solidified, standard antibiotic disc used for control. The plates were incubated at 37 °C overnight. The zones of inhibition were measured after the 24 hrs incubation.

*2.4.1. Antifungal assay*

The same method was followed by this method by using the fungal strains. It was carried out using the agar plate method. The bacterial inoculation was grown in nutrient broth overnight and a fixed volume was inoculated into 10ml aliquots nutrient agar, mixed and then poured over a nutrient agar base in sterile petri dishes this formed the fungal lawn. The paper disc of 6 mm in diameter was soaked in 6 µl of crude extract and placed onto the lawn after it had solidified, standard antibiotic disc used for control. The plates were incubated at 37 °C overnight. The zones of inhibition were measured after the 24 hrs incubation.

## 3. RESULTS AND DISCUSSION

*3.1. Antibacterial assay*

*3.1.1. Padina gymnospora*

The acetone extracts showed a maximum activity against *Salmonella* sp. (32mm) of the inhibitory level and the minimum activity against klebsiella pneumonia(18mm)of inhibitory level.

*3.2. Antifungal assay*

*3.2.1. Padina gymnospora*

Acetone shows the maximum activity in penicillium.sp. (10mm) and moderate activity in penicillium sp. agaist Aspergillus niger (5mm)of inhibitory level .Acetone shows the minimum activity in Candida albicans (8mm)of inhibitory level.

The antimicrobial activity of seaweeds may be influenced by some factors such as the habitat and the season of algal collection, different growth stages of plant, experimental methods, etc., In this study *Gracilaria edilis*, *sargassam* and *padina gymnospora* from Raameshvaram sea and, Tamil Nadu were collected, identified and tested against various pathogenic bacteria. It was found that the acetone extracts of *padina gymnospora* showed maximum activity (32 mm) against salmonella typi (Table 1) and minimum activity was shown by acetone extracts against *Klebsiella pnuemonia* (18mm). The solvent system used for the extraction played a major role in displaying the antibacterial activity. Acetone were suitable solvent for extracting the antibiotic principle. However, there are reports that indicate maximum activity in acetone extracts.

**Table 1. Antibacterial activity of *Padina gymnospora* against human pathogens.**

| Pathogen | Acetone |
|---|---|
| *Klebsiella pneumonia* | 18 mm |
| *Salmonella typhi* | 32mm |

**Table 2. Antifungal activity against the *Padina gymnospora* seaweed**

| Pathogen | Acetone |
|---|---|
| *Aspergillus niger* | 5mm |
| *Candida albicans* | 8mm |
| *Penicillium sp.* | 10mm |

Hence the efficiency of acetone in the extraction of seaweeds is also doing in the antifungal activity against the *Aspergillus niger, Candida albicans*, and *penicillium.sp.,* it was found that the acetone extracts of *padina gymnospora* showed maximum activity (10mm) in penicillium sp.,and the minimum activity showed (5mm) in *Aspergillus niger*, then the moderate amount of avtivity showed (8mm) in candida albicans. Acetone was found to be the best solvent for extracting the active principles in almost all species of seaweeds. Antibacterial activities of seaweeds also varied with the species division. The reason for this was not explained by these workers but it was suggested that more species have to be screened before coming to definite conclusion. In the present study, the species of *Chlorophyta* showed the strongest activities against the test bacteria which was in agreement with the findings of Padmakumar and Ayyakannu. It may be probably due to the tested seaweeds vertical distribution. Green algae mostly occur in the intertidal zone lower region, which may be advantage for the protection of the active compounds within the algal plant from degradation.The padina gymnospora showed minimum activity against *Klebsiella* (18 mm) when acetone was used as a solvent (Table 1) and maximum against Salmonella typhi in acetone extract.

The results from the present screening revealed that the strongest antibacterial activity was exhibited by the methanol extract and the least by the chloroform and petroleum ether. In some species (*Gelidium amansii*) the inhibitory activity was only observed in the extract obtained with one kind of solvent but not in extracts obtained in other solvents, which may suggest that a particular solvent is required to extract some antimicrobial substances within the algal plant and therefore the percentage of inhibitory activity will go up when several solvents are used in the screening.

Selvi and Selvaraj, (2003) screened around 20 algae using methanol and ethanol along Idinthakarai coast and they reported that *Bacillus subtilis* and *Staphylococcus sp.,*were highly susceptible to most of the algal extracts. In the present investigation the ethanol extract showed less activity against Staphylococcus sp.,

Thirumaran *et al*., (2009) reported that antibacterial activity of marine macro alga Dictyota dichotoma from Gulf of Mannar coast, the maximum activity was noted in diethyl ether extracts against *Salmonella paratyphii*. Thirumaran *et al*., (2009) screened the antimicrobial activity of Hydroclathrus clathratus using methanol extracts along the Gulf of Mannar Coast and reported that Pseudomonas aeruginosa were more susceptible than the other extracts.

Taskin *et al.*, (2001), studied the antibacterial activity of methanolic extracts of 6

marine algae, 3 gram positive and 3 gram negative in vitro. They observed a highest inhibition activity by *Corallina officinalis* against *Enterobacter aerogenes*. Bansemir *et al.,*(2006) investigated 26 algal species for their antimicrobial activity by 3 different extracts like dichloromethane, methanol and water. Highest activity was found in dichloromethane extracts. Seenivasan. *et al.,*(2011) performed antibacterial activity studies invitro with 3 extracts namely acetone, methanol and ethanol. They observed that Ulva fasciata in selective media produced good results against E.coli. Cox *et al.,* (2000) screened the antimicrobial activity of 6 species of edible Irish seaweeds. All methanolic extracts of seaweeds inhibited food spoilage and food pathogenic bacteria tested such as Listeria monocytogenes, Salmonella abony, Enterococcus faecalis and Pseudomonas aerogenosa. They found that dried methanolic extracts of red and green seaweeds had significantly lower antimicrobial activity than brown seaweeds. Red and green seaweed extracts showed significantly high antimicrobial activity.

In the present result, the Antimicrobial activity against the *salmonella typhi* (32mm) length of the inhibtions occurred and Acetone shows the minimum activity against *Klebsiella pneumonia* (18mm) of the inhibition level. Under the Antifungal assay Acetone shows the maximum activity against the *penicillium.sp*, (10mm)of the inhibition. Acetone shows the moderate activity against the *Aspergillus niger* (5mm)of inhibition and the minimum activity in *candida sp,.(*8mm) of inhibition zone level.

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# ANTIBACTERIAL ACTIVITY OF EARTHWORMS' COELOMIC FLUID

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## ABSTRACT

This study was carried out with an objective to investigate the antibacterial potentials of earthworm coelomic fluid. The aim of the study is to assess the antimicrobial activity and to determine the zone of inhibition of coelomic fluid of some bacterial and strains. In the present study, the microbial activity was evaluated for potential antimicrobial activity against medically important bacterial strains. The antimicrobial activity of coelomic fluid was determined using agar disc diffusion method. The results showed that the remarkable inhibition of the bacterial growth was shown against the tested organisms. Hence, these coelomic fluids can be used to discover bioactive natural products that may serve as leads in the development of new pharmaceuticals research activities

**Keywords**: Earthworm, Coelomic fluid, Antibacterial activity, Zone of Inhibition.

## 1. INTRODUCTION

Antimicrobial agents are essentially important in reducing the global burden of infectious diseases. However, as resistant pathogens develop and spread, the effectiveness of the antibiotics is diminished. This type of bacterial resistance to the antimicrobial agents poses a very serious threat to public health, and for all kinds of antibiotics, including the major last-resort drugs, the frequencies of resistance are increasing worldwide. Therefore, alternative antimicrobial strategies are need urgently and this situation has led to a re-evaluation of the therapeutic use of ancient remedies.

Earthworms belong to the phylum Annelida class oligochaetea and evolved in last Precambrian period. Earthworms are nocturnal soft-bodied saprotropic invertebrates of agro ecosystem and also one of the major macro fauna of the soil. They occupy a very unique position in the Animal kingdom and that have successfully invaded the terrestrial habitats. The body of earthworm is divided into a serious of uniformly placed segments (annuli). This nature of division of the body both externally and internally has enabled animal to have flexibility and for the initiation of development of good musculature. Earthworms are the first group of animals to have complete digestive system, closed circulatory system with haemoglobin in the plasma as carrier of oxygen and carbon di oxide with a true coelom of mesenchymal origin. Earthworms contain high levels of protein and essential amino acids. It has been proved in feeding trials that earthworm protein is worthy of being exploited as a new animal protein source, which has led to earthworm production on an industrial scale in many developed countries.

The novel antimicrobial short peptide was purified from earthworm (*Eisenia fetida*) by a five-step protocol including ammonium sulfate precipitation, ultra filtration, DE-52 ion exchange chromatography, Sephadex G-10 column chromatography, and C-18 reversed-phase HPLC techniques. The purified peptide was applied to the MALDI-TOP MS to determine the molecular mass and was also subjected to TOF MS-MS analysis to determine the amino acid sequence. As a result a novel antibacterial peptide, named OEP 3121 was obtained with the molecular mars at 5108 Da and the sequence being ACSAG. The immune system is increasingly being studied from comparative perspectives. The analysis at the immune defense system of invertebrates, such as fruit flies and earthworms, is an important effort and these systems are innate, natural non-specific, non-anticipatory and non-clonal. This is in contrast to the macrophage T and B systems that characterize vertebrate adaptive immunity whose properties can be categorized as adaptive, induced specific and anticipatory Cooper *et al.* (2002). In this chapter, we will focus on the earthworm system. Earthworms, like other complex invertebrates, possess several leukocyte types and synthesize and secrete a variety at immuno protective molecule.

The coelomic cavity is metameric and the segments are separated by transversal septa. Regulated transport of the coelomic fluid and coelomocytes between neighboring segments is

ensured by channels comprised of sphincters within the septa. Each segment of the coelomic cavity is opened to the outer environment by paired nephridia and by one dorsal pore through which 9soluble metabolites and corpuscular materials can be excreted or expelled. The coelomic fluid is generally secreted by the earthworm for maintaining the moisture and to help in its physiological activities including respiration and burrowing. However, the animal was facilitated to secrete this fluid by giving external stimuli like rise or drop in temperature or by applying external voltage. There are a number of reports for the collection of coelomic fluid by applying electric stimulation or by cold shock method.

## 2. MATERIALS AND METHODS

### *2.1. Sample collection*

Earthworms were collected from the soil of different habitats by digging and hand sorting method and identified. Coelomic fluid can be directly collected from the body cavity of earthworms without causing any harm to them. In this method of collecting the coelomic fluid, five to six earthworms are taken in an approximately 10cm diameter Petri plate and holding the plates in a slanting position and keep earthworms pointing downwards. Cold shock is given to earthworm by gently moving a small beaker containing a few ice cubes. The coelomic fluid released due to cold shock drips and gets collected at the lower side of the Petri plate. This fluid can be pipette out using a sterilized pipette with fine nozzle. This is the pure coelomic fluid that can be used for different biological investigations.

### *2.2. Antibacterial activity*

Antibacterial potential of the precipitated protein, from earthworm coelomic fluid was used to elucidate the activity by agar well diffusion method

## 3. RESULTS

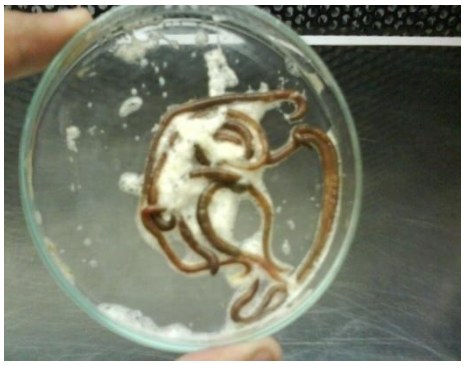
### *3.1. Antibacterial activity*

The antibacterial activity of the sample was checked against gram positive and gram-negative bacteria and it was found that it had a vast range of activity against those human pathogens (Fig. 1). The Zone of inhibition against different human pathogens was listed in Table 1. The present work is supposed to be the first extensive work in antimicrobial activity of Indian earthworm species. To test the antimicrobial activity of coelomic fluid, the inhibition zone formation around the coelomic fluid was noted and measured the diameter of that inhibition zone range. The antimicrobial activity of earthworm coelomic fluid, *Drawida scandens* and *Drawida sulcata* were confined against disease causing microorganism namely, *Vibrio para haemolyticus* and *Bacillus subtillus* through the range of inhibition zone formation.

| Name of the species | *Vibrio para haemolyticus* | *Bacillus subtillus* |
|---|---|---|
| *Drawida scandens* | 0.3cm | 1.6 cm |
| *Drawida sulcata* | 0.5cm | 0.8 cm |

The antimicrobial activity of earthworm coelomic fluid *Drawida scandens* and *Drawida sulcata* were confined through the inhibition zone formation ranging at range 0.3- 1.6 cm and 0.5 – 0.8 cm respectively. The antimicrobial activity in the coelomic fluid of earthworm may be because of innate immune mechanism and detect microorganism by recognizing conserved molecular pattern.

**Fig 1. Collection of earthworm Coelomic fluid**



## 4. DISCUSSION

During the 700 million years of their existence, EWs have evolved in the environment replete with microorganisms, some of which threaten their existence, therefore they have developed efficient defense mechanisms against invading microorganisms. There is a variety of relationships between EW and microbes: (1) microbe as food for earthworm, (2) microbes as nutritive material for growth and reproduction, (3) microbes-mostly Gram positive, pathogenic are digested by EW and thereby facilitate multiplication of useful microbes in the gut and (5) microbes are distributed to new places in soil.

The molecules which defend the EWs from microbes have been detected in the celomic fluid of *Lumbricus* and *Eisenia* . This activity is attributed to

some proteins, such as lysozyme and fetidins . Few reports are also available regarding antimicrobial agents from EWs tissue.

Several bioactive proteins have been found in the coelomic fluid of earthworms. These proteins exhibit a variety of antibacterial, hemolytic, cytotoxic, hemagglutinating; and proteolytic activities, and the biological and chemical nature of the compounds responsible for such activities has been studied extensively, for more than 2 decades .

Current researches in many countries on the identification, isolation and synthesis of some 'bioactive compounds' from earthworms with potential medicinal values have brought revolution in the vermiculture studies (Cooper *et al.,* 1999; Cho *et al.,* 2004). It has been found that coelomic fluid of the earthworms contains more than 40 proteins and exhibits several biological activities including cytolysis, proteolysis, antimicrobial, hemolysis, hemagglutination, tumorolysis and mitogenic (Cooper *et al.,* 2002). Earthworm coelomic fluid contains biologically active molecules and leukocytes that participate in phagocytosis, encapsulation and killing of HeLa, HEp-2, PC-12 and PA317 cells in vitro. The earthworm first line of defense also consists of various substances which are synthesized and secreted along with the coelomic fluid. These substances include lysozymes, agglutinins and *fetidins* which can affect mitogenesis as well as induce agglutination and lysis of bacteria.

The first haemolytic proteins were named *Eisenia fetida andrei* factors and characterized as two glycoproteins secreted by chloragocytes and eleocytes (Balamurugan, 2007). A protein of molecular weight, 42kDa namely, coelomic cytolytic factor was identified from *Eisenia fetida.* It is involved in the activation of pro-phenol oxidase cascade via recognition of Gram-negative bacterial cell wall molecules, such as glucan and lipopolysaccharide. Fetidins are potentially interesting hemolytic and antibacterial proteins secreted by chloragocytes of annelids. The fetidin system, which was originally described as a hemolytic factor, consists of two distinct glycosylated proteins of 40 kDa and 45 kDa. The fetidins of *Eisenia fetida* are responsible for cytolysis, antibacterial reaction and clotting . Another protein of molecular weight 38kDa referred to as Eiseniapore, was isolated from *Eisenia fetida* and it exhibited a strong lytic activity against erythrocytes.

The Earthworm (phylum *Annelida*) is one of the first organisms in the evolution that possess immunological recognition and memory. The EWs like the other complex invertebrates produce several types of leukocytes and synthesize and secrete the variety of immune-protective molecules. They possess innate immunity, as well as some functions associated with the adaptive immunity Cooper *et al*., 1999). The celomocytes involved in innate immunity, play a central role in the earthworm immune system (phagocytosis, releasing of lytic factors. The earthworm celomocyte cells also provide immune functions and possess several CD markers (CD11, CD24, CD45RA, CD45RO, CD49b, CD54 and CD90) associated with innate immunity. Immuno-protective molecules synthesized and secreted from celomocytes induce agglutination, opsonisation and lysis of foreign material.

The studies of different authors have also indicated that the coelomic fluid of earthworm exhibits other biological functions, including bacteriostatic , proteolytic, cytolytic (hemolytic), mitogen activity and antitumor activity against the human hepatoma cells *in vitro* and *in vivo* (Chen *et al*., 2007; Bilej *et al*., 1995; Chen *et al*., 2001.

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# EFFECT OF INDOLE -3- ACETIC ACID ON CALLUS INDUCTION FROM LEAF EXPLANT OF *OCIMUM BASILICUM* LINN.

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## ABSTRACT

*Ocimum basilicum* L. belongs to the family Lamiaceae; contains plenty of phytochemicals with significant nutritional as well as health benefits. Antioxidant activity of methanol extract of *Ocimum basilicum* callus was evaluated using various antioxidant assays. Proliferated callus was obtained on half-strength MS media supplemented with 1.40µM IAA. The callus extract showed considerable DPPH radical scavenging, hydroxyl radical scavenging and ferrous ion chelation activity with $IC_{50}$ value of 16.05, 170.7 and 29.16µg/mL respectively.

**Keywords:** *Ocimum basilicum,* Lamiaceace, *in vitro* callus production, free radical scavenging activity.

## 1. INTRODUCTION

*Ocimum basilicum* L. commonly called as Sweet Basil belongs to the family Lamiaceace is a native plant of Indo Malayan region. It is called the "king of herbs" which contains plenty of phytochemicals with significant nutritional as well as health benefits (Jayasinghe *et al.*, 2003). Sweet basil is cultivated for production of essential oils, dry leaves as a culinary herb, condiment/spice or as an ornamental plant (Zheljazkov *et al.*, 2007). Sweet Basil has shown unique health protecting effects due to its important flavonoids and volatile oils. The unique array of active constituents called flavonoids found in basil provides protection at cellular level. Orientin and vicenin are two water soluble flavonoids that have been of particular interest in basil (Nyak and Uma, 2005). Aromatic leaves and flowering parts of *O. basilicum*are traditionally used as stimulant and tonic in folk remedies to treat various ailments such as poor digestion, stomach ache, feverish illnesses, nausea, abdominal cramps, gastro enteritis, migraine, insomnia, depression, gonorrhoea, dysentery and chronic diarrhoea exhaustion (Chopra *et al.*, 1986). Externally, they have been applied for the treatment of acne, insect stings, snake bites and skin infections (Martin and Ernst, 2004).

## 2. MATERIALS AND METHODS

### *2.1. Tissue culture studies*

#### *2.1.1. Explants selection and mode of sterilization*

Leaf explants were collected from actively growing plants and washed thoroughly in running tap water followed by Teepol treatment for 5-10 min.The explants were subsequently surface sterilized with 0.1% (w/v) mercuric chloride solution for 2-3 min and washed 3-4 times with sterile double distilled water for duration of 15 min with an interval of 5 min for each wash.

#### *2.1.2. Method of media preparation*

MS (Murashige and Skoog) medium (half strength) was employed in the present study. For the preparation of medium only analytical reagents of "Hi-media" grade chemicals and Borosil glassware's were used. Double distilled water was used for preparing the media. The nutrient media basically consists of inorganic salts, carbon source, vitamins and amino acids. Stock solutions were prepared separately for macronutrients, micronutrients, iron, potassium iodide and vitamins. All the chemicals were weighed accurately in electronic weighing machine (And Electronic balance, ER-182 A). All the stock solutions were poured in to well stoppered sterilized bottles and preserved in a refrigerator at 4$^{o}$C. Specific quantity of the stock solutions and growth regulators were pipetted onto a little beaker. The final volume was made up to one litrewith distilled water.

To the above said media, 3% sucrose was added and pH was adjusted to 5.8 with either 0.1N NaOH or 0.1N HCl using a pH meter (ELICO), further 0.8% agar (extra pure gelling point 32-35°C, Hi media, Bombay) was added, melted in a water bath and the medium was dispensed into 25 mL (25 x 150 mm) test tubes (10-15 mL medium). The tubes after covering with cotton plug were autoclaved at 1.06 kg pressure/sq cm for about 20min at 121°C. The autoclaved medium in the culture tubes were cooled and allowed to solidify as slants and were stored at 25ºC in the dark for future use. The inoculation was done after five days to ensure that the tubes were free from contamination.

*2.2.3. Growth regulator and its preparation*

Growth regulatornamely indole 3-acetic acid was used in the experiments. The growth regulator was stored at 4° C until use.

*a) Auxins and their preparation*

Auxin namelyindole 3-acetic acid (IAA) was used in this experiments. The stock solution was prepared by dissolving 10 mg of IAA in 1mL of ethanol.Then the volume was made up to 100 mL with sterile double distilled water and different concentrations (0.28 - 2.8 µM) were used.

*2.2.4. Culture conditions*

The cultures were maintained at 25±2°C under a 16 hr photoperiod of 50-60 µ mol $m^{-2}$ $S^{-1}$ flux intensity provided by cool white fluorescent tubes. Each treatment consisted of five replicates and experiment was repeated thrice.

*2.2.5. Callus induction*

Leaf explants were used for callus induction on MS (half strength)medium supplemented with various concentrations of IAA (0.28 - 2.8 µM)individually. Percentage of callus induction was recorded after 15 days of culture.

*2.2.6. RAPD analysis*

DNA isolation was performed with modified protocol of Padmalatha and Prasad (2006). Freshly collected leaf and callus sample (both *in vivo* and *in vitro*respectively) was ground in CTAB extraction solution using a mortar and pestle along with 0.1% of PVP. The pulverized leaves were quickly transferred to centrifuge tubes. The tubes were incubated at 65° C in hot air oven or water bath for 60-90 min with intermittent shaking and swirling for every 30 min. Equal volume of chloroform: isoamylalcohol (24:1) was added and mixed properly by inversion for 30 min and centrifuged at 12,000 rpm for 15 min at room temperature. The supernatant was carefully decanted and transferred to a new tube. $1/10^{th}$ volume of CTAB/NaCl solution was added and mixed by inversion. Chloroform: isoamylalcohol extraction step was repeated. Aqueous phase was transferred to fresh tubes and equal volume of CTAB precipitation solution was added and centrifuged at 3000 rpm for 5 min at 4ºC. Supernatant was removed and the pellet was washed with high salt TE buffer. 0.6 mL of isopropanol was added and centrifuged at 10,000 rpm for 15 min at 4°C. Supernatant was removed and the pellet was washed with 70% ethanol, centrifuged at 10,000 rpm for 2 min at 4º C. Supernatant was removed and air dried the pellet. The pellet was resuspended in TE buffer.

*2.2.6.1. Preparation of Agarose gel*

Agarose gel (1.5%) was prepared by adding 0.75 g of agarose (low EEO grade, HiMedia, India) in 50 mL of 1X TAE buffer. It was heated to dissolve agarose. Ethidium bromide (0.5 mg/mL) was added, mixed well and poured into the gel casting platform with well former. The gel was allowed to polymerize at room temperature.

*2.2.6.2. PCR amplification*

The extracted DNA was amplified using PCR technique in the Eppendorf gradient thermal cycler with the aim of studying genetic variability of *in vitro* callus of *O.basilicum*. The genomic DNA was amplified using four primers. Each primer is a 10-mer of arbitrary sequence: 1(5'-TGCCGAGCTG-3'), 2(5'-TCGTTCCGCA-3'), 3(5'-CACCTTTCCC-3'), and 4(5'-GTGCAACGTG-3') (GE healthcare, UK). PCR amplification was performed in 20µL reaction mix containing 40 ng genomic DNA for 45 cycles. The following conditions were followed: i) 92ºC initial denaturation for 5 min, ii) 92º C denaturation step for 30 s,iii) 33º C, 33.6º C, 32.5º C and 32º C annealing for 1 min for each primer respectively and iv)72ºC extension for 2 min followed by a final extension of 72° C for 5 min. Reactions were carried out in a volume of 20 µL containing 10 µL of PCR master mix (2x) (Merck Specialties, Mumbai) solution with 4 µL of nuclease free water, 3 µL of primer and 3 µl of template DNA. The final product was separated and visualized using agarose gel electrophoresis.

*2.2.6.3. Electrophoresis of genomic DNA*

The PCR product was separated by horizontal electrophoresis through 1.5% agarose gel

mixed with ethidium bromide (0.5 mg/mL) for 45 min at 50 V in tris acetate EDTA buffer (40 mM Tris; 2 mM EDTA; 20 mM Glacial acetic acid pH8) (Sambrook*et al*., 2001). The samples were mixed well with loading dye (1:1) and the samples were gently loaded on to the wells using a disposable micropipette tip. The bands were visualized using gel documentation system (Biorad, Italy).

## 3. RESULTS AND DISCUSSION

### *3.1. Callus induction*

Leaf explant of *Ocimum basilicum* was cultured on half strength MS medium supplemented with IAA at different concentrations. Medium devoid of hormone did not show any response on callus induction. The inoculated leaf explants of *O. basilicum* on medium containing IAA induced callus after a week of culture. Out of ten different concentrations tested, 0.28 µM failed to induce callus. Good callus proliferation was observed on medium containing 0.56 µM to 1.40 µM IAA. Formation of anthocyanin like pigments from callus was recorded at concentration 0.84 µM and 1.12 µM IAA (Fig. 1). Root induction was observed with increase in concentration (Fig. 2). *In vitro* culture of medicinal plants (Shohael *et al.,*2006; Shin *et al.,*2008; Jeong *et al.,*2009; Park *et al.,*2012) with the objective to isolate secondary metabolites or altering or enhancing the concentration of secondary metabolites (Schijlen *et al.,*2006, Dorais *et al.,*2008) has been well established.Owing to callus itself had the ability to produce secondary metabolites, plant tissue culturists use this capacity to gain many useful chemicals via callus culture *in vitro* such as flavor and fragrance, pigment and pharmaceutical compounds (Ram *et al*., 2011).

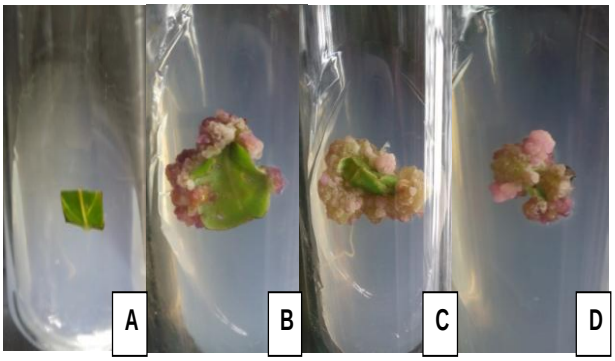


**Fig. 1. Formation of Anthocyanin like pigments on Callus.**

In the present study, *O. basilicum* callus induced on the MS medium containing lower concentrations of IAA released anthocyanins. This result indicated that plant growth regulator is necessary for the production of valuable secondary metabolites.

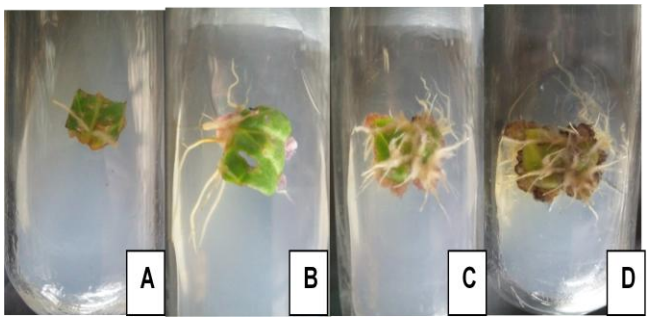


**Fig. 2. Root induction from Leaf explants**

### *3.2. RAPD analysis*

The genetic level variation of *in vitro* developed callus was accessed through RAPD analysis (Fig 3). The result of RAPD analysis indicates *in vitro* developed callus was slightly polymorphic. The polymorphic banding pattern possibly indicates that there was a genetic level variation.

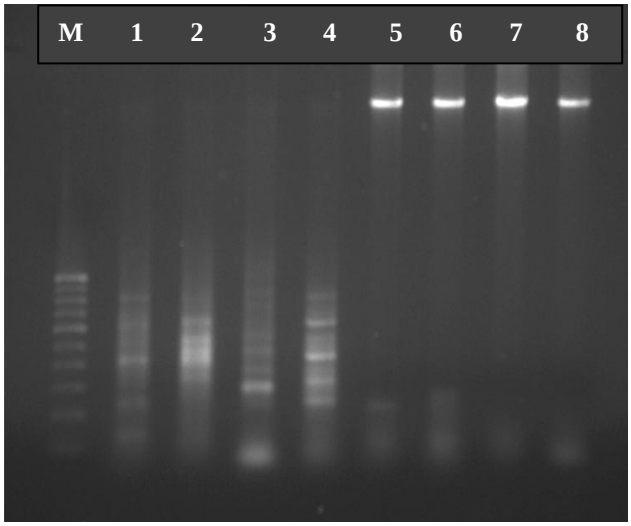


**Fig. 3: RAPD analysis of *in vitro* callus.**

Random amplified polymorphic DNA (RAPD) markers have proved to be very useful tool providing a convenient and rapid assessment of the genetic differences between genotypes (Williams *et al*., 1990). Moreover, RAPD use arbitrary primers that provide a large number of multilocus markers and can be applied to analyze almost any organism even those for which no previous genetic or molecular information are available. RAPD is referred as an appropriate tool for certification of genetic fidelity of *in vitro* propagated plants (Gupta

and Rao, 2002). The polymorphic banding pattern in the callus of *O. basilicum*possibly indicates that there is a negligible level of genetic variation. Bernhardt *et al*. (2014) have evaluated the RAPD banding pattern of eight different *O. basilicum* gene bank accessions and have reported similar result. Anamika *et al*. (2010) reported the same condition in *Pogostemoncablin*. Rady and Nazif (2005) reported that *in vitro* shoots of *O. americanum* gave polymorphic bands by using the random primers.

The current outcome for *O. basilicum* pointed out that IAA exactly had the influence on the antioxidant property of the callus. Similar results for antioxidant activity of *O. basilicum*have been reported in the literature (Javanmardi *et al*., 2003; Seung-Joo Lee *et al*., 2004; Politeo *et al*., 2007; Gulcin *et al*., 2007).

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# ALLELOPATHIC INFLUENCE OF *CYPERUS ROTUNDUS* L. *AND CYNODAN DACTYLON* L. ON PHYSICO- CHEMICAL AND BIOLOGICAL PROPERTIES OF SOIL

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## ABSTRACT

In agricultural systems, allelopathy can be part of the interference between crops and between crops and weeds through soil mediated mechanism and thereby affecting the economical outcome of the plant production. Allelopathic influence of various concentrations of aqueous extracts of two weed species ie.*Cyperusrotundus L.* and *Cynodan dactylon* L. were assessed on physico-chemical and biological properties of rice seedlings grown experimental pot soil. The results revealed that the percentage of NPK levels was minimum in the lower concentrations of two weed extracts than their higher concentration. Among NPK contents, the nitrogen was found higher percentage followed by potassium and phosphorus in all the experimental soil. The population of bacterial, fungi, actinomycetes and total microbial populations were gradually decreased with increasing the concentration of weed extracts and more reduction on microbes was found in *C.rotundus* than *C.dactylon* applied soil

**Keywords:** Allelopathic influence, *Cyperus rotundus, Cynodan dactylon.*

## 1. INTRODUCTION

Chemicals released from plants and imposing allelopathic influences are termed allelochemicals or allelochemics. Most allelochemicals are classified as secondary metabolites and are produced as offshoots of the primary metabolic pathways of the plant. Allelochemicals can be present in several parts of plants including roots, rhizomes, leaves, stems, pollen, seeds and flowers. These are released into the environment by root exudation, leaching, volatilization and/or by decomposition of above ground and underground plant parts.Root exudates are released directly from intact live plant roots into its surroundings (Rovira, 1969). Their volume is small i.e. 2-12 % of the total gross photosynthates (Grodzinsky, 1974), but they play significant role in allelopathy (Whittaker, 1971; Rice, 1974). They are the mediators in the interrelationship between higher plants and microorganisms. In some cases, they provide plants with immunity against phytopathogens (or) sustain the life activity of microflora in the rhizosphere and sustain the life of mycorrhiza to improve mineral nutrition in the plants.

The soil is a dynamic system where activity of substances released can be quite transitory, as they are subjected to destruction, soil absorption and inactivation and transformation by soil microflora. The plants may suffer from these chemicals instantly or sustained toxicity may occur as new toxic products are formed in some of the transformations (Patrick et al. 1964). Besides, microorganisms active in decomposition may themselves produce inhibitory allelochemicals i.e. microbial toxins (McCalla and Haskins, 1964;; McCalla and Norstadt, 1974).

There are numerous reports, which indicate that allelopathic potentiality of weeds plays a major role by affecting the crop growth and nutrient status of soil (Bhowmik and Doll, 1984; Oudhia, 2000; Kalita, 2001). The content of allelochemicals may cause changes in soil chemical characteristics. The presence of *Pluchealanceolata,* an aggressive evergreen asteracean weed, apparently influence certain soil properties such as. pH, electrical conductivity, potassium ($K^+$) and soluble chloride ($Cl^-$). As the *P. lanceolata* infested soils had significant negative effects on seedling growth of various crop plants compared to non-infested soils, it is possible that the effect of allelopathic plants can be due to the allelochemicals in the soil and/or to altered soil nutrients (Inderjit, 1998). the present investigation has been aimed to assess the allelopathic influence of two weed species, *Cyperus rotundus L. and Cynodan dactylon* L on physico-chemical and biological properties of rice seedling grown soil

## 2. MATERIALS AND METHODS

Whole parts (tubers/root,stem, leaves, flowers and seeds) of weed species (*C.rotundus* and *C.dactylon*) were collected from post harvest rice fields of Cuddalore District, Tamil Nadu and washed thoroughly and cut into small pieces. Each (250g) sample was of ground in a mixer using distilled water. The slurry was filtered through muslin cloth and the volume was made up-to 2.5l with distilled water and stored as stock solution. For the preparation of combined weed extracts, equal amount of three weed samples were taken from the stock solution, 15,10,5, and 2.5% concentrations of extracts were prepared by adding distilled water and stored in deep freezer until they were used. Distilled water was used as a control. The weed extracts were prepared freshly every three days upto 15th day.

Earthen pots (30 x 15cm) each filled with 3kg of garden soil were used for the germination studies. The viable seeds were surface sterilized for two minutes in 0.2% mercuric chloride ($HgCl_2$), washed thoroughly in running tap water and sown @15 seeds/pot$^1$.

Each pot was irrigated uniformly with different concentrations of individual and combined weed extracts. Each experiment was carried out with five replicates and repeated thrice. The extracts/water was added to the pots on alternate days up to the 15th day. Germination was recorded after four days. Physico-chemical properties of soil such as pH, electrical conductivity, Available nitrogen (Subbiah and Asija, 1956). Phosphorus (Olsen *et al*. (1954), potassium (Stanford and English, 1949), Organic carbon (Piper,1966) were estimated in the soil sample was collected from all the experimental pots. The total microbial populations (bacteria+fungi+actinomycetes) and dehydrogenase activity (Stevenson,1959).The number of colony forming units (CFU) was taken as an index of total microbial population (Baron *et al*. 1994). The data was statiscally analysed byTurkey's Multiple range Test (TMRT) at $P < 0.05$.

## 3. RESULTS AND DISCUSSION

In agricultural systems allelopathy can be part of the interference between crops and between crops and weeds and thereby affecting the economical outcome of the plant production. The weeds are causing inhibition on germination and growth of crops as well as reducing the yield of the desirable crops through releasing allelochemicals from the dead or live parts (Narwal,1994). The results of present results revealed that the percentage of NPK levels (Table 1) was minimum in the lower concentrations of two weed extracts than their higher concentration. Among NPK contents, the nitrogen was found higher percentage followed by potassium and phosphorus in all the experimental soil.

**Table 1. Physico-chemical parameters of experimental soil exposed to weed extracts**

| Physico-chemical parameters | Control | *C. rotundus* | | | | *C. dactylon* | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1% | 2% | 3% | 4% | 1% | 2% | 3% | 4% |
| pH | 7.21d | 7.30c | 7.33c | 7.41b | 7.48a | 7.30c | 7.31c | 7.39b | 7.45a |
| EC | 1.12d | 1.18c | 1.23b | 1.26b | 1.32a | 1.19c | 1.22b | 1.25b | 1.33a |
| N(%) | 1.12g | 1.47d | 1.55c | 1.66b | 1.73a | 1.48d | 1.56c | 1.65b | 1.72a |
| P(%) | 0.75d | 0.13bc | 0.14b | 0.15b | 0.17a | 0.13bc | 0.14b | 0.15b | 0.17a |
| K(%) | 0.12e | 1.03b | 1.08a | 1.11a | 1.13a | 0.85d | 0.87d | 0.93c | 0.99b |
| OC(%) | 0.13ab | 0.12b | 0.13ab | 0.14a | 0.15a | 0.12b | 0.13ab | 0.14a | 0.15a |

Mean with different alphabets in a row differed significantly as per Turkey's Multiple range Test (TMRT) ($P < 0.05$)

**Table 2. Biological properties of experimentalsoil exposed to weed extracts.**

| Biological parameters | Control | *C. rotundus* | | | | *C. dactylon* | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1% | 2% | 3% | 4% | 1% | 2% | 3% | 4% |
| Bacteria (CFU x $10^6g^1$) | 45.3d | 42.1a | 39.2a | 34.3b | 31.2bc | 43.2a | 40.1a | 36.3b | 33.2b |
| Fungi (CFU x $10^4g^1$) | 15.3e | 11.1a | 10.2b | 9.2c | 7.2d | 12.2a | 10.2a | 9.1c | 8.2d |
| Actinomycetes (CFU x $10^5g^1$) | 9.3f | 6.1b | 4.1d | 4.0d | 3.2e | 7.1a | 5.0c | 5.0c | 4.2d |
| Total microbial Population (CFU x $10^6g^1$) | 6.13e | 4.92a | 4.78b | 4.62bc | 4.36d | 5.08a | 4.92a | 4.76b | 4.51d |
| Microbial activity (5µl H/5g) | 6.78g | 5.63c | 5.41d | 5.32de | 5.16f | 6.16a | 6.05a | 5.92ab | 5.74c |

Mean with different alphabets in a row differed significantly as per Turkey's Multiple range Test (TMRT) ($P < 0.05$)

The population of bacterial, fungi, actinomycetesand total microbial populationswere drasticallydecreased with increasing the concentration of weed extracts and more reduction was found in *C.rotundus* than *C.dactylon* treated soil (Table 2).

The chemical exudates from allelopathic plants are proposed to play a major role. Higher plants release diverse allelochemicals into the environment, which includes phenolics, alkaloids, long-chain fattyacids, terpenoids and flavanoids (Rice,1984 and Chou,1995). Allelopathic effects of these compounds are often observed to occur early in the life cycle, causing inhibition of seed germination and/or seedling growth. The compounds exhibit a wide range of mechanisms of action, affect on DNA (alkaloids), photosynthetic and mitochondrial function (quinones), phytohormone activity, ion uptake and water balance (phenolics) (Einhellig, 2002).Soil is an important factor for agricultural productivity. The physico-chemical analysis) present contrasting trends. While pH, electrical conductivity, NPK and organic carbon levels increased, the biological spectrum declined sharply. The contribution of the decomposing residues to the observed increases cannot be denied. Perhaps, the toxicity of the residues might have eroded the microbial diversity.

Allelopathic effects are often due to synergistic activity of several allelochemicals rather than to single compounds (Williamson, 1990). Under field conditions, additive or synergistic effects become significant even at low concentrations (Einhellig and Rasmussen, 1978). Inderjit and Duke (2003) pointed out that allelochemically-enriched soils might generate chemical stress, which in turn would lead to a higher content of allelocompounds in the acceptor plants either due to the uptake or via de novo synthesis in response to the exposure of allelopathy stress. Inderjit and Dakshimi (1992) noted that a higher content of phenolics retarded the growth of asparagus bean (*Vigna unguiculata* var.sesqupedalis) grown in soil emended with *Pluchea lanceolata* as compared to free soil.

The analysis of the ethyl acetate organic fraction of the aqueous extracts of *C.rotundus* leaves and tubers by GC-MS revealed 19 compounds consisting of organic acids; phenolic, benzoic, and cinnamic derivatives; and fatty acids (Quayyum, *et al*.,2000). The role of phenolic, benzoic, and cinnamic acid derivatives, such as p-coumaric, ferulic, and salicylic acids, and water-soluble organic acids, such as succinic, malonic, citric, acetic, butyric, and propionic acids, as phytotoxic compounds is well documented (Rice, 1984; Blum *et al.,* 1999). Fatty acids, such as decanoic, palmitic, and stearic acids, were also reported as toxic, and their toxicity increased with the increase of double bonds (AlSaadawi*et al.,* 1983). The weed, *C.dactylon* contains beta sitosterol, beta-carotene, vitamin C, palmitic acid, andtriterpenoids. Alkaloids like ergonovine, ergonovivine, others include ferulic acid, syringic acid, vanillin acid,p-coumaric acid (Ravindra,2003).These allelochemicals might be the reason for altering the NPK, OC contents and biological properties of the weed extract applied rice seedling grown soil. However,the detailed study is required to understand the decomposition dynamics and mechanism of action of weed allelochemicals on soil health along with crop growth.

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# STUDIES ON THE ETHNOVETERINARY MEDICINAL PLANTS AMONG THE FARMERS OF DHARAPURAM TALUK, TIRUPUR DISTRICT, TAMIL NADU

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## ABSTRACT

The indigenous knowledge and practice based on locally available bioresources are effective to cure diseases. In this way, ethnoveterinary medicinal plants were used by the farmers of Dharapuram taluk, Tirupur district to cure various diseases of their cattles. The present study results in the collection of 42 plant species belonging to 22 families. The medicinal importance of these plants used by the farmers as traditional medicine for their cattle is enumerated in this study.

**Keywords:** Bio resources, Dharapuram taluk, traditional medicines.

## 1. INTRODUCTION

India is having a vast reservoir of cattle genetic resources not only in terms of population but also in genetic diversity represented by 30 recognized cattle breeds. In Tamil Nadu the total cattle population is 30.8 million (2012). The Indian subcontinent has rich ethnoveterinary health traditions that are the products of decades of experience. Ethnoveterinary research and development is a holistic inter disciplinary study of indigenous knowledge and associated skills, practices, beliefs and social structures pertaining to the healthcare and husbandry of income producing animals has emerged as a fertile field for generation and transfer appropriate and sustainable veterinary alternatives to the stock raisers. In Indian agriculture livestock plays a key role in the farmer's life. They provide farm power, rural transport, manure, fuel, milk and meat but also play a major role in the rural economy by providing income and employment to the small hold farmers and other weaker sections of the society. Ethnoveterinary science in India has a documented history of around 5000 years. In most rural areas people prefer to treat their animals with indigenous drugs. At present over 35,000 plants are known to have healing properties (Jain and Saklani, 1991). All parts of the plants including leaves, bark, fruits, flowers, seeds are used in medicinal preparations (Mc Corkle *et al.*, 1996). Ethno veterinary practices are often cheap, safe, tested time and based on local resources and strengths. These can provide useful alternatives to the conventional animal health care (Kumar, 2002). The Indian council of agricultural research in 2008 collected and recorded 595 veterinary traditions from different sources (Swarup and Patra, 2005). Ethnoveterinary medicines are the reduction in the cost of healthcare for milk animals of dairy farmers, reduction in antibiotic and hormone residues in milk and other animal products by using safe, effective and standardized products based on time tested local traditions and contribution to the economy of local producers.

The importance of the traditional knowledge ethnoveterinary practices by specialists (Vaidhiyars) and local healers who are knowledgeable and experienced in traditional system of treatment, but their knowledge is not documented and is dwindling fast (Jain and Saklani, 1991). As the local healers did not document their knowledge and experience and did not pass it on to others readily, there was danger of extinction of that knowledge (Mathias and Anjaric, 1998). Thus ethnoveterinary medicine is mostly present by villagers as this system of approach dealing with the folk beliefs, knowledge, skills, methods and practices pertaining to the healthcare of animal by tradition. Hence the present study was conducted to document the ethno veterinary medicinal plants used to treat the livestock by villagers of Dharapuram taluk, Tirupur district, Tamil Nadu.

## 2. METHODOLOGY

### *2.1. Study area*

The Dharapuram taluk is a wide agricultural taluk in the Tirupur District. The study area is spread over an area of 5186.34 sq. km and is bounded on the west by Udumalpet taluk, south by Madathukulam taluk North by Palladam taluk and East by Palani taluk. It has an average elevation of

245 m above MSL (Fig.-1). The mean maximum and minimum temperature during winter and summer varies from 32.4ºC to 20º C. The major rivers flowing through the taluk are Amaravathi and Uppaar. Amaravathi Dam is the prime source of irrigation. According to 2011 census, Dharapuram taluk had a population of 65,007. Most of the communities doing agriculture practices. Apart from agriculture they also domesticated cattle for their use in agricultural works. Most of the formers treat their cattle using medicinal plants themselves.

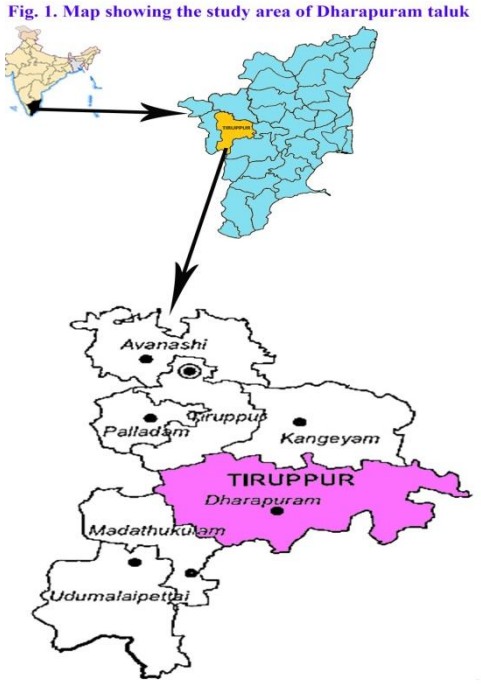


**Fig.1. Map showing the study area of Dharapuram taluk, Tirupur district.**

*2.2. Data collection and local peoples*

The present study was conducted during June 2014 to February 2015. Local traditional healers (Mattu vaidhiyar) having practical knowledge of ethnoveterinary medicinal plants were interviewed in remote villages of Dharapuram taluk. The ethnoveterinary information regarding the local name of the plant, plant part used and herbal remedies to cure their cattle suffering from different diseases are recorded. The collected plants were identified with the help of Flora of the Presidency of Madras (Gamble and Fischer, 1915-1936), *The Flora of British India* (Hooker, 1872-1897) and the Flora of Tamil Nadu Carnatic (Matthew, 1987). The entire herbarium specimens were deposited at the Herbarium of Kongunadu Arts and Science College (KASCH).

*2.3. Enumeration of plants*

The Ethnoveterinary information of 42 plant species was collected and enumerated in alphabetical order. For each species listed botanical names followed by family name, vernacular name (VN), medicinal uses and mode of preparation.

***Acalypha indica*** L. (Euphorbiaceae); **VN**-( Kuppaimeni)

Leaves ground with bulb of *Allium sativum* and *Piper nigrum* seeds are applied on the mouth. To cure mouth disease.

***Albizia lebbeck*** (L.) (Fabaceae); **VN**- Vagai maram

Leaf extract mixed with salt and applied on the eye lid of the cattles to cure corneal opacity.

***Aloe vera*** L. ( Liliaceae); **VN-** Chotthu katthaalai

Leaf gel fed to cattles along with small amount of salt to cure enteritis (kalichal).

***Allium cepa*** L. (Liliaceae); **VN-** Chinna vengayam

Paste made by grounding the bulb with *Cuminum cyminum* seeds and *Indigofera linnaei* leaves. Paste is dilute with butter milk and fed orally to cattle's once a day to cure enteritis (kalichal).

***Allium sativum*** L. (Liliaceae); **VN-** Vellai poondu

Bulb grounded and the paste is fed orally with warm water to cure enteritis (kalichal).

***Aristolochia bracteolata*** Lam. (Aristolochiaceae); **VN-** Aduthinna palai

Paste prepared by grounding leaves with *Corallocarpus epigaeus* rhizome and *Andrographis paniculata* leaves. It is mixed with neem oil and applied externally for 4-5 days to cure scabies.

***Aristolochia indica*** L. (Aristolochiaceae); **VN-** Urikkal chedi

Leaves boiled with neem oil and applied on the affected part for horn ablation.

***Azadirachta indica*** Adr. Juss. ( Meliaceae); **VN-** Veppamaram

Seed oil is mixed with egg albumin and given orally to improve fertility.

***Azima tetracantha*** Lam. (Salvadoraceae); **VN-** Sangamul chedi

Leaves mixed with *Pergularia daemia* and *Croton sparsiflorus* is fed to cattle with grass for 3 days to cure Snake bite (pambu kadi).

***Cadaba fruticosa*** (L.) (Capparidaceae); VN- Velichedi

Leaves ground with *Cuminum cyminum* seeds and *Allium cepa* bulb and fed orally to cattle for diarrhea.

***Calotropis gigantea*** (L.) (Asclepiadaceae); **VN-** Yerukku

Paste made by grounding flower bud and root bark with *Piper nigrum* seeds, dried rhizome of *Zingiber officinalis*, *Piper cubeba* seeds and *Allium sativum* bulb. Paste diluted with water and fed orally to cattles to cure bronchitis.

***Cardiospermum halicacabum*** L. (Sapindaceae); **VN**- Mudakkathan

Leaf juice mixed with *Ferula asafoetida* and lime water and fed orally for 2 days to cow to cure indigestion problem (seriyamai).

***Cassia auriculata*** (L.) (Fabaceae); **VN**- Avaram chedi

Leaves ground with water and given orally once or twice a day to the cattle for diarrhea.

***Canthium rheedii*** DC. (Rubiaceae); **VN-** Karaichedi

Leaves boiled with water and the decoction is mixed and boiled with rice flour and fed orally to cattle for general weakness.

***Cissus quadrangularis*** L. Mant. (Vitaceae); **VN-** Pirandai

Stem juice half a liter of given orally 3 times per day. Stem juice mixed with *Tamarindus indica* juice and applied on the affected area for swelling (Veekkam).

***Coccinia grandis*** (L.) ( Cucurbitaceae); **VN-** Kovai chedi

Leaf juice prepared from equal amount of *Coccinia indica* and *Pergularia daemia* and applied externally on both nostrils of cattle for tongue disease (Nakku pun).

***Corallocarpus epigaeus*** (Rottl. & Willd.) (Cucurbitaceae); **VN-** Kizhi mookku kizhangu

Tuber of ground with leaves of *Pergularia daemia*, *Tinospora cordifolia* and root of *Tribulus terrestries* and the paste is applied around the ears of cattles to cure bronchitis, asthma.

***Cordia monoica*** Roxb. (Cordiaceae); **VN-** Narivizhi maram

Stem bark ground with water and administered orally to cattle for general weakness.

***Cyperus rotundus*** L. (Cyperaceae); **VN-** Korai kizhangu

Rhizome ground with *Acorus calamus* rhizome, *Nicotiana tobaccum* leaves and *Piper cubeba* seeds and the paste mixed with cow's milk and fed orally to cattles to cure lung emphysema (muchadaippu).

***Datura fastuosa*** auct. (Solanaceae); **VN**- Karu-oomathai

Leaves ground with onion and the paste in applied on wound of cows to cure Mastitis (Madi Veekam).

***Desmodium recurvatum*** (Roxb.) (Fabaceae); **VN-** Aadatti

Leaves fried with salt and applied externally on tongue to cure wounds in lips and tongue.

***Dichrostachys cinerea*** (L.) (Fabaceae); **VN-** Vedathalan thazhai

Paste prepared by grounding the leaves with *Cuminum cyminum* seeds and *Allium cepa* bulb and given orally to cattles to cured Enteritis.

***Eichhornia crassipes*** (C.Martius) (Pontederiaceae); **VN-** Agayathamarai

Leaves ground with onion and the paste is mix with lemon juice and butter milk and fed orally three times per day for azhari.

***Euphorbia antiquorum*** L. (Euphorbiaceae); **VN**- Sadhurakkalli

*Euphorbia antiquorum* latex is mixed with *Ficus benghalensis* latex and applied on fracture area and tied with bamboo stick to cure bone fracture.

***Ficus benghalensis*** L. (Moraceae); **VN-** Alamaram

Young prop root ground with *Cocos nucifera* flower and fed orally with cow's milk to the cattle to cure hematuria (Ratha kalichal).

***Justicia adhatoda*** L. (Acanthaceae); **VN-** Aduthinna palai

Leaves ground with *Corallocarpus epigaeus* rhizome and fed orally with neem leaf juice to cattle for two days to cure hematuria (Rattha kallichal).

***Lagenaria vulgaris*** Ser. (Cucurbitaceae); **VN-** Surai

Fruit skin ground with *Piper nigrum* seeds and *Brassica juncea* seeds and mix with rice flour and fed orally to cattle to cure Anthrax (Adaippam).

***Leucas aspera*** Willd. (Lamiaceae); **VN-** Thumbai

Leaves ground with *Ocimum sanctum* and *Melothria maderaspatana* leaves and the paste is fed orally for 2 days for constipation.

***Mimosa pudica*** L. (Fabaceae); **VN-** Thottal sinungi

Leaves ground with cow's milk and fed orally to cattle to improve lactation.

***Momordica charantia*** L. (Cucurbitaceae); **VN-** Pakalkai

Leaf juice applied externally and given orally to cure poisonous bite in cattle.

***Nicotiana tabacum*** L. (Solanaceae); **VN**- Pugaiyilai (Tobacco)

Leaves chewed with *Piper betal* leaf and spit forcely into the eyes of the cattle to cure conjunctivitis (Kan purai).

***Pergularia daemia*** (Forsskal.) (Asclepiadaceae); **VN-** Paruthalan chedi

Leaves ground with *Ocimum sanctum, Cynodon dactylon* leaves and *Piper nigrum* seeds and the juice applied on nostrils of affected animals for bloat.

***Phyllanthus amarus*** Schum. & Thonn. (Euphorbiaceae); **VN**- Kizhanelli

Whole plant ground with leaves of *Ocimum sanctum*, *Leucas aspera* and *Piper nigrum* seeds. Paste diluted with goat urine and fed orally for cows and buffaloes to cure indigestion problems.

***Piper nigrum*** L. ( Piperaceae); **VN-** Milagu

Seed powder mixed with cow ghee and fed orally to cattle to cure lung emphysema (Muchadaippu).

***Pongamia glabra*** Vent. (Fabaceae); **VN-** Pungam

Fruit is ground with hot water and applied for tongue disease.

***Solanum nigrum*** L. (Solanaceae); **VN-** Manathakkali

Leaves ground with a fruit of *Cuminum cyminium* and the paste is fed to the cattle for 2 days to cure ephemeral fever.

***Tephrosia purpurea*** (L.) (Fabaceae); **VN-** Kozhingi

Leaves ground with *Coccinia indica* leaves and applied externally to cure warts.

***Trianthema portulacastrum*** L. (Aizoaceae); **VN-** Neisaranai

Leaves ground with *Pergularia daemia* and *Leucas aspera* leaves and fed orally with water for 2 days to cure mouth disease (Komari).

***Trichosanthes cucumerina***. L. (Cucurbitaceae); **VN-** Pei pudal

Leaves ground with *Tamarindus indica* leaves and the paste is dilute with butter milk and fed orally to cure indigestion.

***Vigna mungo*** Hepper, (Fabaceae); **VN-** Uzhunthu

Seed flour mix with egg albumin and applied on the fracture and tied with bamboo stick.

***Vitex negundo*** L. (Verbinaceae); **VN-** Notchi

Paste prepared by grounding the equal amount of leaves with *Leucas aspera* leaves and *Allium cepa* bulb and applied on the nose of the cattles to cure bronchitis.

***Withania somnifera*** L. (Solanaceae); **VN-** Amukkirachedi

Paste made by grounding rhizome with *Allium cepa* bulb, *Datura metal* root and *Acorus calamus* rhizome and given orally for three days to cure bloat.

## 3. RESULT AND DISCUSSION

The present study results in the documentation of 42 plant species belonging to 22 families. The data shows that eight species of Fabaceae, five species of Cucurbitaceae, four species of Solanaceae and three species each of Euphorbiaceae and Liliaceae were largely employed for preparation of herbal remedies for curing cattle disease. Among the plant parts used, leaf was the mostly used (60%) to treat a particular animal disease followed by root and tuber (17%) seed and fruit (12%) and stem (7%). The whole plant was the least used part in ethno veterinary medicine (4%) (Fig.-2). Among the 42 plant species which are used as ethno veterinary medicine by farmers of study area, 17 species (40%) were herbs from the main source of medicines followed by shrubs and climbers 10 species each (24%) and 5 trees (12%).

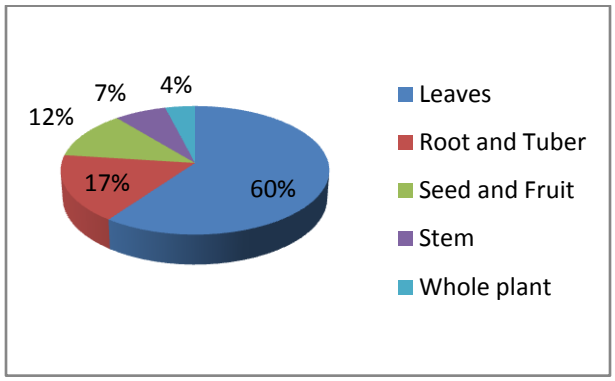


**Fig. 2. Number of prescriptions of different plant parts used in the treatment.**

Generally, fresh parts of the plants were used for the preparation of medicine for livestock illness. It was recorded that oral administration of herbal preparation (decoction, juice, solid extract etc.,) was found as mostly followed mode (62%) to treat the illness followed by raw feeding. The plant extracts were prepared and also applied as paste externally to cure wounds, mastitis, foot and mouth disease, swelling, bone fracture etc. The medicines are administered to the animals with the help of a special apparatus known as kottam (a simple mature hollow stem of Bamboo, which is pointed at one end) Decoctions, plant extracts or other liquid medicines are administered to animals through it.

## 4. CONCLUSION

The Folk health practices largely remain undocumented and are passed on from one generation to the other by word of mouth. Mostly ethnoveterinary treatment is done with the help of locally available herbs. The emerging problems, continuous loss of biodiversity and other natural resources compelled to developed sustainable economically viable and eco friendly system of animal husbandry. The study results in the collection of 42 plant species belonging to 22 families. The plenty use of leaves in the preparation of remedies is common because they available in mostly throughout the year. Combination of plant species and use of water, cow milk, lime water and rice flower for diluting or mixing various ingredients formulations have been practical during the period of treatment.

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