STUDY ON PHYTOCHEMICAL, ANTIOXIDANT POTENTIAL, FTIR, AND GC-MS ANALYSIS OF CORDIA MYXA L.

A short term project work submitted to **St. Mary's College (Autonomous)** affiliated to **MANONMANIAM SUNDARANAR UNIVERSITY** in partial fulfilment of the requirements for the Degree of Bachelor of Science in Botany

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DEPARTMENT OF BOTANY

ST. MARY'S COLLEGE (Autonomous)

THOOTHUKUDI- 628001

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CERTIFICATE

It is certified that this short term project work entitled "**STUDY ON PHYTOCHEMICAL, ANTIOXIDANT POTENTIAL, FTIR, AND GC-MS ANALYSIS OF CORDIA MYXA L.** submitted to **St. Mary's College (Autonomous)** affiliated to **MANONMANIAM SUNDARANAR UNIVERSITY** in partial fulfilment of the requirements for the degree of Bachelor of Science in Botany, and is a record of work done in the Department of Botany, St. Mary's College (Autonomous), Thoothukudi during the year 2022-2023 by the following students.

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It is our humble attempt to present this "**STUDY ON PHYTOCHEMICAL, ANTIOXIDANT POTENTIAL, FTIR, AND GC-MS ANALYSIS OF CORDIA MYXA L.**" First and foremost our sincere gratitude belongs to **Dr. Sr. A.S.J.LUCIA ROSE M.Sc., B.Ed. ,M.Phil., PGDCA, Ph.D.** principal, St. Mary's College (Autonomous) for providing an opportunity to do this project.

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INTRODUCTION

INTRODUCTION

Medicinal plants are Nature's gift to human beings to help them pursue a disease-free healthy life. Plants have been used as drugs by humans since thousands of years ago. As a result of accumulated experience from the past generations, today, all the world's cultures have extensive knowledge of herbal medicine. Two-thirds of the new chemicals identified yearly were extracted from higher plants. 75% of the world's population used plants for therapy and prevention (Orhan, IE 2012). Plants are used medicinally in different countries, and they are the source of many potent and powerful drugs. plants have been an important source of medicine with qualities for thousands of years (Sathyaprabha G *et al*.,2010). Plants in general encompass a wide range of medicinally beneficial bioactive, and they have acquired the ability to create structurally diverse compounds known as secondary metabolites over the evolutionary process.

The use of herbs to treat disease is almost universal and is now recognized by WHO as an essential building block for primary health care. According to world health organisation, 80% of the people living in rural areas depend on medicinal plants as primary, particularly the developing countries. Out of the total 4,20,000 flowering plants reported from the world more than 50,000 are used for medicinal purposes. The medicinal plant are important therapeutic aid for the alleviation of ailments of humankind Historically, plants (fruits, vegetables, medicinal herbs, etc.) have provided a good source of a variety of compounds, such as phenolic compounds, nitrogen compounds, vitamins, terpenoids and some other secondary metabolites, which are rich in valuable bioactivities like antioxidant, anti-inflamatory, anti-tumour, anti-mutagenic, anti-carcinogenic, antibacterial, or antiviral activities. (Maridass and Britto , 2008).

The Bioactive metabolites are considered to be potent bioactive agents for disease treatment as well as prospective sources for the discovery of new medications, food additives, flavours, and other industrially valuable products. (Calixto JB 2000). The subject of phytochemistry or plant chemistry, has developed to be a distinct discipline somewhere in between natural product chemistry and plant biochemistry. Phytochemistry is concerned with the enormous variety of organic structures that are elaborated and accumulated by plants and deals with the chemical structure of these substances, their biosynthesis, turnover, metabolism, their natural distribution and their biological function (Harborne JB 2013).

Antioxidants are capable of preventing oxidative damage, the wide use of natural antioxidants as a replacement of conventional synthetic antioxidants in food and food supplements has been employed, owing to the fact that natural products are considered to be a promising and safe source [Mandal *et al.*, 2011]. Moreover, these natural antioxidants have easy and unlimited access to metabolic processes in the body, and produce virtually none of the side effects associated with synthetic antioxidants [Beevi *et al.*, 2010]. The most commonly used antioxidants at present are Butylated Hydroxy Anisole (BHA), Butylated Hydroxy Toluene (BHT), Propyl Gallate (PG) and Tert-Butyl Hydroquinone (TBHQ). However, they are suspected of being responsible for liver damage and acting as carcinogens in laboratory animals. Therefore, the development and utilization of more effective antioxidants of natural origin are desirable [Raja and Pugalendi, 2009].

Boraginaceae (borage) family comprises about 2740 species distributed in 148 genera (Yadav R, Yadav sk. 2013)Various chemical constituents isolated and characterized from Boraginaceous plants, including pyrrolizidine alkaloids, naphthoquinones, flavonoids, terpenoids, triterpenoids and phenols(Sharma RA, Sing B *et al*., 2009). *Cordia* is an important and representative genus of this family that could grow as trees, shrubs or sometimes subscandents The genus *Cordia* originates from tropical and subtropical regions. About300 species have been identified worldwide, mostly in the warmer regions. *Cordia myxa* is a medium-sized deciduous tree of about 10.5m.

The plant parts like fruits, leaves, stem bark, seeds and roots of most species of this genus, especially *Cordia dichotoma, C. myxa, C. verbenacea, C.martinicensis, C.salicifolia, C. spinescens, C. latifolia, C. ulmifolia*, among others, have long been used in traditional medicine as astringent, anti-inflammatory, anthelminthic, antimalarial, diuretic, febrifuge, appetite suppressant and cough suppressant and to treat urinary infections, lung diseases and leprosy. *Cordia myxa* fruits and seeds are also used as expectorants and are effective in treating diseases of the lungs. Raw fruits contain a gum that can be used beneficially in gonorrhea. They can remove pain from the joints and the burning of the throat, are effective in treating diseases of the spleen, and are used as a demulcent in southern Iran. (Yadav R, Yadav sk. 2013). For the present study, the taxa *Cordia myxa* was selected.

Scope and Objectives

- Collection of leaf and stem from *Cordia myxa* for extract preparation.
- To quantitatively analyze and compare the total phenolics, flavonoids, vitamin C and tannin content of leaves and stem of *Cordia myxa* using spectrophotometric methods.
- To identify and compare the functional group of leaves and stem of *Cordia myxa* by Fourier transform infrared spectroscopy (FTIR) analysis.
- To assess the antioxidant potential of *Cordia myxa* using aqueous extract against DPPH radical scavenging activity.
- To identify the bioactive compounds of the methanol extract of the leaf and stem of *Cordia myxa* using GC-MS analysis.

LITERATURE REVIEW

LITERATURE REVIEW

Phytochemicals are chemical compounds formed during the plants normal metabolic processes. These chemicals are often referred to as "Secondary metabolites" of which there are several classes including alkaloids, flavonoids, coumarins, glycosides, polysaccharides, phenols, tannins, terpenes and terpenoids (Okwu, 2004). In addition to these substances, plants contain other chemical compounds. These can act as agents to prevent unconsiderable side effects of the main active substances or to assist in the assimilation of the main substances. Many herbaceous and medicinal plants contain important photochemical and vitamins such as alkaloids, flavonoids, tannins, cyanogenic glycosides, phenolic compounds, saponins, lignins, vitamin C, vitamin E and carotenoids, which are utilized both by humans and animals as important components of diets (Hussain *et al.*, 2011). The medicinal effects of plants are considered to be due to metabolites, especially secondary compounds, produced by plant species. Phytochemical analysis suggests that the presence of various biologically active compounds [alkaloids, phenols, flavanoids, proteins-lectin, carbohydrates, indigo, steroids etc.] and could be correlated to various therapeutic purposes (Vinoth *et al.*, 2011). Plants have an almost limitless ability to synthesize aromatic substances, mainly secondary metabolites of which 12,000 have been isolated, a number estimated to be less than 10% of the total (Mallikharjuna *et al.*, 2007).

Flavonoids are polyphenolic compounds, which are ingredients of many vegetables and fruits. They are classified into flavanols, flavanones, flavones, isoflavones, catechins, anthocyanins, proanthocyanidins, etc. [Huy *et al.*, 2008]. They

are among the most bioactive plant secondary metabolites which outperform well-known antioxidants.

Natural antioxidants are known to exhibit a wide range of biological effects including antibacterial, antiviral, anti-inflammatory, anti-allergic, anti-thrombic and vasodilatory activities. Antioxidant activity gives rise to anti-carcinogenicity, anti-immunogenicity and anti-aging activity [Gulcin *et al*., 2010].

Flavonoids serve as ROS scavengers by locating and neutralizing radicals [Gill and Tuteja, 2010]. Bioactive properties such as free radical scavenging, inhibition of hydrolytic and oxidative enzymes and anti-inflammatory action of flavonoids is known [Njoku *et al*., 2011]. The antioxidant activity of the dietary phenolics considered to be superior to that of the essential vitamins and is ascribed to their high redox potential, which allows them to interrupt free radical mediated reactions by donating hydrogen from the phenolic hydroxyl groups (Beevi *et al*., 2010).

Phenolics are secondary metabolities that behave as antioxidants due to the reactivity of the phenol moiety (hydroxyl substituent on the aromatic ring). The antioxidant activities of phenolic compounds are also attributed to their ability to chelate transition metal ions, such as those of iron and copper, which have been proposed as the catalyst for the initial formation of ROS (Knezevic *et al*., 2011).

Ascorbic acid (vitamin C) is a vital component in human diet with the highest concentrations in animal organs like the liver, leukocytes, and anterior pituitary. It is used for its antioxidant effect [Ensafi *et al*.,2010]. Vitamin C is a major

ubiquitous non-enzymatic, water soluble antioxidant (Ueta *et al.*, 2003). It acts as ROS scavenger, thus potentially protecting cells from harmful oxidative products [Fossati *et al.*, 2011]. Vitamin C functions in enzyme activation, oxidative stress reduction, and immune function. There is considerable evidence that vitamin C protects against respiratory tract infections and reduces risk for cardiovascular disease and some cancers [Schlueter and Johnston, 2011].

Tannins are group of polymeric phenolic substances. Consumption of tannin containing beverages, especially green teas and red wines can cure or prevent a variety of illness including heart related diseases (Van-Burden and Robinson, 1981).

Antioxidant activity

Antioxidant compounds in food play an important role as a health protecting factor. Primary sources of naturally occurring antioxidants are whole grains, fruits and vegetables. Natural antioxidants can also be replaced by commercially available, synthetic antioxidants such as butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT), which are quite unsafe to use and is restricted due to their carcinogenic effect (Velioglu *et al.*, 1998). Natural antioxidants or phytochemical antioxidants are the secondary metabolites of plants (Walton and Brown, 1999). Carotenoids, flavonoids, cinnamic acids, folic acid, ascorbic acid, tocopherols, tocotrienols *etc.*, are some of the antioxidants produced by this plant for their sustenance. Beta-carotene, ascorbic acid and alpha tocopherol are the widely used as antioxidants (McCall and Frei, 1999).

Swamy *et al.*,(2004) tested the leaf extracts of medicinal plant, *Leptadenia reticulata* for AgNPs production and antioxidant activity studies. He observed that, 500 µg/ml of green synthesized silver nanoparticles showed maximum (64.81 %) radical scavenging activity. The silver nanoparticles were synthesized using aqueous *Piper longum* fruit extract and the aqueous *P. longum* fruit extract and the green synthesized silver nanoparticles showed powerful antioxidant properties *in vitro* antioxidant assays. Haes *et al.*, (2002).

Pourmorad *et al.*,(2006) carried out a comparative study on the antioxidant potentials of some selected Iranian medicinal plant extracts. The antioxidant properties of 25 edible tropical plants were studied by Wong *et al.*, (2006). Badami and Channabasavaraj (2007) studied the *in vitro* antioxidant activities of thirteen medicinal plants collected from Western Ghats of India.

Ademiluyi and Oboh (2008) studied the antioxidant activity of methanol leaf extract of *Viscum album* by using linolenic acid peroxidation and DPPH methods. Effat *et al.*, (2008) screened thirteen medicinal plant extracts for antioxidant activity. MoniRani *et al.*,(2008) evaluated antioxidant activities of methanol extract of *Ixora coccinea* by DPPH free radical scavenging activity, reducing power and total antioxidant activity assays.

Gayatri *et al.*, (2011) observed that the piperine, an alkaloid found naturally in *Piper nigrum* and *Piper cubeba*. It is widely used in various herbal cough syrups and anti-inflammatory, antimalarial, anti-leukemia treatement. Ethanol extract of *Piper cubeba* showed high antioxidant activity.

Inbathamizh *et al.*, (2013) studied in vitro evaluation of antioxidant and anticancer potential of *Morinda pubescens* synthesized silver nanoparticles. The decolorization from purple DPPH radical to yellow DPPH molecule by the sample in a dose-dependent manner with an IC50 value of 84±0.25 µg/ml indicated the sample's high radical scavenging activity, which was closer to that of the standard whose IC50 value was found to be 80±0.69 µg/ml.

Niraimathi *et al.*, (2013) investigated on biosynthesis of silver nanoparticles using *Alternanthera sessilis* (Linn.) leaf extract and determined antioxidant activities. Free radical scavenging activity of the AgNPs on DPPH radical was found to increase with increase in concentration, showing a maximum of 62% at 500 µg/ml. The standard gallic acid, however, at this concentration exhibited 80% inhibition. The IC50 value was found to be 300.6 µg/ml.

The silver nitrate extract of *Annona squamosa* and *Sapium macrocarpum* showed two times more DPPH scavenging activity than the commercial antioxidant butylated hydroxyl anisole. (Ruiz *et al.*, 2008). The silver nitrate extracts of *Melissa officinalis*, *Matricaria recuttia* and *Cymbopogan citratus* were found to possess DPPH scavenging activity. (Pereira *et al.*, (2009). Sowndharajan *et al.*, (2010) studied the antioxidant capacity and total phenolic contents present in the silver nitrate extracts of leaves, stem, and roots of *Melothria maderaspatana* were evaluated. Sathisha *et al.*, (2011) determined antioxidant potentials in silver nitrate extract of some plants, *Curcuma longa*, *Coffea Arabica*, *Tribulus terrestris*, *Bacopa monnieri* and *Trigonella foenumgraceum* using various *in vitro* assays.

Iwalewa *et al.*, (2005) studied the pro and antioxidant effects of silver nitrate extracts of nine edible vegetables in southwest Nigeria using 1, 1-diphenyl-2-picrylhydrazyl free radical assay. The silver nitrate extract of *Helichrysum plicatum* had been reported to have antioxidant activity using two *in vitro* methods, namely DPPH and -carotene linoleic acid assays . (Tepe *et al.*,(2005) .

The silver nitrate extracts of *Chlorophytum borivilianum* had been shown to scavenge DPPH radical and decrease TBRAS (Thiobarbituric Acid Reactive Substances), revealing that it is a promising anti-stress agent as well as a potential antioxidant. (Kenjale *et al.*, 2007).

GC-MS

The chemical composition of the essential oils from leaves and wood of *Ocotea brenesii* growing wild in Costa Rica was determined by capillary GC/FID and GC-MS. From the leaves, 64 compounds were identified, corresponding to 85.9% of the oil, and from the wood 57 compounds were identified corresponding to 69.0% of the oil (Carlos and Jose, 2005). The chemical compositions of the essential oils of *Ocimum basilicum* L. *cv.* purple and *Ocimum basilicum* L. *cv.* green cultivated in Iran were investigated by GC-MS (Seyed, 2006).

GC-MS analysis of *Jatropha curcas* leaves revealed the presence of 16 compounds. The most abundant components were 22, 23-dihydro-stigmasterol (16.14%) alpha-tocopherol (15.18%), beta amylin (7.73%) and dotriacontanol (7.02%) The content of gamma tocopherol reached 2.88% and Vitamin E reached

18.06% in the extract (Wang *et al.*, 2009). The GC-MS analysis of *Strobilanthes crispus* oil revealed the presence of 28 components. The main constituents were found to be phytol, α-cadinol, Megastigmatrienone, 2,3-dihydrobenzofuran and eugenol (Asmah *et al.*, 2006).

Nithya Narayanaswamy and Balakrishnan (2011) evaluated the antioxidant properties of 13 important medicinal plants and it showed that *Ocimum basilicum* leaf, *Alpinia calcarata* leaf, *Jatropha mulitifida* flower, *Hyptis suaveolens* leaf, *Solanum indicum* leaf and *Clitoria ternatea* leaf and flower possessed higher DPPH scavenging activity. Moussa *et al.*, (2011). The aqueous leaf extracts of 124 Egyptian plant species belonging to 56 families were investigated and compared for their antioxidant activity by DPPH scavenging assay. Safi *et al.* (2012) studied the biological activities of aqueous extract of the root of *Jatropha curcas* like antimicrobial and free radical scavenging activities. In the evaluation of DPPH free radical scavenging activity. Olabinri *et al.*, (2013) investigated *in vitro* antioxidant and nitric oxide radical scavenging capabilities of *Jatropha gossypifolia* extract.

Sermakkani M. And V. Thangapandian (2012) evaluated GC-MS analysis of *C. italica* leaves revealed the presence of seventeen compounds. The identified compounds possess many biological properties. For instance, 9,12,15-Octadecatrienoic acid, (Z,Z,Z)- Linolenic acid (R/T 20.06) possesses anti-inflammatory, insectifuge, hypocholesterolemic, cancer preventive, nematicide, hepatoprotective, antihistaminic, antieczemic, antiacne, 5-alpha reductase inhibitor, antiandrogenic, antiarthritic and anticoronary properties. n-Hexadecanoic acid -

palmitic acid (R/T 17.25) can be an antioxidant, hypocholesterolemic, nematicide, pesticide, lubricant activities.

Fenghuan Wei *et al.*, (2015) identified thirty compounds in *Jasminum grandiflorum* by using GCMS. The major volatile components of the flower were 3,7,11,15- tetramethyl-2-hexadecen-1-o (phytol) (25.77 %), 3,7,11-trimethyldodeca -1,6,10-trien-3-ol (12.54 %) and 3,7,11,15- tetramethyl -1-Hexadecen-3-ol (12.42 %). The results show that phytol is the major volatile component of *Jasminum grandiflorum.*

Praveen Kumar P *et al.*, (2018) studied the identification of bioactive compounds from the Neem sap by Gas chromatography and Mass spectroscopy (GC-MS). The GC-MS analysis of the Neem sap revealed the presence of 30 volatile compounds. Among the 30 compounds, the most predominant compounds are fatty acids like Hexadecanoic acid and Pentadecanoic acid. Hence, this current attempt forms a basis for the biological characterization and importance of the compounds which could be exploited for future development of drugs.

Seventy six kinds of chemical compounds were found in methanol extract of *E.cephalotes* including aldehydes (7.9%), phenols (7.5%), fatty acids (5.8%) and furfural (5.4%) and 86 kinds of chemical compounds found in *M.anisodan* extract. Furfural, steroids, vitamin B and flavonoids are the main compounds of *M.anisodan* by S. Mohammadi *et al.*, (2019).

FTIR

A large number of medicinal plants are used as alternate medicine for diseases of man and other animal since most of them are without side effects when compared with synthetic drugs. Identification of the chemical nature of phytochemical compounds present in the medicinal plant will provide some information on the different functional groups responsible for their medicinal properties. Iqbal Ahamed *et al*., (2006) detected major groups of compounds as the most active fraction of four plants extract by infrared spectroscopy.

Ramamoorthi and Kannan (2007) screened the bioactive group of chemicals in the dry leaf powder of *Calotropis gigantea* by FTIR analysis .Kareru *et al.*, (2008) detected saponins in crude dry powder of 11 plants using FTIR spectroscopy.

Muruganantham *et al.*, (2009) carried out the FTIR spectroscopic analysis in the powder samples of leaf , stem and root of *Eclipta alba* and *Eclipta prostratea*. The FTIR analysis of aqueous methanolic leaf extracts of *Bauhinia racemosa* for phytochemical compounds was done by Gauravkumar *et al* .,(2010). Ragavendran *et al*.,(2011) detected the functional groups in various extracts of *Aerva lanata* using spectroscopic method .

Thangarajan Starlin *et al*., (2012), analyzed the ethanolic extracts of *Ichnocarpus frutescens*, by FTIR, revealed the presence of functional group components of amino acids, amides, amines, carboxylic acid, carbonyl compounds, organic hydrocarbons and halogens. Parag A. Petnekar and Bhanu Raman (2013) carried out the FTIR

spectroscopic analysis of methanolic leaf extract of *Ampelocissus lantifolia* for antimicrobial compounds.

FTIR analysis for five selected green leafy vegetables(GLVs) viz., *Hibiscus cannabinus* , *H. sabdariffa* , *Basella alba* , *B .rubra* L. and *Rumex vesicarius* confirmed the presence of free alcohol, intermolecular bonded alcohol, intramolecular bonded alcohol, alkane, aromatic compounds, imine or oxime or ketone or alkene, phenol and amine stretching (Sravan Kumar and Manoj., 2015).

The functional group identification is made by FTIR analysis and the active components based on the peak value in the region of infrared radiation. The ethanolic flower extract of *Erythrina variegata* L. is passed into the FTIR spectroscopy and the functional groups of the components are separated based on the peak ratio. The results of FTIR analysis confirm the presence of functional groups such as non-bonded, O-H stretch, carboxylic group, acidic, H bonded, C-H stretch, asymmetric stretching of –CH (CH2) vibration, C=N (stretch), carbon-carbon triple bond, multiple bonding, carbonyl compound frequency, C=O stretch, C=C stretch, O-H bend, alcoholic group, C-N stretch, C-O stretch, PO3 stretch, =C-H bending and C-Cl (Priyanga *et al.*, (2017).

MATERIALS AND METHODS

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Plant material

Botanical name: Cordia myxa. L

Classification :

Division : Magnoliophyta

Sub – Division : Spermatophyta

Class : Magnoliopsida

Sub-Class : Asteridae

Order : Lamiales

Family : Boraginaceae

Distribution:

The plant was native to Asia temperate and Asia tropical. *Cordia myxa* originated from the area stretching from the eastern Mediterranean region to eastern India, and was introduced long ago in tropical Africa, tropical Asia and Australia, and more recently also in the Americas. It was widely naturalized in the paleo tropics.

Description:

Dioecious shrub or small tree up to 12m tall; bole tortuous or straight; bark grey, cracked; branches spreading, forming a dense crown; branchlets hairy, later glabrous, with very prominent leaf scars. Leaves alternate, simple; stipules absent; petiole 0.5-4.5 cm long; blade broadly ovate to orbicular, sometimes obovate, 3-18 cm × 3-20 cm, base rounded to cordate or cuneate, apex rounded to obtusely acuminate,

margins entire to toothed, glabrous above, glabrous to velvety hairy below. Inflorescence is a terminal or short lateral panicle, 3-8.5 cm long, many-flowered; bracts absent. Flowers unisexual, regular, white to creamy; pedicel 1-2 mm long; male flowers with campanulate calyx 4.5-5.5 mm long, 3-lobed, shortly hairy inside, glabrous outside, corolla tube 3.5-4.5 mm long, lobes 5, elliptical, c.5 mm × 2 mm, reflexed, stamens inserted at corolla throat, exserted, filaments 1.5-3.5 mm long, ovary rudimentary; female flower with tubular -campanulate calyx 6-8.5 mm long, irregularly 3-4-toothed, densely hairy inside, glabrous outside, corolla tube 4.5 – 6.5 mm long, with sterile anthers, ovary superior, ellipsoid to obovoid, 4-celled, style 8-9 mm long, with 4 stigmatic branches 4-5 mm long, Fruit a globular to ovoid drupe 2-3.5 cm long, apiculate, enclosed at base by the accrescent calyx, yellow, apricot or blackish when ripe, pulp almost transparent, mucilaginous, sweet-tasting. Pyrene broadly ellipsoid to globose, c.12 mm long, deeply wrinkled, 1-2-seeded.

Materials And Methods

Collection and processing

The leaves and stem of *Cordia myxa* were collected from Thoothukudi, Tamil Nadu respectively. The collected samples were cut into small fragments and shade dried until the fracture is uniform and smooth. The dried plant material was granulated or powdered by using a blender, and sieved to get uniform particles by using sieve No. 60. The final uniform powder was used for the extraction of active constituents of the plant material.

Extraction (Maxon and Rooney,1972)

One gram of air-dried sample powder was taken in a 100ml flask, to which added 50ml of 1% (v/v) in methanol. The samples were shaken in a reciprocating shaker for 24h at room temperature. The contents were centrifuged at 10,000 g for 5min.The supernatant was collected separately and used for further analysis.

Quantitative analysis of antioxidant

Total phenolic content:(Duan *et al.*,2006)

Reagents

- 50%Folin – ciocalteau reagent
- 20%sodium – carbonate
- Gallic acid – standard

Procedure

100mg of samples were homogenated with 10 ml of distilled water and filtered through a muslin cloth. 1 ml of the filtrate was added to 1.5 ml of deionized water and 0.5 ml of 50% folinciocalteau reagent and the contents were mixed thoroughly. After 1min, 1 ml of 20% sodium carbonate solution was added and mixed with the control containing all the reagents except the sample. After 30 minutes of incubation at 37°c, the absorbance was measured at 750nm. Total phenolics were calculated as Gallic acid equivalent (GAE) per gram of fresh weight.

Total flavonoid content (Zhinshen *et al.*, 1999)

Reagents

- 5% sodium nitrate (NaNo2)
- 10% Aluminium chloride (Alcl3,H2O)
- 1N sodium hydroxide (NaOH)
- Quercetin standard

Procedure

100mg of plant material was homogenized with 10 ml of distilled water and filtered through a muslin cloth. 0.5 ml of the extract was added with 2.5 ml of distilled water and mixed. After 6 minutes 0.15 ml $NaNO$, was added and again after 6min 0.3 ml of 10% $Alcl^3$ was added. After 5 minutes 1 ml of 1M NaOH and 0.5 ml of water were added. Following through mixing of the solution the absorbance against the blank was recorded at 510nm. Quercetin was used as standard and the results were expressed as my quercetin equivalents (QE) 1g fresh weight.

Vitamin C [Ascorbic acid] (Baker and Frank, 1968)

Reagents

- 5% of TCA
- Indophenol reagent
- 20mg of dichlorophenol indophenols was dissolved in 10ml of warm distilled water
- DT reagent 2g of 2, 4 dinitrophenyl hydrazine and 1g of thiourea were dissolved.
- 85% sulphuric acid
- L-ascorbic acid - standard

Procedure

100 mg of plant material was homogenized with 10 ml of 5% Trichloro acetic acid (TCA). The homogenate was centrifuged. 2 ml of indophenols reagent and 0.5ml of DT reagent were added and incubated at 10c for 1 hour and then cooled in the ice bath and 2.5 ml of 85% sulphuric acid was added and shaken well for 30 minutes (until) red colour appeared. The absorbance was measured at 540nm. 1-ascorbic acid was used as standard and the results were expressed as mg/1g/FW.

Estimation of Tannin (Julkunen-Titto, 1985)

Procedure

100 mg of sample homogenized with 10 ml of distilled water and filtrated through a muslin cloth. 1ml of the aliquot of aqueous extract was mixed with 1.5ml of 4% vanillin (prepared with methanol) and 750 µl of concentrated HCL was added the solution was shaken vigorously and left to stand at room temperature for 20 minutes in darkness the absorbance against blank was read at 500nm using UV-Visible spectrophotometer. Results were expressed as mg catechin equivalent (CE) 1g tissue.

FT-IR analysis

A little powder of plant specimen was mixed with KBrsalt, using a mortar and pestle, and compressed into a thin pellet. Infra-red spectra were recorded as KBrpellets on a Thermo Scientific NicotiS5ID1 transmission, between 4000-400 cm^{-1} (Kareru *et al*., 2008).

GC-MS Analysis: (Hema *et al*,.2011)

Extract Preparation

The 50g leaf and stem powder of *Cordia myxa* were serially extracted with 250 ml of Methanol with the help of the soxhlet apparatus. The extraction procedures were continued for 3-4 hours at 60°C -80°C[15]. These extracts were concentrated under a reduced-pressure evaporator and stored in air-tight vials at 4°C for further study.

Phytochemical analysis by GC-MS

Gas chromatography-Mass spectrometry (GC-MS) analysis of the methanolic extracts was performed by using a GC-MS (Model; QP 2010 series, Shimadzu, Tokyo, Japan) equipped with a VF-5ms fused silica capillary column of 30 m length, 0.25 mm dia., and 0.25µm film thickness. For GC-MS detection, an electron ionization system with an ionization energy of 70 eV was used. Helium gas (99.99%) was used as a carrier gas at a constant flow rate of 1.51 ml/min. Injector and mass transfer line temperatures were set at 200 and 240°C respectively. The oven temperature was programmed from 70 to 220°C at 10°C/min, held isothermal for 1 min and finally raised to 300°C at 10°C/min. 2 µl of respective diluted samples was manually injected in the splitless mode, with a split ratio of 1:40 and with mass 18 scan of 50-600 amu. The Total running time of GC-MS is 35min. The relative percentage of each extract constituent was expressed as a percentage with peak area normalization.

Identification of phytochemical components

The identity of the components in the extracts was assigned by the comparison of their retention indices and mass spectra fragmentation patterns with those stored in the computer library and also with published literature. NIST08s.LIB and WILEY8. LIB library sources were used for matching the identified components from the plant material.

ANTIOXIDENT ACTIVITY

Crude sample extracts were prepared by pouring 100ml of distilled water into a conical flask containing 10g of each sample separately in the ratio of 10:1 (V/W). After 24 hours, the mixture was filtrated through whatman no:1 filter paper and the filtrate was evaporated to dryness. Crude (aqueous) extracts of all samples (1mg/ml) were used for the determination of free radical scavenging activity.

Free radical scavenging assays (Hatano *et al.*, 1998).

Free radical scavenging assay was measured by 2-2 Diphenyl, 1-picryl hydrazine (DPPH) method proposed with slight modifications. 1ml of aliquot of the test sample was added to 3ml of 0.004% DPPH solution prepared in methanol. The mixture was vortexed for 1min and kept at room temperature for 30 minutes in darkness the absorbance was read at 517 nm. Allow absorbance of the reaction mixture indicated a high free radical scavenging activity. Ascorbic acid was used as standard.

DPPH scavenging activity (%)

A control –A test / A control * 100

Where, A control is the absorbance of the DPPH solution without the test solution. A test is the absorbance of DPPH with the test solution. The Aqueous extract was used as blank.

RESULT & DISCUSSION

RESULT AND DISCUSSION

Phytochemicals are natural bioactive compounds found in plants and their parts, such as vegetables, fruits, medicinal plants, aromatic plants, leaves, flowers and roots, which work with nutrients and fibres to act as a defense system against disease or, more accurately, to protect against disease. Plant-derived natural products such as flavonoids, phenols, tannins, and ascorbic acids have diverse pharmacological properties including antioxidant activity. The plant parts like fruits, leaves, stem bark, seeds and roots of most species of this genus, especially *Cordia dichotoma, C. myxa, C. verbenacea, C.martinicensis, C.salicifolia, C. spinescens, C. latifolia, C. ulmifolia*, among others, have long been used in traditional medicine as astringent, anti-inflammatory, anthelminthic, antimalarial, diuretic, febrifuge, appetite suppressant and cough suppressant and to treat urinary infections, lung diseases and leprosy. (Yadav R, Yadav sk. 2013). These plants have some active principle which has this medicinal value. For the present study, the taxa *Cordia myxa* was selected.

QUANTITATIVE ANALYSIS:

The total phenol; flavonoid, tannin, vitamin C and vitamin- E were analysed in leaf and stem extract *of Cordia myxa* belonging to the family Boraginaceae

TOTAL PHENOL:

Phenolics are the most widespread secondary metabolites and are believed to be responsible for antioxidant activity. The total phenol contents of the leaf (3.284 mg GAE/g) were higher than that stem (2.770 mg GAE/g) in *Cordia myxa*.(Table:1) phenolic compounds are as a class of

TABLE 1

TOTAL PHENOL CONTENT OF CORDIA MYXA		
Samples	Amount of phenol mg (GAE)/g	
	Leaf	Stem
Cordiamyxa	3.284±0.120	2.770±0.123

Values are the mean of triplicates ± standard deviation. Dry samples were used for analysis.

Garlic acid equivalent (1mg/ml) was used as standard

TABLE:2

TOTAL FLAVANOIDS CONTENT OF CORDIA MYXA		
SAMPLES	**Amount of flavonoids mg (GAE)/g**	
	Leaf	Stem
Cordia myxa	3.159±0.017	2.112±0.034

Values are the mean of triplicans ± standard deviation. Dry samples were used for analysis.

Quercetin acid equivalent (1 mg/ml) was used as standard

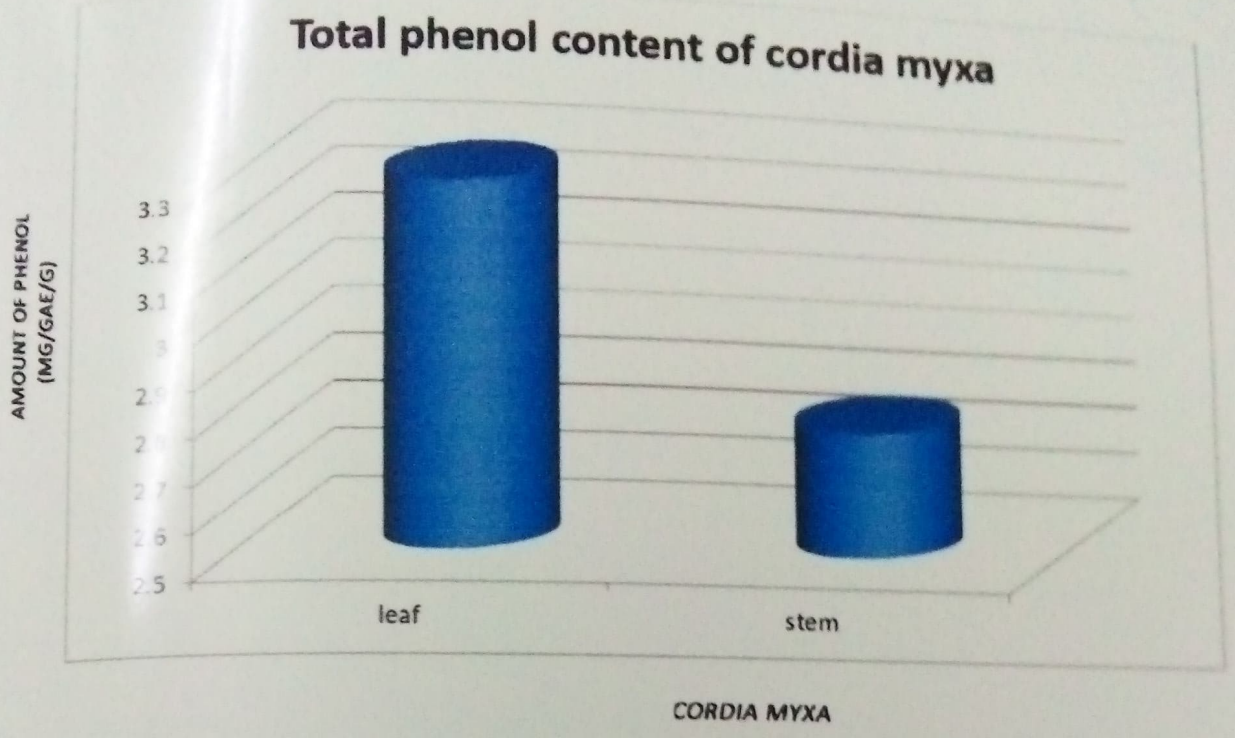


Fig:1 Total phenol content of *cordial myxa*

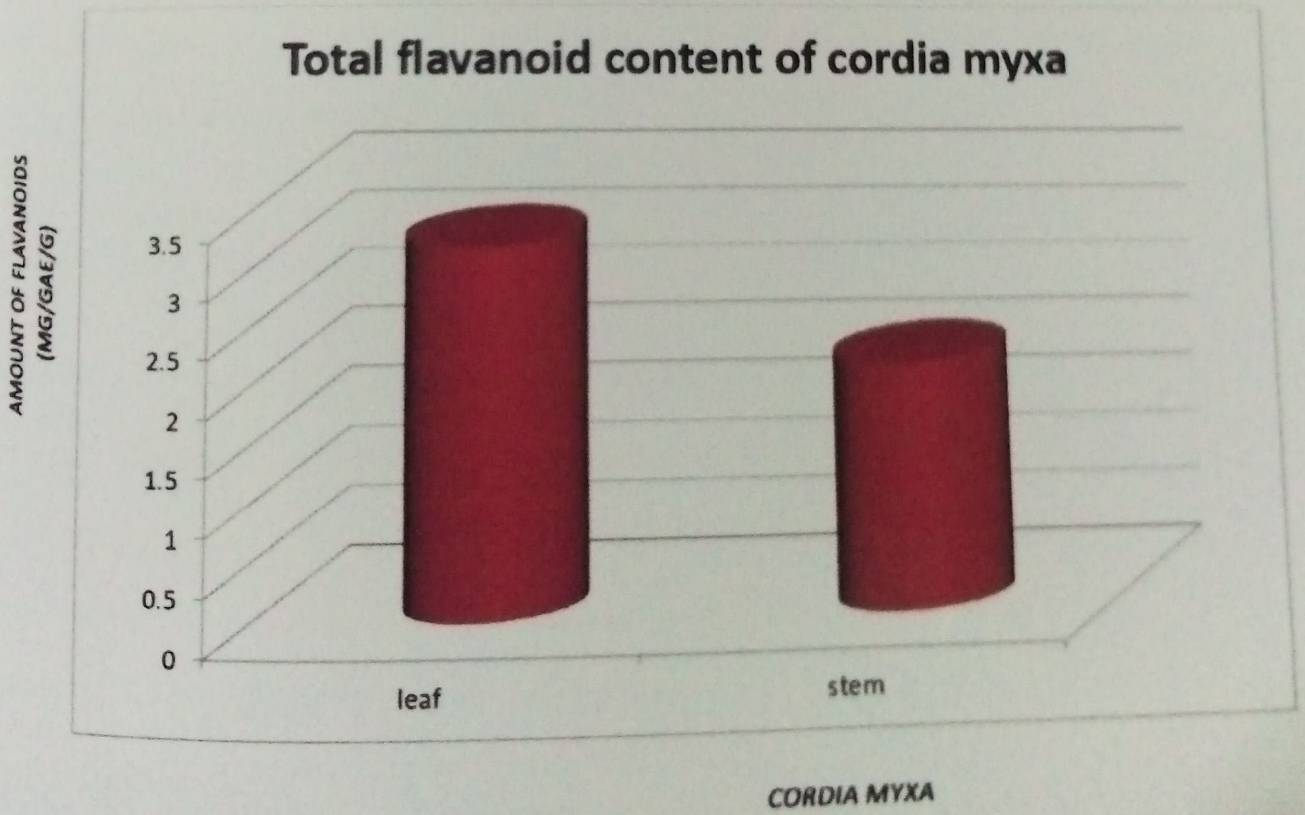


Fig:2 Total flavanoid content of *cordia myxa*

antioxidant agents that act as free terminators. (Shahidi and Wanasundara, 1992). Phenolic compounds have a variety of beneficial activities. They have potent antioxidants and free radical scavengers (Meenakshi *et al*.,2012). The antimicrobials (most of the phenolics) may provide a microbe-free environment within the body.

TOTAL FLAVANOID:

Flavonoids are secondary metabolites and have responsible for antioxidant activity in the medicinal field. The total flavonoid contents of the leaf (3.159 mg QE/g) were higher than that stem (2.112 mg QE/G) in *Cordia myxa*.(Table:2) Flavonoids are potent antioxidants and epidemic studies indicate that high flavonoid intake is correlated with decreased risk of lifestyle diseases like diabetes and cardiovascular disease (kaur *et al*., 2016). Flavonoids are potent water-soluble antioxidants and free radicals which prevent oxidative cell damage and have strong anti-cancer activity (Havsteen, 2008).

TOTAL VITAMIN-C:

Cordia myxa leaf (1.793 mg/g) and stem (1.317 mg/g) contain a significant amount of vitamin C.(Table:3) Vitamin- C is a vital component in the human diet with the highest concentrations in animal organs. Vitamin C is a non-enzymatic, antioxidant water-soluble antioxidant (Ueta *et al*., 2003). Vitamin –C functions in enzyme activation, oxidative stress reduction and immune function. It protects against respiratory tract infection and reduces the risk of cardiovascular disease and some cancer.

TABLE : 3

TOTAL VITAMIN-C CONTENT OF CORDIA MYXA		
Samples	Amount of Vitamin-C (mg/g)	
	Leaf	Stem
Cordia myxa	1.793±0.035	1.317±0.007

Values are the mean of triplicates ± standard deviation. Dry samples were used for analysis.

Vitamin_C Equivalent (1mg/ml) was used as standard.

TABLE: 4

TOTAL TANNIN CONTENT OF CORDIA MYXA		
Sample	Amount of tannin mg (GAE)/g	
	Leaf	Stem
Cordia myxa	1.197±0.078	1.265±0,056

Values are the mean of triplicates ± standard deviation. Dry samples were used for analysis.

Catechin equivalent (1mg/ml) was used as standard.

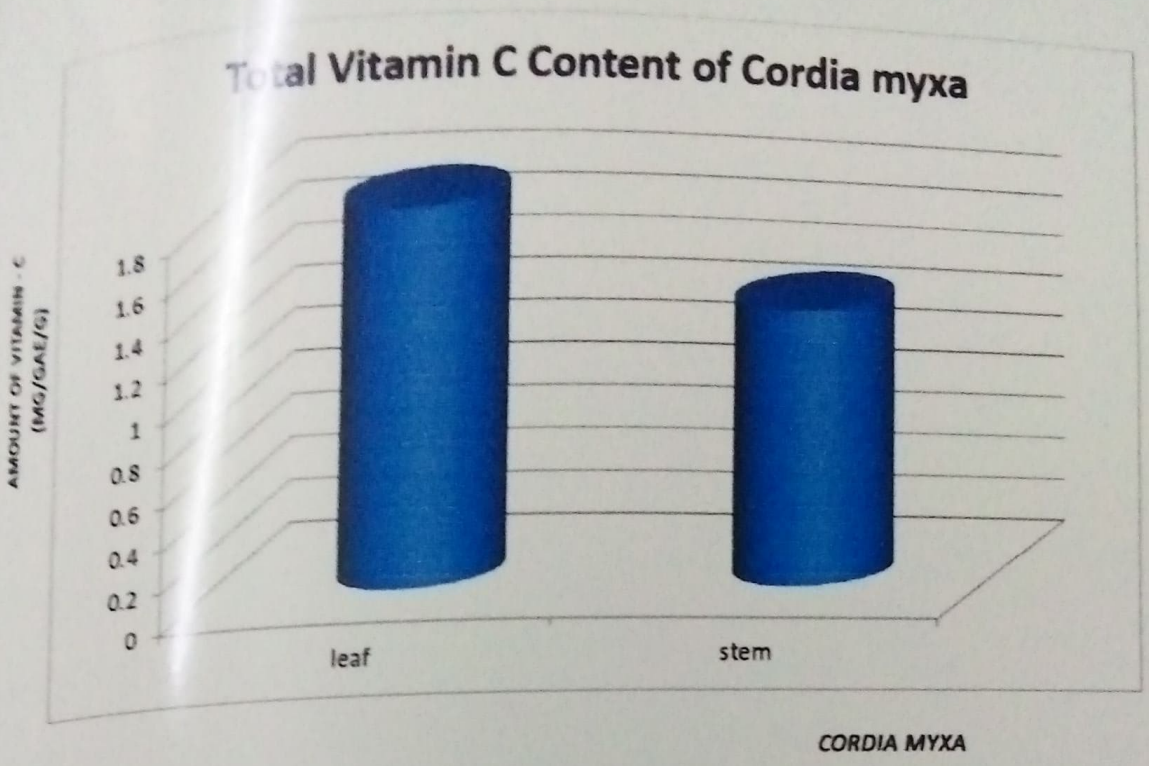


Fig :3 Total vitamin C content of *cordial myxa*

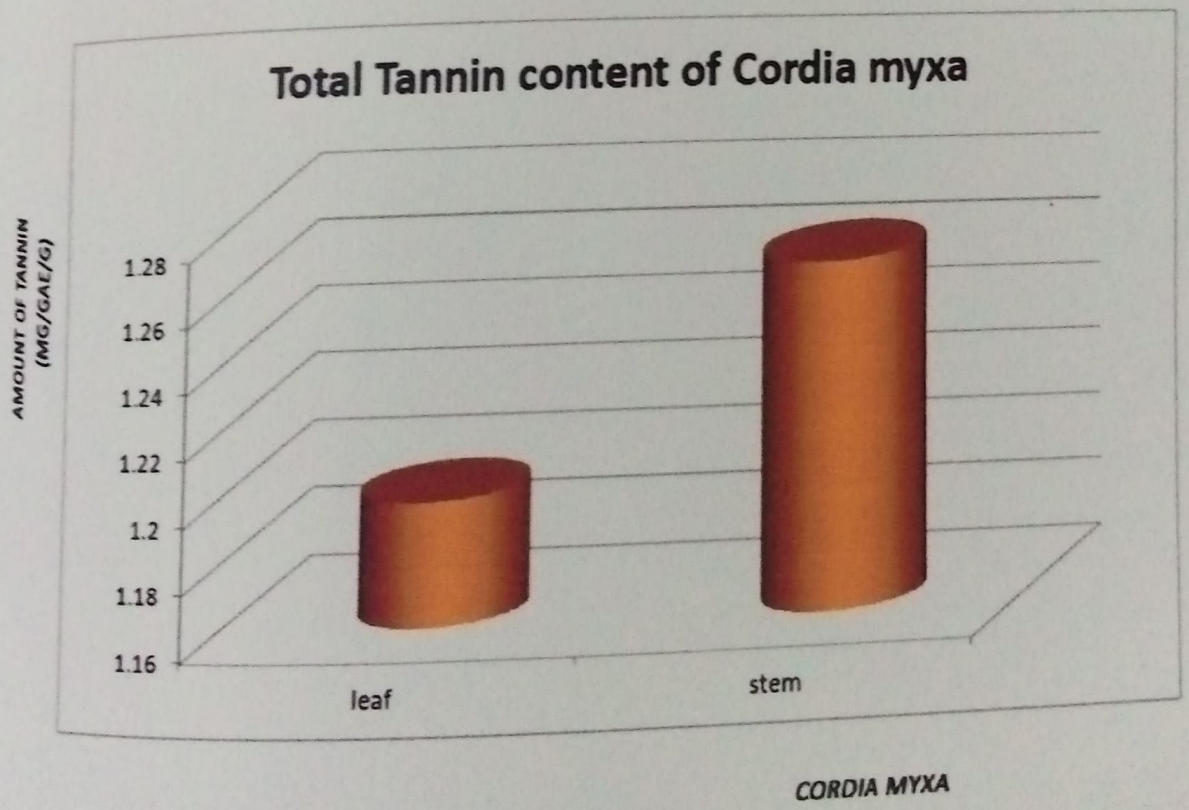


Fig :4 Total Tannin content of *cordial myxa*

TOTAL TANNINS:

Cordia myxa leaf (1.197 mg CE/g) contains the highest amount of tannin, and the stem of *Cordia myxa* contains the lowest amount of tannin (1.265 mg CE/g)(Table:4). Tannins are present primarily in the leaves of trees growing in stressful conditions. They are accumulated in the vacuoles, especially these of the epidermal layer and the palisade mesophyll. Tannins are useful in treating inflammation and ulcers remarkable activity in cancer prevention and anticancer activities (Li *et al*.,2003, Akinpelu *et al*.,2009).

FTIR:

Fourier transform infrared spectroscopy was used to analyse the functional group present in the leaf and stem of the *Cordia myxa*.

The FTIR spectroscopy analysis of *Cordia myxa* leaf obtained peaks at 516.89cm^{-1}, 672.15cm^{-1}, 875.62cm^{-1}, 1028.95cm^{-1}, 1112.85cm^{-1}, 1164.92cm^{-1}, 1232.43cm^{-1}, 1317.29cm^{-1}, 1370.33cm^{-1}, 1455.19cm^{-1}, 1511.12cm^{-1}, 1547.77cm^{-1}, 1626.84cm^{-1}, 1740.64cm^{-1}, 2330.81cm^{-1}, 2380.96cm^{-1}, 2850.59cm^{-1}, 2920.03cm^{-1}, 3438.84cm^{-1}, 3736.82cm^{-1}. These absorption peaks are known to be associated with the stretching vibration for C-Br in Acyclic and Aromatic, C-Br in Actclic Axial, C-F in Poly Fluorinated, C-N in Alkyl amine, C-O-C in Acetates, R-C in Sulphonamide, C-F in Poly Fluorinated, CH3-O- in Alkanes, N-H in Primary amine, C=C in Aliphatic aldehyde, -NH2+ & NH2 C-H Stretch off C=O Aldehydes, Ar-CH3 in Alkanes, N-H in Amines- Primary.Fig:5,Table (5).

The FTIR spectroscopy analysis of *Cordia myxa* stems obtained peaks at 516.89cm^{-1}, 596.93cm^{-1}, 671.18cm^{-1}, 781.12cm^{-1}, 825.48cm^{-1}, 894.91cm^{-1}, 1030.88cm^{-1},

FIG : 5 FTIR spectroscopy analysis of Cordia myxa leaf

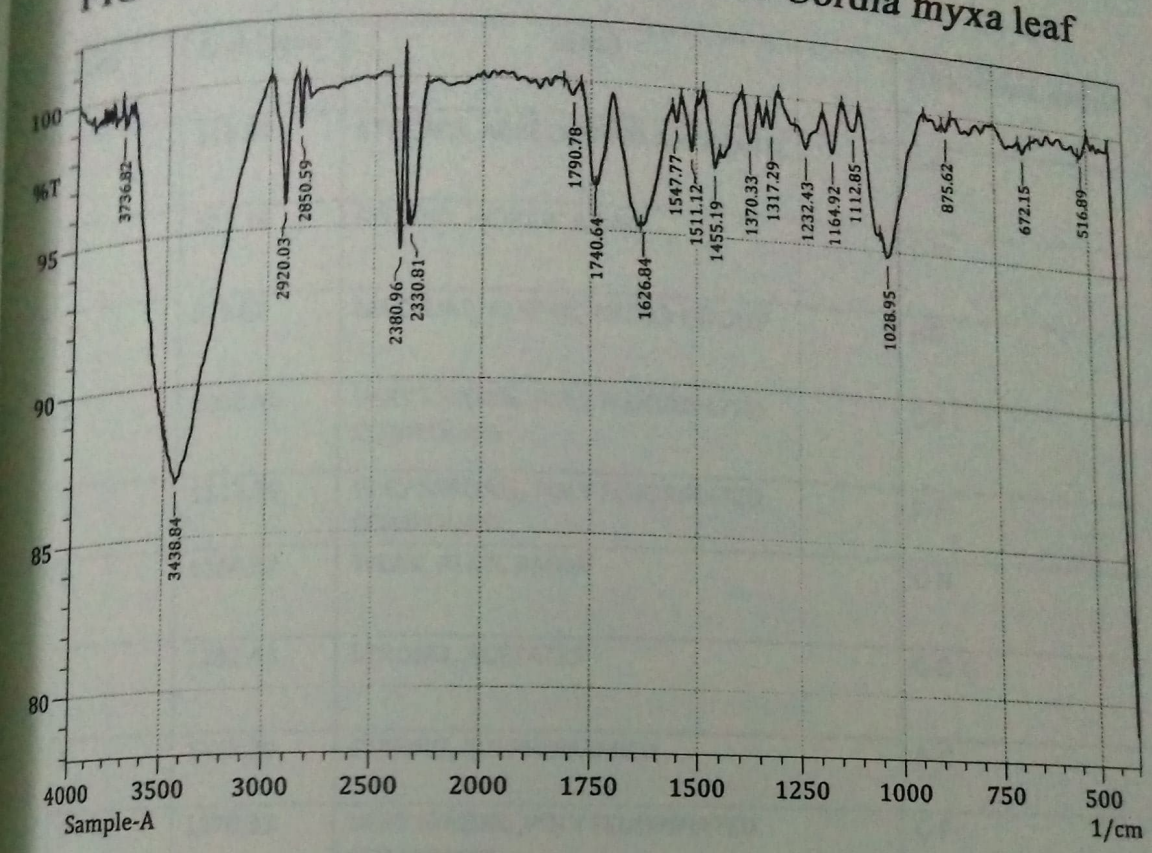


FIG : 6 FTIR spectroscopy analysis of *Cordia myxa* stem

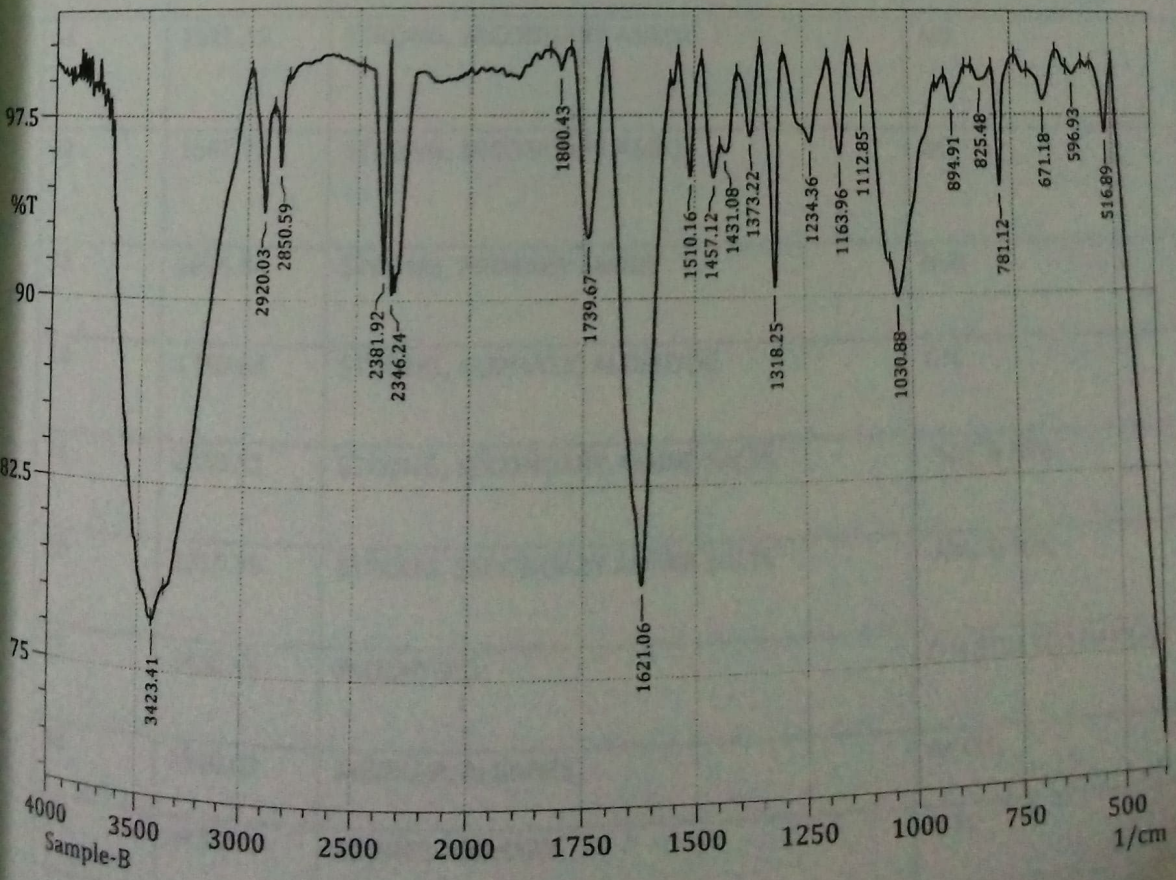


Table:5 FTIR Spectroscopy analysis of *Cordia myxa* leaf

S.NO	Peak Value	BOND	FUNCTIONAL GROUP
1	516.89	STRONG, ACYCLIC AND AROMATIC	C-Br
2	672.15	STRONG, ACYCLIC AXIAL	C-Br
3	875.62	MEDIUM, ALIPHIC NITRO GROUP	NO
4	1028.95	VERY STRONG, POLY FLUORINATED COMPOUND	C-F
5	1112.85	VERY STRONG, POLY FLUORINATED COMPOUND	C-F
6	1164.92	WEAK, ALKYL AMINE	C-N
7	1232.43	STRONG, ACETATES	C-O-C
8	1317.29	STRONG, SULPHONAMIDE	R-C
9	1370.33	VERY STRONG,POLY FLUORINATED COMPOUND	C-F
10	1455.19	MEDIUM, ALKANES	CH_3-O-
11	1511.12	STRONG, SECONDARY AMIDE	NO
12	1547.77	STRONG, SECONDARY AMIDE	NO
13	1626.84	STRONG, PRIMARY AMINE	N-H
14	1740.64	STRONG, ALIPHATIC ALDEHYDE	C=C
15	2330.81	STRONG, SECONDARY AMINE SALTS	$-NH_2^+$& NH_2
16	2380.96	STRONG, SECONDARY AMINE SALTS	$-NH_2^+$& NH_2
17	2850.59	ALDEHYDES	C-H STRETCH OFF C=O
18	2920.03	MEDIUM, ALKANES	Ar-CH_3
19	3438.84	AMINES-PRIMARY	N-H

Table:6 FTIR spectroscopy analysis of *Cordia myxa* stem

S.NO	PEAK	BOND	FUNCTIONAL GROUP
1	516.89	WEAK, SULPHIDES	S-S
2	596.93	STRONG,ACYCLIC AND AROMATIC	C-Br
3	671.18	STRONG, ACTCLIC AXIAL	C-Br
4	781.12	STRONG,POLY CHLORINATE COMPOUNDS	C-Cl
5	825.48	SULPHINIC ACID GROUP	S-O
6	894.91	MEDIUM, BENZENE RING	C-H
7	1030.88	STRONG, SULPHINIC ACIDS	S=O
8	1112.85	VERY STRONG, POLY FLUORINATED COMPOUND	C-F
9	1163.96	WEAK, ALKYL AMINE	C-N
10	1234.36	STRONG, ACETATES	C-O-C
11	1373.22	MEDIUM, CH_3 BENDING	CH_3COO-
12	1431.08	MEDIUM, CH3 BENDING	R-O-CH_3
13	1457.12	MEDIUM, CH3 BENDING	CH_3-O-
14	1510.16	STRONG,NITROSO GROUP	N=O
15	1621.06	WEAK, AMINO ACIDS	NH_3^+

Table:6 FTIR spectroscopy analysis of *Cordia myxa* stem

16	1739.67	STRONG,ALIPHATIC ALDEHYDE	C=O
17	1800.43	WEAK, AROMATIC	CH
18	2346.24	STRONG, SECONDARY AMINE	$-NH_2^+$
19	2381.92	STRONG,SECONDARY AMINE SALTS	$-NH_2^+$
20	2850.59	WEAK, CARBOXYLIC ACID	C-H
21	2920.03	WEAK, KETONES STRECH	C-H
22	3423.41	MEDIUM, SECONDARY AMINE	N-H

1112.85cm^{-1}, 1163.96cm^{-1}, 1234.36cm^{-1}, 1318.251$_{cm}^{-1}$, 1373.22cm^{-1}, 1431.08cm^{-1}, 1457.12cm^{-1}, 1510.16cm^{-1}, 1621.06cm^{-1}, 1739.67cm^{-1}, 1800.43cm^{-1}, 2346.24cm^{-1}, 2381.92cm^{-1}, 2850.59cm^{-1}, 2920.03cm^{-1}, 3423.41cm^{-1}. These absorption peaks are known to be associated with the stretching vibration for S=S Sulphides, C-Br Acyclic and Aromatic, C-Br Actclic axial, C-Cl Poly chlorinate compounds, S-O Sulphinic acid, C-H Benzene ring, S=O Sulphinic acid, C-F Poly fluorinated, C-N Alkyl amine, C-O-C Actates, CH_3COO- CH_3 Bending, R-O-CH_3 CH_3 Bending, N=O Nitroso group, NH_3^+ Amino acid, C=O Aliphatic Aldehyde, CH Aromatic, -NH_2^+ Secondary Amine, C-H Ketone Strech. Fig:6, Table (6)

From the spectral data presence of C-Br, C-F, C-N, C-O-C, R-C, CH_3-C O, C=O, Ar-CH_3, N-H were identified. These bendings are responsible for the presence of the amine group, Dihaloketon group, Asymmetric group, Acyclic and Aromatic group, Carboxylic acid group, sulphinic acid group and sulphides group. The carboxylic acid present in the medicinal plant serves as the main pharmaceutical product in curing fever and pain in the liver, Amine is the main group which are involved in protein synthesis. The study revealed that the whole plant of *Cordia myxa* contains a considerable amount of secondary metabolites and it may be considered in future to be used in human disease management. (Da-young lee and Eun-Hee kim.,2019)

GC-MS Analysis:

The GC-MS analysis of the methanolic leaf extract of *Cordia myxa* confirmed the presence of 12 compounds with retention time. Interpretation of the mass spectrum of GC-MS was using the database of NIST and WILEY libraries. Out of 12 compounds 8 compounds were

majority present in the leaf extract of Cordia myxa respectively 6-Octadecenoic acid, methyl ester (12.743%), Isopulegol (12.790%), Cyclononanone (13.821%), 2-Decenal,(E) (14.104), trans-13-Octadecenoic acid, methyl ester (12.743%), 1H-Indene, 2-butyl-5-hexyloctahydro- (12.790%),2-(1,5-Dimethylhexyl)-cyclobutanone (13.821%),1,2-cyclohexanediol, cyclic sulphite, cis (14.104%)

The 4 minor compounds such as Decyl trifluoroacetate (12.743%), 9-Octadecenal, (Z)- (12.790%), 1-Hexene-3,5-dione (13.821%), 2-Dodecanol (14.104) were also reported from the methanolic leaf extract of *Cordia myxa*. The chemical constituents analysis result of *Cordia myxa* were reported in table-7 and their GCMS chromatogram is presented in Fig-7,Table-7&8.

The first compound identified with less retention (12.743 min) trans-13-Octadecenoic acid, methyl ester, 6-Octadecenoic acid, methyl ester, (Z)- and Decyl trifluoroacetate whereas 2-Dodecanol, 2-Decenal, (E) and 1,2-cyclohexane diol, cyclic sulphite, cis which took longest retention time (14.104 min) to identify. At (14.104 min) -Dodecanol, 2-Decenal, (E) and 1,2-cyclohexanediol, cyclic sulphite, cis were found to be high (28.98%) and the lowest percentage (19.34%) was found to be 2-(1,5- Dimethylhexy)-cyclobutanone, Cyclononanone, 1-Hexene-3,5-dione.

The GC-MS analysis of the methanolic stem extract of *Cordia myxa* confirmed the presence of 18 compounds with retention time. Interpretation of the mass spectrum of GC-MS was using the database of NIST and WILEY libraries. Out of these 18 compounds, 12 compounds are majority present in the stem of *Cordia myxa* respectively Dodecanoic acid, 1-methyl ethyl ester(12.412%), 7-Oxabicyclo (4.1.0) heptane, 3-methyl-(14.105%), Propanedinitrile, methylene-(14.256%), Furazano (3,4-b)pyrazine-5(4H)-one, 6-(1-pyrrolidinyl)- (15.835%),trans-4-Ethoxy-beta-methyl-.beta.-nitrostyrene 4.(19.702%), 9-Oxononanoic acid

FIG : 7 GC-MS Chromatogram of leaf exract (methanol)

Cordia myxa

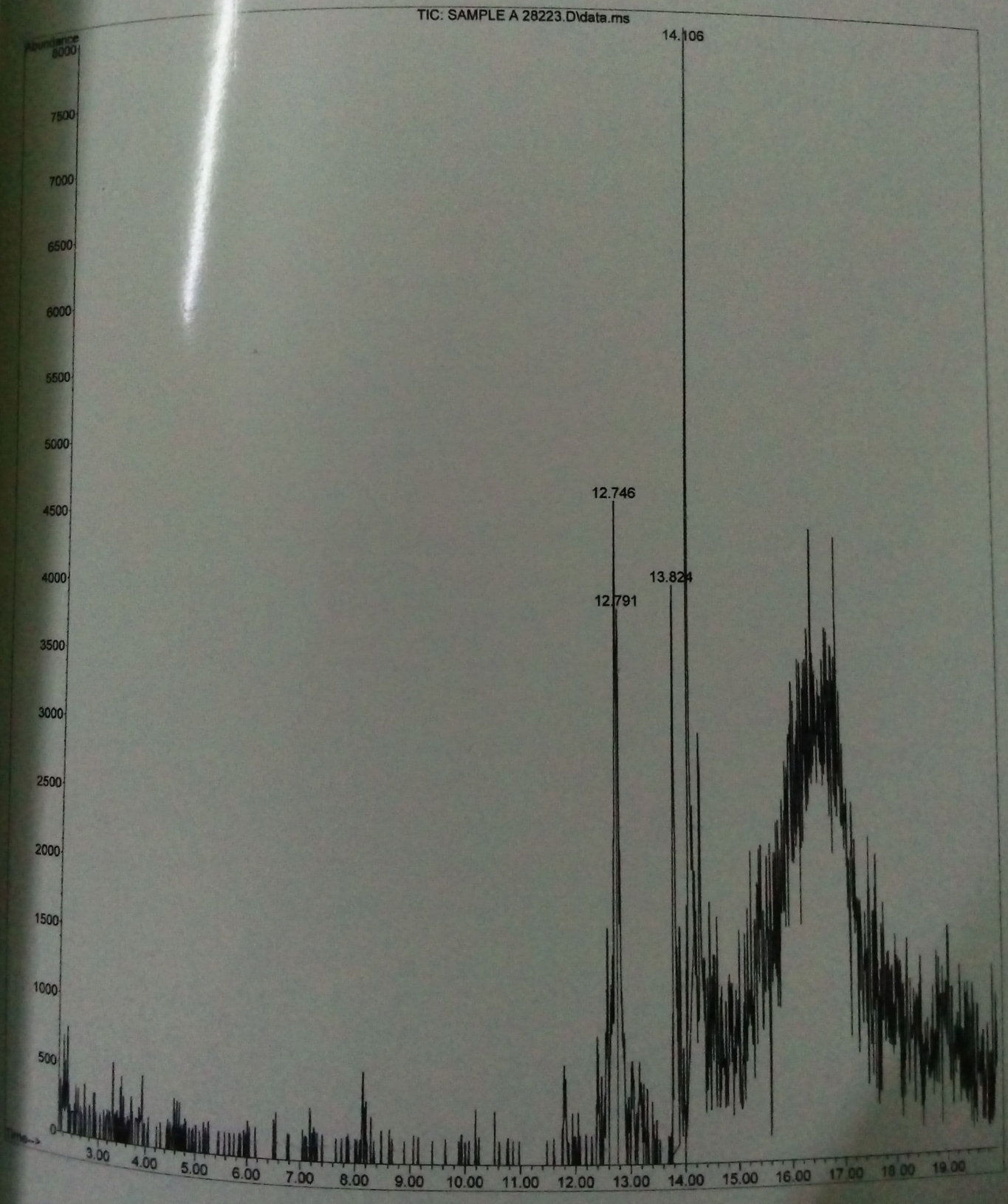


TABLE : 7 Cordia myxa leaf mass spectrum

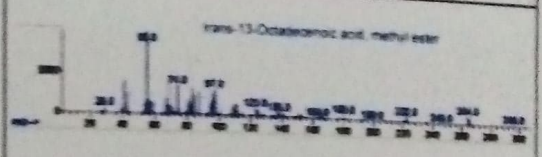
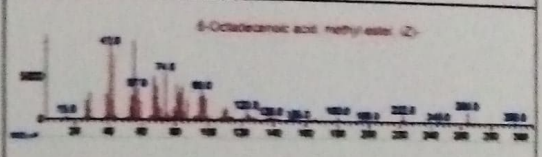
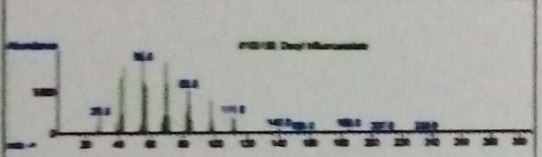
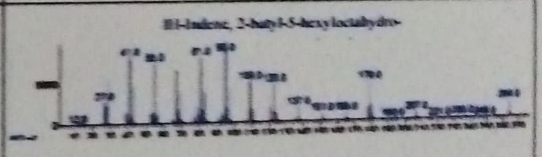
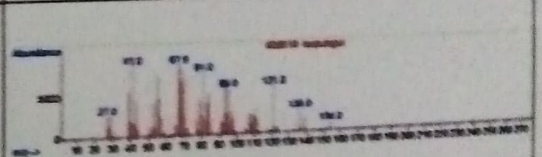
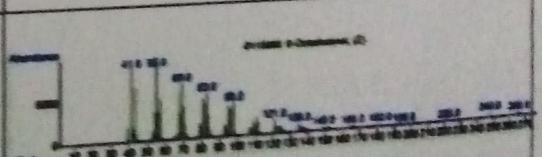
S.NO	RT	Name of the compounds	Area %	Mass spectrum
1	12.743	trans-13-Octadecenoic acid, methyl ester	27.08	
2	12.743	6-Octadecenoic acid, methyl ester, (Z)-	27.08	
3	12.743	Decyl trifluoroacetate	27.08	
4	12.790	1H-Indene, 2-butyl-5-hexyloctahydro-	24.60	
5	12.790	Isopulegol	24.60	
6	12.790	9-Octadecenal, (Z)-	24.60	

TABLE : 7 Cordia myxa leaf mass spectrum

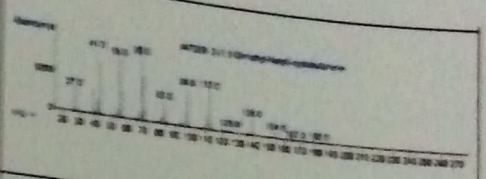
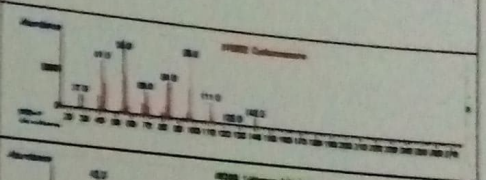
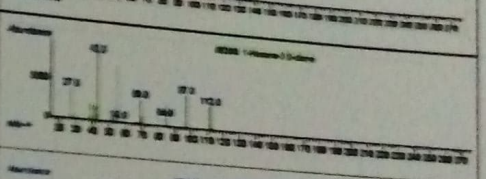
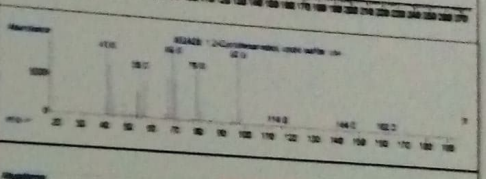
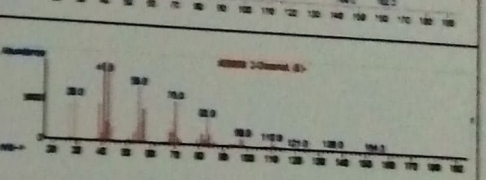
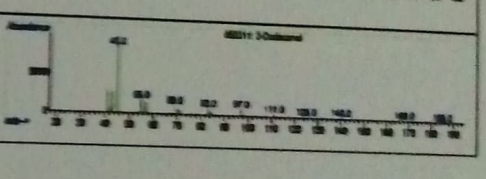
7	13.821	2-(1,5-Dimethylhexyl)-cyclobutanone	19.34	
8	13.821	Cyclononanone	19.34	
9	13.821	1-Hexene-3,5-dione	19.34	
10	14.104	1,2-cyclohexanediol, cyclic sulfite, cis	28.98	
11	14.104	2-Decenal, (E)	28.98	
12	14.104	2-Dodecanol	28.98	

Table : 8 List of chemical compounds identified from methanol leaf extract of *Cordia myxa* GC-MS analysis

S.NO	RT	Name of the compound	Area%	Biological activity
1	12.743	trans-13-Octadecenoic acid, methyl ester	27.08	Antipruritic, kidney function stimulant, Anti viral and Anti inflammatory
2	12.743	6-Octadecenoic acid, methyl ester, (Z)-	27.08	Antieczematic, Anti mutagenic, Antiseborrhenic and Anti hypoxic
3	12.743	Decyl trifluoroacetate	27.08	Antieczematic, Anesthetic general, Anti hypoxic and Anti inflammat
4	12.790	1H-Indene, 2-butyl-5-hexyloctahydro-	24.60	Antineurotic, Antidyskinelic, Anti viral and Anti inflammatory
5	12.790	Isopulegol	24.60	Carminative, Antieczematic, Anti inflammatory and Anti fungal
6	12.790	9-Octadecenal, (Z)-	24.60	Anti infective, Antiviral, Anti septic and Antisecretoric

Table : 8 List of chemical compounds identified from methanol leaf extract of *Cordia myxa* GC-MS analysis

7	14.104	2-Dodecanol	28.98	Carminative, antineurotic, antifungal,anti inflammatory, Eye irritation, oxidizing agent, kidney function stimulant, antipruritic, allergic,
8	14.104	2-Decenal, (E)	28.98	Anti-inflammatory, Carminative, antineoplastic, anti protozoal(Trypanosoma), antihelmintic, antiparasite, insecticide, calcium regulator, anti bacterial
9	14.104	1,2-cyclohexanediol, cyclic sulfite, cis	28.98	(Not found in pass online)
10	13.821	2-(1,5-Dimethylhexyl)-cyclobutanone	19.34	Anti fungal, anti protozoal (coccidial), anti bacterial, insulin promotor, anti ulcerative, anti inflammatory, anti viral(Rhino virus), dermatologic
11	13.821	Cyclononane	19.34	Anti allergic, growth stimulant, insulin promotor, anti viral (influenza), dermatologic, antiviral (Picornavirus), Carminative, ovulation inhibitor.
12	13.821	1-Hexene-3,5-dione	19.34	Laxative, allergic, anti viral(influenza), antineoplastic (pancreatic cancer, breast cancer), anti fungal, anti-inflammatory, anti ulcerative.

FIG : 8 GC-MS Chromatogram of stem exract (methanol)

Cordia myxa

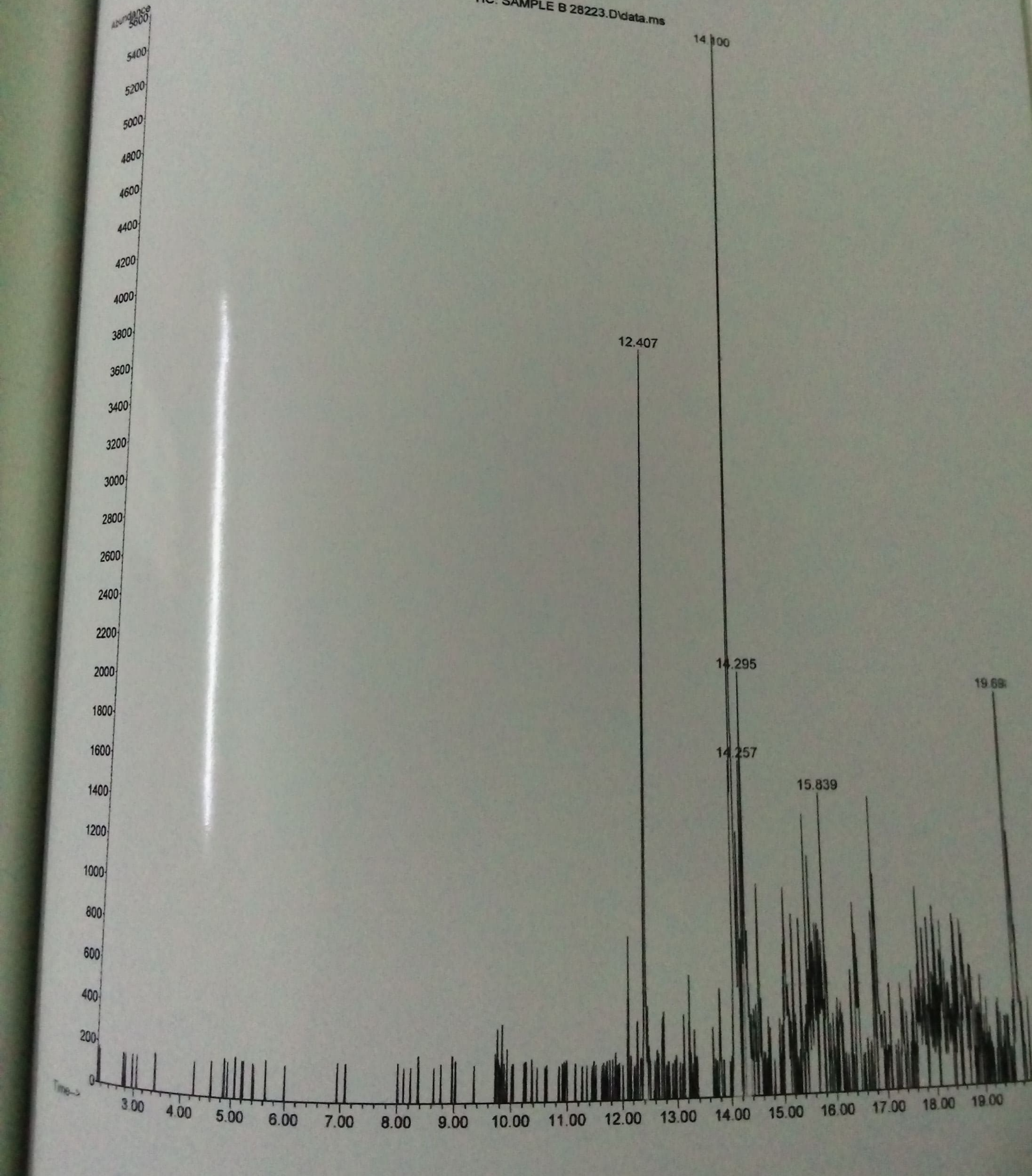


TABLE : 9 *Cordia myxa* stem spectrum

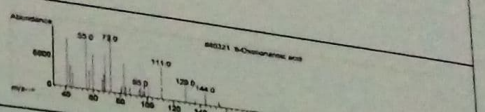
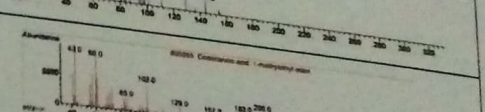
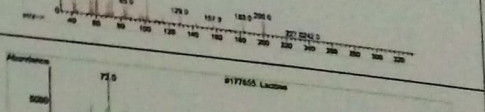
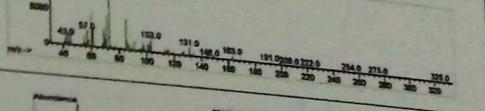
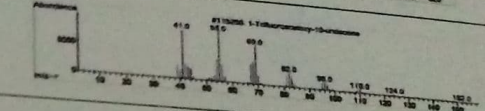
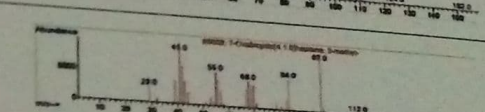
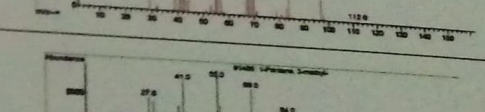
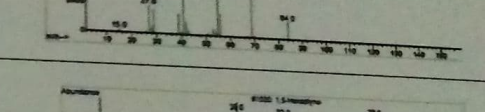
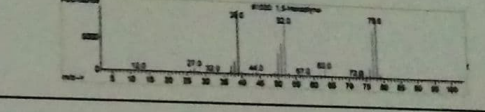
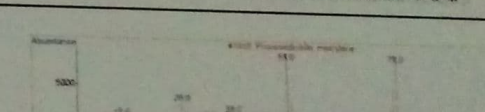
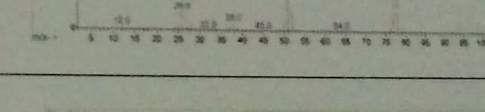
NO	RT	NAME OF THE COMPOUND	AREA%	Mass spectrum
1	12.412	9-Oxononanoic acid	16.21	
2	12.412	Dodecanoic acid, 1-methylethyl ester	16.21	
3	12.412	Lactose	16.21	
4	14.105	1-Trifluoroacetoxy-10-undecene	46.03	
5	14.105	7-Oxabicyclo[4.1.0] heptane, 3-methyl-	46.03	
6	14.105	1-Pentene, 3-methyl-	46.03	
7	14.256	1,5-Hexadiyne	9.36	
8	14.256	Propanedinitrile, methylene-	9.36	
9	14.256	Propanedinitrile, methylene-	9.36	
10	14.294	4-Octanol	14.16	
11	14.294	N-Methoxy-N-methylamonodifluorophosphine	14.16	

TABLE : 9 *Cordia myxa* stem spectrum

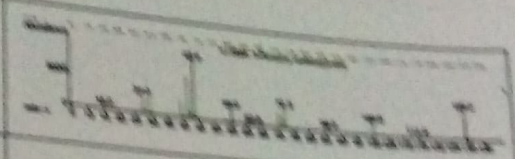
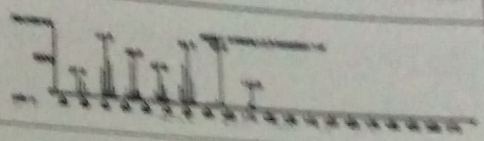
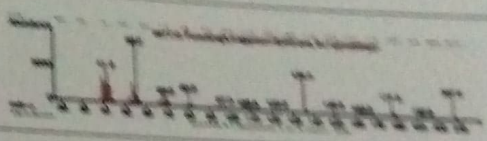
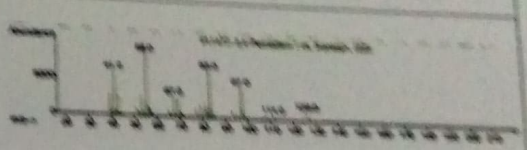
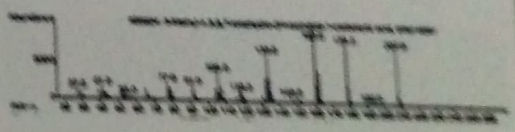
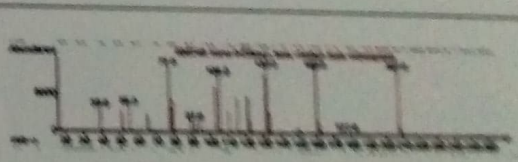
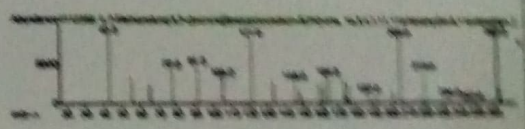
12	14.294	3-Pentane isothiocyanate	14.16	
13	15.835	4-Methyl-2,3-hexadien-1-ol	6.60	
14	15.835	Furazano[3,4-b]pyrazin-5(4H)-one, 6-(1-pyrrolidinyl)-	6.60	
15	15.835	2,4-Pentadien-1-ol, 3-propyl-, (2Z)-	6.60	
16	19.702	3-Methyl-4,5,6,7-tetrahydro-2H-isoindole-1-carboxylic acid, ethyl ester	7.65	
17	19.702	trans-4-Ethoxy-.beta.-methyl-.beta.-nitrostyrene	7.65	
18	19.702	4,7-Methanofuro[3,2-c]oxireno[f]oxacycloundecin-5(2H)-one, 1a,3,4,7,11,11a-hexahydro-8,11a-dimethyl-	7.65	

Table10 List of chemical compounds identified from methanol stem extract of *Cordia myxa* through GC-MS analysis

S.NO	RT	NAME OF THE COMPOUND	AREA%	Biological activity
1	12.412	9-Oxononanoic acid	16.21	Antiinfective, Antieczematic, Anti toxic and Antiseptic
2	12.412	Dodecanoic acid, 1-methylethyl ester	16.21	Antieczematic, Anti hypoxic, Antiseborrheic and Antihelmintic
3	12.412	Lactose	16.21	Antiinfective, Anti toxic, Anti protorval and Antioxidant
4	14.105	1-Trifluoroacetoxy-10-undecene	46.03	Antieczematic, Anti inflammatory, Antiulcerative and Antipruritic
5	14.105	7-Oxabicyclo[4.1.0] heptane, 3-methyl-	46.03	Carminative, Antineoplastic, Antiseborrheic and Anti viral
6	14.105	1-Pentene, 3-methyl-	46.03	Carminative, Antieczematic, Anti viral and Antipruritic
7	14.256	1,5-Hexadiyne	9.36	Antineoplastic, Antiseborrheic, Anti inflammatory and Antieczematic
8	14.256	Propanedinitrile, methylene-	9.36	Antineoplastic, Antiseborrheic, Antihypoxic and Anti viral
9	14.256	Propanedinitrile, methylene-	9.36	Antineoplastic, Antiseborrheic, Antihypoxic and Anti viral

(12.412%),1-Trifluoroacetoxy-10-undecene (14.105%), 1,5-Hexadiyne (14.256%), 4-Octanol (14.294%), N-Methoxy-N-methyl amomodifluorophosphine (14.294%), 4-Methyl-2,3-hexadien-1-ol (15.835%). 3-Methyl-4,5,6,7-tetrahydro-2H- isoindole-1-carboxylic acid, ethyl ester (19.702%).

The 6 minor compounds such as Lactose (12.412%),1-Pentene, 3-methyl- (14.105%), 3-pentane isothiocyanate (14.294%), Propanedinitrile, methylene- (14.256%), 2,4-pentadien-1ol,3-propyl-,(2Z)- (15.853%), 4,7-Methanofuro(3,2-c) oxireno (f)oxacycloundecin-5(2H)-one, 1a,3,4,7,11,11a-hexahydro-8,11a-dimethyl- (19.702%) were also reported from the methanolic stem extract of *Cordia myxa*. The chemical constituents analysis result of *Cordia myxa* were reported in table 8 and their GC-MS chromatogram is presented in fig: 8, Table-9&10.

The first compound identified with less retention (12.412 min) was 9-Oxononanoic acid, Dodecanoic acid, 1-methylethyl ester and lactose whereas 3-Methyl-4,5,6,7-tetrahydro-2H-isoindole-1-carboxylic acid, ethyl ester, trans-4-Ethoxy-.beta.-methyl-.beta.-nitrostyrene, 4,7-Methanofuro[3,2-c]oxireno[f]oxacycloundecin-5(2H)-one, 1a,3,4,7,11,11a-hexahydro-8,11a-dimethyl- was the last compound which took longest retention time (19.702) to identify. At (14.105 min) retention time 1-Trifluoroacetoxy-10-undecene, 7-Oxabicyclo[4.1.0] heptane, 3-methyl-,1-Pentene, 3-methyl- was found to be high (46.03%) and lowest percentage (6.60%) was found to be 4-Methyl-2,3-hexadien-1-ol, Furazano[3,4-b]pyrazin-5(4H)-one, 6-(1-pyrrolidinyl)-, 2,4-Pentadien-1-ol, 3-propyl-, (2Z)-. The abovementioned isolated compounds from the methanolic leaf and stem extract of *Cordia myxa* have a medicinal important

9-Octadecenoic acid (Z)-, methyl ester and 9, 12-Octadecadienoic acid methyl ester (E,E) were identified in the crude extract of *Benincasa hispida* and *Cucurbita moschata* leaf. These compounds have great potential antioxidant, anti-cancer, and anti-inflammatory properties (Hagr, *et al*.,2018). 7-Oxabicyclo (4. 1. 0) heptane,3-methyl found in the stem of *Curcurbita pepo* stem tends to have better antioxidant activity (Ezekwe Ahamefula Sunday *et al*.,2021). Both compounds were present in the leaf and stem extracts of the plant *Cordia myxa* also. The presence of the identified bioactive components present in the leaf and stem extract of *Cordia myxa* could be responsible for the antioxidant and antimicrobial effects of the plants. Identification of these compounds in the plants serves as the basis for determining the possible health benefits of the plant leading to further biological and pharmacological studies.

ANTIOXIDANT ACTIVITY:

An antioxidant is a molecule capable of showing or preventing the oxidation of other molecules. In a biological system, they protect cells from the damage caused by unstable molecules known as free radicals. Antioxidants terminate the chain reactions by removing free radical intermediates, and inhibit other oxidation reactions by being oxidized themselves. They are believed to play a role in preventing the development of chronic diseases like cancer, heart disease, stroke, AD, RA and cataracts (chakraborty *et al*.,2010).

Antioxidant chemicals found in nature inhibit or prevent oxidation of substrate leading to the formation of reactive oxygen species and reactive nitrogen species and thus protect the biological system (Hwang *et al*.,2007). Fruits and vegetables are endowed with antioxidants and consumption of these, prevents and protects from oxidative stress-related diseases,

TABLE: 11

DPPH FREE RADICAL SCAVENGING ACTIVITY

Antioxidant activity in aqueous extract of leaf and stem of *Cordia myxa*

S. No	Aqueous Extract	DPPH free radical assay %
1	*Cordia myxa* (Leaf)	30.40
2	*Cordia myxa* (Stem)	23.30

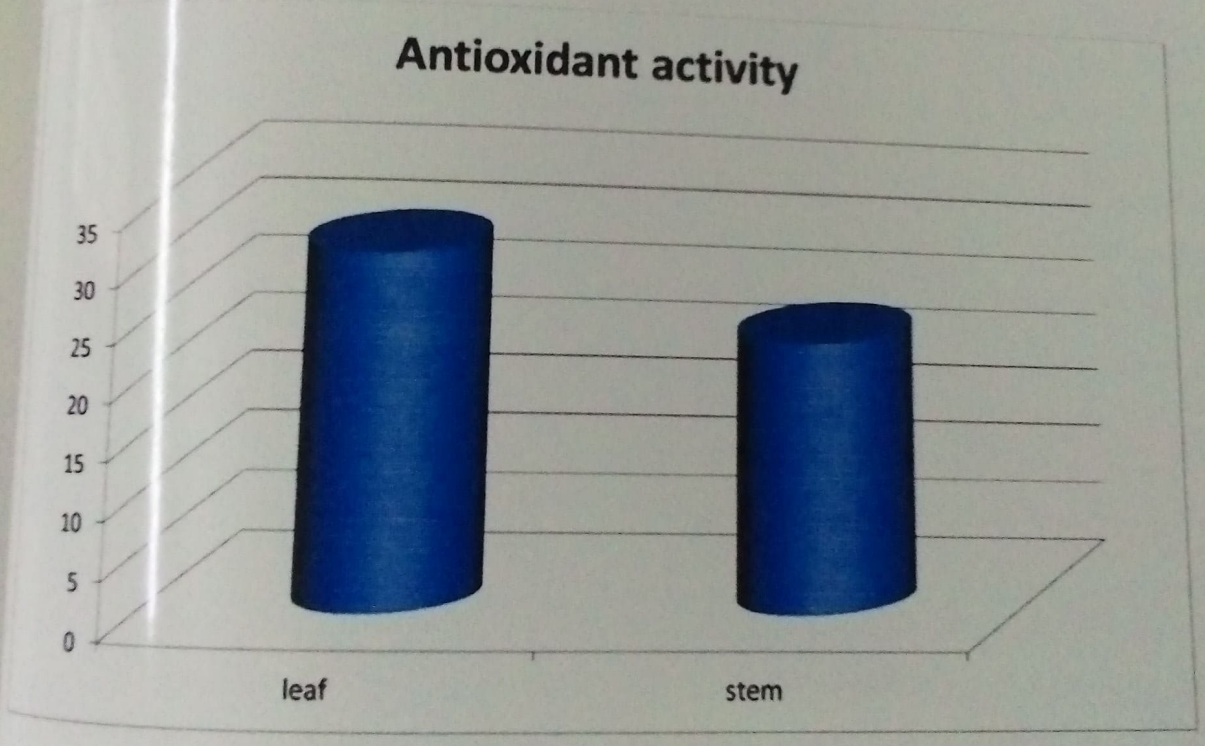


Fig: 9 Antioxidant activity in aqueous extract of stem and leaf of Cordia myxa

inflammatory diseases viz., arthritis, autoimmune disease, carcinogenesis, neurodegenerative diseases, inflammatory disease, cardiovascular disorders etc. Several food industries use butylated hydrooxyanol, butylated hydroxyl toluene and tertiary butyl hydroquinone, the common synthetic antioxidants for preventing lipid oxidation in food products while processing and storage. These synthetic antioxidants have been suspected to be carcinogenic and hence their use as food ingredients has been prohibited (hung and wang 2004). Natural antioxidants comprised of non-detrimental chemical combinations are considered to be rather safer for use in food products. Further, uncared wastes if exploited as a resource of antioxidants, will be more beneficial to humankind and protect the environment. Flavonoids are water-soluble polyphenolic molecules with an antioxidant activity which has many beneficial effects on the cardiovascular system (Evans,1989). Vitamin C acts as a ROS scavenger, thus potentially protecting cells from harmful oxidative products (Fossati *et al.*,). Vitamin E supplement elevates the activities of antioxidant enzymes (Kiron *et al.*, 2004).

DPPH FREE RADICAL SCAVENGING ACTIVITY:

The DPPH is a stable free radical and is widely used to assess the radical scavenging activity of a specific compound or plant extract (Wei *et al.*,2012). DPPH solution shows a strong absorption band at 517 nm appearing as a deep violet colour. The absorption vanishes and the resulting decolourization is stoichiometric with respect to the degree of reduction. The leaf and stem extract of *Cordia myxa* was able to reduce stable DPPH radical to yellow colour diphenyl picryl hydrazine. The degree of reduction in absorption is the reflection of the radical scavenging power of the compound.

SUMMARY & CONCLUSION

SUMMARY AND CONCLUSION

Medicinal plants are Nature' s gift to human beings to help them pursue a disease-free healthy life. *Cordia myxa* well known plant of the family Boraginaceae is used as a therapeutic agent. Various parts like fruits, leaves, stem bark, seeds and roots of *Cordia myxa* are traditionally used as astringent, anti-inflammatory, anthelminthic, antimalarial, diuretic, febrifuge, appetite suppressant and cough suppressant and to treat urinary infections, lung diseases and leprosy. (Yadav R, Yadav sk. 2013). The medicinal effects of plants are considered to be due to metabolites, especially secondary compounds, produced by plants. In this study, we determined flavonoid, tannin and phenol, vitamin C. In this study, we determined flavonoid, tannin and phenol, and vitamin C content of the leaf and stem of *Cordia myxa* using spectrophotometric methods. The result of this study showed that the leaf of *Cordia myxa* has a significant amount of phenol, flavonoid and vitamin C compared to the stem. The stem of *Cordia myxa* has a significant amount of tannin compared to the leaf.

The FTIR spectrum of *Cordia myxa* showed strong IR bands characteristics of Alkyl amine (1164.92 cm^{-1}), Alkanes (1455.19 cm^{-1}), Secondary amine (1547.77 cm^{-1}), Aliphatic aldehyde (1740.64 cm^{-1}), Sulphonamide (1317.29), Acyclic and Aromatic (516.89 cm^{-1}), Aliphic nitro group (875.62 cm^{-1}), Benzene ring (894.91 cm^{-1}), Fluorinated compound(1028.95 cm^{-1}). Carboxylic acid(2850.59 cm^{-1}), Amino acids (1621.06 cm^{-1}), Benzene ring (894.91), Phenol(1318.25). From the spectral data presence of C-Br, C-F, C-N, C-O-C, R-C, CH_3-C O, C=O, Ar-CH_3, and N-H were identified. These bendings are responsible for the presence of the amine group, Dihaloketon group, Asymmetric group, Acyclic and Aromatic group, Carboxylic acid group, sulphinic acid group and sulphides group. The amino acid present in the medicinal plant serves as the main pharmaceutical product in Skeletal muscle function, atrophic conditions, sarcopenia, and cancer, synthesis of hormones, immune function, cardiovascular health. Amide and amino acids are the main groups that are involved in protein synthesis.

The study revealed that the whole plant of *Cordia myxa* contains a considerable amount of secondary metabolites and it may be considered in the future to be used in human disease management.

The GC-MS analysis of a methanolic leaf extract of *Cordia myxa* confirmed the presence of 12 compounds with retention time. Out of these 12 compounds, 8 major and 4 minor compounds are present in the leaf extract of *Cordia myxa*. The GC-MS analysis of methanolic stem extract of *Cordia myxa* was confirmed in the presence of 18 compounds with retention time. The above mentioned isolated compound from the methanolic extract of *Cordia myxa* leaf and stem has medicinal importance.

9-Octadecenoic acid (Z)-, methyl ester and 9, 12-Octadecadienoic acid methyl ester (E,E) were identified in the crude extract of *Benincasa hispida* and *Cucurbita moschata* leaf. These compounds have great potential antioxidant, anti-cancer, and anti-inflammatory properties (Hagr, *et al*.,2018). 7-Oxabicyclo (4. 1. 0) heptane,3-methyl found in the stem of *Curcurbita pepo* stem tends to have better antioxidant activity (Ezekwe Ahamefula Sunday *et al*.,2021). Both compounds were present in the leaf and stem extracts of the plant *Cordia myxa* also. The presence of the identified bioactive components present in the leaf and stem extract of *Cordia myxa* could be responsible for the antioxidant and antimicrobial effects of the plants. Identification of these compounds in the plants serves as the basis for determining the possible health benefits of the plant leading to further biological and pharmacological studies.

The antioxidant or free radical scavenging activity of leaf and stem extracts of this selected medicinal plant is investigated by using methods like DPPH scavenging activity. The leaf and stem extracts of *Cordia myxa* show maximum antioxidant activity. The findings of the present study suggest that *Cordia myxa* could be a potential source of natural antioxidants that could have great importance as a therapeutic agent in preventing or slowing oxidative stress-related degenerative diseases.

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PHYTOCHEMICAL SCREENING, NUTRITIVE VALUE AND ANTIBACTERIAL ACTIVITY OF SELECTED AMARANTHACEAE MEMBERS

A Short Term Project Work Submitted to St. Mary's college (Autonomous) affiliated to Manonmaniam Sundaranar University in Partial Fulfillment for the Degree of

BACHELOR OF SCIENCE IN BOTANY

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THOOTHUKUDI-628001

2022-2023

CERTIFICATE

It is certified that this short term project work entitled **"PHYTOCHEMICAL SCREENING, NUTRITIVE VALUE AND ANTIBACTERIAL ACTIVITY OF SELECTED AMARANTHACEAE MEMBERS"** submitted to **St. Mary's College (Autonomous)** affiliated to **Manonmaniam Sundaranar University** in partial fulfillment of the requirements for the degree of **Bachelor of Science in Botany** and is a record of work done in the Department of Botany, St. Mary's College (Autonomous), Thoothukudi during the year 2022-2023 by the following students.

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CONTENT

INTRODUCTION

INTRODUCTION

Plants are one of the major forms of life on earth. The human civilization directly or indirectly depends upon plants for their very basic needs for survival, food, fodder, fuel, fiber, fertilizer, timber, medicines and several raw materials because of their presence of rich sources of organic compounds like tannins, alkaloids, carbohydrates, terpenoids, steroids and flavonoids. These organic compounds provide a definite physiological action on the human body. Among these the leafy vegetables are one of the major components of a regular diet that provides a combination of necessary nutrients. These are contributors of essential and nonessential organic compounds that have an immense potential for providing health-promoting properties (Roberts J.L and Moreau. R, 2016). Due to geographical and economic prospects, leafy vegetables are much more popular as food items in south-east Asia (N. Dasgupta. N and De. B, 2007).

Green leafy vegetables can form the cheapest and most readily available source of important vitamins, minerals, fibers and essential amino acids, particularly. In most of the developing countries where the daily diet is dominated by starch-stable foods, vegetables can form the cheapest and most readily available source of vitamins, minerals etc. It also enhances the sensory and functional value of food. They are the most readily available source of carbohydrates, fats, vitamins, proteins, minerals and fibers. Their bioactive substances have a wide range of biological functions, including antioxidant and antimicrobial activities and can be helpful in management of oxidative stress and age-related human ailments. They are rich in sources of carotene, ascorbic acid, riboflavin, folic acid and minerals like calcium, iron, and phosphorus. Being a photosynthetic tissue, leafy vegetables have higher levels of vitamin k when compared to fruits and vegetables due to direct involvement of vitamin k in the

photosynthesis process. It also possesses organic rich compounds which are having antidiabetic, anti-carcinogenic, a blood purifier, diuretic, sedative, hepatoprotective, antiscorbutic, laxative, hypolipidemic properties and possess preventive or curative properties against cardiovascular disease, ageing, obesity.

The family Amaranthaceae include about 64 genera and 800 species, among these 6 species were cultivated as leafy vegetables. Several parts of this plant species are used in traditional Indian medicine for numerous therapeutic effects like laxative, diuretic, carminative, cooling, and flatulence. It is a rich source of vitamin-A, vitamin-C, vitamin-E, vitamin-K, vitamin-B_{12}, magnesium, manganese, folate, betaine, iron, calcium, potassium, folic acid, copper, protein, phosphorus, Zinc, niacin, selenium and omega-3 fatty acids. Amaranthus is also packed with a number of antioxidants like polyphenols, flavonoids and carotenoids which are shown to possess anti-inflammatory effects, antimutagenic potential, antineoplastic effects as well as chemo-preventive activities.

Natural crude extracts from plants have been used in traditional medicine to treat various ailments. Amaranth leaves and stems are good economic sources of carotenoids, proteins, including the essential amino acids methionine and lysine, dietary fiber and minerals, such as magnesium, calcium, potassium, copper, phosphorus, zinc, iron, and manganese (Sarker *et al.*, 2014). Amaranth is also abundant in several pigments, such as carotenoids, chlorophylls, amaranthine, anthocyanins, betalains, betaxanthins, and betacyanin`s (Sarker *et al.*, 2018) and natural antioxidant phytochemicals, such as vitamin C, beta carotene, flavonoids, and phenolic acids(Sarker *et al.*, 2009), that act as reactive oxygen species (ROS) scavengers in the human body (Repo-carrasco-Valencia *et al.*,2010) linked with

different degenerative disorders such as aging, inflammation, cancer, cardiovascular complications, and osteoporosis (Wilcox, 2004).

Ascorbic acid (Vitamin C) is a vital component in human diet and it is a major ubiquitous non-enzymatic, water soluble antioxidant (Ueta *et al.*, 2003). Recently, the natural antioxidants present in vegetables have gained the attention of consumers and researchers. Amaranth contains abundant natural antioxidants, such as flavonoids, pigments, phenolics, carotenoids, and vitamin C (Venskutonis *et al.*,2013). These natural antioxidant phytochemicals defend against several diseases, such as cardiovascular diseases, cancer, cataracts, atherosclerosis, retinopathy, arthritis, emphysema, and neurodegenerative diseases (Dasgupta N, 2007; Steffensen *et al.*,2011). Although Amaranth is a low-cost source of minerals, dietary fiber, protein, and antioxidant compounds.

This green leafy vegetables have been reported various antioxidant properties especially in *A. viridis* (Adetutu and Ezekiel, 2013), *A. spinosus* (Ashkor-Kumar *et al.*, 2010; Barku *et al.*, 2013), *A. hybridus, A. graecizans*. Apart from their antioxidant activity, other pharmacological effects such as antimicrobial, anti-inflammatory, anti-malaria, anti-diabetes, anti-carcinogenic and hepatoprotective importance have been reported (Maiyo *et al.*, 2010, Adetutu *et al.*, 2016). While the green leafy plant has reported a potential source of antibacterial activity.

Overall, *Amaranthus* spp. is the one the potential source of various therapeutic value; though its complete therapeutic uses are still unexplored. Scientific interest in *Amaranthus* and its health promoting benefits has increased significantly in the recent past with various reviews presenting nutraceutical properties of Amaranthaceae

species its composition, antioxidant properties and applications. So, the current study was aimed at the following objectives.

- To screen the phytochemical constituents of the selected green leafy vegetables.
- To quantitatively analyse the nutrient composition of a particular plant variety.
- To investigate the antibacterial activity of the extracts of the selected plant against some isolated *E.coli*.

LITERATURE REVIEW

LITERATURE REVIEW

Medicinal plants are the most valuable source of curative drugs used as traditional medicines and folk medicines. Medicinal plants are plants containing potential active ingredients used to cure disease or relieve pain. A wide range of medicinal plant parts are used to extract raw drugs and they possess varied medicinal properties. While some of these raw drugs are collected in smaller quantities by the local communities and folk healers for local use, many other raw drugs are collected in larger quantities and traded in the market as the raw materials for many herbal industries (Uniyal *et al.*, 2006). Nowadays herbal medicines are used as better remedies due to their lesser side effects, better adaptability with an economical affordability (Firas *et al.*, 2009).

Many leafy vegetables have been used in traditional medicine for therapeutic and curative purposes. As well as, many nutritional studies have given an important consideration for dark green leafy vegetables in dietary as rich sources of vitamins, especially vitamins A and C, minerals, including calcium, phosphorus and iron and secondary plant compounds, particularly antioxidants. The dietary intake of leafy vegetables is negatively associated with many chronic disorders such as diabetes mellitus, cancer, cardiovascular diseases, cataract and age-related functional declines (Temple, 2000).

Among these, Amaranthaceae members are the fast-growing plant that is widely distributed throughout the world. It includes about 64 genera 800 species among these 6 species were cultivated as leafy vegetables. Several parts of this plant species are used in traditional Indian medicine for numerous therapeutic effects like laxative, diuretic, carminative, cooling, and flatulence (Jensen, 1978). Among these the leafy vegetables are one of the major components of a regular diet that provides a

combination of necessary nutrients. These are contributors of essential and nonessential organic compounds that have an immense potential for providing health-promoting properties (Roberts J.L and Moreau. R, 2016).

Leafy vegetables have played crucial roles in complementing diets for humans and animals because they have the cheapest and most readily available source of important vitamins, minerals, fibers and essential amino acids, particularly (Agumuo E *et al.*,2017, Anyanwu E *et al.*,2020). In most of the developing countries where the daily diet is dominated by starch-stable foods, vegetables can form the cheapest and most readily available source of vitamins, minerals etc. It also enhances the sensory and functional value of food. They are the most readily available source of carbohydrates, fats, vitamins, proteins, minerals and fibers. Their bioactive substances have a wide range of biological functions, including antioxidant and antimicrobial activities and can be helpful in management of oxidative stress and age-related human ailments.

They are rich in sources of carotene, ascorbic acid, riboflavin, folic acid and minerals like, calcium, iron, and phosphorus. Being a photosynthetic tissue, leafy vegetables have higher levels of vitamin k when compared to fruits and vegetables due to direct involvement of vitamin k in the photosynthesis process. It also possesses organic rich compounds which are having antidiabetic, anti-carcinogenic, a blood purifier, diuretic, sedative, hepatoprotective, antiscorbutic, laxative, hypolipidemic properties and possess preventive or curative properties against cardiovascular disease, ageing, obesity. Leafy vegetables also contributed significant fiber to the human diet. In recent years, studies have shown that fiber has the capacity to lower cholesterol and also strengthen the passage of bowels through the body (Paulpati S *et al.*, 2014; Ezekwe *et al.*, 2021).

In plants, the secondary metabolites function to attract beneficial and repel harmful organisms, serve as phytoprotectants and respond to environmental changes (Lipkin *et al.*, 2004). Phenolic compounds are one of the main secondary metabolites derived from pentose phosphate, shikimate and phenylpropanoid pathways in plants (Tura and Robards, 2002). They are commonly found in non-edible and edible plants and possess numerological biological effects (Kähkönen*et al.*, 1999). They are essential for reproduction and growth of plants. Phenolic compounds possess redox properties, which allows acting as hydrogen donors, reducing agents, metal chelators and singlet oxygen quenchers and hence they are antioxidants.

Some part of the human population still suffers from one or more micronutrient deficiencies as a result of diets that are deficient in nutrient rich foods. Several studies on the chemical composition of leafy vegetables have shown that they contain enormous amounts of micronutrients, several agronomic advantages and economic value. They also contain some chemical compounds that are having important medicinal uses, human well-being and healthy lifestyle. (Fallah *et al*, 2005).

Medicinal properties of plants are due to the combinations of secondary metabolites such as alkaloids, steroids, tannins, and phenolic compounds that are synthesized and deposited in specific or in all parts of the plant. These medicinal properties are specific in a plant family, genus and species, proving the fact that combinations of secondary metabolites are distinct between plant taxa (Parekh *et al.*, 2005). Lamothe *et al.*, 2015 reported that the *Amaranthus caudatus* provide dietary fibres high in pectic substances, xyloglucans, inflammation markers level in hypercholesterolemic rabbits and has a potential to act as a phytoremediation agent for lead (Abubakar.M *et al*,2014).

Phytochemical investigations of these Amaranthaceae green leafy vegetables have presence of various phytochemicals which are involved in radical scavenging activities, such as flavonoid compounds, alkaloid compounds, tannins, phenols, glucosides, and glycosides (Kumar *et al.*, 2010 and Maiyo *et al.*, 2010). Amaranthus is characterized as an antioxidant, antibacterial, anti-inflammatory, antimalarial, antidiabetic, anticancer, and hepatoprotective agent (Jin *et al.*, 2013 and Adetutu*et al.*, 2016). Stintzing *et al.* (2004) used quantitative and qualitative analyses of phenolic compounds and betalains from stem extracts to confirm the antioxidant properties of *Amaranthus spinosus* L. The major betacyanin's detected in *A. spinosus* L. were amaranthine and iso amarantine, and hexacinamates, quercetin, and kaempferol glycosides (Stintzing *et al.*, 2004). Kraujalis *et al.* (2013) also investigated the antioxidant characteristics of solid plant material and discovered that amaranth leaves and flowers, as well as their extracts, have high antioxidant activity (Shabasy and Gayar, 2019). They also reported that, the comparative account of six species of the Amaranthaceae family (*Aervajavanica*, *Aervalanata*, *Amaranthus graecizans* ssp. *sylvestris*, *Amaranthus hybridus* L., *Amaranthus viridis* L., and *Digeramuricata* L.) have significant effects of anti-microbial properties against some pathogenic bacteria (Britannica, 2018).

Amaranthus viridis contains flavonoids which may confer antioxidant abilities on the plant (Ahmed *et al.*, 2013). However, there is no experimental evidence of anticancer effect of the aqueous ethanolic leaf and stem extract of the plant. It is cheaper, readily available and less toxic than synthetic chemotherapeutic drugs.

Ashok Kumar *et al*, 2011 reported that the hepatoprotective activity of methanol extract of *Amaranthus caudatus* against paracetamol-induced hepatic injury in rats and Antinociceptive and Antipyretic activities.

Hosamani KM *et al.*, 2004 reported that the active principles of *Alternanthera sessilis*, extracted in oil, were used to treat infected wounds and the herb also proved styptic in colitis; its nutritive value makes the herb a potent tonic with a wide range of application. Poultice of pounded fresh material is used in sprains, burns, and eczema, carbuncle, erysipelas and acute conjunctivitis. A decoction is recommended as a herbal remedy to treat wounds, flatulence, nausea, vomiting, cough, bronchitis, diarrhoea, dysentery and diabetes. Its roots can relieve inflamed wounds. Their leaves are boiled and drunk as an antihypertensive remedy (Acharya E *et al.*, 2006). It has been reported to possess antimicrobial, molluscicidal, moderate antimutagenic, antidiarrhea, cytotoxic and antiviral activities (Rastogi *et al.*, 1998).

Sarker *et al.*, 2020 reported that the green amaranth is abundant in antioxidant phytochemicals, proximate composition, antioxidant activity, and minerals and offers a large possibility of supplying minerals, vitamins, and antioxidants to deficient communities.

MATERIALS AND METHODS

MATERIALS AND METHODS

Plant material

***Amaranthus viridis* Linn**

Classification

Class	:	Dicotyledons
Sub class	:	Monochlamydeae
Series	:	Curvembryae
Family	:	Amaranthaceae

Tamil Name : Kuppaikeerai

Description

From East Asian origin, *A. viridis* widespread in tropical and subtropical regions of the world. It is an annual herb. Stem is striate, ground and soft woolly tomentose. It has a Taproot system. Leaves are simple, alternate, pale green, soft, shortly stalked, suborbicular or with an obtuse tip. The upper surface of the leaf is pubescent while the lower one is densely hairy. The leaves on the side branches are much reduced.

Spike inflorescence. The Flowers are very small, sessile. Female flowers are more numerous than the male flowers. It is superior to one celled, with one pendulous ovule, perianth – green, 3 segments with an acute tip but not sharply, anthers are 2 celled. Fruit capsules wrinkled, small and brown.

Alternanthera sessilis Linn

Classification

Class : Dicotyledon
Sub class : Monochlamydeae
Series : Curvembryae
Family : Amaranthaceae

Tamil Name : Ponnnaganni

Description:

The plant occurs throughout the tropical and subtropical regions of the world. Perennial herb, many branches. Its habit and dimension vary greatly depending on the humidity level: in dry condition, it is erect in wet condition, it is prostrate. Main root is taproot, white or brown. When the plant is prostate, adventitious roots appear

at the nodes creeping on the ground. The stem is longer, hollow and floating in aquatic conditions. It is glamorous except for two opposite narrow lines of whitish hairs on the erect parts, and tufts of white hairs at the nodes. Leaves are simple, opposite and decussate, paired blades are generally the same size. Petiole is indistinct. The laminas are narrow and elongated, very variable in shape and size. Apex acute to obtuse, shortly acuminate, base cuneate to alternate. Inflorescences are sessile spikes. The fruit is an utricle, obcordate to orbicular obcordate.

Amaranthus caudatus Linn

Classification

Class : Dicotyledons
Sub class : Monochlamydeae
Series : Curvembryae
Family : Amaranthaceae

Tamil name : Thandukeerai

Description

A. caudatus is an indigenous crop from the high Peruvian Andes. It is an Annual herb. Stem is green in colour. Leaves are simple, spirally arranged, alternate, lanceolate, entire margin. Stipules absent. The plant has long, slender, red to gold drooping flowers. Flowers unisexual, sessile. Male flowers with 5 stamens. Female flowers with superior, 1-celled ovary crowned by 3 stigmas. Inflorescence is large and complex, consisting of numerous cymes arranged in axillary and terminal spikes. Fruit is an ovoid globose capsule. Seed is globose.

***Spinacia oleracea* Linn**

Classification

Class : Dicotyledons
Sub class : Monochlamydeae
Series : Curvembryae
Family : Amaranthaceae

Tamil name : Pasalaikeerai

Description

Cultivated worldwide in temperate areas and in the cooler parts of the tropic. Native to Asia, probably of Persian origin being introduced into Europe about the first century. The spinach is an annual plant, long cultivated for the sake of its succulent leaves. Stem is erect, 30 to 60 cm high, round, smooth, piped, succulent, sometimes reddish. Alternative leaves, the lower ones very long petiole, variously lobed with lobes of an acute triangular shape smooth on both sides. Male flowers on long terminal glomerate spikes and on short ones from the axil, very numerous, sessile, calyx 4 parted, stamen 4, anther twin, very large. Female flowers are axillary, sessile, calyx 2 tipped with a projecting horn on each side, growing into spines when the seed is ripe, styles generally 4, while tapering. Capsules 1celled, 1-valved, armed with 2 opposite short horns and crowned with the small remaining calyx. Leaves are arranged in a rosette, from which a seed stalk emerges. The flowers are inconspicuous and produce small dry fruits. Seeds can be sown every two weeks from early spring to late summer.

***Amaranthus dubius* Linn**

Class : Dicotyledons
Sub class : Monochlamydeae
Series : Curvembryae
Family : Amaranthaceae

Tamil name : Arai keerai

Description

This plant is native to South America, Mexico, and the West Indies, tropical and subtropical regions of the United States, Africa, Australia and Asia. *Amaranthus dubius* is an annual erect plant. The stem is slightly short, little or unbranched and very often pinkish red in colour. The leaves are arranged alternately along the stem. They are oval and held by long petioles. The stem is full reddish, cylindrical rather angular hairless or with short or slightly long hairs. The margin is entire. The inflorescence consists of green flowers, assembled in axillary globular in the basal part of the plant. Spike inflorescence. The lower glandular are formed only from female flowers. These are in the terminal inflorescence with few male flowers only at the top. The flowers consist of 5 petals. Deciduous male flowers with 5 stamens. The fruit is an ovoid shaped capsule with a short neck, bulging below the base of the stage. The fruit is a small capsule that opens at maturity by a small top of the end. It contains a single shiny seed dark brown to black in colour 3 persistent stigmas. It opens with a heavily wrinkled top cover. The seed is lenticular around 1 mm in diameter dark brown to black in colour and shiny.

The success of any scientific investigation mainly depends on the nature of material used and methods employed for the purpose. This chapter deals with methods of sample collection, preservation and experimental methods involved in this study. The phytochemical, nutritive and antibacterial estimation of *Amaranthus viridis, Amaranthus caudatus, Amaranthus dubius, Spinacea oleracea* and *Alternanthera sessilis* were collected from VMS nagar Thoothukudi district, Tamil Nadu. The collected samples were washed with tap water to remove dust and foreign materials. The leaf samples were dried under shade and dried and coarsely powdered using a blender. The final uniform powder was used for active constituents of the plant materials.

PREPARATION OF EXTRACT:

The fine powder (10g) was extracted with 200 ml of methanol, chloroform and aqueous extract using Soxhlet apparatus. The prepared extract was used for further analysis.

QUALITATIVE PHYTOCHEMICAL ANALYSIS:

Phytochemicals are naturally occurring and biologically active plant compounds that have potential disease inhibiting capabilities. Plants are endowed with various phytochemical screening of proteins, alkaloids, terpenoids, tannins, flavonoids, saponin, steroids, cardiac glycosides and quinine present in the powder leaf parts of *Amaranthus viridis, Amaranthus caudatus, Amaranthus dubius, Spinacea oleracea* and *Alternanthera sessilis* in methanol, chloroform and aqueous extracts were carried out by the standard procedure

Test for Alkaloids

1ml of plants extract was taken and added 3-5 drops of Wagner's reagent (1.27g of iodine and 2g of potassium iodine in 100ml of water) and observed for the formation of reddish-brown precipitate or colouration indicated the presence of alkaloids.

Test for Carbohydrates (Molisch's Test)

1ml of plant extract was taken and added 3-5 drops Molisch's reagent, along with this added 1ml of concentrated sulphuric acid (H_2SO_4) down the side of the test tube. Then allowed the mixture to stand for 2-3minutes. It was observed red or dull violet colour at the interface of the two layers which indicates the presence of carbohydrates.

Test for Cardiac Glycosides (Keller killani Test)

1ml of extract was taken and treated with 1ml of glacial acetic add and 2-3drops of 5% ferric chloride solution. This was under layered with 1ml.of concentration sulphuric acid. Observed a brown ring at the interface shows the presence of deoxy sugar characteristics of cardenolides. A violet ring appeared below the ring while in the acetic acid layer resulted information of a greenish ring.

Test for Flavonoids (Alkaline Reagent Test)

1ml of extract was taken and treated with 3-5 drops of 20% NaOH solution. It was observed for the formation of intense yellow colour which becomes colourless. In addition of 0.5ml diluted Hcl indicated the presence of flavonoids.

Test for Phenols (Ferric Chloride Test)

2ml of distilled water followed by a few drops of 10% ferric chloride was added to 1ml of the extract. Formation of blue or green colour indicated the presence of phenols.

Test for Saponins (Foam test)

1ml of extract was taken and added to water and shaken well. Vigorously observed for the formation of honeycomb like foam for 10-15minutes. Indicated the presence of saponins.

Test for Tannins (Braymer's Test)

1ml of extract was taken and treated with 1ml of 10% alcoholic ferric chloride solution was observed for the formation of blue or greenish colour indicated the presence of tannins.

Test for Terpenoids (Salkowski Test)

1ml of extract was treated with and 0.5ml of concentrated Hcl and observed for the formation of yellow precipitate or colouration indicated the presence of terpenoids.

Test for Quinones

1ml of extract was taken and added 5ml of distilled water and observed the turbidity indicated the presence of quinones.

Test for Amino acid (Ninhydrin Test)

Heat 3 ml test solution and 3 of drops 5% ninhydrin solution in a boiling water bath for 10 minutes. Purple or bluish colour appears indicate the presence of amino acids.

Test for Protein (Biuret Test)

3ml of test solution add 4% NaOH and few drops of $CuSO_4$ solution, Violet or pink colour appears indicates the presence of protein.

QUANTITATIVE ANALYSIS

Estimation of Vitamin C (Ascorbic acid) (Baker and Frank, 1968)

Reagents:

- 5% of TCA
- Indophenol reagent
- 20mg of dichlorophenol indophenols was dissolved in 10ml of warm distilled water
- DT reagent 2g of 2, 4 dinitrophenyl hydrazine and 1g of thiourea were dissolved.
- 85% sulphuric acid
- L-ascorbic acid-standard

Procedure:

100 mg of plant material was homogenized with 10ml of 5% Trichloro acetic acid (TCA). The homogenate was centrifuged. To 2ml of indophenol reagent and 0.5ml of DT reagent was added and incubated at 10°C for 1hour and then cooled in ice bath and 2.5ml of 80% sulphuric acid was added and shaken well for 30 minutes (until) red colour appeared. The absorbance was measured at 540nm. l-ascorbic acid was used as standard and the results were expressed as mg/g.

Estimation of Carbohydrate

Extraction

Grind 1 gm of plant material with 20 ml distilled water using a mortar and pestle. Filter through a cheesecloth, centrifuge the filtrate for 10 minutes around 6000rpm, make up the filtrate to 100 ml with water and discard the pellet.

Estimation

Take 1 ml of the extract in duplicates and add 1 ml of phenol (5%) and 5ml concentrated H_2SO_4. Mix well and keep in a boiling water bath for 10 minutes (until colour develops). Cool to room temperature and measure the OD at 490 nm using blank. Extrapolate the OD in the standard graph of the glucose. From this calculate the amount of glucose present in 100 ml, which will be equal to the amount of sugar present in 1 gm of plant material.

Estimation of Protein

Weight 1g of plant tissue and grind it with 10 ml of distilled water. Filter through cheesecloth. To the filtrate add 10 ml of 5% cold TCA to precipitate the protein. Centrifuge and collect the pellet that contains protein. Dissolve the pellet in 10ml of 0.1N NaOH. To 1ml of this protein extract, add 4ml of Biuret reagent and mix well. Measure the absorbance at 520nm.

ANTIBACTERIAL ACTIVITY

The test organisms were obtained from the department of Botany, St. Mary's college (Autonomous), Thoothukudi. Antibacterial activity of each plant

extract was analysed using gram negative bacteria of *E.coli* were used in this study. Bacterial pathogen was sub-cultured in agar medium and maintained.

Whatman No:1sterile filter paper discs were impregnated with 1mg/ml concentration and dried aseptically at room temperature. The spread plates were prepared by proper concentration of inoculation. Each sample loaded disc was placed in a seeded agar plate. After 24 – 48 hours of 37^0C incubation, the diameter of the inhibition zone was measured. For positive control, Ampicillin disc was used.

RESULTS AND DISCUSSION

RESULT AND DISCUSSION

Phytochemicals are natural bioactive compounds found in plants and their parts such as leaves, fruits, flowers. It acts as a defence system against disease so that it helps to protect against disease. Different vegetables are considered as sources of human health promoting components (Scalbert A *et al.*,2005). While leaf vegetables are widely used in the human diet, they are low in calories and fat, but high in dietary fibres, significant amounts of minerals, such as iron and calcium and some antioxidants such as vitamin C, vitamin E and others. On the one hand phytochemicals are a Plants way of protecting itself. On the other hand, they have beneficial effects on human health. Various plants of Amaranthaceae species are traditionally used as antioxidant, antimicrobial, antifungal, anticholinergic properties. The phytochemical analysis of different leaf extract (methanol, chloroform and aqueous) of Amaranthaceae were used to analyse some phytochemicals such as cardiac glycosides, flavonoids, phenols, saponins, steroids, tannin, terpenoids and anthraquinone.

QUALITATIVE ANALYSIS

The phytochemicals such as flavonoid, tannin, saponin, terpenoid, phenols, quinone, cumarins, amino acid, carbohydrate, protein, alkaloids were qualitatively analysed in leaf extract of five different Amaranthaceae species such as *Amaranthus caudatus, Amaranthus viridis, Amaranthus dubius, Alternanthera sessilis and Spinaceae oleraceae.*

The results obtained from the preliminary phytochemical screening for powdered leaf extract of *A. viridis* were consistent with observation by Pandhare *et al.*,(2012). However, from Table 1, flavonoids, sterols, and terpenoids were absent.

Table -1 Phytochemicals analysis of selected Amaranthaceae species

Plant	solvents	PHYTOCHEMICALS											
		flavanoid	alkaloid	terpenoid	glyco sides	tannin	saponin	quinone	Amino acid	Carbo hydrate	Protein	steroids	phenol
Amaranthus viridis	aqueous	+	+	+	+	+	+	–	+	-	+	-	+
	methanol	+	-	-	+	-	+	-	-	-	+	-	-
	chloroform	-	+	-	+	+	+	-	+	-	+	-	-
Amaranthus dubius	Aqueous	-	+	-	+	+	+	+	+	+	+	-	+
	methanol	+	+	+	+	+	+	+	+	+	+	+	-
	chloroform	+	+	+	+	+	-	+	-	+	+	+	+
Amaranthus caudatus	aqueous	+	+	-	-	-	+	-	-	-	+	+	+
	methanol	-	+	-	+	-	+	+	-	-	-	+	+
	chloroform	-	-	-	+	+	+	+	+	-	+	-	+
Spinacia oleraceae	aqueous	+	+	+	+	-	+	+	+	-	+	-	-
	methanol	+	-	+	-	+	-	-	+	+	-	+	+
	chloroform	-	-	+	-	-	+	+	+	+	+	+	-
Alternanthera sessilis	aqueous	+	-	-	-	+	+	+	+	-	-	+	-
	methanol	-	+	+	-	-	+	-	-	-	+	-	-
	chloroform	+	-	-	+	-	-	+	+	-	-	+	+

Alkaloids and steroids present were present in the leave samples of *A. viridis* in this study while Umila (2012) and Antara (2012) both reported the absence of alkaloids and sterols in leaf samples of *A. caudatus* and *A. dubius* respectively which could be due to difference in geographical location or certain environmental conditions such as injury. The preliminary phytochemical screening of *A. caudatus* leaves by Urmila (2012) revealed the presence of glycosides, saponins and tannins but alkaloids and sterols were absent. In the case of present study, the preliminary phytochemical analysis of *A. dubius* aqueous chloroform and methanolic leaves extract revealed the presence of alkaloid, tannin, glycoside, quinone, carbohydrate while steroids and terpenoids are absent in aqueous extract. This study has revealed the potential benefits of the leaf extracts of *Amaranthus viridis* as a source of antioxidant agents for the synthesis of chemotherapeutic drugs.

NUTRITIVE VALUE ANALYSIS

Quantitatively, the most important of nutrients are the carbohydrates synthesized by plants, since they provide most of the energy utilized by the plant parts. The main organic material in the working tissue of plants is protein. In plants, vitamin C can control the division, elongation, and differentiation of cells, as well as programmed cell death. Vitamin C plays a significant role in the control of cell division. The carbohydrate, vitamin C and Proteins are essential for plants. So the total vitamin-C, carbohydrate and protein were analysed in leaf extract of *Amaranthus viridis, Amaranthus dubuis, Amaranthus caudatus, Spinaceae oleracea* and *Alternanthera sessilis* belonging to the family Euphorbiaceous.

TOTAL CARBOHYDRATE

Carbohydrates are the main polysaccharide stored in seeds. It represents the major source of carbohydrates in the human diet. Carbohydrate is a main food source in the human diet with the highest concentration in animal organs. Overall the present investigation showed that *Amaranthus caudatus* leaf (21.1mg/g) *Alternanthera sessilis* leaf (19mg/g) *Amaranthus dubius* leaf (12mg/g) *Amaranthus viridis* leaf (10mg/g) *Spinaceae oleracea* (6mg/g) contain significant amount of Carbohydrate (Table 2 & Fig. 1). The more carbohydrate content was reported in *Amaranthus caudatus* than other plants.

TOTAL VITAMIN C

Vitamin – C is a vital component in human diet with the highest concentration in animal organs. It is a non-enzymatic, antioxidant water soluble antioxidant (Ueta *et al.*,2003). The maximum level of vitamin C reported in *A. dubius* (78.58mg/g) next to this *A. caudatus* (30.95mg/g) contains significant amount of Vitamin C was reported (Table 3; Fig. 2). The maximum level of vitamin C was noticed in *Amaranthus dubius* leaf (17.46mg/g) which is equivalent to our daily requirement of vit C (75mg/g) level for a healthy diet as proposed by WHO (2020). Vitamin-C functions in enzyme activation, oxidative stress reduction and immune function. It protects against a respiratory tract infection and reduces risk for cardiovascular disease and some cancer.

Table: 2 Total carbohydrate content in selected Amaranthaceae species

S.No	Samples	Amount of Carbohydrate (mg/g)
1.	*Amaranthus viridis*	10mg/g
2.	*Amaranthus caudatus*	21.1mg/g
3.	*Amaranthus dubuis*	12mg/g
4.	*Spinaceaeolearaceae*	6mg/g
5.	*Alternanthera sessilis*	19mg/g

Table :3 Total vitamin C content in selected Amaranthaceae species

S.No	Samples	Amount of Vitamin C (mg/g)
1.	*Amaranthus viridis*	17.46mg/g
2.	*Amaranthus caudatus*	30.95mg/g
3.	*Amaranthus dubuis*	78.58mg/g
4.	*Spinaceaeoleraceae*	19.84mg/g
5.	*Alternanthera sessilis*	23.02 mg/g

Dry samples were used for analysis. Vitamin C Equivalent (1 mg/ml) was used as standard.

Table 4: Total protein content in selected Amaranthaceae species

S.No	Samples	Amount of Protein (mg/g)
1.	*Amaranthus viridis*	3mg/g
2.	*Amaranthus caudatus*	9mg/g
3.	*Amaranthus dubuis*	8mg/g
4.	*Spinaceae olearaceae*	8.5mg/g
5.	*Alternanthera sessilis*	2.5mg/g

Fig 1 : Total carbohydrate content in selected Amaranthaceae species.

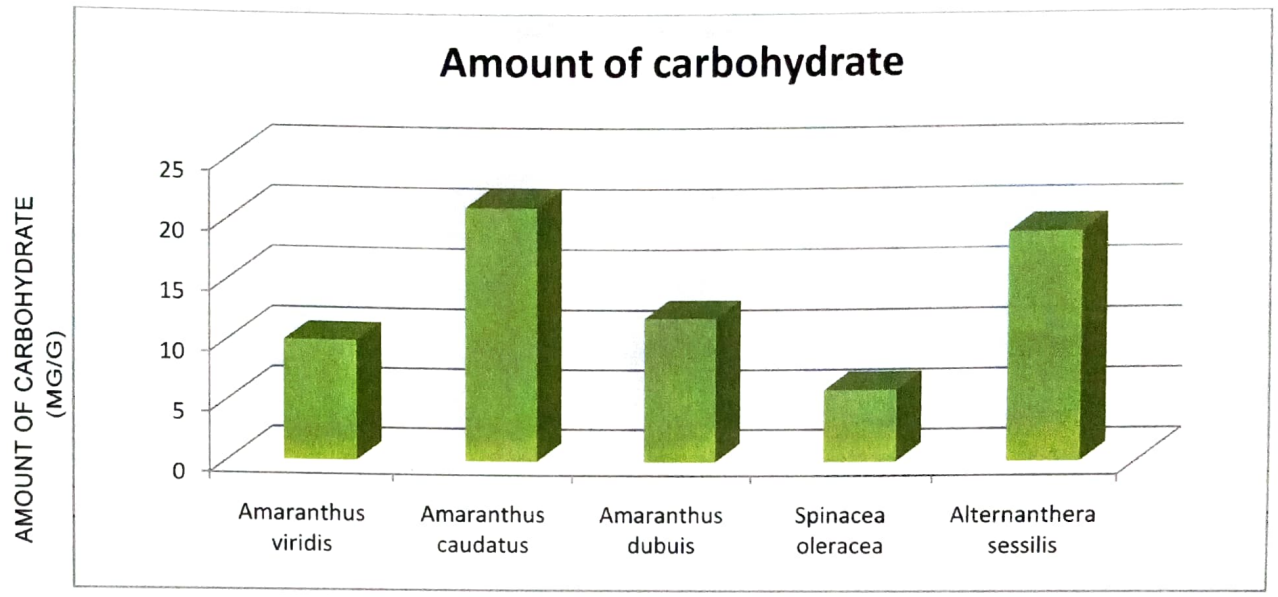


Fig 2 : Total Vitamin C content of selected Amaranthaceae species

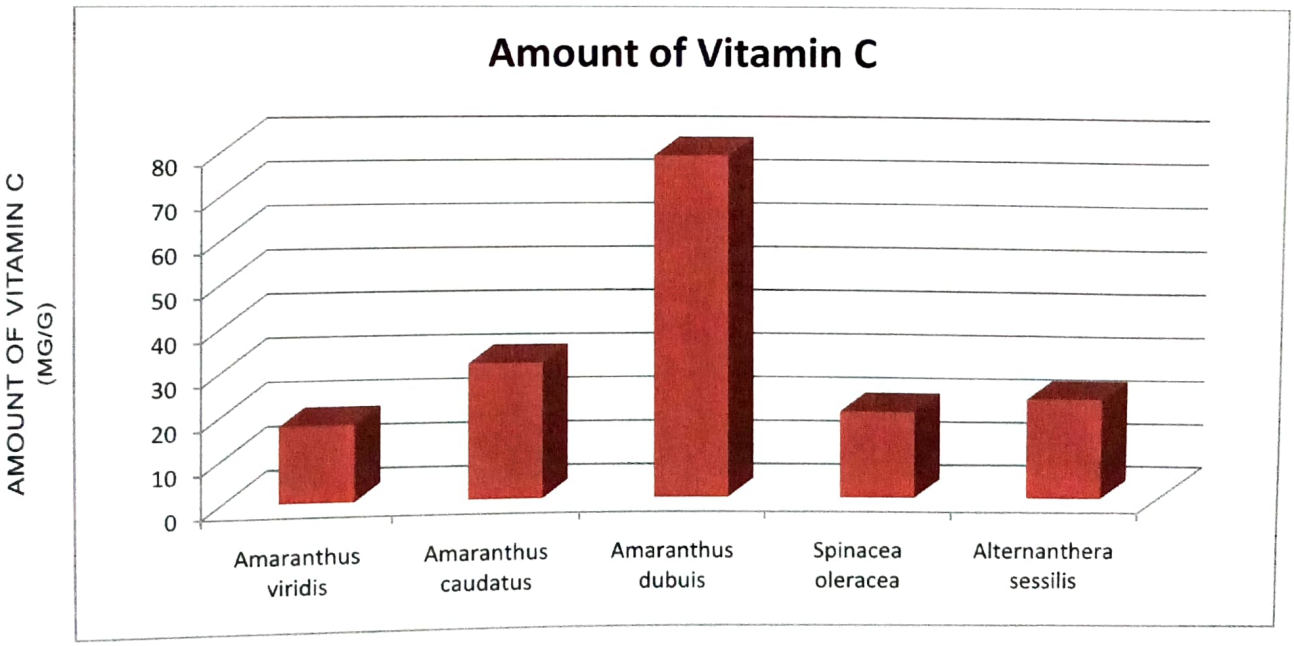
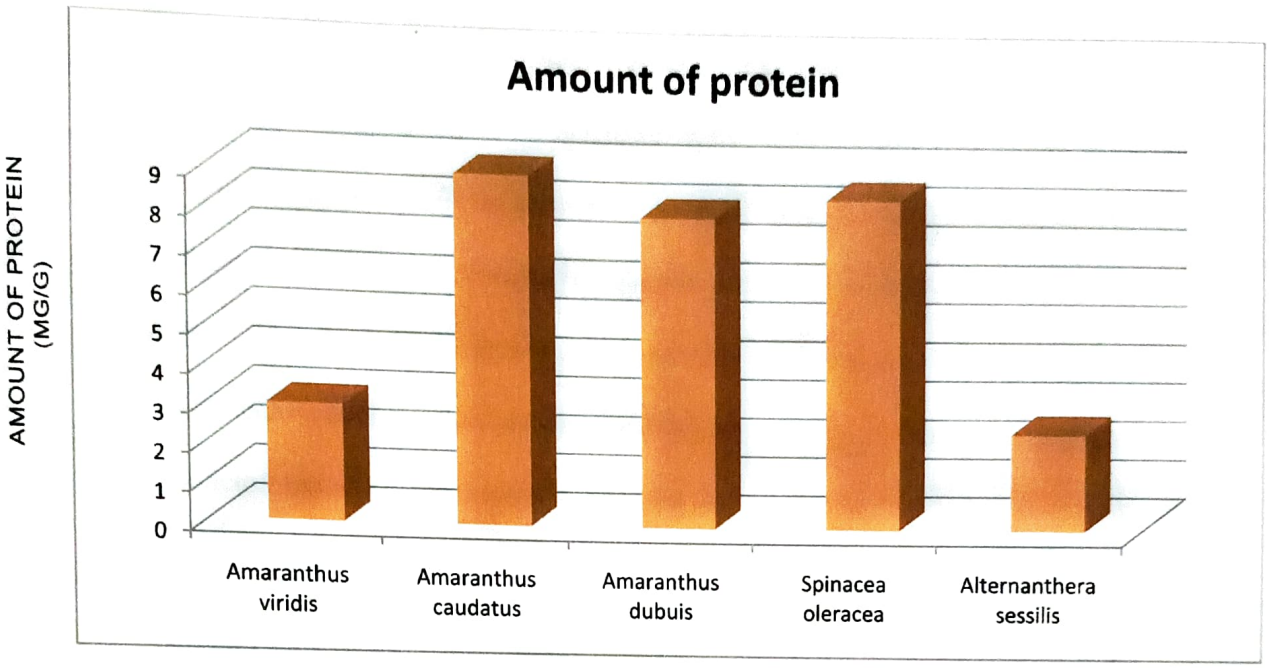


Fig 3 : Total protein content of selected Amaranthaceae species.



TOTAL PROTEIN

Amaranthus caudatus leaf (9mg/g) *Spinaceae oleracea* leaf (8.5mg/g) *Amaranthus dubius* (8mg/g) *Amaranthus viridis* leaf (3mg/g) *Alternanthera sessilis* (2.5mg/g) contain significant amount of protein (Table 4; Fig. 3). Protein acting as an enzyme and hormones, maintaining proper fluid and acid-base balance, providing nutrient transport, making antibodies, enabling wound healing and tissue regeneration, and providing energy when carbohydrate and fat intake is inadequate. The experiment conducted based on the principle reported more amount of protein in *Amaranthus caudatus* than other plants.

ANTIBACTERIAL ACTIVITY

The antimicrobial activity of various selected seeds was investigated against the selected clinical pathogen *Escherichia coli* by using disc diffusion method. Table 5 shows the antibacterial activity of the methanolic, chloroform and aqueous extract of *Altenanthera sessilis, Amaranthus viridis*, *Amaranthus dubuis*, *Amaranthus caudatus*, *Spinacea oleracea*, the highest effect to the above extract was observed on chloroform extract of *Amaranthus viridis* with a zone of inhibition 27mm while the aqueous extract of *Altenantherasessilis* has the least inhibition zone of 4mm.

The result of Antibacterial activity of *Amaranthus viridis* using different solvent extract showed that the chloroform extract (27mm inhibitory zone) was found to be effective against pathogenic bacteria. The lowest inhibitory zone (10mm) is found in methanol extract of *Amaranthus viridis*. The methanol extract of *Amaranthus dubuis* found a maximum inhibitory zone (19mm) than other extract of *A. dubuis* and minimum inhibitory zone (12mm) found in chloroform extract of *A. dubuis*. According to *A. caudatus*, the chloroform extract showed the maximum inhibitory

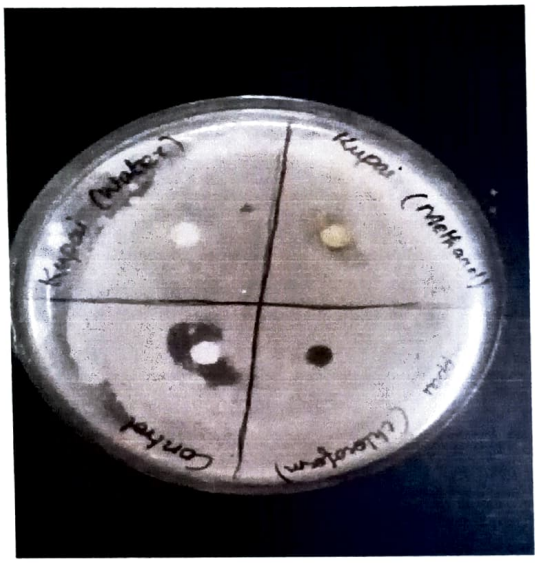
zone (19mm) than other extract and minimum inhibitory zone (16mm) shown in aqueous and methanolic extracts.

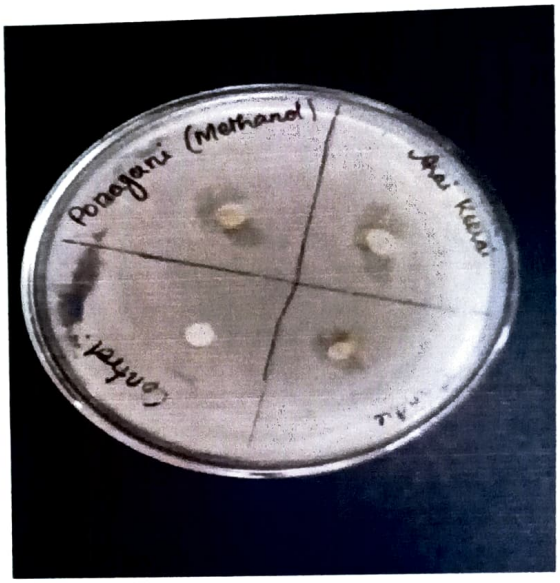
The Aqueous extract of *Spinacea oleracea* found maximum inhibitory zone (17mm) than other extract of *Spinacea oleracea* and minimum inhibitory zone(10mm) found in chloroform extract. The methanol extract of *Alternanthera sessilis* found maximum inhibitory zone (18mm) than other extract and minimum inhibitory zone (4mm) found in aqueous extract. Balakrishnan *et al.,* (2003) reported that Amaranthaceae family comprises many species with biological activities and good antibacterial activities which are used in nutrition and alternative medicine. This research work revealed that all the selected leaf variety are performed good and active against *E.coli* pathogen.

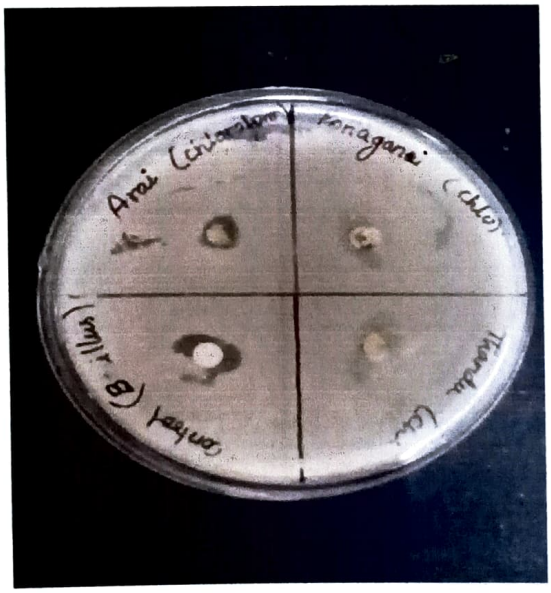
Table 5 : Antibacterial activity of different solvent extract of selected Amaranthaceae species

S.No	Bacterial pathogen (*E.colli*) / Plants	Zone of Inhibition			
		Ampicillin	Methanol	Chloroform	aqueous
1.	*Amaranthus viridis*	20mm	10mm	19mm	15mm
2.	*Amaranthus dubuis*	20mm	19mm	12mm	15mm
3.	*Amaranthus caudatus*	20mm	16mm	19mm	16mm
4.	*Spinacea olearacea*	20mm	13mm	10mm	17mm
5.	*Alternanthera sessilis*	20mm	18mm	15mm	4mm

Plate 1: *In vitro* antibacterial activity of aqueous, methanol and chloroform extracts of selected Amaranthaceae species







SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

Plants possess nutritional, industrial, medicinal and other beneficial effects. Especially leafy vegetables are one of the major components of a regular diet that provides a combination of necessary nutrients. Green leafy vegetables are healthy foods that can help complete a balanced diet. They are typically rich in nutrients and fibre and low in calories and fat. The family Amaranthaceae members of *Amaranthus caudatus, Amaranthus viridis, Amaranthus dubius, Alternanthera sessilis and Spinacia oleracea* were analysed for various phytochemicals, nutritive value and their antibacterial potential. In the phytochemical screening, it clearly showed that various secondary metabolites like phenols, flavonoids, alkaloids, glycosides, are abundantly reported in their water and methanolic extract compared to the ethanol extract. This significant level of phenolic groups distributed in the plants is responsible for biological activities, including antioxidant, chemo preventive, neuroprotective, cardioprotective and immunomodulatory properties (Oluwole *et al.,* 2022). Other than the phytochemicals screening, the present study was focused on identifying some nutritive value such as carbohydrate, protein and vitamin C content.

The result of this study showed more significant amounts of carbohydrate were noticed in the leaves of *A.caudatus* (21.1mg/g) and *Alternanthera sessilis* (19mg/g) than the other plants. The carbohydrates perform numerous roles in living things. They act as a primary source of energy which is converted into glucose to generate energy essential for metabolism in every cell of the body. While in the protein estimation, the maximum concentration was reported in *Amaranthus caudatus* (9mg/g). It means that the daily need for protein consumption is at least 0.8 grams of protein for every kilogram of body weight as recommended by The National

Academy of Medicine. Our study also proved that these leafy vegetables are the cheapest and easily available source of protein in our healthy diet. vitamin C is the most easily destroyed by oxidation, and in extracts, juices and foods with cut surfaces, it may be oxidized by exposure to air (Fox and Cameron, 1984). It is a water-soluble antioxidant known to be important to health and for proper functioning of the human body. Antioxidants can prevent the chemical damage caused by reactive oxygen species such as free radicals that are generated by a variety of sources including pesticides, tobacco smoke, exhaust fumes, certain pollutants and organic solvents (Ogunlesi *et al.*, 2010). In this study, plants with higher vitamin C compositions were noticed in *Amaranthus dubius (78.58mg/g) Amaranthus caudatus* (30.95mg/g) and *Alternanthera sessilis* (23.02mg/g). The differences in the composition may be due to some environmental factors including geographic region, season, and climate, as well as pollution, the latter partly due to enhanced oxidative stress (Anitra and Rowe, 2020).

The secondary metabolites like flavonoids, saponins, tannins, steroids and alkaloids are Phyto protectants and are important for cell growth, replacement, and bodybuilding (Kubmarawa *et al.,* 2008). Their medicinal value is due to the presence of some chemical substances that can produce a defined physiological action on the human body with antioxidant, antibacterial, anti-inflammatory, antiviral, immune system stimulant and detoxification activities (Johanna., 2003).

This study was carried out to evaluate the *in -vitro* antibacterial activity of selected Amaranthaceae plants. The antibacterial activity of five green vegetable extracts was assayed in vitro by agar disc diffusion against gram negative bacteria - *E.coli*. The data showed the maximum inhibitory zone was noticed in *Amaranthus viridis* (27mm) and *A. caudatus* (25 mm) and the best activity was obtained with

chloroform extract. The results from the current study indicate that *A. viridis* leaves and *A. caudatus* leaf extracts contained varied types of pharmacologically active compounds like tannin, phenol, saponin, flavonoid and antimicrobial activities. So, this study strongly recommended all selected Amaranthaceae members have the rich potential of phytochemical, nutritive and anti-bacterial properties.

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ASSESSMENT OF PTERIDOPHYTE DIVERSITY IN AND AROUND KAMAMKULI POND, KILLIYOOR TALUK, KANNIYAKUMARI DISTRICT

A short term project work submitted to

ST.MARY`S COLLEGE (Autonomous), THOOTHUKUDI

Affiliated to

MANONMANIAM SUNDARANAR UNIVERSITY

in partial fulfilment of the requirement for the degree of

BACHELOR OF SCIENCE IN BOTANY

BY

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CERTIFICATE

This is to certify that this project work entitled **"ASSESSMENT OF PTERIDOPHYTE DIVERSITY IN AND AROUND KAMAMKULI POND, KILLIYOOR TALUK, KANNIYAKUMARI DISTRICT"** is submitted to **St. Mary's college (Autonomous), Thoothukudi** affiliated to **MANONMANIAM SUNDARANAR UNIVERSITY** in partial fulfilment of the award of the degree of **Bachelor of science in Botany**, and is a record of work done in the Department of Botany, St. Mary's College (Autonomous), Thoothukudi during the year 2022 – 2023 by the following students.

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CONTENTS

INTRODUCTION

Among the diverse form of plant life, on one end are the unicellular algae, confined to moist habitats and on the other end are the higher plants capable of growing on relatively dry land. Plant life is assumed to have originated in water and in the process of evolution from a free living independent cell, the fundamental unit of structure and function evolved a multicellular organism with a division of labour among its tissue. Probably, the next advance was its remarkable manifestation, the alternation of generation. The cyclic alternation between sexual and asexual generation made possible the invasion of land and migration to land was accompanied by a corresponding complexity of internal organization was partly an adaptation to a change of habitat from water to land and in amply illustrated by bryophytes-the amphibians of the plant kingdom. Bryophytes with a simple internal organization have a limited capacity for survival on dry land. The land plants have complex internal organization and pteridophytes occupy an intermediate position between bryophytes and higher land plants (Rashid, 1976).

Pteridophytes constitute a significant and important group in the plant kingdom. As the first true land plants, they offer a very favourable material for the study of various adaptations that have made the colonization of land possible for the plants. Pteridophytes have a long geological history on our planet. They are known from as far back as 380 million years. Fossils of pteridophytes have been obtained from rock strata belonging to Silurian and Devonian periods of the paleozoic era (Rajan, 1995).

Most of the flora in the present world is comprised of seed-bearing plants known as angiosperms, but around 280-230 million years ago, seedless vascular

plants, pteridophytes dominated our planet surface (Bir, 1994). This is one of the most primitive plant groups and isknown as the 'vascular cryptogams'. They are also known as 'ferns and fern allies'. It is estimated that pteridophytes originated during the Silurian and Devonian periods, and became the dominant plant group in the carboniferous period. They played a massive role in the establishmentof plants on land during these periods. Due to their high reproductive ability and simple genetic makeup, pteridophytes quickly invaded the seashores, riverbanks, and places with very little disturbances (Kenrick and Crane, 1997). In the past, there were large fern trees that showed secondary growth, but at present, the numbers of tree ferns are very few. Currently, pteridophytes constitutethe second largest floral group.

Fern and fern-allies can be seen in humid and shady places. The common types of forests that act as habitat for pteridophytes are tropical, subtropical and moist- deciduous forests. Geographically ferns can be seen from sea level to the highest mountains (Dixit, 2000). They are highly sensitive to microclimatic conditions, thus even small disturbances in the climatic and other environmental factors can cause their extinction from the natural habitats,and hence the existence of pteridophytes is largely dependent on the existence of these forests. Pteridophytes can also be seen as epiphytes on trees, lithophytes on the crevices of rocks, and even as hydrophytes completely immersed in water.

India is a subcontinent that hosts a wide variety of habitats. The climatic condition in India varies from the hot and dry Thar Desert in the North-West to the wettest place on the earth, Mawsynram in the North-East. The country is home to the dry deciduous forest in its southern part and also accommodates the Great Himalayas in the North. In this way, each part of this subcontinent shows a variety of habitat for pteridophytes and a large portion of these species are endemic. The

main hotspots of pteridophyte diversity in India are:

- The Eastern Himalayas
- The Western Himalayas
- The Western Ghats
- The Eastern Ghats
- Central India
- Andaman and Nicobar Islands

Pteridophytes are a plant group that falls between non-tracheophytes and spermatophytes and account for over 48 families, 587 genera and 12000 species worldwide. The richness of the species is affected by the rainfall, moisture and habitat availability. Most species are found in tropical and moist temperate regions followed by subtropical regions. They are wildly utilized as vegetables, traditional remedies, and for landscaping and gardening. Proteins, vitamins, crude fiber and minerals are all found in edible pteridophytes and steroids, terpenoids, phenolic acids, and flavonoids are only a few of the compounds found in them (Khoja *et al.,* 2022).

Pteridophytes are the seedless vascular cryptogams which occupy a crucial central position in the evolutionary history of plant kingdom between the lower non-seed bearing and higher seed bearing plants. In India, pteridophytes constitute an important component of flora next to angiosperms (Chandra *et al.*, 2008). Jain and Sastry (1980) reported 17 rare and endangered species of pteridophytes from India. The pteridophytes are moisture and shade loving plants that dependent upon the microclimatic conditions of the region for their successful survival (Rekha and Krishan, 2017).

About 9% world Pteridophytes occurs in India or only in 2.5% landmass of the world. Ferns and Fern-allies in Indian flora and represented by 33 families 130 genera and 1267 species among them 70 species are endemic to India. In India Pteridophytes are distributed in all the phytogeographical zones of India ranging from sea level to alpine Himalayas where they grow as hydrophytes, mesophytes, lithophyte, epiphyte, hemiepiphyte, climbers etc. They are found in all ground habitats such as ravine, forest floor, on slopes, grassland, on rocks and crevices, on open walls and stone boulders and at certain places they form gregarious thickets. As epiphytes different species of Pteridophytes also distributed on different part of tree as on base of tree, bole, branches, forking etc.

Pteridophytes, the seedless vascular plants, had a very flourishing past in dominating the vegetation on the earth about 280-230 million years ago. Although they are now largely replaced by the seed bearing vascular plants in the extant flora today, yet they constitute a fairly prominent part of the present day vegetation of the world. India with a highly variable climate has a rich diversity of its flora and Pteridophytic flora greatly contributes to its diversity. Pteridophytes also form an interesting and conscious part of our national flora with their distinctive ecological distributional pattern. On a very conservative estimate 500 species of ferns and 100 species of fern-allies are on record from India (Rawat and Satyanarayana, 2015).

Region-wise studies reveals, that maximum number of 700 species (*i.e.* 58% of Pterido-phytes) occur in Eastern Himalayas and adjoining states. Thus, Eastern Himalayas may be termed as one of the Hot Spots diversity centre for pteridophytes. In other regions viz., 400 species in Southern India,300 species in North-West India and 100 species in Central India and 125 species in Andaman and Nicobar Islands (Rawat and Satyanarayana, 2015).

According to a census, the pteridophytic flora of India comprises of 67 families, 191 genera and more than 1,000 species (Dixit 1984) including 47 endemic Indian ferns, less than 10% of those reported previously and 414 species of pteridophytes (219 at risk, of which 160 - Critically endangered, 82 - Near-threatened and 113 - Rare), constituting 41-43 % of the total number of 950-1000 pteridophytes of India. The vascular flora of our country in general has about 15,000 species and as a constituent of Indian flora of vascular plants, the ferns and fern-allies form only five percent part as far as the number of species is concerned. But, due to their abundance in individuals as well as their conspicuousness in epiphytic vegetation and in the terrestrial vegetation along forest margins roadsides and forest floors, the contribution of ferns and fern-allies to the vegetational pattern in India rank only next to the flowering plants.

In view of variable climatic and altitudinal variations the Indian sub-continent represents Himalayas, Gangetic plains and Thar Desert as biodiversity centres. Maximum number of diversity of pteridophytes observed in Himalayas, Eastern and Western Ghats. Except Pachmarhi and Parasnath hills; gangetic plains and Aravalli hills or towards North-west Hindu-Kudh much pteridophytes do not occur. The lesser rainfall from Eastern Himalayas to Western hills is responsible for a decrease in pteridophytic vegetation.

Pteridophytes (ferns and fern-allies) are the most primitive vascular plants that appeared on the Earth, in the mid-Paleozoic era during the Silurian period which began 438 million years ago. They are the earliest of the plants ever evolved on the earth heralding the presence of a well-developed vascular system, xylem for water and phloem for food transport respectively and hence, are referred as ‘vascular cryptogams’.

The arrival of pteridophytes, with specialized water and food conducting tissues, heralded an era of greater colonization in terrestrial ecosystems, to an extent that many of them could attain great heights like the flowering trees. After successfully establishing themselves as land plants, a very rapid rate of evolution was stimulated and witnessed among them with which they dominated most of the forests on earth's surface by the approach of carboniferous period. With the passage of time, especially with the evolution and dominance of the flowering plants, beginning in the late Cretaceous, the decline of the pteridophytes began Nevertheless, this interesting group of plants, bridging the non-vascular cryptogams with the seed plants, higher in the evolutionary hierarchy, continues to occupy numerous niches on the land and in marshes and swamps and even in water bodies (Dudani *et al.,* 2011).

India has a rich and varied pteridophytic flora due to its Gondwana land origin, its drift from south of the Equator towards Eurasia far north, carrying the progenitors of today's pteridophytes from Australia, Africa, Madagascar etc. as well as probable endemics of its own. The rise of the Himalayas along the India-Eurasia merger line created diversified topography and varied climatic conditions ranging from warm and humid sea shores to arid deserts to elevations experiencing arctic cold, creating numerous micro-climates congenial for growth of ferns and fern allies, almost unparalleled anywhere on the Earth (Dudani *et al.,* 2014).

Moreover India's strategic geographical position would have facilitated migration of species, including several pteridophytes from Eurasia and South-east Asia and *vice-versa*, a notable factor that would have reduced endemism among the fern community. Today, among the vascular plants, pteridophytes form a major part next only to the angiosperms in India. Of the 12, 000 pteridophyte species enumerated in the world, around 1000 species from 70 families and 192 genera occur in India.

The major centers for pteridophytes diversity are Eastern and Western Himalayas, Western Ghats, Eastern Ghats, Central India and Andaman and Nicobar Islands (Dudani *et al.*, 2014).

The Western Ghats constitute one of the 34 global biodiversity hotspots along with Sri Lanka, on account of exceptional levels of plant endemism and by serious levels of habitat loss (Conservation from south of Gujarat to the end of the peninsula (lat. 8° and 21° N and long. International, 2005). The rugged range of hills stretching for over 1600 km along the west coast 73° and 78° E), covering a geographical area of about 160,000 km2, is interrupted only by a 30 km break in Kerala, the Palghat Gap (Radhakrishna, 2001). The Western Ghats have an average height of 900 m, with several cliffs rising over 1000 m. The presence of perennial streams and rivers, evergreen forests, grasslands and high altitude sholas and many other habitats of this mountain chain harbor almost 320 species of ferns and fern-allies (Dudani, 2014).

Pteridophytes are the considered one of the early land dwellers and most primitive group of vascular plants that appeared on this planet in the mid-Palaeozoic era (i.e. approx. 438 million years ago) during the Silurian period (Dudani *et al.*, 2011, 2014). Their adaptation to terrestrial condition by evolving specialized tissues for the translocation of water and food is responsible for their greater colonization in terrestrial ecosystems.

Development of vascular tissue not only contributed in water and food translocation but also played crucial role in mechanical support. Therefore, many of them such as *Cyathea* and *Wilsonia* (tree ferns) could attain great heights like trees. This interesting group of plants form an important component of forest ecosystem and act as connecting bridge between the non-vascular cryptogams and the seed plants and occupy various niches on the land, in marshes, swamps and in water bodies

(Dudani *et al.,* 2011). They flourish in moist tropical and temperate forests while, they also occur in different eco-geographical regions of the world, where the conditions are not conducive for growth (Dixit, 2000). The majority of them thrive well in shady and moist places but a few survive in rock crevices and dry places while some of them such as *Salvinia* and *Azolla* grow in aquatic habitats (Bower, 1923, 1963).

According to Smith *et al.* (2006), it is estimated that there are about 9000-15000 species of pteridophytes that occur throughout the world while Moran (2008) predicted it to be approximately 13,600 species. Due to diversified topography, variable climatic conditions and geographical position, about 1200 species of pteridophytes are reported from India (Dixit, 1984, 2000; Sukumaran *et al.,* 2009; Dudani *et al.*, 2011; Patil and Dongare, 2013, Kavitha *et al.,* 2015; Kachhiyapatel *et al.,* 2015; Patel *et al.,* 2015; Patil *et al.,* 2012, 2014, 2016; Rajput *et al.,* 2016), in which nearly 17% species are endemic (Sanjappa and Venu, 2010).

Studies on pteridophyte of Gujarat were taken up by contemporary researchers such as Phatak *et al.* (1953), Chavan and Mehta (1956), Gaekwad and Deshmukh (1956), Chavan and Sabnis (1961), Chavan and Padate (1962, 1963), Mahabale (1948, 1963), Shah and Vaidya (1964), Nayar and Devi (1964), Padate (1969), Inamdar and Shah (1967). Gujarat Ecological Commission (1996) documented 16 species of pteridophytes from different parts of the state, including forest areas. Thereafter, this group of plants was completely neglected and studies on them lagged behind. However, recently few sporadic reports about the occurrence of pteridophyte have been carried out by Patel *et al.* (2010), Dabgar (2012) and Modi and Dudani (2013).

Pteridophytes (comprises ferns and fern allies) represent the earliest vascular land plants originated some million years ago and still some of them are luxurious irrespective of all the geological and climatological disturbances which occurred from time to time, without many changes in their morphology. They form a conspicuous element of vegetation all over the earth's surface. Pteridophytes are important from the evolutionary point of view, because they show the evolution of vascular system in plants and also clearly show the process of evolution of seed habit in plants. They are considered as connecting link between higher vascular plants and lower non vascular plants. They remain primitive tracheophytes lacking flowers and seeds and propagate through haploid spores and exhibit independent alternation of generations (Kirishnan and Rekha, 2021).

Ecologically they are adapted to almost all possible situations from tropics to temperate regions except in the Polar regions and deserts. They grow luxuriantly in moist tropical and temperate forests and their occurrence in different eco-geographically threatened regions from sea level to the highest mountains are of much interest. The world flora consists of approximately 12,000 species of pteridophytes of which around 1000 species distributed in 70 families and 192 genera are likely to occur in India. Most of the pteridophytes diversity in India is observed in the Himalayas, Eastern and Western Ghats. The Western Ghats, is rich with more than 300 pteridophytes.

Western Ghats is the 1600 km long chain of hills of Peninsular India, ranging from the Tapti river basin of the southern Gujarat to the Kanyakumari of Tamil Nadu. It is one of the most significant geological structures, which controls the climate and culture of the Peninsular Indian states of Gujarat, Maharashtra, Karnataka, Kerala and Tamil Nadu. It offers innumerable microhabitats for the luxuriant growth of flora,

including the pteridophytes, the second largest floral group. Urbanization is a leading cause of habitat loss and biological homogenization (Mckinney, 2006). Remnant ecosystem embedded in urban areas, especially forests, provide important services such as moderating local climate, storing water, and filtering air, as well as increasing citizens' well-being (Alberti, 2010; Grimm *et al.*, 2008). However, the balance of components ensuring ecological integrity that is, biophysical structure, species composition and functional processes- is difficult to maintain in urban forest patches (Ordonez and Duinker, 2012). This is because most of these components are disturbed at multiple spatial scales by human activities (Alberti, 2010).

The plant communities of edge habitats are often composed of a higher proportion of competitive, pioneer, and ruderal plants than forest cores (Godefroid and Koedam, 2004; Guirado *et al.*, 2006; Lapaix and Freedman, 2010). The presence of edges may also favor the influx of invasive and exotic plants into forests (Cadenasso and Pickett, 2001). Observed changes in the composition of floristic assemblage of urban ecosystem are usually exacerbated by extensive areas of impervious surfaces that foster the formation of urban heat island (UHIs) (Bechtel and Schmidt, 2011), which may in turn cause thermal and hydric stress to organisms not adapted to these conditions (Grimm *et al.*, 2008). This anthropogenic climate disturbance, the human stranglehold over nature and the novel microhabitats created in a heterogeneous matrix differentiate urban areas from the other landscapes creating a unique distribution pattern of the plants that must be under-stood for the preservation of remaining ecosystems (Williams *et al.*, 2009). Although forests in urban areas are never pristine, it is possible to establish a scale of their relative integrity and to identify the forests whose conservation should be prioritized. Landscape metrics can be used to assess structural integrity, which is known to

decrease in forests that are smaller, less connected, and surrounded by a strongly anthropized matrix (Carignan and Villard, 2002; Dale and Beyeler, 2001). Biological indicators that have either a negative (e.g., exotic organisms) or a positive (e.g., native organisms) response to eco-logical integrity can also be used (Carignan and Villard, 2002).

Species richness estimates calculated from judiciously chosen guilds or functional groups, can effectively represent patterns and processes related to many components of ecosystems (Dale and Beyeler, 2001), but efficacy varies with sampling unit size (Dufrêne and Legendre, 1997) and a method to control this confounding effect is usually necessary (Bräuniger *et al.,* 2010). Species richness is a fundamental measure of community and regional diversity and underlies many ecological models that area analyzed by a number of species recorded in the samples (Tessler *et al.,* 2016). Elevation gradients can serve as natural experiments for studies on community and ecosystem responses to long-term changes in climate in a changing world (Sundqvist *et al.,* 2013). Pattern of species richness along elevation gradients is a classic subject in ecology and biogeography (Ah-Peng *et al.,* 2012).

Studies on relationship between species richness and elevation gradients resulted in development of a more complete understanding about the nature and more effective plans for conserving biological diversity in the context of global change (Grytnes *et al.,* 2006). Ecology of terrestrial and marine ecosystems has been studied over a century, and human utilization of both realms was documented going back thousands of years (Knapp *et al.,* 2017). The regional patterns of species richness are a consequence of many interacting factors, such as plant productivity, competition, geographical area, historical or evolutional development, regional species dynamics, regional species pool, environmental variables, and human activity (Zobel, 1997).

Species richness on elevation gradient studies identified two main correlation patterns such as monotonic and humped. “Monotonic” was referred to as decrease in species richness with increasing elevation, and “humped” was referred to as highest distribution and species richness near the middle of the elevation gradient (Rahbek, 1995; Grytnes and Beaman, 2006). Carpenter (2005) stated that 49% of altitudinal gradient studies across the globe on different vegetation showed a humped species richness trend (with major groups of insects, small mammals, birds, and vascular plants with maximum species richness) with 500-m or lower to 1500-m or higher elevation and that 24% of the studies showed little change in species richness at lower elevations and decline at higher elevations. Plant species richness declines monotonically above an elevation gradient of 1500 m (Vazquez and Givnish, 1998). Global climate is probably the principal determinant of the vegetation pattern, which has considerable influence on distribution, structure, and ecology of the forest ecosystem, and it is assumed that changes in climate would alter constitution of an ecosystem (Singh *et al.*, 2015).

Climate variables seem to be most important for explaining species richness patterns with elevation gradients for all kinds of living organisms (Bhattarai *et al.*, 2004). Climate factors, viz., temperature, potential evapotranspiration, length of the growing season, humidity, air pressure, nutrient availability, ultraviolet radiation, and rainfall, are varied for elevation, all of which can have an effect on distribution of species and their richness along the gradient in any forest ecosystem (Funnell and Parish, 2001). The community structure and ecosystem processes always differ along elevation gradients in almost all vegetation. Ecosystem and ecological responses to elevation are commonly driven by changes in temperature, and many community and ecosystem level variables often respond similarly to elevation across contrasting

gradients (Sundqvist *et al.,* 2013). A majority of elevation gradient studies are focused on woody plants (Kitayama, 1992; Liberman *et al.,* 1996), although the largest share of plant species in several forests belongs to nonwoody plants (Gentry and Dodson 1987). Epiphytic plants that grow on the surface of trees contribute to more than half of the plant species richness in tropical forests, which provides unique microclimates and habitats for other species; thus, their decline could negatively affect many animals and plants that rely on them (Wang *et al.,* 2017).

Pteridophytes have been a popular subject of studies on species elevation relationships, with the highest diversity in tropical and subtropical mountains (Bhattarai *et al.,* 2004). It is generally accepted that tropical regions are reported to have higher species richness than temperature areas, but documentation of diversity patterns within tropics is limited in particular to vascular cryptogams (Gentry, 1982). Pteridophytes shows a peculiar type of life cycle, that combines wind-dispersed spores and mostly with free-living gametophytes. This unique characteristic feature improves a surplus level of complexity when making biogeographical comparisons of pteridophytes with other vascular plants (Watkins *et al.,* 2006).

Pteridophytes are mostly related to its ecological structure, and very few studies have addressed the change of diversity along elevation gradients. A majority of previous reports on distribution of pteridophytes along elevation gradients in different geographical regions show a "humped" distribution pattern (Watkins *et al.,* 2006). In India, contributions about the taxonomy, ecology, ethnobotany, and distribution pattern of pteridophytes are available in the literature from time to time, but enough attention has not been given toward the diversity of this unique group along elevation gradients.

Ecological indicators (EIs) are useful tools to link empirical results, models, and theories with environmental applications. They are broadly employed in the classification of environments and in the evaluation of natural and/or anthropic disturbance or stress (Siddig *et al.*, 2016). One definition considers EIs as a species or group of species that readily reflects the abiotic or biotic state of an environment (Dale and Beyeler, 2001; Heink and Kowarik, 2010). This definition includes only species and/or group of them, but other taxonomic levels (family, genus) or still ecological attributes (as richness and diversity) could be adopted.

The total number of pteridophyte species present in India is c. 1100 and of these 337 taxa are considered to be threatened or endangered (nearly one third of the total). It should be realised that IUCN listing (IUCN, 2010) is organised by countries and the global rarity and endangerment of species is therefore often somewhat masked in an area where the floras are intimately related. This particularly applies to the two major groups of Sino-Himalayan and S. E. Asian/Malesian elements present in India which extend across the eastern borders into China, Myanmar etc. It also applies to the Lankan/ Indian peninsular element in the south, which contains the highest number of Indian endemics. A list of Asian globally threatened species of narrow distribution is given by Ebihara *et al.* (2012) for which the 76 Indian, Nepalese and Bhutanese species listed have been extracted from the present paper. The present list is reduced compared to that of 414 threatened pteridophytes given by Chandra *et al.* (2008) as it concerns only the top six IUCN categories, EX (Extinct), EW (Extinct in the wild), CR (Critically endangered), EN (Endangered), VU (Vulnerable) and NT (Near threatened), whereas Chandra *et al.* (2008) list was a more preliminary one which did not set out to follow the IUCN categories until more information became available. The IUCN categories given here apply to political India only.

In addition more information about the status of species in Arunachal Pradesh has become available (Fraser-Jenkins and Benniamin, 2010a; Fraser-Jenkins, 2010b) and has revealed that a number of species that are very rare else-where in India are much more common in the far North-East in Arunachal Pradesh and some other North-Easternmost States of India. Adjustment has also been made to the status of a number of species, either taxonomically, or for IUCN category, now that more information from Indian herbaria, particularly CAL, BSA and LWG, has become available to the author. A few of the species that have now been excluded for taxonomic or other reasons have been listed here for explanatory reasons, but in square brackets and without categories. Many other species previously estimated to be Endangered and Endemic have been elucidated taxonomically by Fraser-Jenkins (2008a, 2008b) and Chandra *et al.* (2008) and excluded.

The classification of Fraser-Jenkins (2010a) has been used in the list, with some modifications according to more recent work. In general this is similar to that of Kramer and Green (1990) and Smith *et al.* (2006). But it is less similar to two molecular cladonomy lists recently produced by Christenhusz *et al.* (2011) and Rothfels *et al.* (2012), which are seen here as being insufficiently taxonomically based and to recognize too many groups that have no possible morphotaxonomic significance. They also split many other groups that have been more successfully sunk into recognisable categories of more major value. Their schemes are therefore not accepted here as being applicable to taxonomic classification and are seen as being of less use to Botanists.

The Western Ghats, one among 34 global biodiversity hotspot centers, is rich in floral and faunal diversity with great endemism throughout the plant and animal kingdom (Daniels, 2003). The criteria for a region to be recognized as a

"Biodiversity Hotspot" by Conservation International (2005) is the presence of a minimum of 1500 endemic species of vascular plants and the loss of at least 70 percent of its original habitat. Due to the distribution of endemism, Nayar and Geevarghese (1993) compared the ecological niches in the Western Ghats to be similar to that of an Island. The mountain chain has perennial streams, rivers, evergreen forests, and high altitude sholas, thus making a perfect habitat for ferns and fern-allies.

The Western Ghats covers a distance of 1600 km from Kanyakumari in Tamil Nadu to Tapti valley in Gujarat state with an area of 160000 km^2. It runs parallel to the western coast of India traversing the states of Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamil Nadu. The continuous stretch of the Western Ghats is interrupted by a 30 km break-in Kerala. The interrupted part is known as 'Palghat Gap' (Radhakrishnan, 2001). Mountain ranges like Nilgiri Hills, Anamallays Hills and Palni Hills are present in the Ghats, and they have various forest types like scrub forests at an elevation of 200-500 m, moist deciduous forests (500-900 m), tropical moist evergreen forests (1200-1500 m) and Shola forest above 1500 m. The Western Ghats gets an annual rainfall of 1000 to 5000 mm.

Based on the studies done by Manickan and Irudayaraj (1992), the Western Ghats harbors 349 pteridophyte species out of 1200 Indian pteridophyte species. According to Manickam and Irudayaraj (1992), a large portion of pteridophyte species in the Western Ghats is endemic. The most diverse genera present here is *Asplenium, Selaginella*, *Pteris, Athyrium, Diplazium*, etc. Dudani *et al.* (2011) found that the major families seen in the Western Ghats were Aspleniaceae, Polypodiaceae, Thelypteridaceae, Selaginellaceae, etc. According to Dixit (2000), based on the available literature, Karnataka holds the maximum diversity of pteridophytes in the

family Aspleniaceae which is comprised of 27 species. Other major pteridophyte families were Polypodiaceae, Athyriaceae, Thelypteridaceae, Selaginellaceae, Pteridaceae, etc.

Studies on pteridophytes are gaining momentum and this is shedding light on the medicinal and economic importance of these plants. Understanding the flora of a region always helps in understanding the change in the ecosystem and in-vitro and ex-situ conservation can be widely exploited to bring back the threatened species from the verge of extinction and preserve this plant group for our coming generations.

REVIEW OF LITERATURE

The study of pteridophytes of South India began with Van Rheede (1703) who included 20 illustration of 16 species of ferns and fern allies from Kerala and their description in *Hortus Malabaricus*. Linnaeus (1753) referred to this work while naming the Indian species in his *Species Plantarum*. Manilal (2003) transliterated Van Rheede's *Hortus Malabaricus* to English. References to ferns of south India can also be found in Hooker's *Icones Plantarum* (1837-1854) and *species filicum* (1846-1864).

The most significant contribution on the south Indian pteridology is by Col.R.H. Beddome, conservation of forests, Madras presidency. Based on his field work and study of earlier works (Hooker and Greville, 1829-1831; Hooker, 1846-1864; Hooker and Baker, 1868; Moore, 1857-1862). Beddome published his monumental work, Ferns of southern India (1864), which recorded 240 species of Pteridophytes from peninsular India. Following this, he published *Ferns of British India* (1866) and Supplement to the Ferns of Southern India and Ferns of British India (1876). In 1883, the Handbook to the ferns of British India, Ceylon and the Malay peninsula was published and supplement was added in 1892. Even to-day, Beddome's work remains as one of the most important and useful reference for the identification of Indian fern and flora. Since then, the concepts of various taxonomic groups of ferns have considerably been changed and altered. Nayar and Kaur (1974) and Chandra and Kaur (1987&1994) have published the nomenclatural equivalents to the ferns described by Beddome.

The earliest major work on the pteridophytes of the Nilgiris was by Guastavo Kunze (1851) who reported eighty two fern species and 12 fern allies and described 22 new species. Sharma *et al.* (1977) have listed 147 species of ferns and fern allies

from the Nilgiris based on the collections. Krishnamurthi (1953) mentioned a tree fern *Cyathea nilgirensis* as of ornamental or horticulture value.

Pteridology in India

The different accounts presented by Prof. R.C. Ching, dealing with the Himalayan ferns and C.B. Clarke's study of the North Indian ferns (Clarke, 1880) are perhaps the most noteworthy since Beddome's studies. Afterwards, Baynes (1887) beautifully illustrated 33 species of ferns from India in 17 plates in his *Album of Indian Ferns*.

During the past fifty years, there has been remarkable contribution in almost all fields of Pteridology by Indian botanists (Bir, 1987a). The studies on the ferns of peninsular India have been reviewed by Nair and Bhargavan (1981) which gives an insight in to the historical heritage of our culture related to the studies on ferns and their utilization in the indigenous system of medicine. Madhusoodanan *et al.* (2001) reviewed the studies and contributions made by different pteridologists on the various aspects of ferns and fern-allies of South India from 1947 to 1997.

Dixit and Vohra (1984) had given a brief account of all the genera reported from India in their 'A dictionary of Pteridophytes'. Dixit (1984) published A Census of Indian Pteridophytes giving author citations and distribution of ferns and fern allies occurring in India. Later Chandra (2000a) updated the nomenclature of 219 taxa enumerated by Dixit. Chandra (2000b) also enumerated the ferns occurring in India with all their synonyms and distribution. Fraser-Jenkins (2008a) published a taxonomic revision of three hundred ferns occurring in India and provided a revised census list.

Various checklists of the fern flora of limited geographical regions have been published from time to time. The only attempt at a serious floristic study of any region

is ferns and fern allies of Meghalaya state by Baishya and Rao (1982) which includes 256 species of ferns and fern allies along with key to their identification, and brief taxonomic account of each taxon. But it lacks detailed morphological descriptions of taxa and taxonomic notes are not precise; hence the work is only of limited utility. An enumeration of species of plants of Palni hills (South India) is published by Manikam and Ninan (1976), listing 133 species. The ecology of 150 taxa of ferns of the Palni Hills have been studied by Manikam and Ninan (1984). Manikam (1986) also published Fern Flora of Palni Hills which includes detailed descriptions on ecological data of 137 species (including 8 new species) belonging to 64 genera and 13 varieties. Subsequently, Manikam and Irudayaraj (1992) published Pteridophyte Flora of the Western Ghats–South India which includes descriptions and illustrations of 239 species occurring in Western Ghats south of Palghat gap. Nayar and Geevarghese (1993) published the Fern Flora of Malabar giving elaborate descriptions of 170 species of ferns from this area.

Blatter and Almedia (1922) published Ferns of Bombay and provided a brief description of the taxa along with their description. Holtum (1976) has dealt the family Thelypteridaceae including 10 species for the flora of Hassan district, Karnataka. Nair *et al.* (1988, 1992a, 1992b and 1994) provided brief description and ecological account of the fern allies and ferns of Kerala. Pteridophytes of Karnataka state have been enumerated by Rajagopal (1999) published Polymorphic ferns of the Western Ghats which explains the polymorphism in 10 south Indian ferns. Pullaiah *et al.* (2003) published Pteridophyte in Andhra Pradesh, India enumerating a total of 89 species of ferns and fern allies belonging to 51 genera spread over 32 families.

Monographic and revisionary works

Holttum (1965) gave a detailed account on the Tree – Ferns of the genus *cyathea* in Asia and discussed about the taxonomy, nomenclature and distribution of nine species. Panigrahi (1975) revised the genus *Pityrogramma* in Asia and discussed about the taxonomy, nomenclature and distribution of four species of *Pityogramma* naturalised in Asia. Holttum (1983) revised the family Thelypteridaceae in Europe.

Sledge has done remarkable work on the Ceylon flora. His contributions include Ceylon species of *Aspelinium* (1965), the athyrioid ferns of Ceylon (1962), the dryopteroid ferns of Ceylon (1973), the tectarioid ferns of Ceylon (1972), the Ceylon species of *Leptochilus* (1956) the Hymnneophyllaceae of Ceylon (1968), the Thelypteridaceae of Ceylon (1981), the Polypodiaceae and Grammitidaceae of Ceylon (1960) and the genus *Elaphoglossum* in the Indian peninsula and Ceylon (1967). Walker (1960) clarified the confusions regarding seven species under the *Pteris quadriaurita* complex in Ceylon

Alston (1945) was the first person who enumerate 58 species of *Selaginella* from British India and provided a key for identification. Out of which 44 species are confined to the present political boundaries of India. Alston (1952) made a revision of the West Indian species of *Selaginiella.* Gupta (1962) revised the genus *Marsilea* in India. Later Panigrahi and Dixit (1969) studied the family Osmundaceae and Satijja *et al.* (1983) revised the genus *Pyrrosia* in India. Afterward Dixit published revisionary works on *Lycopodiaceae* of India (1988) and "Selaginellaceae of India*"* (1992). Singh and Bir (1989) revised the genus *Asplenium* in India and Fraser-Jenkins (1991) studied the genus *Polystichum* in India

In South India, revisionary works on families like Aspleniaceae (Azeez *et al.,* 2008), Hymenophyllaceae (Hameed *et al.,* 2003) Polypodiaceae (Nampy and

Madhusoodanan, 1998), Thelypteridaceae (Leena and Madhusoodanan 1994; Manikam and Irudayaraj 1990), Pteridaceae (Manickam and Irudayaraj, 1991and genera like *Microsorium* (Madhusoodan and Nampy, 1993), *Pteris* (Sreenvias, 2010) were carried out. Jyothi and Madhusoodanan (1993) studied the Cheilanthoid ferns of South India and Kurup *et al.* (2008) revised the primitive ferns of South India which includes 23 species coming under 12 genera.

Status of pteridophytes

The world conservation monitoring centre at Cambridge, England, listed 1650 threatened species of pteridophytes world-wide (Jermy, 1990), under the following categories: presumed Extinct-20, Endangered-67, vulnerable-9, rare-354, candidate species for conservation -1318. Based on their new criteria for species to be include in the red list, IUCN (1998) listed 770 threatened species of Pteridophytes world –wide.

Much study has been carried out in India on threatened species of flowering plants and their conservation, but ferns and fern–allies, which constitute edible and valuable part of the national flora, have attracted less notice. First attempt in this respect was the work done by Jain and Sastry (1980) who listed 17 rare and endangered pteridophytes from India along with Angiosperms. Afterward, Dixit (1983) reported 25 rare and interesting pteridophytes; whereas Datta (1983) listed only five pteridophytes as rare. Bir (1987) identified 104 rare and endangered pteridophytes from different parts of India. Nayar and Sastry (1987, 1988, 1990) include 31 threatened pteridophytes in the Red Data Book of India Plants. Madhusoodanan (1991) listed rare and endangered ferns of Western Ghats of Kerala and later on, Manickam (1995) reported 44 rare and endangered species of ferns from the Southern Western Ghats. Bennianmin *et al.* (2008) developed a key for identification of rare and endangered ferns and fern allies in the Western Ghats.

Chandra *et al.* (2008) lists 29 fern-allies and 358 ferns as threatened taxa of pteridophytes from India. According to them 219 species of pteridophytes to be considered as 'At risk' in India and among them, 160 come into the IUCN category of 'Critically endangered'; 82 species to be considered as 'Near-threatened' and 113 species to be considered under the category of 'Rare'. Recently, Ebihara *et al.* (2012) provided a list of narrowly distributed Asian pteridophyte taxa towards an assessment of globally threatened species. Out of the total 886 taxa enumerated by them, 577 taxa occur in Southeast Asia, 215 taxa occur in East Asia and 101 taxa occur in South Asia.

Ferns are the most diverse group and the oldest lineage of vascular plants and the second-most speciose after angiosperms with approximately 12000 species. But, currently many pteridophyts extinction are fragmentation, degradation and habitat destruction, commercial collection, pathogens, predators and invasive species, climate change and pollution. These ferns are not only taxonomic oddities but those are plats with dynamic relationship to their environment. The Western Ghats of Peninsular India is of grate phyto-geographical importance which constitutes one of the 34 global biodiversity hotspot centres, on account of exceptional levels of plant endemism because of its diversified topograpghy and varied climatic conditions. Recently Fracer-Jenkins reviewed pteridophytic numbers to be 1000 species of fern and fern allies in India, Western Himalyas and Western Ghats supported 399 and 349 pteridophytes species of fern and fern allies in India, repectively. In central Western ghats, Karnataka region houses richest pteridophytic diversity.

Kumar (1998) documented 159 species from Munnar forest divison. Among them 109 species were terrestrial and 50 epiphytic. A checklist of rare and endangered species found in different forests of Munnar were also provided. Dudani *et al.* (2014)

stated that the major families of pteritophytes found in the Western Ghats are Aspleniaceae, Polypodiaceae, Thelypteridaceae, Selaginellaceae, Pteridaceae, *etc.* Whereas, in the generic level, maximum diversity was observed in the genus *Asplenium, Selaginella, Pteris, Athyrium, Diplazium, etc.* The Western Ghats also harbours endemic species like *Polystichum manickamianum, Cyathea nilgiriensis, Bolbitis semicordata, Selaginella radicata*. Many endangered pteridophytes like *Psilotum nudum, Tectaria zeylanica, Lindsaea malabarica, Cheilanthes rufa.* may soon face the brunt of extinction.

According to Moran, there are 13,600 species of ferns globally, and of this, approximately 1200 species with 70 families and 192 genera are seen in India. In India, there are 1200 pteridophyte species with 70 families and 192 genera. The pteridophyte hotspots in India are the Himalayas, Western Ghats, Eastern Ghats, Central India, and Andaman and the Nicobar Islands. The Western Ghats occupies only 6% of the India landmass and still holds a pteridophyte diversity of 383 species.

Pteridophytes are the seedless vascular cryptogams which occupy a crucial central position in the evolutionary history of plant kingdom between the lower non-seed bearing and higher seed bearing plants. In India, pteridophytes constitute an important component of flora next to angiosperms (Chandra *et al.*, 2008). Jain and Sastry (1980) reported 17 rare and endangered species of pteridophytes from India.

According to a census, the Pteridophytic flora of India comprises of 67 families, 191 genera and more than 1,000 species (Dixit, 1984) including 47 endemic Indian ferns, less than 10% of those reported previously and 414 species of Pteridophytes (219 At risk, of which 160 critically endangered, 82 Near-threatened and 113 Rare), constituting 41-43 % of the total number of 950- 1000 Pteridophytes of India. Chandra Shubhash (2000) recorded 34 families, 144 genera and more than

1100 species of ferns with about 235 endemic species from Indian region. The vascular flora of our country in general has about 15,000 species and as a constituent of Indian flora of vascular plants, the ferns and fern-allies form only five percent part as far as the number of species is concerned. But, due to their abundance in individuals as well as their conspicuousness in epiphytic vegetation and in the terrestrial vegetation along forest margins roadsides and forest floors, the contribution of ferns and fern-allies to the vegetational pattern in India rank only next to the flowering plants.

A major boost to fern studies in India came with the establishment of the Indian Fern Society in 1983. This organization has helped to bring together the pteridologists of the country, and is promoting interest in the study of ferns through meetings and through its publications. With the start of Indian Fern Journal in 1984, a channel has been created for communication with international groups of pteridologists. Bir wrote an account of "Pteridology in India" giving details of work done in various fields. Foreign scientists did lot of work on Indian Pteridophytes. Of which R.H. Beddome, C.B. Clarke and C.W. Hope are the pioneers, worked upto the end of 19th century. Beddome's Handbook of the ferns of British India", Ceylon and Malay Peninsula" is the only authentic useful work even to-day. Regional flora on Nagaland (Jamir and Rao, 1988) Meghalaya, (Baishya and Rao, 1981), Tripurs (Singh and Panigrahi, 2005). (Arunachal Pradesh) and North-West Himalayas have already been published. Checklist on pteridophytes of North-East India; Darjeeling and Sikkim Himalayas, Western Himalayas, Mount Abu in Rajasthan and other places viz., Pachmarhi, Tamiya and Patalkot in Madhya Pradesh, Kambab; Shevroy and Pachaku-Tattachi hills and Bombay, Mahabaleshwar, Mather and Kanara etc. in

Western Ghats have been published. Dixit (1984) published "A census of Indian pteridophytes" and "Dictionary of Pteridophytes of India" respectively.

Each species of fern has its own preferences of micro habitat depending on the temperature, humidity, soil type, moisture, pH, light intensity, etc., and in many cases are very specific indicators of the conditions they need (Shaikh and Dongare, 2009). It is well observed and noted that most species of ferns succeed under high humidity and shade conditions (Page, 1979), unless they are species that prefer more xeric conditions and are more heliophilous. *Cyathea* sps. and *Angiopteris* sp. are among those perennial ferns which prefer swampy/moist habitats with low light intensities for their growth. Similarly, another endemic fern *Osmundahuegeliana* prefers the moist and humid banks of free flowing perennial streams and rivers (Dudani *et al.*, 2012). Another endemic fern species *Bolbitis subcrenatoides* is commonly found growing as terrestrial inside the fully covered forest floors and sometimes along road cuttings or edges in the forest. *Pteridium revolutum*syn. *Pteridium aquilinum*is an adventive alien species of the region, an escape from gardens into the wild surroundings of Western Ghats, which has a preference for growing gregariously on fully exposed grassy slopes. *Lygodium flexosum* is the only scandent or climbing fern recorded in the current study prefers to grow among the bushes along the partially or fully exposed roadsides. The commonly growing terrestrial species such as *Blechnum orientale* and *Dicranopteris linearis* were observed to be growing abundantly and forming thickets in many places. The common lithophytic fern species in the study region were *Pityrogramma calomelanos, Leucostegia truncata* and *Adiantum philippense* while the common epiphytic fern species observed were *Drynaria quercifolia* and *Lepisorus nudus*.

Most of the pteridophytes recorded in this study have various medicinal and other miscellaneous applications. Among all, *Pteridium revolutum* is perhaps the most widely used terrestrial fern species for various purposes. The tender fronds of this fern are used as vegetables and also in soup preparations while the rhizomes are boiled or roasted and eaten. The rhizome of this fern is astringent, anthelmintic and is useful in diarrhea and inflammation of the gastric and intestinal mucous membranes. The rhizome is boiled in oil and is made into an ointment for wounds. The dried fronds of the fern are also employed as packaging material and have also been tried as a source for paper pulp (Manickam and Irudayaraj, 1992). Another widely occurring fern in the study region – *Tectariaco adunata*, has antibacterial properties and is used in the cases of asthma, bronchitis, honey bee stings and the cooked tender portion of this fern is employed for curing stomach trouble (Dixit and Vohra, 1984; Manandhar, 1996; Das, 1997). The climbing fern *Lygodium flexosum* is used as an expectorant and in the treatment of rheumatism, sprains, scabies, ulcers, eczema and coughs (Singh et al, 1989; Manandhar, 1996).

Other important medicinal applications of the pteridophytes include: use of the rhizome of *Drynaria aquercifolia* as antibacterial, antiinflammatory, tonic, in the treatment of typhoid fever, dyspepsia, cough, diarrhea, ulcers and other inflammations (Dixit and Vohra, 1984; Warrier *et al.*, 1996); use of the fronds of *Osmunda huegeliana* as tonic, styptic and also for the treatment of rickets, rheumatism and for intestinal gripping (Dixit and Vohra, 1984); use of the fronds of *Pityrogramma calomelanos* for the treatment of asthma, cold and chest congestion (Dixit and Vohra, 1984); use of the rhizome of *Leucostegia truncata* as antibacterial and in the treatment of constipation (Benjamin and Manickam, 2007). Besides these exemplary medicinal properties, the pteridophytes have long been greatly valued as ornamentals. They are

used to enhance the beauty of the landscape and find their place in gardens, nurseries and during functions for beautification purposes.

Ferns and lycophytes – forming together the paraphyletic pteridophytes – are important components in tropical rainforests globally (Mehltreter, 2010). They are often less recorded in biodiversity surveys compared to timber trees or birds, although several studies demonstrated the high value of ferns and lycophytes as indicators to characterize tropical rainforest biosystems (Mehltreter, 2010; Pouteau *et al*., 2016; Silva *et al*., 2018). Despite the documentation of these plants, they also tend to be less utilized compared to some flowering plant lineage, but their socio-economic importance has been highlighted in several studies focusing on their utilization of ferns in the Philippines (Zamora and Co, 1986; Amoroso, 1990; Buot, 1999; Banaticla and Buot, 2004; Barcelona, 2005; Coritico *et al.*, 2020). Unfortunately, there is little to no information about these plants occurring at SINP, which inhibits efforts to explore the effectiveness of this protected area for fern and lycophyte conservation.

The pteridophytes tend to increase in number in the north-south direction of Western Ghats, obviously due to the more number of rainy months and higher altitudes with cooler climates. Maharashtra has 64 species of Pteridophytes, most of them confined to northern Western Ghats, Karnataka has about 174 species of pteridophytes, mostly growing in central Western Ghats (Rajagopal and Bhat, 1998) and Kerala and Tamil Nadu together, especially in a block south of Palghat gap alone account for 239 species (Manickam and Irudayaraj, 1992). There have been some notable studies on the pteridophytes of central Western Ghats in Karnataka with the earliest record of 75 ferns species from North Canara district. After a gap of more than three decades, Blatter and Almeida (1922) included 90 species of ferns from North Canara district in their work ‘Ferns of Bombay’. Subsequent studies on

pteridophytes of Karnataka included collection of four species of *Selaginella* from the state by Alston (1945); listing of 25 species of pteridophytes by Kammathy *et al.*, (1967); preparation of an artificial key for the 70 species of pteridophytes recorded from Mysore city and its neighbouring areas; inclusion of 10 species of fern family Thelypteridaceae in 'Flora of Hassan District' by Holttum (1976).

After a significant time gap, there has been a surge in various research aspects of pteridophytes of central Western Ghats. Some of the recent studies on ferns and fern-allies include the record of 23 species of pteridophytes in Madhuguni state forest of central Western Ghats by Deepa *et al.*, (2011); enumeration of 22 species of pteridophytes from Agumbe forest of central Western Ghats (Nataraja et al, 2011); survey and record of 21 species of pteridophytes in the Yana sacred forests of central Western Ghats by Dudani *et al.*, (2013) and record of 38 taxa of pteridophytes from Kemmangundi forest of Karnataka by Deepa *et al.*, (2013). As it is evident from the available literatures, there is still a serious depth of information pertaining to the pteridophyte diversity of many important biodiversity rich areas of Karnataka. Hence, this study was taken up with the aim of exploring the pteridophytic diversity as a part of an ecological study carried out by our multidisciplinary team during 2010-11 in the Sakleshpurtaluk of Hassan district.

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grow among the bushes along the partially or fully exposed roadsides. The commonly growing terrestrial species such as *Blechnum orientale* and *Dicranopteris linearis* were observed to be growing abundantly and forming thickets in many places. The common lithophytic fern species in the study region were *Pityrogramma calomelanos*, *Leucostegia truncata* and *Adiantum philippense* while the common epiphytic fern species observed were *Drynaria quercifolia* and *Lepisorus nudus*. Most of the pteridophytes recorded in this study have various medicinal and other miscellaneous applications. Among all, *Pteridium revolutum* is perhaps the most widely used terrestrial fern species for various purposes. The tender fronds of this fern are used as vegetables and also in soup preparations while the rhizomes are boiled or roasted and eaten. The rhizome of this fern is astringent, anthelmintic and is useful in diarrhea and inflammation of the gastric and intestinal mucous membranes. The rhizome is boiled in oil and is made into an ointment for wounds. The dried fronds of the fern are also employed as packaging material and have also been tried as a source for paper pulp (Manickam and Irudayaraj, 1992).

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However, as the humid places and water bodies are prioritized by the humans for settlements, farming, power generation, setting up of industries etc. the most sensitive pteridophytes depending upon such habitats tend to vanish from the region. Muktesh (1998) studied the fern flora of Kerala with special reference to the Sylvan Valley of Munnar. He recorded 159 species of ferns and fern allies belonging to 70 genera and 29 families. It was also found that once abundant species of Munnar forest like *Osmunda hugelina, Angiopteris evecta, Cyathea spp*., *Diplazium spp. Polystichum spp*. etc., have become rare due to deforestation and man-made and natural forest fire.

Kavitha *et al.,* studied the diversity of pteridophytes of Ponmudi hills in 2015. The study area is carpeted by thick tropical forest with a diversity of 28 pteridophyte species. The dominant forest types were tropical evergreen and moist deciduous. Joseph and Thomas (2015) collected 15 chasmophytic pteridophyte species from the Urumbikkara hills of Idukki district of Kerala and, the species belonged to 11 families and 11 genera. Joseph *et al.,* (2017) studied the pteridophyte flora of Dr. Salim Ali Bird Sanctuary, Thattekad, Ernakulam; and reported the presence of 30 species of ferns and fern- allies belonging to 23 genera. The sanctuary covers an area of 25.16

km and has tropical evergreen forests, semi evergreen forests, tropical moist deciduous forests, and Mahogany plantations. The pteridophyte flora of Akamala forest station, Thrissur district, Kerala was documented by Rekha and Athira (2017). The study area was home to 24 species of pteridophytes. Of these, 2 species belonged to the 'endangered' category, 4 species belonged to the 'rare' category and one species belonged to the 'at risk' category.

Tamil Nadu is the southernmost state of India. It has a geographic area of 1,30,060 km and a forest cover of 26,281 km and that is 20.2% of the total area of the state (Ruma, 2018).The state has four major geographical divisions such as the Eastern and coastal plains, central uplands, western Karnataka plateau, and the central Eastern Ghats. There are nine types of forests in the state and among these tropical dry deciduous forest occupies 46.98% of the total forest area. The average rainfall that Tamil Nadu receives is 3000- 5000 mm per year. Since Tamil Nadu has both the Western Ghats and the Eastern Ghats passing through it, it holds a rich pteridophyte flora and many studies have been conducted to explore this diversity. Sukumaran *et al.* (2009) recorded.

The diversity of pteridophytes in miniature sacred forests of the Kanyakumari district in Southern Western Ghats. A total of 24 species were reported from here and out of these 3 were endemic, 3 were endangered and 8 were rare. In a study conducted by Abraham and Ramachandran (2013), six species were added to the pteridophytic flora.

The wet evergreen forests of Sakleshpur, which is considered as the 'Hottest hotspot of biodiversity' was surveyed by Dudani *et al.* (2014) and a total of 45 species of pteridophytes were reported from this region. Parashurama *et al.* (2016) assessed the pteridophyte diversity in Mudigere taluk, Central Western Ghats, Karnataka, and a

total of 26 species of pteridophytes belonging to 17 families were obtained from the study area. Their habitat was also observed and it was recorded that 22 species were terrestrial.

Maharashtra is a state with a geographic area of 3,07,713 Km (Ruma, 2018). Maharashtra has a forest cover of 21% and has mountain ranges with tropical rain forests. 17% of the state has deciduous forests. Sixty four fern species have been reported from Maharashtra and most of these are confined to the northern Western Ghats (Manickam and Irudayaraj, 2003). A new addition was done to the flora of Maharashtra by Sachin *et al.* (2016). Goa has a geographical area of 3702 km and of this, 2229 km is forest area. 95% of its forest area has 'protected area' status due to the presence of four wildlife sanctuaries. Datar and Laksminarasimham (2010) conducted a study to compile data on the pteridophyte diversity of Goa and concluded that Goa has a pteridophyte flora comprising of 47 pteridophyte species and these belonged to 32 genera under 20 families.

Gujarat has a land area of 1,96,244 km and a forest cover of 14,757 sq km (Ruma, 2018). In 1996, the Gujarat Ecological Commission documented 16 pteridophyte species from different parts of Gujarat. Later few studies were done by Patel *et al.* (2010) and Dabgar (2012).

OBJECTIVES

The present study was carried out with the following objectives

i) To document the presence of variety of pteridophytes in the form of different taxas.

ii) To analyze the further distribution of species in the locality of Kamamkuli pond.

iii) To rationalize a relationship between diversity and the similarity of ferns in the study area.

MATERIALS AND METHODS

Study area:

The study area is Kamamkuli pond located in Killiyoor taluk, Kanniyakumari district, Tamil Nadu, India. The field collection was carried out in and around the location with Lat 8.236932, Long. 77.214392. There was no human habitat upto ½ Km around the pond was surrounded by small running streams and agricultural plantations with water flowing around, which favoured the luxuriant growth of pteridophytes.

Survey methodology:

Intensive field exploration was done in Kamamkuli pond, Killiyoor taluk, Kanniyakumari district during November 2022 to March 2023, to document and collect ferns and fern allies. Specimens have been collected except in few cases. Photographs were taken for collected specimens.

Identification of specimens:

The species identity were checked and verified with the help of illustrations and Floras, particularly Ferns of southern India (Beddome, 1863-1864); Ferns of British India (Beddome, 1866) Pteridophyte Flora of Western Ghats (Manickam and Irudayaraj, 1992); Pteridophytes of the Western Ghats A Pictorial Guide (Benniamin and Sundari, 2020). The identities of some doubtful specimens were verified with the help of eminent pteriodologists. The specimens were then dried, processed and labelled by standard herbarium method given by Jain and Rao (1977). Field observations such as habitat, ecology and distribution were also noted. The processed

specimens of all taxa collected were incorporated in the PG and Research Department of Botany, St. Mary's College (Autonomous), Thoothukudi for future reference.

RESULTS

The current study reveals the distribution of 17 species (Table – 1) of pteridophytes along the Kamamkuli pond located in Killiyoor Taluk, Kanniyakumari district, Tamil Nadu. Seventeen species of pteridophytes belongs to seven families namely family Pteridaceae, Thelypteridaceae, Gleicheniaceae, Davalliaceae, Nephrolepidiaceae, Salviniaceae and Hymenophyllaceae (Figure – 1, Plate I and II). The botanical description is given below.

***Davallia repens* (L.f.) Kuhn**

Common name: Dwarf Hares-Foot Fern

Description:

Rhizome slender, white-waxy, densely covered with appressed red-brown scales with pale scarious margins bearing fragile deciduous hairs. Fronds in Australian material generally simple and pinnatifid, narrowly triangular, coriaceous. Stipe 0.5–12 cm long, bearing similar scales to rhizome; rachis with scattered scales on lower surface, glabrous on upper surface. Pinnae deeply lobed almost to rachis; widest point 8–85 mm; upper surface glabrous; lower surface rarely with a few dark simple hairs; margins highly variable in degree of lobing but basal lobe pair always distinct, usually larger and asymmetrical with much deeper lobing on the basal side; apex rounded on sterile lobes to acuminate on fertile lobes; false veins absent. Sori marginal, grouped near apices of pinna lobes, mostly in sinuses formed by a marginal tooth projecting from basal side of sorus; indusium generally elongate, attached at a narrow base, apex extending beyond margin.

***Lygodium flexousum* (L.) Sw.**

Common name: Maidenhair Creeper

Table 1 – Distribution of pteridophytes in the Kamamkuli pond

S. No	Name of the species	Family	Habitat	Distribution in site of collection	IUCN Category
1.	*Davallia repens* (L.Fil) Kuhn	Davalliaceae	Terrestrial	++	VU
2.	*Lygodium flexousum* (L.) Sw.	Gleicheniaceae	Terrestrial	+	-
3.	*Trichomanes obscurum* Blume.	Hymenophyllaceae	Terrestrial	++	-
4.	*Nephrolepis multiflora* (Roxb.) Jarret	Nephrolepidiaceae	Terrestrial	+++	-
5.	*Adiantum caudatum* L.	Pteridaceae	Terrestrial	+++	-
6.	*Adiantum latifolium* Lam.	Pteridaceae	Terrestrial	+++	-
7.	*Adiantum philippense* L.	Pteridaceae	Lithophytic	+	-
8.	*Ceratopteris thalictroides* (L.) Brongn	Pteridaceae	Aquatic	++	-
9.	*Mickelopteris cordata* (Roxb. Ex Hook. & Grev.) Fraser-Jenk	Pteridaceae	Terrestrial	++	-
10.	*Pityrogramma austroamericana* Domin	Pteridaceae	Terrestrial	++	-
11.	*Pityrogramma calomelanos* (L.) Link	Pteridaceae	Terrestrial	++	-
12.	*Pteris vittata* L.	Pteridaceae	Terrestrial	++	-
13.	*Salvinia molesta* D.S. Mitch.	Salviniaceae	Aquatic	+++	-
14.	*Thelypteris articulata* (Houlston & T.Moore) Tagawa & K.Iwats	Thelypteridaceae	Terrestrial	++	-
15.	*Thelypteris dentata* (Forssk.) E.P. John.	Thelypteridaceae	Terrestrial	++	-
16.	*Thelypteris ochthodes* (Kunze) Ching.	Thelypteridaceae	Terrestrial	++	-
17.	*Thelypteris paludosa* (Blume) K. Iwats	Thelypteridaceae	Terrestrial	++	EN

PLATE - I

STUDY AREA

Davallia repens

Lygodium flexousum

Trichomanes obscurum

Nephrolepis multiflora

Adiantum caudatum

Adiantum latifolium

PLATE - II

Adiantum philippense

Ceratopteris thalictroides

Mickelopteris cordata

Pityrogramma calomelanos

Salvinia molesta

Thelypteris articulata

Thelypteris articulata

Thelypteris dentata

Figure - 1 Percentage distribution of families of pteridophytes in Kamamkuli pond

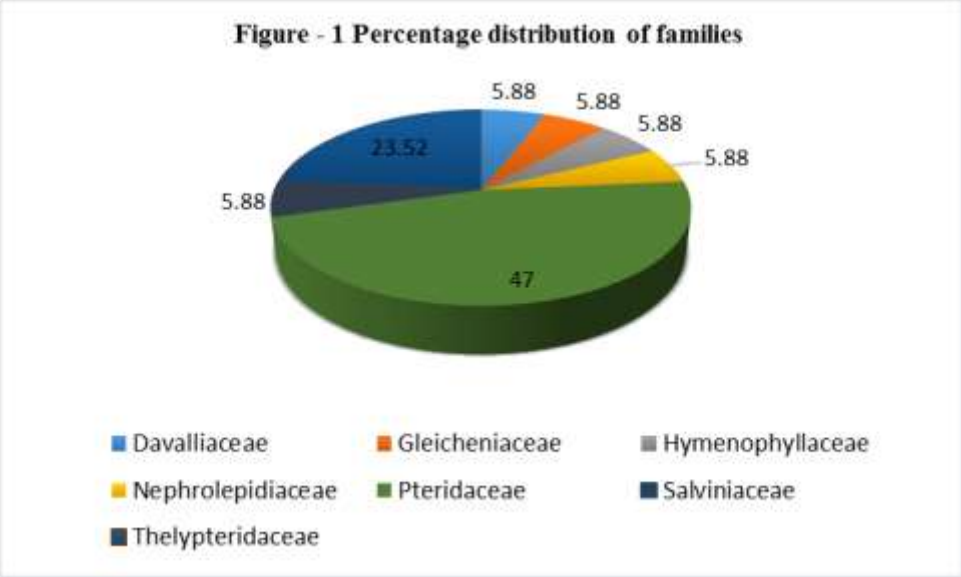


Figure - 2 Habitat percentage distribution of pteridophytes in Kamamkuli pond

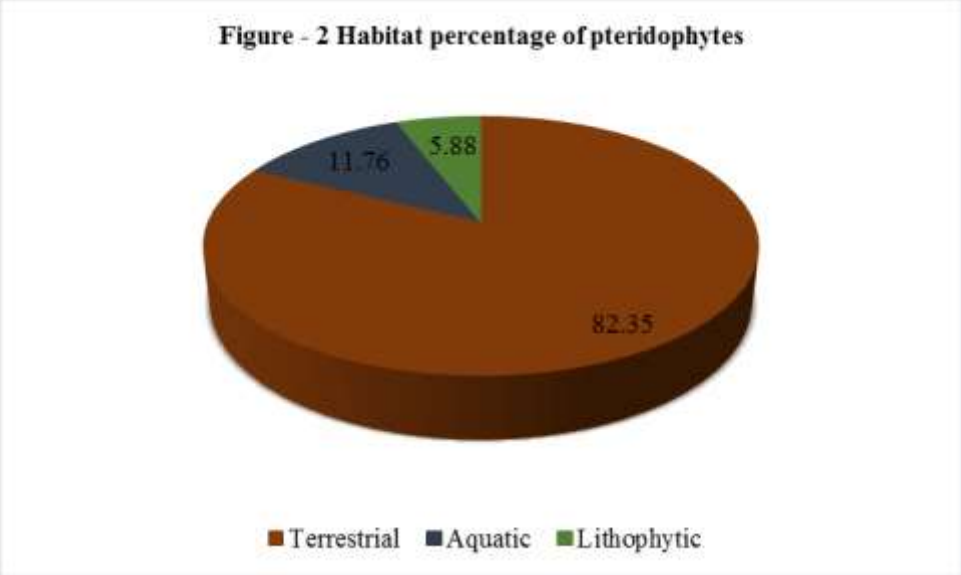
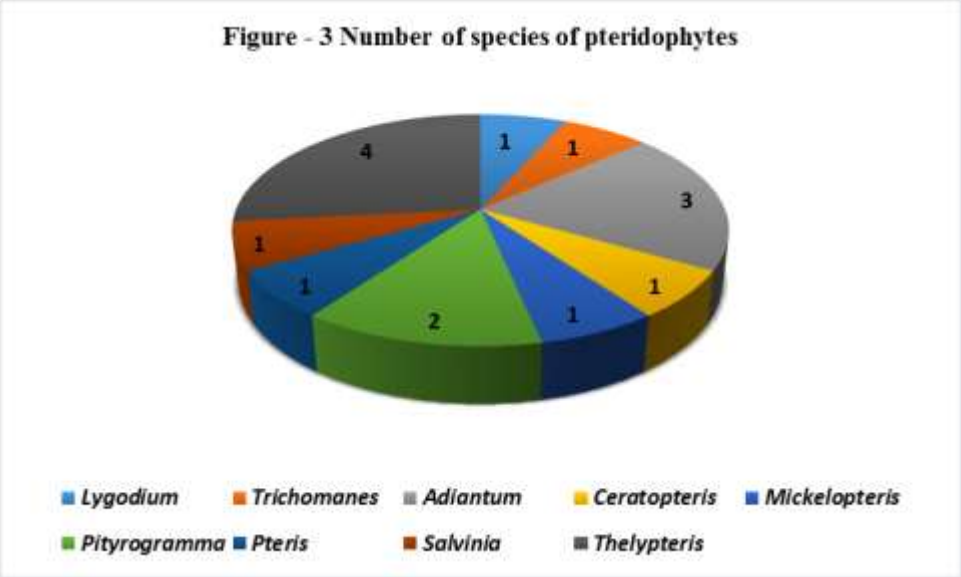


Figure – 3 Number of species reported per genus in Kamamkuli pond



Description:

Stem scales appressed, bicolored with margins transparent. Tubers absent. Petiole moderately to densely scaly; scales appressed, dark brown with pale margins. Blade sparsely to moderately scaly, hairy abaxially, hairs pale brown. Scales scattered to dense, brown, margins pale. Central pinnae narrowly deltate, sometimes elliptic, base rounded basiscopically, slightly auriculate to truncate acroscopically, acroscopic lobe acute to oblong, margins biserrate to irregularly serrate to serrulate, apex attenuate and occasionally slightly falcate; costae adaxially densely hairy, hairs pale, erect. Indusia circular to horseshoe-shaped.

***Adiantum caudatum* L.**

Common name: Walking fern

Description:

Rhizome erect, short; scales concolorous, golden brown, with entire margins. Fronds tufted, long. Stipe long, dark brown, hairs multicellular and dark brown to brown. Lamina 1-pinnate, lanceolate in outline; rachis dark brown, hairs multicellular and dark brown to brown. Apex usually prolonged into a whiplike stolon rooting at tip to form new plantlet. Pinnules alternate, or lower ones subopposite, horizontally spreading or slightly obliquely spreading; lower pinnules gradually reduced, suboblong; brownish green; both surfaces sparsely multicellular hirsute; base asymmetrical; lower margins entire, upper margins deeply divided into many narrow lobes; lobes linear, margins entire, upper part again lobed into fine linear segments. Sori 5–12 per pinna; false indusia dark brown, orbicular or oblong, hairy, upper margins flat and straight, entire, persistent.

***Adiantum latifolium* Lam.**

Description:

Terrestrial herb with long creeping, densely scaly rhizome, 3-4 mm thick. Scales lanceolate or linear, very narrow pointed at apex, dark reddish brown, clathrate, entire or with few outgrowths. Fronds 40-55 x 20-28 cm; stipe 25-36 cm long, black polished, scaly beneath, hairy above; lamina deltoid in outline, bipinnate; primary pinnae, oblong, lanceolate in outline, 5-6, alternate, largest in middle; pinnules obtuse to rounded at apex, serrate; sessile or subsessile, acroscopic base truncate, basiscopic base cuneate, excised, coriaceous; veins very close, repeatedly forking, anastomosing, largest pinnae in the middle, terminal pinnae rhomboid, larger. Sori oblong or elliptic, yellowish brown. Sporangial capsule, subglobose. Spores triangular, yellowish, verrucoid.

***Adiantum philippense* L.**

Common name: Maidenhair Fern

Description:

Terrestrial herb with erect, rhizome. Scales linear or lanceolate, acuminate, dark brown to black, clathrate, entire. Fronds simply pinnate; stipe 17-23 cm long, scaly at base, pinkish-brown polished above, lamina 30 x 8-10 cm, lanceolate in outline; pinnae, semicircular, acroscopic margin shallowly lobed, basiscopic base entire, coriaceous or subcoriaceous; veins forked to anastomosing. Sori linear 0.6-2 cm, dark brown, indusia brownish. Sporangial capsule subglobose, stalk 250 µm long. Spores brownish yellow, planoconvex, thinly granulose.

***Ceratopteris thalictroides* (L.) Brongn**

Common names: And water Horn fern, Indian fern, Oriental wate rfern, Water fern, Water sprite

Description:

Aquatic or semi aquatic herbs with erect rhizome, 4 x 2-3 cm, with thick long, fibrous, fleshy roots. Scales pale brown, membranous, ovate or elliptic, acute, entire. Fronds dimorphic; stipe 15-20 cm long; sterile lamina simply pinnate; pinnae ovate or deltoid in outline, variously lobed, coriaceous, fleshy, glabrous, veins anastomosing, indistinct; fertile lamina simply pinnate, pinnae tripinnatifid, lobes linear, fleshy. Sporangial capsule sessile. Spores trilete with thickly folded ridges.

***Mickelopteris cordata* (Roxb. Ex Hook. & Grev.) Fraser-Jenk**

Common name: Heart fern

Description:

Extremely attractive fern is characterized by its heart-shaped leaves, which are also covered with numerous dark hairs. The leaves sit on long black-brown petioles. In addition, it is dimorphic and, above a certain size, forms not only its trophophylls for photosynthesis but also sporophylls for spore production, which are characterized, among other things, by significantly longer petioles. In its preferred habitats in Southeast Asia it grows both as epiphytic and terrestrial in loose substrate congregations.

***Pityrogramma austroamericana* Domin**

Description:

Terrestrial herbs with erect rhizome, 3-5 x 2-3 cm. Scales lanceolate, long acuminate, pale brown. Fronds 20-30 x 5-10 cm, bipinnate; stipe 8-10 cm long, scaly beneath, dark brown polished, grooved above; lamina ovate in outline; pinnae lanceolate, acuminate in outline, progressively reduced towards apex; pinnules lanceolate, acute, margins serrate, basal pinnules auricled, progressively reduced towards apex, glabrous above, covered by yellow powder below. Sori acrostichoid

when mature. Sporangial capsule globose. Spores dark brown, tetrahedral, trilete, granulose.

***Pityrogramma calomelanos* (L.) Link**

Common name: Silver Fern, Silverback Fern

Description:

Terrestrial herb with erect, densely scaly rhizome. Scales, brownish, linear, entire. Fronds bipinnate; stipe, dark-pinkish brown, polished; lamina triangular in outline; pinnae, lanceolate, acuminate in outline, pinnules rhomboidal to lanceolate, acute, lobed to serrate, pinnae and pinnules progressively reduced to apex, rachis and costa grooved above, raised below; lower surface of pinnules white crusted. Sori acrostichoid. Sporangial capsule, globose, stalk 250 µm long. Spores triangular in outline, yellowish with pinkish thickenings.

***Pteris vittata* L.**

Common name: Chinese brake fern or ladder brake fern

Description

Rhizome suberect, densely scaly at apex; scales ovate lanceolate, entire, acuminate, up to 3×1mm, pale brown; stipes bent at base 6 × 0.1cm ,round at the abaxial surface, grooved at the adaxial side, pale brown, scaly at the base. Lamina lanceolate, simply pinnate, narrowing towards the base, terminated by a pinna larger than the lateral ones; pinnae up to 1cm apart, lower ones opposite, upper ones sub-opposite, sessile, ascending, middle pinnae up to 6×0.7cm, terminal one up to 10× 0.5cm, base cuneate or truncate, apex acuminate, margin serrate in the non-soral part, entire in the rest, veins obscure, forked once from or above the base. Sori linear, continuous along the margin except the apex.

***Salvinia molesta* D.S. Mitch.**

Common name: Kariba weed, African payal

Description

Aquatic free floating ferns. Stem spongy, terete, up to 2mm thick, brown, branched with nodes and internodes, submerged leaves modified into root-like organs, up to 5cm long, covered by brown hairs. Normal leaves born at the nodes in two opposite pairs, erect floating, sessile ovate to oblong, entire, pale green, lower surface glabrous, upper surface with dense hairs born on the intervenal areas, stiff, erect with a common stalk, branched into four, separate hooked branches; veins slightly distinct below, anastomosing, areoles parallel, elongated; herbaceous in texture; normal leaves spongy due to the presence of hairs; sporocarps born in clusters on submerged leaves, ca.10 in number, ovoid, apiculate, up to 2mm in diameter, sessile, densely hairy; microsporangia born on branched receptacles in cluster in microsporocarps, megasporaangia born in megasporocarps

***Thelypteris articulata* (Houlston & T.Moore) Tagawa & K.Iwats**

Description:

Terrestrial fern. Rhizomes erect, sparsely scaly at the apex. Scales basifixed, ovate, acuminate, base broad, margin glandular hairy, pale brown, concolorous. Fronds tufted, simple pinnate; stipes scaly at base above glabrous, acicular hairy; lamina lanceolate, glabrous above, hairy below, dark green, with a terminal pinna similar to lateral ones; texture sub coriaceous; pinnae upto 12 pairs, sub opposite or alternate, sessile or sub sessile, margin shallowly lobed, apex acuminate, acroscopic base broad cuneate to truncate, basiscopic base cuneate, lower 2-3 pairs of pinnae slightly deflexed; pinnae lobes cut down one fourth way to the costa, segments 15-20 pairs, acute, slightly ascending. Veins distinct, anastomosing, upper 2-3 pairs free, lower surface sparsely hairy. Sori round, small, median on veins, arranged in two rows; indusia glabrous; sporangia bearing club shaped glandular hairs on stalk; spores monolete, pale brown.

***Thelypteris dentata* (Forssk.) E.P. John.**

Common name: Downy maiden fern

Description:

Terrestrial fern. Rhizomes suberect or shortly creeping, apices densely scaly. Scales light-brown linear-lanceolate, acuminate apex, margin entire. Fronds subclustered; stipe bases covered with scales, dark brown, stramineous distally; lamina simple pinnate, bases slightly narrowed, apices acuminate, brownish green when dried, shortly hairy adaxially, densely puberulent abaxially, sometimes with glandular hairs, texture herbaceous to papery; lateral pinnae 15–20 pairs, proximal 2 to 3 pairs progressively shortened; pinnae lanceolate to oblanceolate, sessile, subopposite, bases rounded-truncate, apices acuminate; pinnae lobes more than half way cut down to the costae, segments 15–25 pairs, oblong, slightly oblique, basal acroscopic one slightly longer, rounded-obtuse at apices, margin entire. Veinlets 6–8 pairs per segment, proximal pair anastomosing, next pair running to sinus membrane, intervenal area with several acicular hairs,. Sori orbicular, arranged in two rows on both side of the costule; indusia shortly hairy, brown. Spores monolete, irregularly cristate.

***Thelypteris ochthodes* (Kunze) Ching.**

Description:

Terrestrial herbs. Rhizome short creeping or suberect, rarely erect, up to 6 cm thick; scales broadly ovate, about 4 x 5 mm, uniformly pale brown, apex acuminate, margin entire or with few small elongate outgrowths. Stipes up to 105 x 1 cm, dark brown, sparsely scaly at base, grey brown or purple-brown, glabrous above, rounded below, grooved above, three or four pairs, dark brown aerophores present along each side of the stipe. Lamina ovate or lanceolate, terminating with a pinna having larger

lobes at the basal part, acuminate, pinnae up to 35 pairs, sessile, subopposite or alternate, about 10 pairs of basal pinnae abruptly reduced to tubecles, pinnae in the distal part of the lamina progressively reduced; rachis tetragonal, grooved on each side, except the lower side; largest pinna, linear lanceolate, apex acuminate, base truncate or subtruncate, margin lobed; lobes oblong, apex acute or rounded, entire; costa distinctly raised, rounded below; pinnae dark green above, pale green below; texture subcoriaceous; densely hairy, hairs long, soft, sender, pale brown acicular, margin of the lobes bears few short, stiff acicular hairs. Sori supra-median on each vein, except few pairs of distal part of the lobe, yellowish-green; indusia with few acicular hairs; spores, yellowish-green, exine densely, coarsely tuberculate.

***Thelypteris paludosa* (Blume) K. Iwats**

Common name: Marsh fern

Description:

Perennial fern has erect to ascending compound. Fertile leaves tend to be a little smaller in size than infertile leaves; they are both deciduous and die down during the winter. The compound leaves are pinnate-pinnatifid in structure and lanceolate to lanceolate-oblong in outline; their petioles are pale tan or pale purplish tan and mostly glabrous. The blade tissue of these leaves is light green and hairless on both the upper and lower sides. In contrast, the central stalk of the compound leaf and the lateral stalks of the pinnatifid leaflets are finely pubescent on their lower sides. Each compound leaf has 10-40 pairs of leaflets; these leaflets are deeply pinnatifid and narrowly lanceolate-oblong. Often, a compound leaf and its leaflets are slightly curved and twisted. The lobes of the leaflets are oblong or oblong-lanceolate in shape, while their margins are smooth and strongly involute (curved downward). The lobes are spaced close together along the length of each leaflet. On the lower surface of

each lobe, there is a central vein with several lateral veins. Each lateral vein becomes forked and divides into two veins.

Of the seventeen species reported, the family Davalliaceae, Gleicheniaceae, Hymenophyllaceae, Nephrolepidiaceae and Salviniaceae were monospecific with species (Figure - 3) namely *Lygodium flexousum*, *Trichomanes obscurum*, *Nephrolepis multiflora*, *Salvinia molesta* D.S. Mitch. *Davallia repens* (L.Fil) Kuhn, respectively. The family Pteridaceae was the dominantly reported with eight species namely *Adiantum caudatum* L, *Adiantum latifolium* Lam, *Adiantum philippense* L, *Ceratopteris thalictroides* (L.) Brongn, *Mickelopteris cordata* (Roxb. Ex Hook. & Grev.) Fraser-Jenk, *Pityrogramma austroamericana* Domin, *Pityrogramma calomelanos* (L.) Link, *Pteris vittata* L. whereas the family Thelypteridaceae is recorded with four species namely *Thelypteris articulata* (Houlston & T.Moore) Tagawa & K.Iwats, *Thelypteris dentata* (Forssk.) E.P. John., *Thelypteris ochthodes* (Kunze) Ching, *Thelypteris paludosa* (Blume) K. Iwats.

Among the pteridophytes documented habitat wise 14 (Figure – 2) species were terrestrial, two species namely *Ceratopteris thalictroides* (L.) Brongn and *Salvinia molesta* were aquatic and *Adiantum philippense* L. was lithophytic. Regarding distribution of pteridophytes in the site of collection *Nephrolepis multiflora*, *Adiantum caudatum* L, *Adiantum latifolium* Lam, and *Salvinia molesta* was commonly reported in the study area. *Nephrolepis multiflora* and *Adiantum latifolium* were occupying the entire area due to its aggressive rhizome, followed by occasional distribution of *Davallia repens, Trichomanes obscurum, Ceratopteris thalictroides, Mickelopteris cordata, Pityrogramma austroamericana, Pityrogramma calomelanos, Pteris vittata, Thelypteris articulata, Thelypteris dentata, Thelypteris*

ochthodes and *Thelypteris paludosa* whereas *Lygodium flexousum* and *Adiantum philippense*.

As per the IUCN of the seventeen species documented, two species were enlisted under IUCN Category. *Davallia repens* was found enlisted under vulnerable category and *Thelypteris paludosa* under endangered category. The genus Thelypteridaceae was recorded with four species. Whereas genus *Adiantum* was reported with three species. *Pityrogramma* was genus was reported with two species. Whereas all other genes like, *Davallia*, *Lygodium*, *Trichomanes*, *Nephrolepis*, *Ceratopteris*, *Mickelopteris*, *Pteris* and *Salvinia* were collected very rarely.

DISCUSSION

The current investigation on the distribution of pteridophytes along the Kamamkuli pond located in Killiyour Taluk, Kanniyakumari district, Tamil Nadu reveals the distribution 17 different species of pteridophytes belonging to seven families. The study gives a broad outlook about the pteridophytes of Kamamkuli pond where 17 pteridophytes were encountered. Majority of the pteridophytes are belong to the family Pteridaceae (8), followed by Thelypteridaceae (4) and the remaining families are Davalliaceae (1), Nephrolepidiaceae (1), Salviniaceae (1), Hymenophhyllyaceae (1). Among 17 pteridophytes 15 are terrestrial, 2 are aquatic and 1 climber. At that place the pteridophytes like *Adiantum caudatum, Adiantum latifolium, Nephrolepis multiflora,* and *Salvinia natans* are commonly distributed.

Among the pteridophytes reported the genus *Thelypteris* was recorded with maximum number of species followed by the genus *Adiantum* and *Pityrogramma*. The genus *Lygodium, Trichomanes, Nephrolepis, Caratopteris, Mickelopteris*, *Pteris* and *Salvinia.* The family pteridaceae was dominantly reported with eight species followed by family Thelypteridaceae with four different species. The family pteridaceae was diverse in distribution in the locality as it was collected with five different genus so the family was diverse whereas the family Thelypteridaceae was reported with four different species all of which belongs to a single genus *Thelypteris* so there was no diversity among the family in the area of study.

Global climate is probably the principal determinant of the vegetation pattern, which has considerable influence on distribution, structure, and ecology of the forest ecosystem, and it is assumed that changes in climate would alter constitution of an ecosystem (Singh *et al.,* 2015). Climate variables seem to be most important for

explaining species richness patterns with elevation gradients for all kinds of living organisms (Bhattarai *et al.,* 2004). Climate factors, viz., temperature, potential evapotranspiration, length of the growing season, humidity, air pressure, nutrient availability, ultraviolet radiation, and rainfall, are varied for elevation, all of which can have an effect on distribution of species and their richness along the gradient in any forest ecosystem (Funnell and Parish, 2001). Majority of the pteridophytes collected was terrestrial in habit. It shows that the microclimatic conditions and ambient temperature in the surrounding environment was present which influenced the survival of the terrestrial pteridophytes. Though the pteridophytes where terrestrial they were collected along the banks of water bodies which clearly indicates that the microclimatic conditions are an essential factor for their survival. Two species namely *Ceratopteris thalictroides*, *Salvinia molesta,* were aquatic in habitat. *Lygodium flexousum* was a climber and *Adiantum philippense* was lithophytic in habitat.

Distribution of pteridophytes in the site of collection is an indicating factor of its diversity. The diversity is also influenced by the canopy of vegetation. *Nephrolepis multiflora, Adiantum caudatum, Adiantum latifolium* and *Salvinia molesta* was dominantly reported in the study area *Nephrolepis multiflora, Adiantum latifolium* occupied the entire barren land area around the water bodies with moisture content. Whereas *Salvinia molesta* was collected from the small water bodies along the pond. *Davallia repens, Adiantum caudatum, Adiantum latifolium, Adiantum philippense, Ceratopteris thalictroides, Mickelopteris cordata, Pityrogramma austroamericana, Pityrogramma calomelanos, Pteris vittata, Thelypteris articulata, Thelypteris dentata, Thelypteris ochthodes* and *Thelypteris paludosa* was occasionally reported in the study area. *Lygodium flexosum and Adiantum philippense* was reported with a single species alone. *Adiantum philippense* was found inside a cave like appearance with

water from small stream running where the genus *Adiantum* was surviving with a single species alone.

Among the collected pteridophytes. Two species namely *Davallia repens and Thelypteris palusoda* was enlisted under IUCN Category as vulnerable and endangered respectively. Majority of the pteridophytes obtained during the study are of economically important. According to Fraser-Jenkins (2012), out of the total 1100 indigenous pteridophyte of India 337 species are considered to be threatened or endangered. According to the current study there was only one species each under vulnerable and endangered category respectively and the remaining were not enlisted under IUCN category.

Small urban patches contribute less evaporative cooling from trees, and are therefore more affected than large forests by the diffusion of dry and warm microclimatic conditions from the matrix to the forest interior (Grimm *et al.,* 2008). High water availability usually stimulates pteridophyte growth and controls the diversity of favourable habitats (Richard *et al.,* 2000). Contrary to such expectations, it was documented that lower pteridophyte richness in pond surrounded by large proportions of water bodies than in patches surrounded by small water bodies. Water is a key element for pteridophytes to thrive, the recurrence of anthropogenic disturbances in ecosystems located near water bodies, could have caused a cumulative population decline, and eventually the local extinction of a large number of pteridophytes. Actually, some of the highest rates of extinction have been found for native herbaceous plants living in urban riparian forests, while the introduction of exotic plants continues year after year, leaving floristically degraded sites (DeCandido *et al.,* 2004). At the microhabitat scale, abundant shrub cover was negatively correlated to pteridophyte richness, indicating that sample plots dominated by shrubs

had a lower number of pteridophyte species. In general, pteridophytes are poor competitor against ligneous plants (Grime, 1985), which are more tolerant of anthropogenic disturbances in urban areas (LaPaix and Freedman, 2010). Despite the impact of biological interactions, the number of pteridophyte species in assemblages was essentially controlled by physicochemical conditions associated to topographic and edaphic properties. Moisture and soil pH are two parameters recognized as important gradients along which ferns are distributed in temperate forests (Richard *et al.*, 2000), and this is supported by the results of current study too.

The results showed that pteridophyte richness was negatively correlated with shrub cover, but positively correlated to soil moisture. Shrub density in edge habitats is often high, while air and soil moisture are low, due to lateral exposure to solar radiation (Murcia, 1995). These conditions may have induced higher interspecific competition, influenced fertility during the gametophyte stage, and caused hydric stresses on the fronds, as several pteridophytes have no physiological mechanism effective to control water loss (Page, 2002). Ionic concentration and pH imbalances in cells may cause physiological gaps (Bryson and Barker, 2002). Surprisingly, several species of pteridophytes tolerate high salt concentrations in their mature aerial organs (Bryson and Barker, 2002), but their prothallus cells may be intolerant to salts (Bogdanovi´c *et al.,* 2012). This phenomenon illustrates the limitations engendered by the two distinct stages (gametophyte and sporophyte) in the pteridophyte life cycle (Page, 2002).

Studies on pteridophytes are gaining momentum and this is shedding light on the medicinal and economic importance of these plants. Understanding the flora of a region always helps in understanding the change in the ecosystem and in-vitro and ex-situ conservation can be widely exploited to bring back the threatened species from

the verge of extinction and preserve this plant group for our coming generations. Even though the present study was carried out in a short duration, 17 pteridophytes were encountered. A detailed investigation may yield further number of pteridophytes from Kalkulam taluk, Kanniyakumari district, Tamil Nadu, India.

SUMMARY AND CONCLUSION

The current study reveals the distribution of 17 species of pteridophytes along the Kamamkuli pond located in Killiyoor Taluk, Kanniyakumari district, Tamil Nadu. Seventeen species of pteridophytes belongs to seven families namely family Pteridaceae, Thelypteridaceae, Gleicheniaceae, Davalliaceae, Nephrolepidiaceae, Salviniaceae and Hymenophyllaceae. Among the pteridophytes documented habitat wise 14 species were terrestrial, two species namely *Ceratopteris thalictroides* (L.) Brongn and *Salvinia molesta* were aquatic and *Adiantum philippense* L. was lithophytic.

Regarding distribution of pteridophytes in the site of collection *Nephrolepis multiflora*, *Adiantum caudatum* L, *Adiantum latifolium* Lam, and *Salvinia molesta* was commonly reported in the study area. *Nephrolepis multiflora* and *Adiantum latifolium* were occupying the entire area due to its aggressive rhizome, followed by occasional distribution of *Davallia repens, Trichomanes obscurum, Ceratopteris thalictroides, Mickelopteris cordata, Pityrogramma austroamericana, Pityrogramma calomelanos, Pteris vittata*, *Thelypteris articulata, Thelypteris dentata*, *Thelypteris ochthodes* and *Thelypteris paludosa* whereas *Lygodium flexousum* and *Adiantum philippense*. *Davallia repens* was found enlisted under vulnerable category and *Thelypteris paludosa* under endangered category. As per the results obtained in the current study, it is assumed that the actual mechanism which controls the number of species in each elevation, is likely to be a mixture of factors related to biology, climate and geometric constraints. The results also suggested that, climate variables, viz., temperature, rainfall, and humidity, have a major role in species richness. The present study reveals the distribution of diverse species within small locality indicates in ambient requirements being full filled in the study area. Although these hypotheses

were based on interpolated climate and species data, exact authentication is needed with real sampling from fixed sample plots with measured climate variables. The pteridophytes form a vital component of the ecosystem. Botanical explorations should be increase in the under explored botanically rich areas for documenting the diversity and ecological characteristics of pteridophytes and taxonomic reinvestigation should take place in order to avoid the confusion with new species and existing species.

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COMPARATIVE STUDY ON THE PHYTOCHEMICAL SCREENING, ANTIOXIDANT AND ANTIBACTERIAL ACTIVITIES OF DIFFERENT FRUIT SAMPLES

A Short Term Project Work Submitted to St. Mary's college (Autonomous) affiliated to Manonmaniam Sundaranar University in Partial Fulfillment for the Degree of

BACHELOR OF SCIENCE IN BOTANY

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DEPARTMENT OF BOTANY

ST.MARY'S COLLEGE (AUTONOMOUS)

THOOTHUKUDI-628001

2022-2023

CERTIFICATE

It is certified that this short term project work entitled **"COMPARATIVE STUDY ON THE PHYTOCHEMICAL SCREENING, ANTIOXIDANT AND ANTIBACTERIAL ACTIVITIES OF DIFFERENT FRUIT SAMPLES"** submitted to **St. Mary's College (Autonomous)** affiliated to **Manonmaniam Sundaranar University** in partial fulfillment of the requirements for the degree of **Bachelor of Science in Botany** and is a record of work done in the Department of Botany, St. Mary's College (Autonomous), Thoothukudi during the year 2022-2023 by the following students.

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CONTENT

Introduction

INTRODUCTION

A significant portion of our natural treasure is medicinal plants. They produce a variety of conventional and contemporary medicines. It is likely that the usage of medicinal plants to heal illnesses and diseases extends back to the dawn of human civilisation. To relieve their pain from acute and chronic illnesses, bodily discomforts, wounds, and injuries, our ancestors were forced to employ any natural remedy they could find. The well-known founder of modern medicine, Hippocrates (460–377 BC), once said, "Let food be thy medicine and medicine be thy nourishment." phytochemicals and serve as the plant's defence against microbial diseases and pest infestations. (Doughari, 2012).

On the other side, the study of natural products is known as phytochemistry. The vast array of organic chemicals that plants acquire are the subject of phytochemistry, or plant chemistry, which examines their chemical compositions, biosynthesis, turnover, and metabolism, as well as their natural distribution and biological functions. (Harborne 1980).

Phytochemicals are specific, non-nutritive plant compounds that have some ability to stave off disease. Although the human body does not need them to maintain life, they do provide protection from diseases. (Kokate, 2006). There are numerous ways that a phytochemical can function. It can function as an antioxidant and defend cells against the harm caused by free radicals, such as polyphenols, carotenoids, etc. Terpenes, for example, can be stimulated, lowering the risk of breast cancer. It might function as a hormone stimulant and antibacterial agent. It might even function as binders to stop infections from sticking to human cell membranes. (Johann, 2007).

Phytochemicals are already a part of our diet through vegetables and fruits.

A long, healthy life and the prevention of chronic diseases have both been linked to a variety of food products. Some goods have been labelled as functional foods or nutraceuticals. Food products that contain antioxidants are in high demand on the market today as nutraceuticals. As antioxidants, phenolic acids and flavonoids are chosen due to their curative and preventative properties.(Fan et al., 2007). Fruits are low fat source of sodium and calories while dried fruits possess high mineral and protein content (Siddhuraju, 2003).

Due to their availability, relative affordability, and non-toxic nature when compared to modern medicine, plant-based medications continue to be a significant source of therapeutic agents. They have also attracted a lot of attention in recent years because of their wide range of pharmacological properties. (Albino et al., 2013).

Active plant secondary metabolites with a variety of pharmacological effects are abundant in fruits and vegetables. (Gladvin, 2016).For many centuries and into the current era, these secondary metabolites continue to be used in traditional medicine. The development of technology made it possible to profile each and every molecule for more extensive medicinal uses(Naz et al., 2014).

The presence of phenolic compounds, such as phenolic acids, flavonoids, tannins, and nitrogen compounds, such as alkaloids and amines, as well as vitamins, terpenoids, and other metabolites, which have a high antioxidant activity, is generally credited with the health benefits of fruits and vegetables. (El-Beltagi, 2011). Due to these materials' capacity to reduce oxidative stress by neutralising or scavenging reactive especies via hydrogen donation, before they harm cells and other biological

components, this action is possible. (El-Beltagi, 2018).

Research on plant-based nutraceuticals that focuses on the identification and evaluation of novel phytochemicals with potential to improve human health and reduce the risk of disease and illness (Che and Zhang,2019). A healthy diet should include fruits, vegetables, and functional foods because they are a great source of secondary metabolites such dietary fibre, natural antioxidants, and diverse phytochemicals(Butt et al., 2015).

The Rutaceae family member *Aegle marmelos* Linn., also known as "Beal," is a well-known Indian medicinal plant with therapeutic value. Often seen in Hindu sacred groves is the beal tree. Huge quantities of the leaves are harvested to be utilised in religious rites since it is thought to be sacrilegious.(Jain, 1979). Alkaloids, coumarins, and steroids are just a few of the phytoconstituents that have been extracted and discovered from various sections of the tree, including the leaves, fruits, wood, root, and bark. Aegelenine, aegeline, skimmianine, marmelosin, aurapten, epoxyaurapten, marmin, marmesin, xanthotoxin, scopoletin, decursinol, and haplopine, as well as umbelliferone, 6-methyl-4-chromanone, skimmin, psoralen, 6,7-dimethoxycoumarin, and tembamide, are alkaloids, cou (Shoeb et al., 1973). Moreover, fruit contains the alkaloid marmeline, also known as N-2-hydroxy-2-[4 - (3′, 3′- dimethyl allyloxy) phenyl] cinnamide, as well as xanthotaxol, alloimperatorin, and other compounds (10). - The fruit contains sitosterol and its glycoside as well (Sharma *et al*., 1980).

Indian gooseberry, also known as *Phyllanthus emblica* L. (Syn. Emblica officinalis), is a member of the Euphorbiaceae plant family. It is very nourishing and is said to be a significant nutritional source of minerals, amino acids, and vitamin C.

The entire plant, but notably the fruit, which has been utilised in Ayurveda, is used for therapeutic purposes. The fruits of the amla tree are frequently used in Ayurveda and are said to strengthen immunity. The active ingredients found in *Phyllanthus emblica*have been shown in a recent study to have significant therapeutic significance. It is helpful in the treatment of cancer, diabetes, liver disease, heart problems, ulcers, anaemia, and a number of other illnesses. Moreover, it has uses as an immune system modulator, an antipyretic and analgesic, cytoprotective, diuretic, laxative, stomachic, carminative, antitussive, and gastroprotective. Moreover, it helps in lowering cholesterol levels, ocular problems, and cognitive enhancement. In addition, it functions as an antibacterial and a means of neutralising snake venom. It is frequently used in the herbal preparation known as triphala, which contains fruits from the *Phyllanthus emblica, Terminalia chebula*, and *Terminalia belerica*in equal amounts. (Subedi and Subedi, 2014)

The well-known tropical tree *Psidium guajava*, also known as the guava, is widely farmed for its fruit. It is a member of the Myrtaceae family. Essential oils, polysaccharides, minerals, vitamins, enzymes, triterpenoid acid alkaloids, steroids, glycosides, tannins, flavonoids, and saponins are just a few of the phytochemicals and antioxidants found in guava. Vitamin C and A concentrations are higher in guava. Guavas are also a fantastic source of pectin, a vital dietary fibre. It contains significant amounts of carotenoids, fructose, and flavonoids. Current research focuses on the phytochemistry and therapeutic usefulness of *Psidium guajava* (gutaking into account its historical context, significant components, and typical usage. (Dakappa *et al*., 2013).

Scope and Objective

SCOPE AND OBJECTIVES

Due to the fact that natural medicine is free from pollution, nearly non-toxic, and exhibits no side effects, herbal medicine is becoming more and more respected than contemporary medicine. The widespread use of modern allopathic treatment is accelerating the emergence of infections that are resistant to common synthetic medications and the occurrence of multiple drug resistance. In order to create natural medicine that is biodegradable, safe, and has minimal adverse effects, this admonished man to investigate plants with therapeutic capabilities (Prusti *et al.,* 2008).

Objectives

- Preliminary phytochemical screening of ethanol, methanol, and aqueous extracts of fruits of *Aegle marmelos, Phyllanthus emblica,* and *Psidium guajava.*
- *Screening of antibacterial activity of* screening of ethanol, methanol, and aqueous extracts of fruits of *Aegle marmelos, Phyllanthus emblica,* and *Psidium guajava.*
- *Screening of* antioxidantactivity *of* ethanol, methanol, and aqueous extracts of fruits of *Aegle marmelos, Phyllanthus emblica,* and *Psidium guajava.*

Review of Literature

REVIEW OF LITERATURE

Guava has mush nutritional value throughout the world. Many beneficial compounds from plant such as, isoflavonoids, guaijaverin ,gallic acid, catechin, rutin,naringenin,quercetine, picathechin, kaempferol flavonoids, lecithin, exhibit good potential activity against different diseases. A diverse and beneficial package of nutrition is present in guava fruit, carbonyl compounds present in fruit give it a special odor. Fruit contains manganese, thiamine, riboflavin, niacin, iron, vitamin A and C. The leaf , fruits, seeds, bark are very useful against blood pressure, cancer, diabetes and gastrointestinal problems. Various disease like anorexia, aches, bacterial infections, toothache, ulcers, coughs, diarrhea, worms, spasms, sprains, wounds, boils, menstrual problems, colic, convulsions, colds, dysentery, dyspepsia, nausa, tonic, bowel disorders, fever, gingivitis, bronchitis, catarrh, haemorrhoids, itch, jaundice, stomach problems, cholera, chorea, edema, epilepsy, nephritis, respiratory problems, rheumatism, scabies, painful or sensitive condition of the threat, swelling, can be cured by guava. The fruit has pharmacological potential properties like antimicrobial, antifungal, antioxidant, anticancer, anti-diabetes, and anti-diarrheal (Muhammad, 2021).

The key phytochemicals present in watermelon fruit includes lycopene, vitamin C, β-carotene and polyphenols. The native wild type of watermelon species differ in phytochemicals and other nutrients from hybrid species of watermelon. The major bioactive phytochemicals present in watermelon fruit peel includes vitamin C, E, lycopene, and β-carotene responsible for the antioxidant property. According to this study the extract active fruit phytochemicals present in watermelon emphasizes

antioxidant and antibacterial properties of the extract. Phytochemical extraction using various solvents shows methanolic extract is ideal for a wide range of active compounds and extraction yield as well. The extract has demonstrated excellent antibacterial and antioxidant activity of fruit extract. The study provides a scientific basis for the diversity of active compounds present in watermelon fruits and activity (Gladvin and Santhi*, et ,al* 2020).

The main phytochemicals of plums (fruit flesh and skin) were analyzed. Total polyphenols, flavonoids, tannins, anthocyanins, and reducing power were higher in 'African Rose' fruit. The ethanolic and ethyl acetate extracts of two plum cultivars were both high in the antioxidant effect with IC50 13.923 and 18.416 μg/ml of ethanolic extract of 'African Rose', and 'Santa Rosa' respectively. The IC50 of 'African Rose' and 'Santa Rose' extract against Caco-2 was 4 and 8.5 μg/ml. GC-MS analysis was carried out, fourteen and twenty one compound were identified in 'Santa Rosa' and 'African Rose' respectively. The fruits had an antimicrobial action against gram positive and negative bacteria. There was anticancer activity against 3 cell lines: Liver cell line (HepG2), colorectal adenocarcinoma (Caco-2) cell line, and breast cell line (MCF-7) (Hossam *et al*., 2019).

The nutritional, phytochemical, antioxidant and antibacterial activity of dried plum (*Prunus domestica*) were studied to understand its health benefits. The nutritional composition proved its potential as an energy source with low fat content. Protein and dietary fiber content obtained were 3.80% and 2.79% respectively. It was found to be a moderate source of minerals like magnesium, calcium, iron as well as other nutrients. The phytochemical analysis of the dried fruit revealed it to be a good source of total

phenolic and flavonoids. The extract has a moderate antioxidant potential, thus confirming it as a potent electron and hydrogen donor (Sanchi ,*et,al* 2014).

Phytochemistry, micronutrient composition and in vitro antioxidant potentials of *Citrus maxima* juice was studied. *Citrus maxima* juice was obtained from its fruit using a manual screw juice extractor. Analysis was carried out using standard methods. Phytochemical analysis of fresh juice of *C maxima* fruit showed the presence of phenols, flavonoids, tannins, alkaloids, glycosides, steroids and terpenoids. Zinc, copper, iron, magnesium, Vitamins C and E were present in appreciable quantities (Lawrence *et al.,* 2022).

Preliminary phytochemical analysis of *Passiflora foetida* Linn. proved that it consist of phytochemicals such as carbohydrates, protein, fat, reducing sugar, ascorbic acid, flavonoids, alkaloid, phosphorous, magnesium, calcium, amino acid, cholesterol and phenolic compounds. Presence of this biochemicals proved that this plant has high medicinal value and low level of toxicity. This study leads to the conservation of this plant. It has both economical and nutraceutical value. (Revathy and Sunilkumar, 2019).

This study on the *Citrus limonum* portion (pulp or peel), has more number of phytochemicals. The aqueous extracts of the pulp revealed the presence of carbohydrates, alkaloids, tannins, fixed oils, reducing sugars, proteins, cardiac glycosides, steroids, phytosterols, phenols and flavonoids, whereas the ethanolic pulp extracts showed only the presence of fixed oils, reducing sugars, cardiac glycosides, steroids, phytosterols, flavonoids and amino acids. On the other hand, the aqueous peel extracts showed the presence of carbohydrates, alkaloids, tannins, fixed oils, proteins, cardiac glycosides, steroids, phenols and flavonoids and amino acids, whereas the

ethanolic peel extracts revealed that they contained carbohydrates, saponins, tannins, fixed oils, cardiac glycosides, steroids, phytosterols, phenols and flavonoids (Blessy *et al*., 2011).

The phytochemical screening of Fruit Pulp of *Canarium schweifurthii* (that was carried out, the methanolic extract revealed the presence of saponins, terpenoids, steroids, glycosides and carbohydrates, tannins and flavonoids. n-hexane extract revealed the presence of steroids and glycosides, while saponins, terpenoids, tannins, carbohydrates and flavonoids were absent. Chloroform and ethyl acetate extracts revealed the presence of terpenoids, tannins, steroids, glycosides, carbohydrates and flavonoids. Alkaloids had the highest percentage (14.4%) and oxalate had the lowest percentage (1.06%). The antimicrobial screening indicates that methanolic extract was active against *E. Coli* (37mm) and *Klebsilla pneumonia* (32mm). It was inactive against against *Bacillus subtilis*, *Pseudomonas aeroginosa* and *Salmonella typhii*. n-hexane and Chloroform extracts were inactive against all the bacteria used. Ethyl acetate extract was active against *Bacillus subtilis* (12mm), *E. Coli* (27mm), *Pseudomonas aeroginosa* (21mm), *Klebsilla pneumonia* (28mm) and *Salmonella typhii* (22mm). The important of the plant in traditional medicine were discussed with respect to the role of this plant in ethnomedicine in Nigeria (Shaba *et al*., 2013).

The Phytochemical constituents of the dried powdered plant fruits were extracted using chloroform and methanol solvents, results revealed the presence of alkaloids, carbohydrates, glycosides, flavanoids, proteins, amino acids, tannins, phenolic compounds, sterols, steroids, fixed oils, fats and resins. The methanolic extract which have high phytochemical constituents used for the evaluation of antimicrobial activity at 100mg/ml, which evaluated against some common pathogenic bacteria using

agar diffusion method. Gram positive bacteria *Staphylococcus aureus* and gram negative bacteria *Pseudomonas aeruginosa* were used and antimicrobial activity of the concentrated extracts was evaluated by the diameter zone of inhibition against the above microorganisms. Fruit extract were active against both stains of bacteria. The above observation indicates that *P.emblica* has broad spectrum antibacterial activity and a potential source of new classes of antibiotics that could be useful for development of new medicines with lesser side effects. (Ashna and Suganthi, 2019).

Phyllanthus emblica extracts exhibited potent antibacterial and antifungal against all the selected bacterial and fungal species. The extracts exhibited the growth inhibitory activity in a dose-dependent manner. Also, the study reveals *Phyllanthus emblica* shows good antimicrobial activity (Abhay *et al*., 2020)

The screening and study of fruit flour of *Artocarpus heterophyllus* Lam for phytochemical constituents were performed using standard qualitative methods. The constituents obtained were carbohydrates, proteins, fats, flavonoids, phenols, carboxylic acids, coumarins, saponins and phytosterol. . The antioxidant activity was determined using 2,2-Diphenyl-1-picryl hydrazyl (DPPH) assay for hexane, chloroform, acetone, ethyl acetate, benzene, methanol and aqueous extracts. The results showed varying degrees of free radical scavenging activity. Methanol and ethyl acetate extracts showed an IC50 value of 636.55 µg/ml and 713.35 µg/ml respectively (Sreelatha *et al.,* 2018).

The fruit extracts of *Terminalia chebula* Retz. contained different types of phytochemicals such as glycosides, alkaloids, flavonoids, phenolic compounds, saponin, steroids, quinine and tannin. The antibacterial activity of crude extract of *T.*

chebula Retz. was studied against gram- negative bacteria such as *Escherichia coli, Pseudomonas aeruginosa* and *Klebsiella pneumoniae* and gram-positive bacteria such as *Bacillus subtilis*, *Staphylococcus aureus*. The antibacterial activity was studied by disc diffusion method. Extracts with the different solvent of *T. chebula* Retz. exhibited the antibacterial activity bacterial strains. In general, all extracts inhibited the growth of all test microorganisms and in disc method, with the range of concentration of 100µl, 150µl and 200µl the extract, the growth of all microorganisms was inhibited and also showed dose dependent activity. Of the eleven solvent used methanol, ethanol and acetone seems to be the best solvent when compare to other solvants (Tensingh and Astalakshmi, 2014).

Annona muricata is a species of the genus Annona of the custard apple tree family, Annonaceae, which has edible fruit. The aim of this study was to carryout for check the Antibacterial, Antifungal and Phytochemical activity from methanolic and aqueous extract of leaf and fruit of *Annona muricata*. An antibacterial activity of *Annona muricata* was evaluated on Pathogenic bacteria (*Staphylococcus aureus*, *Streptococcus pyogenes*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Klebsiella pneumoniae, Escherichia coli* and *Proteus mirabilis*) by Well diffusion method. Antifungal activity of *Annona muricata* was evaluated on *Cryptococcus neoformans* and *Candida albicans*. Phytochemical analysis was done by using standard methods. Phytochemical screening was used to determine the presence of Alkaloids, Flavonoids, Carbohydrates, Glycosides, Proteins, Amino acids, Saponins, Tannins, Terpenoids in Methanolic and Aqueous extract of *Annona muricata*. These findings support the traditional use of *Annona muricata* in varies disorders (Vinothini and Lali, 2016).

The study on nutritional status, antioxidant activity, and total phenolic content

in fruits, i.e., mango (*Mangifera indica*), apple (*Malus domestica*), and vegetable, i.e., bottle gourd (*Lagenaria siceraria*), and ridge gourd (*Luffa acutangula*) peels were conducted. The antioxidant activity and total phenolic content (TPC) were evaluated by using methanol extracts along with 2, 2-diphenyl-1-picrylhydrazyl (DPPH), Folin–Ciocalteu (FC) assay, respectively having Butylated hydroxyl toluene (BHT) and Gallic acid (GA) as standard. The TPC and antioxidant activity in the peels ranged from 20 mg GAE/g to 525 mg GAE/g and 15.02% to 75.95%, respectively, which revealed that investigated fruit and vegetable peels are rich source of phytochemical constituents (Yumna, 2022).

Apple fruit is a major source of phenolic compounds, dietary fibers (pectin and cellulose) and antioxidants. The nutritional potential of apple cultivar Florina and focused on the chemical composition and antioxidant potential of its fruits was studied. Physicochemical characteristics such as moisture and ash content, phytochemical composition including sugar content, organic acids, phenolic acids (hydroxycinnamic acid), flavonols, dihydrochalcones, anthocyanins, mineral composition in apple cultivar Florina were summarized and noted that they showed antioxidant potential (.Nadezhda .2019).

Bananas, one of the most widely consumed fruits worldwide, are a rich source of valuable phytochemicals. In this study, the antioxidant and the anticancer potential of banana flesh was investigated. Of the four kinds of banana flesh extracts, the hexane extract (HE) had the highest total polyphenol content (2.54 ± 0.60 mg GAE/g) and total flavonoid content (1.69 ± 0.34 mg RE/g), followed by the chloroform fraction, total ethanol extract, and ethanol fraction. HE was found to exert a strong radical scavenging activity on 2,2-diphenyl-1-picrylhydrazyl (DPPH•) and 2,2′-azino-bis(3-

ethylbenzothiazoline-6-sulfonicacid) (ABTS•) free radicals (DaeKyeong *et al*., 2022).

Aqueous extraction of coffee pulps revealed a content of total polyphenols between 4.9 and 9.2 mg gallic acid equivalents (GAE)/g DM. The antioxidant capacity was between 51 and 92 µmol Trolox equivalents (TE)/g DM as measured by the assay with ABTS radical. Bourbon variety from Congo and maragogype variety showed highest caffeine contents with 6.5 and 6.8 mg/g DM. In all samples chlorogenic acid, protocatechuic acid, gallic acid and rutin were present. The beverage Cascara contained 226 mg/L of caffeine and 283 mg GAE/L of total polyphenols whereas antioxidant capacity amounted to 8.9 mmol TE/L. (Andrea *et.al*., 2017).

Total phenolic contents and antioxidant activities of pulp, seed and skin of 22 grape varieties (7 white and 15 red) grown in the Marmara region of Turkey were determined (common, registered or candidate cultivars). The total phenolic contents of grape pulp, seed and skin parts ranged from 9.26 to 62.29, from 162.29 to 326.18 and from 96.61 to 167.42 mg gallic acid equivalents/100 g fresh weight, respectively. Seasonal changes were noticeable in the total phenolic contents and antioxidant activities of different grape parts. The antioxidant activity of grape seeds of registered or candidate cultivars was the highest, followed by skins and pulps. The antioxidant activities of grape skins were higher in red varieties than in white varieties. The results indicated that registered and candidate red or white grape cultivars may have high amounts of phenolics and possess a superior antioxidant activity in comparison to popular cultivars, such as BilecikİrikarasI, Hamburg Misketi, Alfons and Isabella.(Yusuf I2015).

Antioxidant activity and total phenolic content of raw, cooked (by boiling, steaming, microwaving, marinating with vinegar, cooking with white wine, grilling, frying) and lyophilized pumpkin (*Cucurbita maxima* Duch.) pulp were evaluated to determine the impact of processing on its potential health benefits. Phenols were measured by using the Folin–Ciocalteu reagent with gallic acid as standard. Antioxidant capacities were measured by two different analytical assays for the evaluation of the free radical scavenging ability (DPPH test) and the ferric reducing antioxidant power (FRAP test). The processing conditions markedly increased total phenolic content and antioxidant properties of pumpkin pulp (Lrene *et.al*. 2013).

Phytochemical analyses of fruit peel extract demonstrated the presence of reducing agent such as steroids, flavonoids, polyphenolics, tannis, reducing sugar and amino acid compound (Singh *et al*., 2019).

In vitro studies, extracts and phytochemicals of *A. muricata* have been characterized as an antimicrobial, anti-inflammatory, anti-protozoan, antioxidant, insecticide, larvicide, and cytotoxic to tumor cells. In vivo studies of the crude extracts and isolated compounds of *A. muricata* were shown to possess anxiolytic, anti-stress, anti-inflammatory, contraceptive, anti-tumoral, antiulceric, wound healing, hepato-protective, anti-icteric and hypoglycemic activities (Ana *et al*., 2018).

Plants belonging to the genus *Opuntia* spp. are the most abundant of the Cactaceae family, grown throughout America and the Mediterranean central area. Its fruit, known as cactus pear or prickly pear, is an oval berry grouped in different colors. Some studies have shown its antioxidant activities which may help in preventing chronic pathologies such as diabetes. The purpose of the study was to evaluate the antioxidant capacity of three varieties of prickly pear juice (red-purple, white-green and

yellow-orange) in five different concentrations (100, 250, 500, 750, and 1000 mg/mL) by DPPH (1,1-diphenyl-2-picrylhydrazyl radical) colorimetric method, selecting the best variety to determine its anticlastogenic potential against methyl methane sulfonate (MMS). The results indicate that the highest antioxidant was found in the juice of the prickly pear red-purple variety (PPRP), in all concentrations. Its anticlastogenic potential was therefore evaluated with a micronucleus assay(Eduardo *et al*., 2013).

In Mexico black cherry (*Prunus serotina* Ehrh.) fruits are consumed fresh, dried or prepared in jam. Considering the evidence that has linked intake of fruits and vegetables rich in polyphenols to cardiovascular risk reduction, the aim of this study was to characterize the phenolic profile of black cherry fruits and to determine their antioxidant, vasorelaxant and antihypertensive effects. The results derived from this study indicate that black cherry fruits contain phenolic compounds which elicit significant antioxidant and antihypertensive effects. These findings suggest that these fruits might be considered as functional foods useful for the prevention and treatment of cardiovascular diseases (Yahia *et al.,* 2021).

The antioxidant activities of peel, pulp and seed fractions of 28 fruits commonly consumed in China were determined using the ferric reducing/antioxidant power assay (FRAP assay). The contribution of vitamin C to the antioxidant activity of fruit pulps was also calculated. The results showed that hawthorn pulp had the highest FRAP value among all fruit pulps and followed by date, guava, kiwifruit, purple mulberry, strawberry, white pomegranate, lukan and honey tangerine pulps and etc. Most of fruit peel and seed fractions were stronger than the pulp fractions in antioxidant activity based on their FRAP values. The contribution of vitamin C to the FRAP value of fruit pulps varied greatly from fruit to fruit as calculated. We concluded that peel and seed

fractions of some fruits, such as pomegranate peel, grape seed, hawthorn peel, longan and lychee seeds possessed relatively high antioxidant activity and might be rich sources of natural antioxidants (Jijun *et al*., 2003).

The antioxidant activity and the chemical composition of methanol extracts from peel and pulp belonging to two species of Tunisian prickly pears *Opuntia ficus indica* (spiny and thornless forms) and *Opuntia stricta* have been studied. The antioxidant capacity was measured by DPPH radical scavenging activity. The total phenolic compound (TPC) and the total flavonoid content were determined by the Folin–Ciocalteu method and colorimetric method, respectively. The phenolic compounds were identified and quantified by high-performance liquid chromatography (HPLC) coupled with an electrospray ionization mass spectrometry (ESI-MS). The results showed that *O. stricta* fruits present the best antioxidant activities than the two forms of *O. ficus indica*, while the TPC was more important in *O. ficus indica* than in the *O. stricta* fruits. The peels have higher flavonoids than pulp, and the thornless variety has more flavonoid than the spiny. The RP-HPLC and ESI-MS analysis detected two classes of phenolic compounds and betalain pigments. Isorhamnetin derivatives are the dominant flavonolglycoside identified in *O. ficus indica* (spiny: 65.25 $\mu g \cdot g^{-1}$; thornless: 77.03 $\mu g \cdot g^{-1}$) and *O. stricta* peels (19.22 $\mu g \cdot g^{-1}$) (Jamila *et.al*, 2014).

Fig is an important source of bioactive compounds and has been a typical component in the health-promoting Mediterranean diet for many centuries. This study was conducted to evaluate differences between phytochemical composition and antioxidant properties of juices of peel, pulp and total fruit of figs from three different varieties grown in Tunisia Mediterranean coast and corresponding to three different colors (green, purple and black) as well as the effect of maturation stage on the amounts

of phytochemical composition including total phenols content (TPC), total flavonoids content (TFC), total ortho-diphenols content (TOPC), total tannins content total (TTC) and total anthocyanins content (TAC). Antioxidant potential was assessed by two assays: 1,1-diphenyl-2-picrylhydrazyl (DPPH) scavenging capacity and reducing power (RP) and showed that different fig juices extracts exhibited the same antioxidant capacity in both systems tested and at different concentrations. Black peel juice acted as the greatest antioxidant by having the highest DPPH and RP activities followed by the juice of black fig total fruit. The antioxidant capacities observed were attributed to higher total phenolic, flavonoid and anthocyanin contents according to the chemometric results. Comparison of phytochemical composition of fig fruits during the development stage revealed a significant increase of TPC, TFC, TOPC, TTC and TAC in the ripe fruits of the three tested varieties.mThis is the first study comparing the phytochemical composition and antioxidant potential of juices of *Ficus carica* L. peels, pulps and total fruits (Amira, 2016).

The potential effects of the digestion process on antioxidant properties and individual phenolic compounds of two European gooseberries (*Ribes uva-crispa*): Tixia and Invicta were studied. Gooseberries were digested via an *in vitro* digestive model with active or heat-inactivated enzymes. Digested and undigested samples were subject to antioxidant assays including total phenolic content (TPC) assay, DPPH radical scavenging assay, and oxygen radical absorbance capacity (ORAC) assay. Furthermore, the individual phenolic compounds in gooseberries before and after digestion were extracted and determined. Results revealed that digestion enhances the availability of antioxidants in both gooseberries, where the digested fruits showed higher total phenolic content and antioxidant capacity. In addition, Tixia gooseberry possesses

higher antioxidant capacity than Invicta based on TPC, DPPH, and ORAC results. Eight phenolic antioxidants were identified and quantified in Tixia and Invicta gooseberries. Among the identified phonic compounds, only quercetin hydrate was significantly improved by digestion. Our findings indicate that digestion enhances TPC content and antioxidant activity in gooseberries (Jung *et al*., 2013).

Papaya (*Carica papaya* L.), a plant of medicinal and food value, is widely planted in tropical regions. This study was conducted to compare the tissues of different organs of papaya as well as the leaves and flowers of 9 cultivars of papaya. The three methods, namely, the 2,2'-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay, the 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) radical scavenging assay and the ferric reducing antioxidant power (FRAP) assay, were used to determine the total antioxidant activities. Also, the total phenolic content and the total flavonoid content were investigated to evaluate the antioxidant capacity. Our research shows that leaves and roots of papaya manifested higher antioxidant properties among all tested organs, and leaves and flowers of Daqing cultivar exhibited the strongest antioxidant ability. Overall, our results indicate papaya has the potential to become a natural antioxidant resource (Ruining *et al*., 2022).

Ripe and unripe exotic pepino fruit were evaluated for antioxidant activity, total phenols, and flavonoid content. The antioxidant potency was investigated by employing various established in vitro systems, such as 1,1-diphenyl-2-picrylhydrazyl (DPPH), 2-2'-azinobis(3-ethylbenthiazoline-6-sulphonic acid (ABTS), hydroxyl radical scavenging, reducing power, ferrous ion chelation, ferric reducing antioxidant power (FRAP), and lipid peroxidation. The EC(50) values of ripe ethanolic extract on DPPH

radical, reducing power, ferrous ion chelation, ABTS radical, FRAP, hydroxyl radical, lipid peroxidation (brain), and lipid peroxidation (liver) were obtained to be 2.20, 2.81, <5.00, 34.06, 8.53, 1.30, 1.75, and 0.51 mg/mL, respectively. However, the EC(50) values for unripe fruit extract were noted to be 3.75, 3.40, 11.25, 40.12, 9.75, 0.80, 1.91, and 0.63 mg/mL, respectively. Ripe fruit exhibited the highest values of antioxidant activity in all the scavenging assays except for hydroxyl radical scavenging assay. Ripe pepino had higher total phenol and flavonoid content than unripe fruit. This study suggests that possible mechanism of the biological activities may be due to free radical scavenging and antioxidant characteristics, which may be due to the presence of polyphenols in the fruit extracts (Sudha *et al*., 2012).

Persimmon (*Diospyros kaki)* exhibits potent antioxidant effects in DPPH, ABTS, reducing power, and FRAP methods of analysis. The levels of nutritional constituents showed significant differences among all the samples. In particular, tartaric acid, glucose, gallic acid, epicatechin gallate and aspartic acid were observed to be the predominant component for each of their general chemical groups, with total average contents of 1876.51 mg/kg, 62.69 g/kg, 12.73 mg/kg, 208.99 mg/kg, and 31.84 mg/100 g, respectively. Moreover, this location exhibited the greatest antioxidant activity with highest total phenolic (298.01 mg GAE/kg) and flavonoid (32.11 mg/kg RE) contents. Our results suggest that strong antioxidant activities of persimmons correlate with high phenolic acid and catechin contents, particularly gallic acid and epicatechin gallate. Additionally, these two compounds may be key factors when considering the useful ingredients of persimmon (Nazir *et al*., 2013).

Materials and Methods

MATERIALS AND METHODS

This chapter describes the plant samples, materials, chemicals and reagents used for the study. It also discusses the methods used for the evaluation of phytochemical screening, antioxidant activity and antibacterial properties of fruits of *Aegle marmelos, Psidium gujava* and *Phyllanthus emblica.*

Collection of samples

Based the medicinal properties and literature studies, three fruits namely *Aegle marmelos, Psidium gujava* and *Phyllanthus emblica* were selected for the present study. The fruits were shown in Plate 1. The fruits were bought from the fruit market in Thoothukudi.

Preparation of fruit powder

The fruits were washed in running tap water and wiped using blotting paper. The fruits were chopped into small pieces and kept in a petridish. The petridish was kept inside the Hot air oven for 12 hrs. The dried fruit pieces were powdered in a blender and stored separately for further studies. The powder is shown in Plate 1.

Preparation of extracts

Aqueous, methanol and ethnolic extract of *Aegle marmelos, Psidium gujava* and *Phyllanthus emblica* were prepared using cold extraction method as shown in Plate 2. The extracts were prepared by measuring 2 g of the fruit powder and placed in a conical flask and added with 20 ml of distilled water, methanol and ethanol in separate conical flasks. The flasks were left for 24 hrs and filtered to get the extract. The extracts were stored in the refrigerator for further studies.

Plate – 1

Aegle marmelos

Psidium gujava

Phyllanthus emblica

Fruit Powder

Aegle marmelos

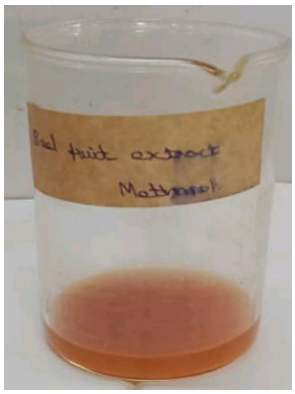
Psidium gujava

Phyllanthus emblica

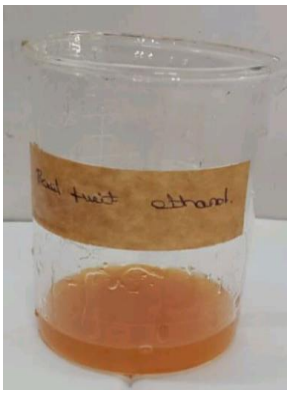
Plate 2

Fruit extract of *Aegle marmelos*

Aqueous



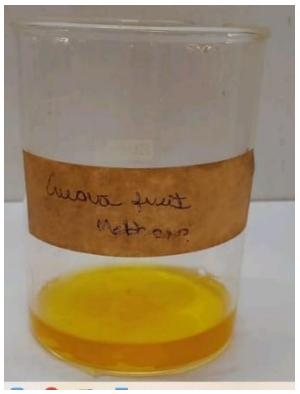
Methanol



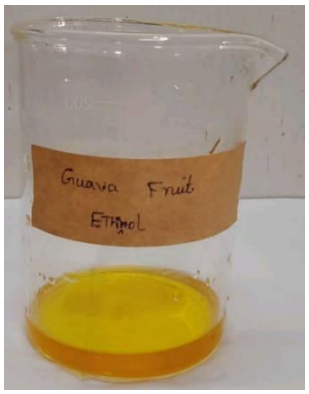
Ethanol

Fruit extract of *Psidium gujava*

Aqueous

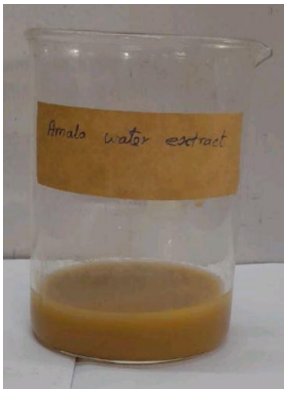


Methanol

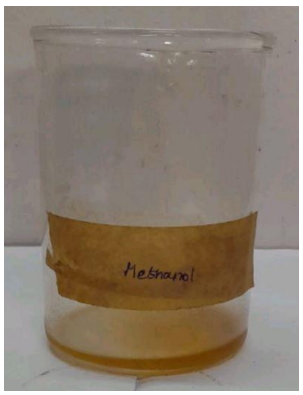


Ethanol

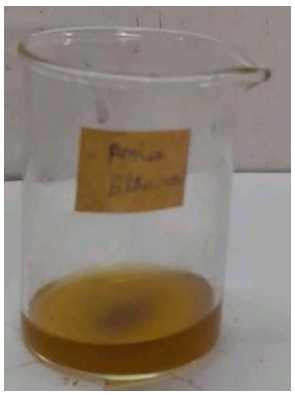
Fruit extract of *Phyllanthus emblica*



Aqueous



Methanol



Ethanol

Phytochemical Screening

All the qualitative estimations were done by referring to the methods followed by various other researchers (Tripathi *et al.*,2019)

1. **Test for Tannins:**

   2g of each sample extracted in water was added with 2 drops of 5% ferric chloride, the appearance of brown color confirmed the presence of tannins.

2. **Test for Phlobatannins**:

   2ml of each sample was taken in test tubes, added with deionized water and few drops of 1% HCl and then boiled up to 100˚C. The occurrence of red turbidity confirmed the presence of phlobatannins.

3. **Test for Saponins (Froth formation):**

   Saponin content was determined by boiling 1ml plant sample in 10ml deionized water for 15 min. and the extract was shaken vigorously after cooling to record the froth formation on the upper surface.

4. **Test for Terpenoids**:

   5ml of aqueous extract was added with 2ml chloroform and 3ml conc. sulfuric acid. The appearance of a red/brown interface confirmed the presence of terpenoids.

5. **Copper Acetate Test for Diterpenes**:

   The extracts were mixed with water and 3-4 drops of copper acetate solution. The occurrence of emerald green color gave a positive result.

6. **Salkowaski Test for Triterpenes**:

   Chloroform was added to the extracts and filtered. Few drops of conc. H2SO4 were added to the filtrates. The mixture was agitated and kept until it

became still. The golden yellow color of reaction mixture appeared due to the triterpenes.

7. **Test for Flavonoids**:

Samples were added with few drops of 1% NH3, yellow color observed which showed the presence of flavonoids. After this, aqueous extracts were added with 10ml DMSO, heated followed by adding magnesium chloride and finally, the appearance of red color on adding conc. HCl confirmed the presence of flavonoids.

8. **Test for Alkaloids:**

1ml of aqueous extract of each sample was added with 2- 3 drops of Wagner's reagent which gave orange-red precipitation as positive results.

9. **Test for Reducing Sugar:**

1g of each sample was added with 10ml deionized water and Fehling solution A and B. After heating at 100˚C on a water bath a brick red precipitate appeared due to the presence of reducing sugars.

10. **Xanthoproteic Test for Proteins**:

The extracts were added with few drops of Conc. HNO3. The yellow color precipitate appeared due to the presence of proteins.

11. **Legal's Test for Glycosides**:

Samples were added with 2% sodium nitroprusside, 20% sodium hydroxide and pyridine. The mixture turned into pinkish red color due to the presence of cardiac glycosides.

12. Test for Phenol (Lead acetate test):

About 1 ml of extract was taken and 0.5 ml of 1% lead acetate solution was added and the formation of precipitate indicated the presence of tannins and phenolic compounds.

DETERMINATIONOFANTIOXIDANTACTIVITIES

Free Radical Scavenging Assay (Horbone, 1984)

Requirements:

- DPPH
- Methanol

Procedure:

Free radical scavenging assay was measured by 2-2Diphenyl,l-picrylhydrazine(DPPH)method .1ml aliquot of test sample was added to 0.004% DPPH solution prepared in methanol. The mixture was vortexed for 1 minute and kept at room temperature for 30 minutes in darkness. The absorbance was read at 517nm. A low absorbance of the reaction mixture indicated a high free radical scavenging activity .Ascorbic acid is used as a standard.

$$\text{DPPH Scavenging activity (\%)} = \frac{A_{control} - A_{test}}{A_{control}} \times 100$$

A control is the absorbance of the DPPH solution without test solution. A test is the absorbance of DPPH with the test solution. Methanol was used as blank.

Ferric Ion Reducing Antioxidant Assay (Oyaizu, 1986)

Requirements:

- Phosphate buffer

- 10% TCA
- 0.l%Ferricchloride solution

Procedure:

1 ml of the test solution was mixed with 1 ml of phosphate buffer (0.2 M, pH6.6) and incubated at 50ºC in a water bath for a minute. The reaction was stopped by adding 1 ml of 10% TCA solution and then centrifuged at 5000rpm for l0 minutes .The supernatant (1.5 ml) was mixed with 1.5 ml of distilled water and 0.1 ml of 0.l%Ferric chloride solution and allowed to stand for 10 minutes. The absorbance was measured at 700 nm and higher absorbance indicates greater reducing power. Ascorbic acid was used as control.

Hydrogen Peroxide Scavenging Activity (Chandrika *et al.*, 2007)

Requirements:

- Phosphatebuffer
- H_2O_2
- Ascorbicacid

Procedure:

Samples were dissolved in 0.5 ml of 0.1 M phosphate buffer (pH 7.4), mixed with 0.5 ml of 20 mM H_2O_2 solution and measured at 230 nm. Ascorbic acid and phosphate buffer were used as positive and negative controls respectively .The activity was calculated according to the following equation:

$$H_2O_2 \text{ scavenging activity}(\%) = (1 - A_1/A_0) \times 100$$

Where A_1 is the absorbance of the test sample and A_0 is the absorbance of negative control.

ANTIBACTERIAL ASSAY

Bacterial cultures of *Bacillus subtilis* were obtained from our department and were used for evaluating antibacterial activity. The bacteria were maintained on nutrient broth at 37ºC in incubator.

Preparation of Inoculum:

The gram positive bacteria (*Bacillus subtilis*) and gram negative bacteria (*Escherichia coli*) were pre-cultured in nutrient broth overnight and incubated at 37ºC.

Disc Diffusion Method (Kirby *et al.*, 1986)

The antibacterial assay was done on human pathogenic bacteria such as *Bacillus subtilis, Escherichia coli* was studied by standard disc diffusion method. The cultures were spread on to nutrient agar plates using sterile cotton swabs. Sterile paper discs of 5 mm diameter with mushroom extract and standard antibiotic (Streptomycin 100 mg/ml) discs were placed over the inoculated plates followed by overnight incubation at 37ºC. The antibacterial activity was assigned by measuring the diameter of the zone of inhibition around the disc.

Results and Discussion

RESULTS AND DISCUSSION

This research work was done to compare the phytochemical screening, antioxidant and antibacterial activities of fruits of *Aegle marmelos, Psidium gujava* and *Phyllanthus emblica.* First of all, the bioactive compounds were evaluated for which phytochemical screening was done to check the presence/absence of many bioactive compounds. The second objective was to check and compare the antioxidant potential of different fruits using DPPH method, Hydrogen peroxide scavenging assay and FRAP assay. The third objective was to check and compare the antibacterial potential of fruits of *Aegle marmelos, Psidium gujava* and *Phyllanthus emblica* sequentially extracted in various solvents. In this chapter results of experiments performed for the fulfillment of the above mentioned objectives are discussed.

Phytochemical Screening.

In the present study, preliminary phytochemical screening of primary and secondary metabolites was done using various qualitative estimation methods and is represented in Table 1. Tannins, diterpenes, triterpenes, flavonoids, alkaloids, reducing sugar, protein glycosides and phenols are reported in all the extracts of the fruit of *Aegle marmelos*. Rajan *et al*., in 2011 screened the phytochemicals present in aqueous and alcoholic extracts of *A. marmelos* fruit pulp and confirmed the presence of many polar and nonpolar compounds viz. steroids, terpenoids, flavonoids, phenolic compounds, lignin, essential oil, inulin, proteins and carbohydrates. Alkaloids were present only in alcoholic extracts whereas Brijesh and co-workers in 2009 also screened the decoction of unripe *A. marmelos* fruit for the presence of phytochemicals and found that this decoction contained carbohydrates, glycosides, amino acids, proteins, tannins, flavonoids, and phytosterols.

Table 1: Preliminary Phytochemical Screening of selected fruits

S.No.	Name of the test	*Aegle marmelos*			*Psidium guajava*			*Phyllanthus emblica*		
		Aqueous	**Methanol**	**Ethanol**	**Aqueous**	**Methanol**	**Ethanol**	**Aqueous**	**Methanol**	**Ethanol**
1.	Tannins	+	+	+	+	-	+	-	-	-
2.	Phlobatannins	-	-	-	+	-	-	+	-	-
3.	Saponins	-	+	+	+	-	+	+	-	-
4.	Terpenoids	-	+	+	+	-	+	+	-	-
5.	Diterpenes	+	+	+	+	+	+	-	-	-
6.	Triterpenes	+	+	+	+	+	+	+	+	-
7.	Flavonoids	+	+	+	-	+	+	+	+	-
8.	Alkaloids	+	+	-	-	+	+	+	+	-
9.	Reducing Sugar	+	+	+	+	+	+	+	+	+
10.	Proteins	+	+	+	+	+	+	+	+	+
11.	Glycosides	+	+	+	+	-	-	+	+	-
12.	Phenol	+	+	+	+	-	+	+	-	+

(+) - indicates presence; (-) – indicates absence

In the present study, the preliminary phytochemical screening showed the presence of tannins, diterpenes, triterpenes, reducing sugar, protein glycosides and phenols in the aqueous extract of the fruit *Psidium guajava* whereas the flavonoids and alkaloids are reported in the alcoholic extracts. The ethanolic fruit extract of *P. guajava* contained sugars, flavonoids, phenols, alkaloids and coumarins. This is in confirmation to the work done by Sushmita *et al*., (2012), who found that the fruit contains sterols as well as flavonoids, triterpenoids, carbohydrates, oils, and alkaloids. The secondary metabolites significantly give the biological properties of medicinal plants for instance anti-oxidant, hypoglycemic, anti-microbial, anti-diabetic, anticarcinogenic, anti-inflammatory, anti-cholinergic, anti-malarial and anti-leprosy activities (Naseer et al., 2018).

The preliminary phytochemical screening of *Phyllanthus emblica* fruit extracts showed the presence of terpenoids, triterpenes, flavonoids, alkaloids, reducing sugar, protein, glycosides and phenols in the aqueous extract but few of them are absent in the alcoholic extracts. Mirunalini *et al* 2010 proved that the presence of phenols and alkaloids are attributed to their medicinal properties.

Antioxidant Activity

Scavenging of free radical is calculated in terms of percentage inhibition and with an increase in the concentration of sample extracts containing the antioxidative phytochemicals, the inhibition percentage of free radicals also increases. Higher the secondary metabolite content in the sample, a lesser concentration of it will be required to inhibit the 50 % amount of free radical.

Table 2: Free Radical Scavenging Assay of selected fruit extracts

Sample	Free Radical Scavenging Assay (%)		
	Aqueous	Methanol	Ethanol
Aegle marmelos	41.35	4.60	80.41
Psidium guajava	37.05	5.80	49.79
Phyllanthus emblica	2.98	7.19	4.79

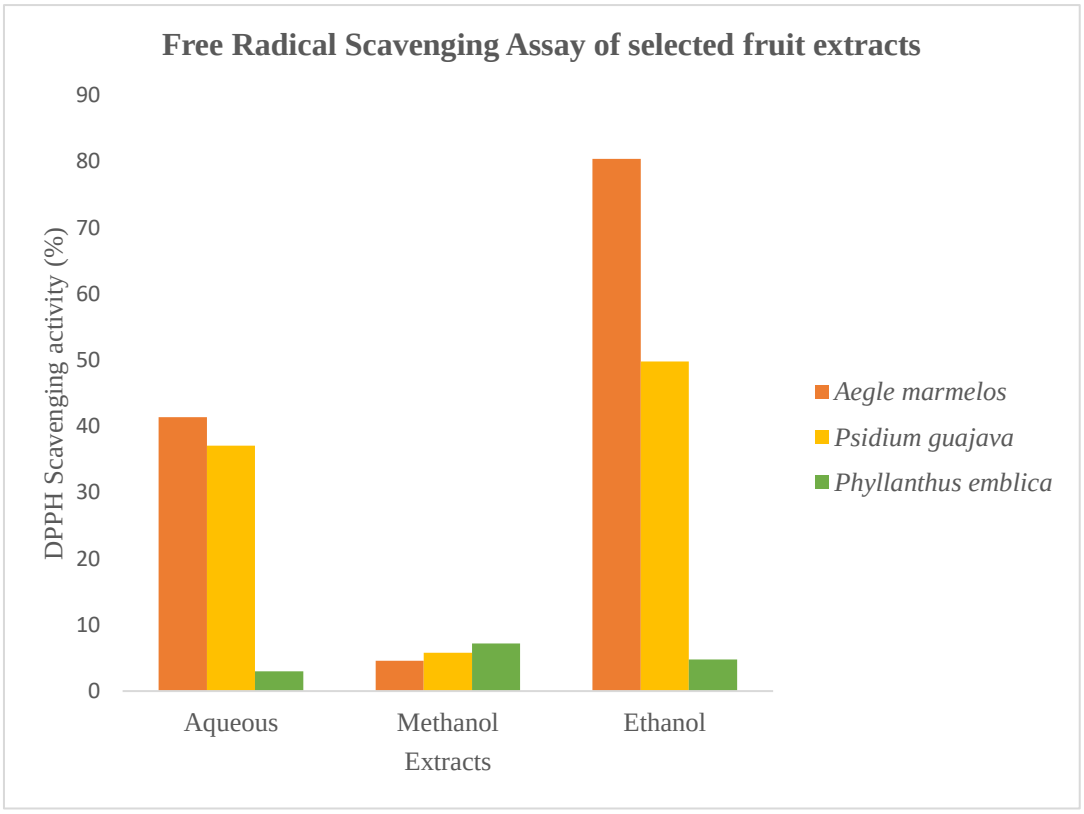


Figure 1: Free Radical Scavenging Assay of selected fruit extracts

Free Radical Scavenging Assay:

In DPPH method of free radical scavenging assay of the selected fruit extracts is shown in Table 2 and Figure 1. The highest inhibition activity is measured in the ethanolic extract for the fruit *Aegle marmelos* with 80.41% followed by the ethanolic extract of the fruit *Psidium guajava* with 49.75%. The least scavenging activity is measured in the aqueous extract of *Phyllanthus emblica* with 2.98%. This is due to its lesser efficiency to scavenge the free radicals, because a high concentration of the sample is required to scavenge 50% amount of the free radicals. A study done by Suvimol and Pranee in 2008, suggests that Thai Bael fruit pulps have higher total phenolic content and DPPH radical scavenging activity than other fruits and vegetables (Suvimol & Pranee, 2008). Fresh amla shows 81.42% antioxidant activity, whereas amla powder and amla candy have 59.2% and 77.75% antioxidant activity respectively. Rajpreet and Usha (2015) were also found almost similar trends in antioxidant activity in fresh amla, amla powder, and amla candy. Antioxidant activity was high in amla candy followed by fresh amla. The result obtained with the fruit extract of *Psidium guajava* may be concluded that guava is a fruit rich in bioactive compounds that might be used in various ways to offer to the population the possibility of preventing certain chronic diseases at low cost (Alothman, 2010).

Ferric Ion Reducing Antioxidant Assay:

In FRAP assay, a ferric tripyridyltriazine (Fe3+– TPTZ) complex converts into a colored ferrous tripyridyltriazine (Fe2+–TPTZ) and measures the reducing potential of an antioxidant reaction. The result of the assay is shown in Table 3 and Figure 2. The highest reducing power is noted in the ethanolic extracts of *Aegle marmelos*, *Psidium guajava* and *Phyllanthus emblica* with the absorbance of 0.940, 0.438 and 0.710 respectively.

Table 3: Ferric Ion Reducing Antioxidant Assay of selected fruit extracts

Sample	Ferric Ion Reducing Antioxidant Assay (OD)		
	Aqueous	Methanol	Ethanol
Aegle marmelos	0.151	0.710	0.940
Psidium guajava	0.257	0.238	0.483
Phyllanthus emblica	0.356	0.403	0.710

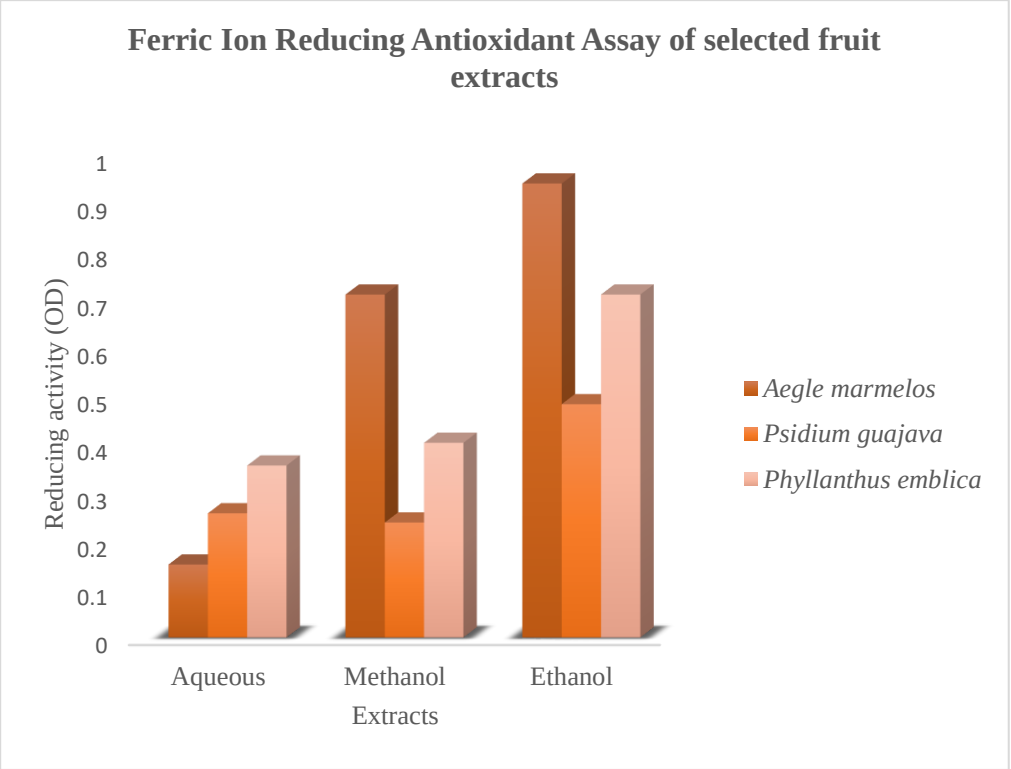


Figure 2: Ferric Ion Reducing Antioxidant Assay of selected fruit extracts

Karthika in 2016 studied *A. marmelos* fruit and leaves for their phytochemical composition and antioxidant activity and established a correlation between their bioactive principle and radical scavenging capacity (Karthika 2016). A study made on the wild fruits reducing power capacity was found to be higher extent in *P. emblica* followed by *Szygium* cumini, *P.guajava* and values were 318.01±0.969, 38.74±0.093, 35.87±0.41, respectively (Kelawala and Ananthanarayanan, 2004)

Hydrogen Peroxide Scavenging Activity

In the present study the hydrogen peroxide scavenging activity of the aqueous, methanol and ethanolic extracts of fruits of *A. marmelos, P.guajava* and *P. emblica* are shown in Table 4 and Figure 3. The highest activity is noted in the methanolic and ethanolic extracts of *P. emblica* fruit with the inhibitory percentage of 94.41 and 90.37 which is followed by the ethanolic extract of *P.guajava* and methanolic extract of *A. marmelos* with the inhibitory effect of 87.16% and 62.6%. Higher scavenging effect might be connected to its higher total phenolic content. Phenolic compounds have been proved to be responsible for the antioxidant activity of *P. emblica* fruit. (Nascimento *et al*., 2000). The phenolic compounds present may have acted as free radical scavengers by virtue of their hydrogen-donating ability, confirming scavenging ability of the extract (Chanda and Kaneria, 2011)

Antibacterial activity:

The knowledge of drug has developed together with the evolution of scientific and social progress. Drugs derived from medicinal plants are effective, easily available and less

Table 4: Hydrogen Peroxide Scavenging Activity of selected fruit extracts

Sample	Aqueous	Methanol	Ethanol
Aegle marmelos	41.2	62.6	0.489
Psidium guajava	49.8	38.35	87.16
Phyllanthus emblica	54.59	94.41	90.37

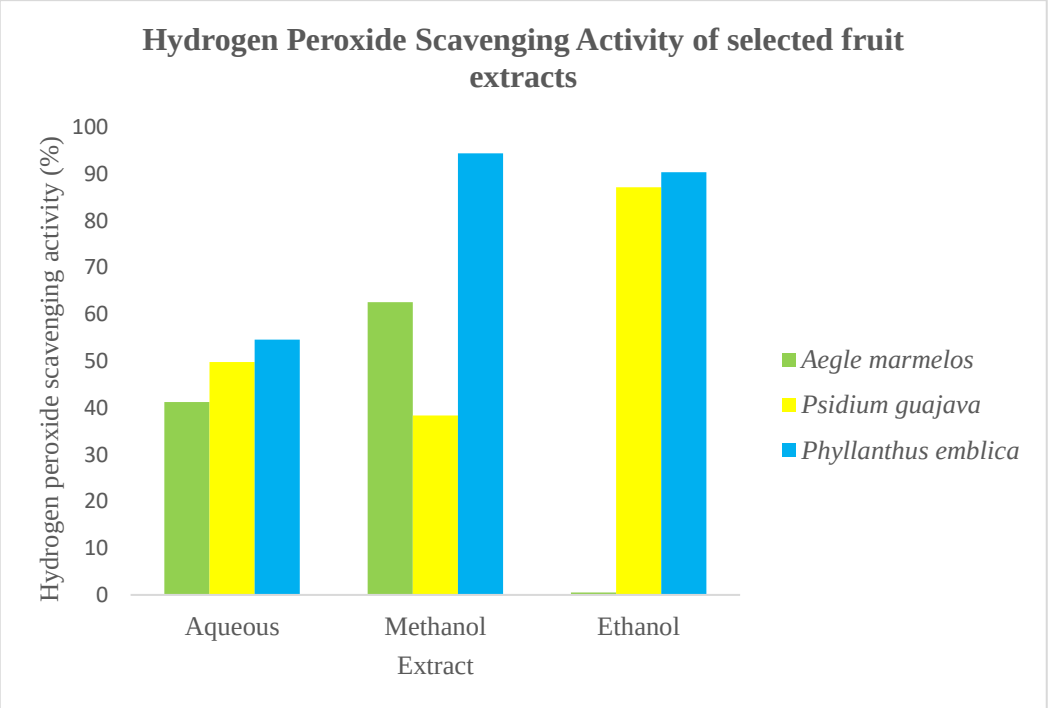


Figure 3: Hydrogen Peroxide Scavenging Activity of selected fruit extracts

expensive and rarely have side effects. Initial screening for the potential antibacterial and antifungal compounds from fruits may be performed by using the crude extracts. The most commonly used methods to determine antimicrobial susceptibility is the disc or agar well diffusion assay. The results of this study indicated that different parts of the plant significantly inhibited the growth of bacterial and fungal colonies with varying zones of inhibition possibly due to the presence of various bioactive compounds.

The antibacterial activity of the aqueous, methanol and ethanolic extracts of fruits of *A. marmelos, P.guajava* and *P. emblica* are shown in Table 5, Figure 4 and Plate 3. Minimal activity of the extracts are observed over all. Among this the methanolic extract of *Psidium gujava* shows good activity against *Bacillus subtilis* and *Eschericia coli.*

Parihar and Kumar in 2014 evaluated the antibacterial activity of *Aegle marmelos* fruit, leaf and stem extracted in methanol, water, and petroleum ether against *Escherichia coli, Bacillus subtilis* and *Salmonella typhi* by Agar well diffusion method. Fruit extracted in methanol was found to be the most sensitive and effective plant extract against the bacteria. Their study suggested that the plant is promising for the development of phytomedicine as it shows significant antimicrobial properties (Parihar and Kumar, 2014). In 2014, Ariharan and Nagendra Prasad concluded that the inhibitory activity of the plant extracts is due to the presence of phenolics (Ariharan and Prasad, 2014). Results found in this study were supported and/or opposed in the data reported in literature. Nascimento *et al.* conducted a study which supports the finding of the present study in which the guava extract was able to have inhibitory effects against *Staphylococcus* and *Bacillus* and no effect on the *Escherichia* and *Salmonella*,

Table 5: Antibacterial activity of selected fruit extracts

Extract	Zone of inhibition (mm)							
	Escherichia coli				*Bacillus subtilis*			
	Control	Aqueous	Methanol	Ethanol	Control	Aqueous	Methanol	Ethanol
Aegle marmelos	1.7	0.2	0	0	1.6	0.1	0	0.8
Psidium guajava	1.7	0	0.5	0	1.4	0.1	1.3	0
Phyllanthus emblica	0.3	0.2	0.1	0	0.7	1	0.2	0

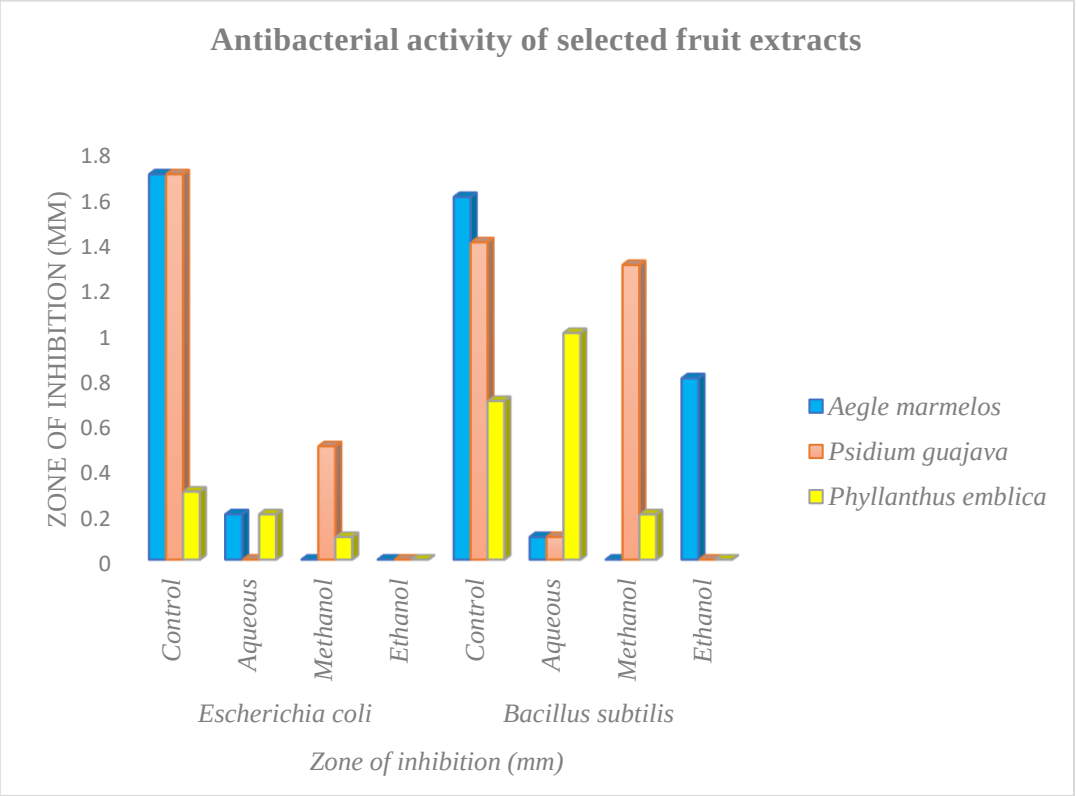


Figure 4: Antibacterial activity of selected fruit extracts

Plate 3

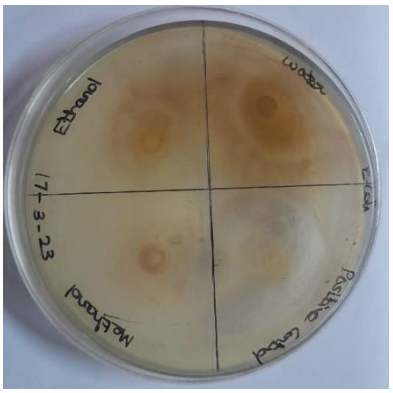
A. Antibacterial activity of *Aegle marmelos* fruit extracts

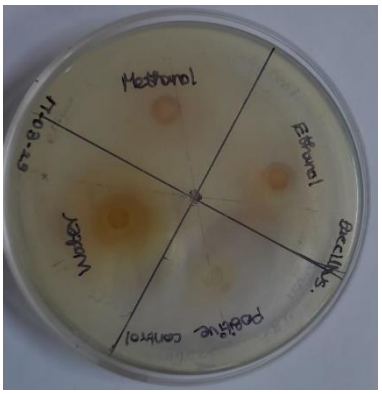
Escherichia coli ***Bacillus subtilis***

B. Antibacterial activity of *Psidium guajava* fruit extracts

Escherichia coli ***Bacillus subtilis***

C. Antibacterial activity of *Phyllanthus emblica* fruit extract





Escherichia coli ***Bacillus subtilis***

whereas Chanda and Kaneria oppose the findings concerning the Gram negative bacteria. However Vieira *et al*. 2001 found guava sprout extracts were effective against inhibiting *E. coli*. Aqueous infusion extract of P. *emblica* exhibited potent antimicrobial activity against *Enterobacter cloacae followed by Escherichia coli and Klebsiella pneumoniae.* Aqueous infusion and decoction of E. *officinalis exhibited strong antibacterial activity against E. coli, K. pneumoniae, K. ozaenaeProteus mirabilis, Pseudomonas aeruginosa, Salmonella typhi, S. paratyphi A, S. paratyphi B and Serratia marcescens* (Kumar *et al.,* 2011).

Summary and Conclusion

SUMMARY AND CONCLUSION

Fresh fruits of *Aegle marmelos, Psidium gujava* and *Phyllanthus emblica* were collected from the market and were extracted using aqueous, methanol and ethanol. The extracts were tested for the phytochemical screening, antioxidant and antibacterial activity.

The phytochemical analysis showed the presence of Tannins, diterpenes, triterpenes, flavonoids, alkaloids, reducing sugar, protein glycosides and phenols are reported in all the extracts of the fruit of *Aegle marmelos* and *Phyllanthus emlica.* In *Psidium gujava,* tannins, diterpenes, triterpenes, reducing sugar, protein glycosides and phenols were noted in the aqueous extract whereas the flavonoids and alkaloids are reported in the alcoholic extracts. The presence of alkaloids and flavonoids in these fruits helped them to obtain their medicinal values.

Three methods were used to analyse the antioxidant potential of these fruits. In the DPPH assay, The highest inhibition activity is measured in the ethanolic extract for the fruit *Aegle marmelos* with 80.41% followed by the ethanolic extract of the fruit *Psidium guajava* with 49.75%. The least scavenging activity is measured in the aqueous extract of *Phyllanthus emblica* with 2.98%. The least activity has the highest antioxidant capacity. In the ferric ion reducing antioxidant assay. The highest reducing power is noted in the ethanolic extracts of *Aegle marmelos*, *Psidium guajava* and *Phyllanthus emblica* with the absorbance of 0.940, 0.438 and 0.710 respectively. In the hydrogen peroxide scavenging assay, the highest activity is noted in the methanolic and ethanolic extracts of *P. emblica* fruit with the inhibitory percentage of 94.41 and 90.37 which is followed by the ethanolic extract of *P.guajava* and methanolic extract of *A.*

marmelos with the inhibitory effect of 87.16% and 62.6%. Thus it is shown that the aqueous and ethanolic extracts of *Phyllanthus emblica* shows high antioxidant activity. This can be attributed to their high medicinal value.

The antibacterial activity of these extracts showed limited activity against *Escherichia coli* and *Bacillus subtilis.*The methanolic extract of *Psidium gujava* shows good activity against Bacillus subtilis and *Eschericia coli.* Though the result was not consistent.

From the present study it is concluded that all the three selected fruits have quite an amount of primary and secondary metabolites as studied in the phytochemical screening. The antioxidant activity was high in the ethanolic extract of *Phyllanthus emblica* which was directly proposed to its medicinal value. The antibacterial activity was not very consistent but then, the higher activity was noted in *Psidium gujava.* This is a preliminary study in identifying the medicinal property of these fruits. Further study is needed to extract drugs from these fruits to make them as edible drugs.

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EXPLORATION OF FLORISTIC DIVERSITY IN VAGAIKULAM VILLAGE, THOOTHUKUDI DISTRICT

A Short – term project submitted to

ST.MARY'S COLLEGE (AUTONOMOUS)

Affiliated to

MANONMANIAM SUNDARANAR UNIVERSITY

in partial fulfilment of the requirements for the degree of

BACHELOR OF SCIENCE IN BOTANY

By

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2. J. MONISHA	**: 20AUBO26**
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DEPARTMENT OF BOTANY

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THOOTHUKUDI -628 001.

APRIL 2022-2023

CERTIFICATE

It is certified that this short-term project work entitled "**Exploration of Floristic Diversity in Vagaikulam Village, Thoothukudi District**" submitted to **St. Mary's College (Autonomous)** affiliated to **Manonmaniam Sundaranar University** in partial fulfilment of the requirements for the degree of Bachelor of Science in Botany, and is a record of work done in the Department of Botany, St. Mary's College (Autonomous), Thoothukudi during the year 2022-2023 by the following students.

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CONTENTS

INTRODUCTION

INTRODUCTION

The existence of life on this planet is greatly enhanced by few balancing factors of this Universe such as sun, earth, air, water and vegetation are playing together a greater role in Vegetation maintains the ecological balance on earth for wellbeing of human life. Ecosystem of a particular place is depending upon the land use practices and its careful management for future. In present situation of time it may be termed as crucial use of land cover of biodiversity which make it a serious issue for the study for economical and biological point of view. Ecosystem, which provides the life support system at earth to human beings is one of the part of biodiversity and working in favor of human, providing sustainable livelihood (Rai, 2012). Loss of ecosystem is directly affect the economic development and well as ecological economics, by altering the biological function such as environmental stimuli and gene knockdown. In present time it is a great challenge for world society because loss of biodiversity is directly affecting the climate change and it is essential to utilize the available forest produce in a sustainable way, otherwise it will be a cause of fast degradation of our environment (Singh et al., 2002; Rai, 2009; Rai and Lalramnaghinglova, 2010).

It has been observed that majority of the population of the world is badly affected due decrease in biodiversity. In a study it was found that in past one or two century, the extinction rate of plant species has increased by more than hundred times so the population of fauna is decreasing on this planet. The clever lives at this earth are rightfully and cruelly misusing the natural resources of earth surface which are changing unbelievable.

India is one of the 12 “mega-diversity” countries in the world and this country has a forest area of 23.81% of the country’s geographical area. Mankind has been utilizing plants for food and medicinal purpose since the time immemorial. Therefore various aspects of plants towards health, economic value, sustainable utility, their conservation, floral assessment and documentation are necessary. India is a rich center of plants diversity. Distribution of plants depends on their genetic makeup, various environmental factors like temperature, water and other edaphic factors (Curtis and Cottom, 1956; Phillips, 1959; Misra, 1968).

Plant diversity is the most important feature, which plays a vital role in complexity of natural ecosystems. Plant diversity deals with the enumeration of plant species growing in a particular region at a particular time. Its assessments are considered as the basic requirement to understand the current status of plant diversity. The structure, composition, and vegetative functions are most significant ecological attributes of a particular ecosystem, which show variations in response to environmental as well as anthropogenic variables (Shaheen et al., 2012). Major threats to ecosystems and biodiversity are loss of habitat, fragmentation, overexploitation, pollution, invasions of alien species, and global climate change (Gairola et al., 2008). The plant diversity is one of the most important component of terrestrial ecosystems, which plays a critical role in maintaining an area’s stability (Cunningham *et al.,* 2015). A diversified flora also helps in slopes stabilization, soil improvement, the buffering of weather extremes and the provision of habitat for wildlife (Pearse and Hipp, 2009). It becomes a major topic of concern in recent decades that how to conserve an environment on sustainable basis.

Moreover, it is the legitimate source of fundamental needs including food, medicine, and other products, as well as a growing public awareness of its importance in ensuring human well-being (Díaz, 2006; Hester and Brooker, 2007). In case of species diversity, the best indication is species richness which is highlighted by various environmental factors such as temperature, annual rainfall and soil composition (Khan *et al.,* 2016). Resultantly, it affects composition of plant communities and geographical distributionin an environment (Ullah *et al.,* 2015; Hussain *et al.,* 2019).

Variation in plant species and community structure along with the altitude and latitude is a well-established phenomenon which affects climate (Shaheen, 2012). It induces apparent threats and even permanent loss triggered through various elements including climate change, strong demographical growth and various anthropological activities such as urbanization, industrialization, overgrazing and deforestation (Baillie *et al.,* 2004). Deforestation along obscured vegetation caused ecological disruption, change in soil structure due to physical weathering, and rock denudation, ultimately become reason in floods and disrupted the structure of entire natural flora (Rahman *et al.,* 2016). This threat is particularly predominant in places where significant population and density exists, consequently it derives an increase in resource demand, and eventually appears as exploitation of available natural resources *viz.,* overgrazing, deforestation and overexploitation (Iqbal *et al.,* 2020; Malik *et al.,* 2016).

The study of plant diversity provides required knowledge about the various plant species regarding their nomenclature, distribution, utility and ecology. These

studies also aid in understanding fundamental biological concepts like speciation, isolation, endemism, and evolution. Plant diversity is the utmost value to basic research because the data generated through these studies are highly useful in ecological, biogeographic, taxonomic and evolutionary studies. Knowledge generated by these studies are utilized by a breadth of applied research fields including land management, forestry, conservation biology, ecology, and range science. It forms the basis for regional floras and systematic monographs.

SCOPE AND OBJECTIVES

SCOPE AND OBJECTIVES

India is a land of physical, cultural, social and linguistic diversity endowed by nature with enormous biological diversity. As a result, India consists of 17,000 flowering plant species and accounts for 8% of the global biodiversity with only 2.4% of the total land area in the world (Hajra and Mudgal, 1997; Reddy, 2008). Biodiversity is a part of our daily lives and livelihood and constitutes the resources upon which families, communities, nations and future generations depend. Human society from the very beginning of its appearance on this earth has been indispensably associated with the plant kingdom for its survival (Elizabeth and Dowdeswell, 1995; Kumar and Singh, 2013).

Due to large scale anthropogenic disturbances in the form of exclusive agricultural practices, industrialization, livestock feed, fuel-wood collection and forest fires, the floral diversity of our nation is facing threats of extinction, which will eventually lead to losses of genetic diversity. This is much needed to defend this valuable wealth for the interests of our own and of upcoming generations. Detailed studies are required for every habitat for proper documentation of species diversity. a number of studies have been undertaken in different parts of the India as well as in abroad (Yadav et al., 2004; Das and Das, 2005; Reif, 2006; Kamal-Uddin et al., 2009; Qureshi and Bhatti, 2010; Yadav et al., 2010; Qureshi et al., 2011; Khatun et al., 2013; Yadav and Bhandoria, 2013; Kaur et al., 2016; Kaur et al., 2017). For a detailed and near to complete assessment, smaller areas provide better outputs as they can be thoroughly investigated. Keeping in view the aspects, a study of the existing plant diversity of

Vagaikulam village, Thoothukudi India has been conducted. A thorough literature survey also reveals that there is no such a survey on plant diversity in Vagaikulam village. Hence the present study has been undertaken with the following objectives:

- To systematically explore the floral diversity of the study area.
- To provide a short description of the collected taxa.
- To document the diversity of medicinal plants in the study area by interviewing local peoples.
- To find out the edible taxa available in the study area.

AREA OF STUDY

AREA OF STUDY

Vagaikulam is a small village in Thoothukudi district in Tamil Nadu, India. It is in between the cities Tirunelveli and Tuticorin in Tamil Nadu. The village is noted for its domestic airport, which started functioning from April 2006. Already the Highway NH-7A run between Tuticorin and Tirunelveli has been widened by two additional lanes. The extension of highways goes up to Kanyakumari and Thiruvananthapuram, Kerala. This is done to manage the increasing amount of cargo movements from Tuticorin port to various locations. The area between Tirunelveli and Tuticorin has been increasingly industrialized, and especially Vagaikulam has become an ICD (Inner cargo container terminals) point. (thehindu.com). The maximum temperature ranges from 27^{o}C to 30^{o}C and minimum temperature ranges from 20^{o} C to 23^{o}C. The average rainfall is 30.3 mm per year.

Figure 1a: Study Area- Vagaikulam village

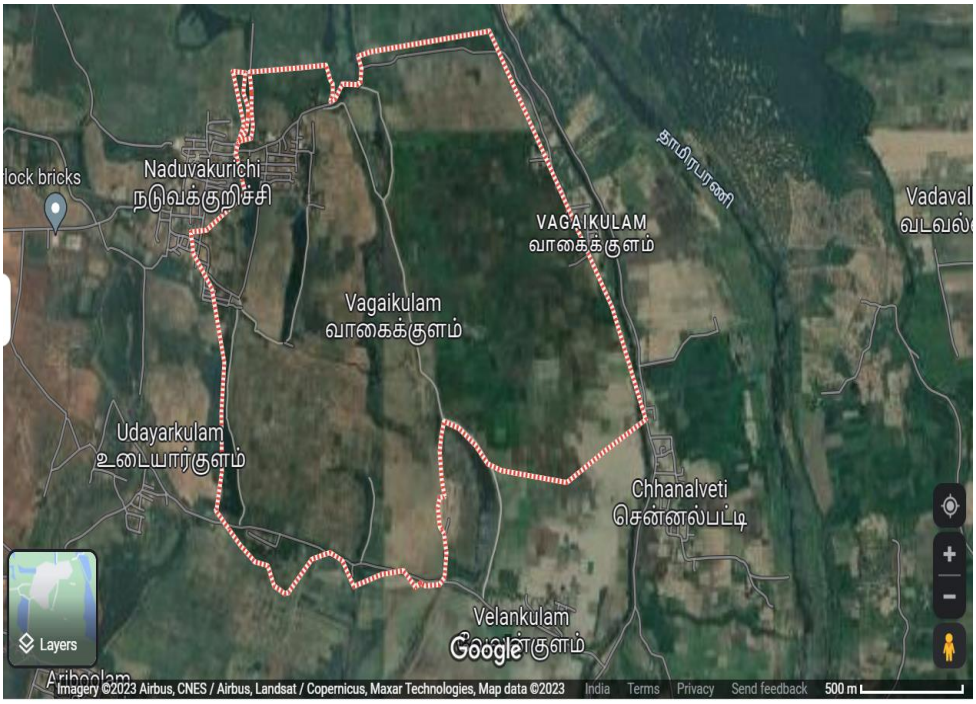

Figure 1b: Google map of Vagaikulam village

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Biodiversity brings enormous benefits to mankind from direct harvesting of plants and animals for food, medicine, fuel construction material, and other uses to aesthetic, cultural, recreational and research values. Benefits of ecosystem include climate and water regulation; the creation and protection of soils, helping to reduce floods and soil erosion, shoreline protection, providing natural controls of agricultural pests and promote creative evolution. People have been using medicinal plants from time immemorial for the treatment of various types of disease traditionally. Traditional medicinal plants use in India is about 4000 years old. Herbs had been used by all cultures throughout history. It was an integral part of the development. About 80% of the people in developing countries use traditional medicines for their health care Ghosh, (2003). In less developed/developing countries 80% of the people still rely only on traditional medicine obtained from local plants and 85% of traditional medicine involve the use of plant extracts (Farnsworth *et al.,* 1985). Since adequate hospital facilities and allopathic doctors are absent in much of the tropics, any destruction of tropical forests would concomitantly destroy the primary healthcare network involving local plants and traditional 'doctor' (Balick, 1996). About 90% of medicinal plants used in industries are collected from the wild. Over 70% of the plant collection involves destructive harvesting because of the use of the parts like roots, bark, wood, stem and the whole plant in case of herbs. The assessments done so far for the prioritized native medicinal species have resulted in the assignment of threatened status to nearly 200 plant species (Ved *et al.,* 2005). In view of the tremendously growing world population, increasing anthropogenic activities, rapidly eroding natural ecosystem etc. The natural habitat for a great number of herbs and

trees are dwindling. Many of them are facing extinction. According to the Red list of threatened species 44 plant species are critically endangered, 113 endangered and 87 vulnerable in India alone (McNeely *et al.,* 2005).

Study of Floral diversity in India:

Singh and Pandey (1980) have recorded medicinal plants loss of the tribes of Rajasthan. These medicinal plants belong to 104 genera and 54 families. Information about these 125 plant species were gathered and documented from locals including vaids, herbalists and forest officials in tribal areas. Medicinal folk recipes were also documented.

Maya *et al*. (2002) worked on plant patterns in river channels of Kerala. An eco taxonomic study was undertaken to determine the floristic composition of the Chittar river. Chittar River, in selected transects. During the study the plants recorded fall under 4 divisions, 50 families, 78 genera and 81 species. Of these 18 species noted as large trees, 24 species as aquatic and the rest are as bank species.

Chauhan (2003) worked on important medicinal and aromatic plants of Himachal Pradesh. Himachal Pradesh situated in the lap of the Western Himalayas is considered a veritable emporium of medicinal and aromatic plants having diverse agro-climatic condition. Out of around 3500 species more than more than 1000 species have been documented as medicinal and aromatic for the state.

Das *et al.* (2009) conducted an ethno-medicinal survey of plants in Tripura state and revealed some less known medicinal plants have been used by the indigenous tribes. He enumerated the valid scientific name, family, local name, habit,

dosages and traditional formulation of 33 species belonging 32 genera and 25 families.

Shiragavae (2015) surveyed total 57 valuable plant species belonging to 36 families in Gadhinglaj region by collecting the information from the experienced medicinal practitioners.

An ethnobotanical survey was conducted by Sharma *et al*. (2015) to document the traditional of medicinal plants that are used by the local communities residing in Himachal Pradesh. About 25 different plant species were recorded which were used for their medicinal values and for other remedial purposes by the local inhabitants.

Floristic Diversity in Tamil Nadu

State of Tamil Nadu is endowed with a variety of flora such as those existing in costal zones, forests in plains, and in hills at mid elevation, high elevation flora as in the Nilgiris, the upper Palanis and the Anamalai. It is also interesting that in some districts such as Tirnunelveli there are floristic elements associated with sea coast, dry thorny type, dry deciduous to the higher elevation flora. Tamilnadu has 42 forest types (Champion and Seth, 1968). Matthew (1983) had enumerated from Tamilnadu carnatic region about 2260 species of flowering plants under 983 genera and173 families and likewise 111 species from 59 genera and 33 families in pteridophytes and Gymnosperms withll species belonging to 9 genera and 5 families. Gamble and Fischer (1915-1935) has enumerated 4,516 species in the then Madras presidency.

Coastal areas are highly dynamic and undergoing rapid change. The knowledge of land use/land cover change is very important to understand the natural resources, their utilization, conservation and management. Land use is obviously

constrained by environmental factors such as soil characteristics, climate, topography and vegetations. But, it also reflects the land as a key and finite resource for most human activities including agriculture, industry, forestry, energy, production, settlement, recreation and water catchments and storage. Many studies have been reported on the quantitative plant biodiversity and inventories of various forests of Tamil Nadu (Sukumar *et al*., 1992; Ganesh *et al*., 1996; Ghate *et al*., 1997; Parthasarathy and Karthikeyan,1997; Parthasarathy,1999; Ayyappan and Parthasarathy, 1999) and on the coromandal coast (Muthuramkumar *et.al*., 2006)

An oral care medicinal plants survey was conducted by Ganesan (2008) in different districts of Tamil Nadu. A total of 114 plants species distributed among 97 genera belonging to 51 families were recorded. Most of the plants are used to relieve toothache (29.82%), as toothbrush (25.43%), mouthwash/gargle (16.66%), against common dental diseases (14.03%), mouth related stomatitis /ulcer/gingivitis (12.28%) and gum bleeding/disorders (10.53%).

Sindhu *et al.* (2012) have undertaken a survey to highlight the efficiency of some potential medicinal plants occur in Chennimalai hills, Erode district. They documented 50 medicinal plants were spread over 27 families and among which 6 plants belong to monocots and one (*Actinopteris dichotoma*) belongs to Pteridophyte which are frequently used by the local villagers for minor ailments such as boils, cuts, wounds, diarrhoea, head-ache, jaundice, skin infection and general debility.

Sivasankari *et al.* (2013) recorded the medicinal plants of Uthapuram Village, Madurai district, Tamilnadu, South India for the first time and the usage of these medicinal plants to remediate the diseases among the peoples.

The survey of medicinal plants was done at Egalnatham Krishnagiri district, Tamil Nadu, India, 32 important medicinal plants were observed and listed in this study. The plants were reported with its common/ Vernacular name, morphology of parts used, family and its medicine/ Commercial properties (Madhankumar and. Murugesan, 2016).

Ethnobotanical survey was conducted to collection of medicinal plants used by local people at Vadachennimalai Hill, Salem district of Tamil Nadu, India. In this study 70 medicinal plant species of 61 genera belonging to 36 families are discussed. Medicinal plants used by local people in Vadachennimalai have been listed along with plant parts used with its ethnomedicinal significance (Anand *et al.,* 2016).

The floristic study was undertaken by Ravi *et al.* (2016) to enumerate the floristic composition of Veddhagiri hills, the Southern Western Ghats of Erode district.

Kuralarasi *et al.* (2017) studied the Flora of Arunachalapuram Village, Virudhunagar District, Tamil Nadu and they listed 143 plants species systematically which counts including indigenous cultivated and naturalized plants. Among which 124 plants belong to Dicotyledons and 19 plants belong to Monocotyledons. These 143 plants belong to 45 families. The Family Poaceae (Gramineae) has representatives with a maximum 15 members in Arunachalapuram village.

Previous Exploration in Thoothukudi District

Muthukumar and Samuel (2010) conducted direct interview among local communities and fishery communities Tuticorin District, Tamil Nadu and listed a total of 41 medicinal plants and their popular uses.

Muthukumar and Samuel (2011) studied Coastal sand dune flora in the Thoothukudi District, Tamil Nadu, southern India and identified total of 42 species belonging to 38 genera and 26 families at different distances from the shoreline.

An ethno-medicinal plant survey was carried out in Srivaikundam village of Tuticorin District, Tamilnadu to discover the kinds of herbal remedies used by the local populations. It resulted in about 41 medicinal plants for the treatment of several diseases either in single or in combination with some other ingredients. The information on correct botanical identities with family, local name and traditional practice of 41 plant species belonging to 28 families are discussed for the treatment of various illnesses (Rama Rajan and Muthu Kumarasamy, 2012).

Sheela *et al.* (2016) conducted an intensive exploration in Thoothukudi district giving importance to sedges which form major constituent of wetland ecosystem. They have done floristic survey of Cyperaceae and to record field data on habit, habitat, distribution status and phenology and recorded 53 species belonging to 15 genera, of which 13 taxa are economically valuable and five are medicinally important.

MATERIALS AND METHODS

MATERIALS AND METHODS

The source of materials for this work was the periodical collection of plant specimens, from Vagaikulam, Thoothukudi district. Field trips were undertaken to three months to study the floristic diversity.

The specimens were collected and processed and mounted following customary methods (Fosberg and Sachet, 1964). Field data has been noted in the field diary. Specimens were identified using Gamble's Flora of presidency of Madras (1997), Matthew's flora of Tamil Nadu Carnatic (1983). The identified specimens were described briefly. The medicinal uses of identified plants and edible plants were determined by interviewing local people.

Description of the plants from the study area:

1. Botanical name: *Abutilon indicum* G.Don.

Family: Malvaceae

Vernacular name: Tutthi

Description:

An erect woody herb. Stem with smooth close tomentum. Leaves usually cordate and long petioled, dentate. Flowers solitary, on axillary cls, yellow; involucral bracteoles 0. Calyx 5, valvate sepals. Corolla 5, imbricate petals, adnate below to the stamina tube. Stamens numerous, free above. Carpels 10-20, stigmas small, capitates. Ripe carpels ultimately separating from the central axis, dehiscent, 1-5 seeded, acte. Seeds minutely furrowed, glabrous.

2. Botanical Name : *Acalypa hispida* Burm.F.

Family : Euphorbiaceae

Vernacular Name : Cat's tail

Description :

shrubs 2-4 m tall. Stipules persistent, ovate to elliptic, c. 8 by 13 mm, midrib hairy, without capitate trichomes. Leaves alternate, 12-25 x 9-18 cm, ovate to elliptic, chartaceous; base slightly cordate to obtuse, margin serrate to deeply crenate with a gland on tooth tip, apex acute to acuminate, surface; 3 ribbed at base, lateral nerves 5-8 pairs; petiole 10-15 cm long. Inflorescences axillary, 1 per axil, spicate, straight, densely flowered, rachises usually hidden by flowers; peduncle 17-30 mm long. Pistillate flowers c. 1 mm diameter; 4-6 per node; bracts sessile, 0.5-1 by 0.5-1 mm, hairy outside, entire, apex acute. Calyx ca. 1 mm diameter, sepals (3 or) 4, ovate to elliptic, c. 0.5 by 0.3 mm, hairy outside. Ovary globose to oblate, trilocular; stigmas

3, 5-8 mm long, each divided 6-16 times, smooth. Bisexual flowers and fruits unknown

3. Botanical name: *Acalypha indica* L.

Family: Euphorbiaceae

Vernacular name: Kuppaimeni

Description :

Annual herb. Leaves . Leaves alternate, flowers monoecious, male parts minute, followed by a tuft female flowers , the bracts generally leafy, male of 4 minute valvtemembrabous lobes, at first combined. Petals 0. Disk 0, stamens many, often 8, on a convex receptacle; filaments short, free. Ovary 3 celled ovule solitary in each cell. Fruit a small capsule of 3 small , 2 valved, crustaceous cocci. Seeds subglobose; testa crustaceous; albumen fleshy; cotyledons flat.

***4. Achyranthes aspera* L.**

Family: Amaranthaceae

Vernacular name : Nayuruvi

Description :

Herbs. Leaves opposite, entire. Petaloid. Flowers hermaphrodite, slender simple and panicled spikes; bracts membranous, spinescent, persistent; bracteoles 2, spinescent. Stamens 2-5 filaments. Staminides which are toothed lacerate; anthers 2 celled. Ovary oblong, subcompressed 1-celled; ovule solitary; style filifirm; stigma. Capitellate. Fruit an oblong. Seed inverse, oblong; embryo annular, surrounding the album.

5. Botanical name :*Adhatoda vasica* N.

Family: Acanthaceae

Vernacular name : Adhatodai

Description :

A dense shrub with a foetid scent. Leaves entire. Flowers subsessile, bracts herbaceous, bracteoles similar but usually narrower. Calyx 5-partie, the lobes imbricate, the 2 lowest often subconnate. Corolla-tube short. Stamens 2, near to the top of the corolla-tube; anthers 2 celled, the cells minutely apiculate at base. Ovary 2-celled; ovules in each cell; style filiform; stigma entire. Fruit clavate capsule. Seeds 1 or 2, suborbicular, compressed, rugos

6. Botanical name :*Aerva lanta* Forsk.

Family: Amaranthaceae

Vernacular name : Pongapoo

Description :

Erect, alternate flowers hermaphrodite, small, in simple, bracts and 2 bracteoles small. Perianth calycine, membranous, 5- rarely 4-lobed; pubescent above and white-wolly beneath up to 1 in. Stamens 5, rarely 4; anther 2 celled. Ovary ovoid 1-celled, ovule pendulous from a long basal funicle; style simple; stigma capitellate. Fruit a membranous utricle. Seed inverse; testa coriaceous; embryo annular, surrounding the floury albumen.

7. Botanical name *: Aloe vera* L.

Family: Liliaceae

Vernacular name : Katthalai

Description :

Aloe vera is a stemless or very short- stemmed plant growing to 60-100 cm tall, spearheading by offsets. Leaves are thick and fleshy, green, the margin of the leaf is serrated and has small white teeth. The flowers produced in summer on a spike up to 90 cm tall, each flower being pendulous, with a yellow tubular corolla 2-3 cm long.

8. **Botanical name : *Amaranthus viridis* L.**

Family: Amaranthaceae

Vernacular name : Kuppai – kirai

Description :

Erect, annual herb; leaves alternate. Flowers small, monoecious, in axillary clusters or dense terminal thyrsoid panicles ; bracts herbaceous, persistent ; bracteoles 2 perianth cycline. Stamens 2-5 , as many as the perianth lobes; filaments free; anthers 2 celled. Ovary ovoid, compressesd, ovule solitary, erect, style short; stigma 2-3. Fruits ovoid; seed orbicular, compressed.

9. **Botanical name *:Anisomeles malabarica* R.Br.**

Family: Lamiaceae

Vernacular name : Pyimarutti

Description :

Erect , branching coarse shrubby herb , densely white woody , often very aromatic, the stems usually tetragonous. Leaves opposite ; flowers are pale purple colour and it is used in medicine, flowers in axillary whorls with short spikes ; bracts linear , calyx ovoid , straight , equally 5- lobed . Corolla 2-liped . Stamens 4 , didynamous , exserted , the lower pair longer; anthers of upper pair 2-celled. Disk equal ovary 4-parite; style slender.

10. Botanical name: *Annona squamosa* L.

Family: Annonaceae

Vernacular name: Sitha maram

Description:

Trees. Leaves obtuse, 2-3 in long – glaucous beneath, flowers greenish solitary, leaf opposed; sepals 3, small, valvate, petals 3, valvate, the inner whorl

wanting; stamens numerous; anther cells narrow, dorsal, contiguous. Ovaries many, subconnate; style oblong; ovule L, erect . fruit green many- celled, ovoid or globose many – seeded.

11. Botanical Name : *Aristida adscencioinis* L.

Family : Poaceae

Vernacular Name : Needle Grass

Description :

An annual or short-lived perennial, tufted xerophilous grass . Aristida adscensionis varies widely in its morphology . The culms are thin, erect or geniculate, stiff, simple or branching at the lower nodes, yellow to bright green in colour, becoming straw coloured . The leaves are linear, narrow, up to 20 cm long . The inflorescences are panicles, up to 30 cm long, more often dense and narrow but sometimes lax and flexuous . The seed-heads are purplish with spikelets densely clustered on the branches. The spikelets are covered with three unequal, scabrous and 1-2.5 cm long awns, hence the American name six-weeks three awns or six-weeks triple-awn .The seeds are very sharp .

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12.Botanical Name : *Artocarpus altillis* (Parkinson) Fosberg

Family : Moraceae

Vernacular Name : Breadfruit

Description:

An evergreen tree that reaches a height of 15-20 m. The trunk ranges between 60 and 120 cm in diameter and produces branches above 4 m from its base. The bark is smooth. The crown is conical in shape in the first years of growth and becomes more rounded with maturity. The leaves are alternate, dark green and smooth on their upper side, and lighter green with reddish hairy veins on the underside. They are very variable in shape, ranging from obovate to ovate entire lobs to clear pinnate dissected lobs. They are about 45 cm long but can range from 15 to 90 cm depending on variety. Artocarpus altilis is monoecious and bears male and female flowers on the same tree. Male flowers are borne on club-shaped spikes that can be as long as 45 cm. Female inflorescences are globose clusters of about 1500-2000 small flowers. Once pollinated, the flowers develop into a spherical to cylindrical, honeycombed, smooth to rough-skinned, fruit of 10 to 30 cm in diameter and 0.25 to 6 kg in weight. It has a yellow to green rind and a starchy creamy white to yellow pulp (starch content about 20%). Fruits may or may not contain seeds, depending on the variety.

13.Botanical Name : *Asparagus racemosus* W.

Family : Lilliaceae

Vernacular Name : Satawari

Description :

Satawari is a scandent, much-branched, spinous under-shrub with tuberous roots. The roots are fascicled, fleshy, spindle-shaped, light ash-coloured externally and white internally, more or less smooth when fresh, but on drying, develop longitudinal wrinkles and lack any well-marked odour. Branches are modified into cladodes with long basal decurved spines. Flowers are white, fragrant, and minute, about 3 mm long and occur in solitary or fascicled, 2.5–5 cm long, racemes. Fruit is a three-lobed, red coloured berry, up to 6 mm in diameter, with mottled seeds and oily endosperm. Flowering and fruiting occur in December–January.

14.Botanical Name : *Barleria prionitis* L.

Family : Acanthaceae

Vernacular Name : Cemmuli

Description:

Prionitis is a small, erect, spiny shrub, up to 1.8 m tall with spines in lower leaf axils, branched. Stems and branches terete, smooth, lenticellate, glabrous. Petiole 1-2.5 cm; leaf blade elliptic to ovate, 4-10.5 × 1.8-5.5 cm, both surfaces pubescent when young but soon glabrescent, sparsely strigose along midvein, base attenuate and decurrent onto petiole, margin entire, apex acute. Flowers clustered in axils of upper leaves and/or bracts; bracts linear-oblong, 1.2-2.2 × 0.2-0.8 cm, margin ciliate, apex abruptly acuminate; bracteoles linear-lanceolate, to 1.4 × 0.2 cm, spine-tipped.

15.Botanical Name : *Bauhinia purpurea* L.

Family : Fabaceae

Vernacular Name : Kalavilaichi

Description:

A small to medium-size deciduous tree growing to 17 feet (5.2 m) tall. The leaves are 10–20 centimetres (3.9–7.9 in) long and broad, rounded, and bilobed at the base and apex. The flowers are conspicuous, pink, and fragrant, with five petals. The fruit is a pod 30 centimetres (12 in) long, containing 12 to 16 seeds. Leaves are alternate.

16.Botanical Name : *Biophytum poterioides* Edgew. Ex. Hook. F

Family : Oxalidaceae

Vernacular Name : Red Little Plant

Description:

Red Little Tree Plant Annuals, stem slender, up to 15 cm long. Flowers are long-styled. Petals are inverted-lance shaped, 8-10 x 4-5 mm, tip flat, limb brick red-flame or pink. Shorter stamens 2 mm long, hairless; the longer 3.5 mm long, finely velvet-hairy. Sepals are lanceshaped or narrowly lanceshaped, 4-4.5 x 0.75-1 mm, half as long as flower, 6-nerved, longer than capsules, glandular hairy outside, hairless within. Style is 0.25-2.8 mm long; stigma flattened, rounded toothed-bifid. Flower-cluster-stalk 1.5-5 cm long, bristlyly hairy, eglandular. Bracts ovate, 2.5-3 mm long, bristlyly hairy, intermingled with a few glandular hairs, tip tapering. Flower-stalks 1.5-2 mm long, hairless or occasionally with 1-5 glandular trichomes. Leaves are 4-15 jugate, axis slightly winged, 2.8-9.5 cm long, sparsely patently bristly and septately glandular hairy. Leaflets are often overlapping, 3-10 x 4-5 mm, last one obovate, oblique, midrib eccentric; others oblong, lateral nerves 10-15 pairs, oblique to midribs, inprominent. Fruits are 4-4.5 x 3-3.5 mm, apically fringed with hairs on

the ribs. Red Little Tree Plant is endemic to Tamil Nadu. It usually grows in waste lands and wet arable land at elevations of 100-400 m.

17. Botanical name: *Boerhaavia diffusa* L.

Family: Nyctaginaceae

Vernacular name : Caranai

Description:

A diffuse herb with stout rootstock and many erect or procumbent branches, the flowers red, leaves thick, in unequal pairs. Ovate oblong or sub orbicular, acute or obtuse, rounded or subcordate at base , 9 labrous above, white beneath, somewhat undulate on the margin, up to 2 in long, 1-25 in broad, petiole slender up to 1 in long, nerves 3-4 pairs. The fruit viscid .

18.**Botanical Name : *Bryonia cretica* L.**

Family : Cucurbitaceae

Vernacular Name : Ivirali

Description :

Bryony's light yellow, malodorous root grows as fat as a beet and can weigh as much as 2.5 kg. The plant's rough-haired stalks grow up to 4 m long and grasp hedges and fences with spiralling, unbranched, creeping tendrils. The stemmed, short-bristled leaves pentafid or palmate beyond the middle are entire or bluntly toothed on the margins. Each leaf stands opposite a tendril.The red bryony is dioecious (two-housed) greenish-white and grouped in long-stemmed clusters, while the somewhat smaller, light green female plants sit in tufts resembling calyces in the leaf axils. The thin-skinned, spherical, scarlet red, poisonous berries develop in the Fall. The berries of the black-berried white bryony are black when ripe, whereas the black bryony has red berries, too.

19.Botanical Name : *Caesalpinia pulcherrima* SW.

Family : Fabaceae

Vernacular Name : Mayulkonrai

Description:

A shrub growing to 3 m tall. The leaves are bipinnate, 20-40 cm long, bearing three to 10 pairs of pinnae, each with six to 10 pairs of leaflets 15-25 mm long and 10-15 mm broad. It is sometimes called Dwarf Poinciana due to the resemblance of its flowers and leaves to those of Gulmohar. They are botanically related but Peacock flower plant grows only to a height of about 3 meters, retains its leaves throughout the year, and blooms continuously. Flowers, which appear in clusters on long erect stems, are smaller than those of Gulmohar and have exceptionally long stamens and a prominent pistil which protrudes from the center. The most common color is red-orange, but one variety has pure yellow flowers. It can be easily propagated by seeds.

20. Botanical name : *Calotropis gigantean* R.Br.

Family: Asclepidaceae

Vernacular Name : Erukku

Description:

Large erect milky shrubs, very pale in colour. The bark. Leaves opposite, decasite, broad. Flowers medium- sized, in umbellate. Calyx 5-loped, glandular. Corolla scales 5, fleshy. Stamens inserted at the base of the corolla; anthers short, broad, pollen-masses solitary, flattened; ovary of 2 distinct carpels. Fruit of 2 large, inflated, fleshy, thick follicular mericarps,seeds ovate, the broad apex surrounded long slender silky hairs.

21.Botanical Name : *Cassia alata* L.

Family : Fabaceae

Vernacular Name : Cimaiyakatti

Description :

The shrub stands 3–4 metres tall, with leaves 50–80 centimetres (20–31 in) long.The leaves close In the dark.The inflorescence looks like a yellow candle.The fruit, shaped like a straight pod, is up to 25 cm long. Its seeds are distributed by water or animals.The seed pods are nearly straight, dark brown or nearly black, about 15 centimetres (5.9 in) long, and 15 millimetres (0.59 in) wide. On both sides of the pods is a wing that runs the length of the pod. Pods contain 50 to 60 flattened, triangular seeds.

22. Botanical name: *Cassia auriculata* L.

Family: Fabaceae

Vernacular name: Avarai

Description:

Shrubs. Leaves abruptly pinnate, flowers bright yellow, often large and showy, terminal panicles; calyx-tube very short; lobes 5, imbricate. Stipules are auricle shaped hence its name. Petals 5, stamens 10, ovary stalked, many-ovuled; style incurved; stigma terminal, truncate, sometimes ciliolate. Seeds transverse, compressed, albuminous.

23. Botanical name : *Cassia covessi* A. Gray

Family: Fabaceae

Description:

Grows to 30–60 cm tall, and is leafless most of the year. The leaves are pinnate, 3–7 cm long, with two or three pairs of leaflets (no terminal leaflet); the

leaflets are elliptical, 1.0-2.5 cm long. The flowers are yellow in color, with five rounded petals about 12 mm long.

24. Botanical name : *Cathranthus roseus* G.Don.

Family: Apocynaceae

Vernacular name : Nithya kalyani

Description:

Herbs. Leaves opposite, rarely alternate, entire; stipules 0. Flowers regular, hermaphrodhite, axillary cymes; bracts small. Calyx inferior; lobes 5, imbricate; often with glands within at the base. Corolla usually salyer shaped or funnel shaped; lobes 5, rarely 4,contorted and often twisted in bud. Stamens 5, rarely 4,alternate with the corolla lobes inserted in the corolla tube; filaments short; anthers linear oblong. Disk 0.Ovary 1 celled with 2 parietal placentas with axile placentas, ovules 2,style simple, stigma bifid. Fruit a dry fleshy drupe, seeds various, often compressed, albumen hard, embryo straight; cotyledons flat, radical superior.

25. Botanical Name : *Celosia argentea* L.

Family : Amaranthaceae

Vernacular Name : Pannai Keerai

Description:

Silver cockscombs are erect, branching plants, 60-75 cm tall, with narrow-elliptic or lance-shaped, strongly veined leaves 5-15 cm long, and hundreds of tiny flowers packed in dense spikes of silver-white flowers which usually stand above the foliage. They are beautiful plants with soft, dense feathery spikes, produced in profusion. Wonderful straw-like flower when dried. It offers fresh shape and colour to cut flower, or everlasting flower arrangements, with 10-13 cm flower spikes on 60 cm

stems. Slender, cylindrical pink or rose flowerheads have a metallic sheen because the individual flowers are silvery-white at their bases.

26. Botanical name : *Celosia cristata* L.

Family: Amaranthaceae

Vernacular name : Kozhi poo

Description :

Herbs, annual. Leaves alternate. Flowers hermaphrodite, in terminal, interrupted -spike,sessile pedicelled , coloured ; bracts and bracteoles scarious, shinning; stamens 5; filaments slender , connate below in a membranous hypogynous cup; anthers 2- celled; ovary 1- celled, ovoid ;ovules 2; stigma simple. Fruit utricle dehiscing in circumscissle fashion near the middle, membranous, seeds 2 erect , lenticular.

27. Botanical Name : *Centratherum punctatum* Cass.

Family : Asteraceae

Vernacular Name : Kattuchiragam

Description:

An erect perennial herbaceous species, up to about 70 cm tall, with pubescent cylindrical stem that ramifies in the upper part. The leaves, on short winged petiole, are simple, alternate, ovate to lanceolate with toothed margins and pointed apex, 2-8 cm long and 0,8-4 cm broad, dotted of tiny transparent glands, aromatic when crumpled.The typical inflorescences of the Asteraceae, terminal, solitary, sessile, sub-globose, of about 3,5 cm of diameter, formed by 30-60 hermaphroditic tubulose flowers (flosculous) inserted on a flat discoid base, the receptacle, surrounded by a hemispherical involucre, of 1-2 cm of diameter, formed by 30-50 bracts, the outer ones, 1-2 cm long, are foliaceous and curved, the inner ones, 0,6 cm

long, scarious (membranous) and spinescent. Imbutiform corolla of lavender to purple colour, 0,8-1,4 cm long, with cylindrical tube and 5 linear lobes with pointed apex, about 3 mm long.The fruits are achenes (or, better, cypselae) of pale brown colour, linear, striped, 1-2,5 mm long provided of caducous pappus formed by filiform scales of pale yellow colour, 1-3 mm long, that facilitate its dispersion through the wind.

28. Botanical name : *Chloris barbata* SW.

Family: Poaceae

Vernacular name : Railpullu

Description:

Perennial, rarely annual, erect herbs. Leaves usually flat, some times complicate. Inflorescence of solitary, racemosely arranged spikes, erect or stellately spearding. Spikelets sessile, unilateral, 2 seriate, not joined on the rhachis, with 1-4 perfect florets and 1-3 imperfect above; rhachilla articulated above the glumes, prolonged beyond the upper perfect floret and bearing 1-3 empty lemmas above. Glumes 2, membranous, unequal, persistent, narrow,1- nerved, keeled, mucronate. Lemmas 3 nerved, acute, obtuse, 2 fid, usually awned; paleas 2 nerved, 2 keeled, containing a bisexual floret. Lodicules 2, minute. Stamens 3. Styles 2, free.Grain linear- oblong or ellipsoid, compressed, free within the lemma and palea; often with a loose pericarp.

29. Botanical name: *Cissus quadrangularis* L.

Family: Vitaceae

Vernacular name: pyrandai

Description:

Shrubs; stems 4 –winged, fleshy, contracted at the nodes; flowers hermaphrodite, petals 4 induplicate- valvate, stamens 4, filaments slender, ovary 2-

celled, with 2 ovules in each cell; style subulate; stigma small . fruit 1- seeded, a fleshy berry, seeds ellipsoid albumen with 3 vertical lobes; cotyledons reniform, sometime 3, radicles rather large, style short. Fruit a compressed, ovoid orbicular, seed inverse, lenticular; testa crustaceous; embryo annular.

30. Botanical Name : *Citrus limetta* L.

Family : Rutaceae

Vernacular Name : Sathukudi

Description:

A small tree up to 8 m (26 ft) in height, with irregular branches and relatively smooth, brownish-grey bark. It has numerous thorns, 15–75 mm (0.59–2.95 in) long. The petioles are narrowly but distinctly winged, and are 8–29 mm (0.31–1.14 in) long. Leaves are compound, with acuminate leaflets 50–170 mm (2.0–6.7 in) long and 28–89 mm (1.1–3.5 in) wide. Flowers are white, 20–30 mm (0.79–1.18 in) wide. Fruits are oval and green, ripening to yellow, with greenish pulp. The pith is white and about 5 mm (0.20 in) thick. Despite the name sweet lime, the fruit is more similar to a greenish orange in appearance.

31. Botanical nam :*Cleome viscosa* L.

Family: Capparidaceae

Vernacular name: Naikkaduku

Description:

Herbs. Leaves digitately 3-5 foliolate. Flowers solitary and axillary, yellow, sepals 4, petals 4, ascending, imbricate in the bud. Stamens 6-20, inserted on the disk. Ovary sessile or shortly stalked; style short or 0; ovules many on 2 parietal placentas. Capsule oblong or linear, valves 2, deciduous and leaving the seeds

attached to the placentas. Seeds reniform. Whole plant viscous with stalked glanda; ovary densely glandular, sessile; capsule thinly glandular.

32. Botanical Name : *Clerodendrum Speciosum*

Family : Verbenaceae

Vernacular Name : Red Bleeding Heart

Description:

Red Bleeding Heart is an artificial hybrid of the Bleeding-Heart vine, producing ovate leaves and racemes of rosy-red flowers which fade to rosy-rust, and remain on the vine for some time. It is an evergreen, frost-tender shrub or climber up to around 3 m tall with heart-shaped, dark green, deeply-veined leaves. The plant blooms with clusters of glorious scarlet flowers surrounded by pink and scarlet calyxes and bracts.

33.Botanical name: *Clitoria ternatea* L.

Family: Fabaceae

Vernacular name: Sangu poo

Description:

Herbs, climbing. Leaves pinnate, 3-many foliolate; stipules persistent, small, subulate flowers showy, axillary, solitary; bracts persistent, stipule-like; bracteoles large. Calyx membranous, tubular. The 2 upper teeth sub connate. Corolla much exserted. Stamens diadelphous; anther uniform ovary stipitate, many ovuled; style elongate, incurved, bearded along the inner side. Pod linear-oblong, flattened, many- seeded seeds sub-globose or compressed; strophiole 0.

34. Botanical Name : *Coleus amboinicus* L.

Family : Lamiaceae

Vernacular Name : Karpooravali

Description:

It grows up to 1 m (3.3 ft) tall. The stem is fleshy, about 30–90 cm (12–35 in), either with long rigid hairs (hispidly villous) or densely covered with soft, short and erect hairs (tomentose). Old stems are smooth .Leaves are 5–7 cm (2.0–2.8 in) by 4–6 cm (1.6–2.4 in), fleshy, undivided (simple), broad, egg/oval-shaped with a tapering tip (ovate). The margins are coarsely crenate to dentate-crenate except in the base. They are thickly studded with hairs (pubescent), with the lower surface possessing the most numerous glandular hairs, giving a frosted appearance. The petiole is 2–4.5 cm (0.79–1.77 in). The aroma of the leaves can be described as a pungent combination of the aromas of oregano, thyme, and turpentine.[5] The taste of the leaves is described as being similar to the one of oregano, but with a sharp mint-like flavor.[6]Flowers are on a short stem (shortly pedicelled), pale purplish, in dense 10-20 (or more) flowered dense whorls (cymes), at distant intervals, in a long slender spike-like raceme. Rachis 10–20 cm (3.9–7.9 in), fleshy and pubescent. The bracts are broadly ovate, 3–4 cm (1.2–1.6 in) long, acute. The calyx is campanulate, 2–4 mm (0.079–0.157 in) long, hirsute and glandular, subequally 5-toothed, upper tooth broadly ovate-oblong, obtuse, abruptly acute, lateral and lower teeth acute. Corolla blue, curved and declinate, 8–12 mm (0.31–0.47 in) long, tube 3–4 mm (0.12–0.16 in) long. Trumpet-like widened; limb 2-lipped, upper lip short, erect, puberulent, lower lip long, concave. Filaments are fused below into a tube around the style.The seeds (nutlets) are smooth, pale-brown, roundish flattened, c. 0.7 by 0.5 mm .

35. Botanical Name : *Coleus plectranthus* Lour.

Family : Lamiaceae

Vernacular Name : Karpooravali

Description:

Inflorescence: Raceme Flower Color: Blue or pink/ Purple/Lavender/ WhiteOften 2-lipped in racemes

36. Botanical Name : *Croton bonplandians* Baill.

Family : Euphorbiaceae

Vernacular Name : Aathuppoondu

Description:

Herbs, young parts stellate-pubescent and viscous glandular. Leaves 2-5 x 1-2 cm, ovate-lanceolate, base attenuate, margin faintly serrulate, apex gradually acute, densely stellate scaly on both sides when young, sparsely so below and glabrous above on ageing; petiole to 1.5 cm long. Racemes to 10 cm long; pedicels glandular on either side. Male flowers 3-4 mm across; perianth 2-seriate, greenish-white, outer c. 1 mm long, inner c. 2 mm long; stamens many. Female flowers few, towards base, 2.5-3 mm across; perianth 1-seriate, lobes 5; ovary subglobose, tomentose; style short; stigma 3, each forked to form 6 lobes. Capsule 5-6 mm across, ovoid, warty. Seeds 3, globose, caranculate.

37. Botanical name *: Dactyloctenium aegyptium* B.

Family: Poaceae

Vernacular name : Kakka-kalpul

Description:

An annual herb, with wiry stems, that bend and root at the lower nodes, with tips that may rise to about 2 ft in height. It is a very common weed of open spaces and wasteland. Leaves are typically grass-like,2-30 cm long, 2-9 mm wide, with blades and sheaths that are without hair. Leaf margins have long, stiff hairs. Flowers arise in 1-7 spikes, 1-6.2 cm long, 3-7 mm wide, at the tip of stems.

38. Botanical name *: Datura metel* L.

Family: Solanaceae

Vernacular name : Oomatham poo

Description :

Shrubby herbs , leaves large , entire deeply toothed . Flowers large , white , solitary , erect, calyx long –tubular herbaceous, 5 lobed , corolla long tubular , funnel- shaped , the mouth wide. Stamens 5 , attached near the base of the tube ; filaments filiform ; anthers longitudinally dehiscing. Ovary 2; style filiform ; stigma 2-lobed . Fruit an ellipsoid spinescent 4-celled capsule , 4 valved . Seeds many , compressed, rugose; embryo peripheric.

39. Botanical Name: *Euphorbia heterophylla* L.

Family: Euphorbiaceae

Vernacular Name: Paal perukki

Description:

An annual herbs, glabrous to pilose. Leaves alternate below, opposite above, 4-12 x 0.3-7 cm, broadly ovate, elliptic, obovate, or panduriform, rarely linear, glabrous or pilose, margins entire to coarsely serrate, apex acute, short-acuminate, or short-cuspidate, base rounded to cuneate, green, sometimes floral leaves white or with splotches of purple at base, never red; petioles 1-4 cm long; stipules absent or minute and gland-like. Cyathia in dense terminal cymes; involucre 2-2.5 mm high, glabrous, gland 1, cup-shaped with a circular opening, without an appendage; staminate flowers numerous. Capsules subglobose, 3-4 mm long, glabrous; seeds dark brownish gray to black, sometimes mottled, truncate-ovoid, angled, 2-2.5 mm long, coarsely tuberculate, ecarunculate.

40. Botanical name : *Euphorbia hirta* L.

Family: Euphorbiaceae

Vernacular name : Ammanpatchaiyarissi

Description :

Herbs. Leaves alternate, entire. Flowers monoecious, combined in an inflorescence of many male flowers surrounding a solitary female and accompanied by many bracteolets; stamen in male florets solitary, the filament jointed on a pedicel. Anther 2-celled, erect the cells usually sub globose, opening longitudinally, ovule solitary in each cell; styles 3, free, fruit a capsule, dehiscing ventrally, seeds albuminous; cotyledons flat; radical superior.

41. Botanical Name **:** *Euphorbia milli* Des Moul.

Family **:** Euphorbiaceae

Vernacular Name **:** Christ plant

Description:

It is a succulent shrub growing to 1.8 cm tall with densely spiny stems. The straight slendon spines upto 3cm long help it scramble over other plants.

42. Botanical Name **:** *Euphorbia tirucalli* L.

Family **:** Euphorbiaceae

Vernacular Name **: K*odi kalli, Tiru-kalli***

Description:

Shrubs; branchlets terete, succulent, articulated. Leaves deciduous, 5-10 mm long, linear-oblong, base cuneate, apex obtuse to subacute. Cyathia clustered in the forks of the branchlets, shortly pedicelled, mostly female. Involucre campanulate; glands 3-5, transversely oval, peltate, lobes short, hairy; appendage 0. Male florets

bracteolate, bracteoles laciniate at tip. Styles short, recurved, 2-lobed. Capsule 5 mm, globose, cocci compressed, velvety. Seeds ovoid, smooth.

43. Botanical Name :*Evolvulus alsinoides*

Family: Convolvulaceae

Vernacular name: Vishnukranthi

Description:

This is a very slender, more or less branched, spreading or ascending, usually extremely hairy herb. The stems are 20-70 cm long, and not twining. The leaves, which are densely clothed with appressed, white, and silky hairs, are variable clothed, lanceolate to ovate, and usually 0.5-1 cm in length (but may be larger); the apex is blunt with a little point and the base is pointed. The flowers are pale blue and 6-8 mm in diameter. The fruit (capsule) is rounded, and usually contains 4 seeds.

44. Botanical name: *Gompherna serrata L.*

Family: Amaranthaceae

Description:

A perennial herb, prostrate, 20-50 cm tall, rooting at lower nodes and internodes, usually forming a dense mat. Plant is green to dark green. Leaves are elliptic to oblong-obovate, pointed at tip, velvet-hairy on upper surface. Flower-spikes are snow-white, spherical, elongating to a cylinder up to 2.5 cm long.

45. Botanical name: *Gossypium arboreum* L.

Family: Malvaceae

Vernacular name: Kattuparuthi

Description:

Shrub up to 3 m tall, extremely variable, most parts densely covered with minute stellate hairs and patent simple hairs, nearly all parts irregularly dotted with

black oil glands; twigs slender, terete. Leaves spirally arranged; stipules linear to lanceolate, often falcate, 4–15 mm long, caducous; petiole 1–14 cm long; blade ovate to orbicular in outline, 2–12 cm in diameter, palmately lobed or parted with 3–7 segments, frequently with an extra tooth in the sinuses, base cordate, lobes ovate to narrowly lanceolate, apex acute or acuminate, sometimes obtuse, margin entire, pedately 5–9-veined, nectaries usually inconspicious or absent. Flowers solitary, usually on sympodial branches; pedicel 0.5–6 cm long not articulated, usually without apical nectaries; epicalyx segments (bracteoles) 3, closely embracing the corolla and fruit, rarely spreading, united for 1 cm or more, 1.5–3.5 cm × 1.5–3 cm, slightly accrescent in fruit, base deeply cordate, apex acute, margin entire or remotely toothed, glabrous inside, hairy outside, persistent; calyx cupular, 5–12 mm long, truncate to inconspicuously 5-dentate, glabrous; corolla at opening usually cream to yellow and after 1–2 days turning red or purple, with or without a purplish centre, petals 5, imbricate, obovate, 2.5–4.5 cm long; stamens numerous, forming a column 1.5–2 cm long, filaments 1.5–4 mm long, anthers 1-celled; pistil with 3–5-celled ovary and one short style with clavate, 3–5-sulcate stigma. Fruit (‘boll’) an globose, ovoid or elongate capsule 1.5–2.5 cm in diameter, beak 3–5 mm long, opening loculicidally, after dehiscing and splitting often reflexed, outside densely pitted and glabrous, 3 (–4)-celled with 5–8 seeds per cell. Seeds ovoid to globular, 5–8 mm in diameter, with a copious covering of fairly long, white or rusty, woolly hairs (lint or floss) firmly attached to the seed, and also with a fine, short tomentum (fuzz). Seedling with epigeal germination.

46. Botanical name: ***Helliconia psittacorum*** L.f

Family: Heliconiaceae

Description:

A small herb. Leaves : Smaller, narrow-lanceolate leaves. Inflorescence and Flowers : Inflorescence on long stalk, bracts orange, pointed, flower greenish yellow. Significance : Ornamental plant.

47. Botanical name: *Hibiscus rosa-sinensis* L.

Family: Malvaceae

Vernacular name: Sembaruthi

Description:

Herbs, shrubs or rarely trees. Leaves stipulate, uaually palmately lobed. Flowers axillary, Bracteoles 4-12 . Calyx 5-lobed , valvate. Petals 5, connate at the base and adunate to the stamina tube. Staminal tube truncate. Ovary 5- celled; Ovules 3 or more in each cell; styles 5, connate below; stigmas usually capitate. Capsule loculicidally 5- valved, 5 celled. Seeds reniform globose, glabrous velvety cottony or scaly.

48. Botanical name : *Indigofera tinctoria* L.

Family: Fabaceae

Vernacular name : avuri

Description

An erect shrub, 50-100 cm tall. Leaves are compound, 2.5-11 cm long, with 9-13 leaflets. Leaf-stalk 1.3-2.5 cm; stipels mi-nute; leaflet-stalks about 2 mm; leaflet blades opposite, obovate-oblong to obovate, 1.5-3 x 0.5-1.5 cm, both surfaces with appressed medifixed trichomes, above sometimes hairless, base broadly wedge-shaped to rounded, tip rounded to notched. Flowers are borne in ra-cemes 2.5-5 cm, laxly flowered; flower-cluster-stalk absent; bracts bristlelike, 1-1.5 mm. Flower-stalks are 4-5 mm, reflexed in fruit. Calyx is about 1.5 mm, with trichomes; teeth

triangu-lar, as long as tube. Flowers are red; standard broadly obovate, 4-5 mm, outside with brown trichomes; wings about 4 mm; keel as long as wings. Stamens 4-5 mm; anthers heart-shaped. Ovary hairless. Pods are linear, deflexed and straight to semicircular but never sickle shaped, 2.5-3 cm, hairy or hairless; endocarp purplish red blotched. Seeds are 5-12 per legume, cubic, about 1.5 mm.

49. Botanical name : *Ipomea carnea* Jacq.

Family: Convolvulaceae

Vernacular name : Neyvelik

Description:

Prostarte herbs. Leaves alternate. Flowers axillary, solitary, bracts various. Calyx of 5 equal sepas, often enlarge in fruit. Corolla campanulate funnal shaped, the limp plicate, very slightly lobed. Stamens 5 usually included; filaments filiform ovary 2. Seeds usually 4, glabrous velvety; cotyledons crumpled, bilobed.

50. Botanical Name : *Ixora coccinea* L.

Family: Rubiaceae

Vernacular Name: Idly poo

Description:

It is a branched shrub, up to 1 m tall; branches hairless. Leaves are mostly stalkless, opposite deccussate, 4-8 x 1.5-6.5 cm, entire, apiculate, blunt or with a short sharp point, 8-15 pairs at lateral nerves, hairless; stipules triangular, cuspidate or awned. Flowers are borne at branch-ends, in dense corymb-like cymes, flower-cluster-stalk very short or absent; bracts about 8 mm long. Flowers are stalkless, bright scarlet, hypanthium 1-1.5 mm long, becoming hairless, teeth, about 0.5 mm long. Flower-tube is prominently long, 2.5-4.0 cm long, 1.5 mm wide, hairless, petals 8-10 x 4-5 mm, twisted in bud, throat hairless. Stamens are 4, inserted on the throat of

flower-tube, filaments very short. Style protruding; stigma 1.5 mm long. Fruit is spherical, red when ripe, crowned with the sepal-cup teeth.

51.Botanical Name : *Jasminum malabaricum* W.

Family : Oleaceae

Vernacular Name :Malabar Jasmine

Description:

It is a large climber, growing up to 3-5 m. Woody stems are 4 cm thick. Slender branches are spreading and trailing. Oppositely arranged membranous leaves are 8-12 cm long, and broadly ovate, with a sharp tip. The base of the leaf is either rounded or heart-shaped, and the stalk is 1-3 cm long. Fragrant white flowers appear in branched cymes at the end of branches, upto 50 in a single cyme. Petals are 6-10, 2 cm long, lance-like and spreading. The narrow tube below the petals is 2 cm long. It is found planted near many temples, and is used in worship. This one is very rare in northern parts of India.

52.Botanical Name : *Jatropha curcas* L.

Family : Euphorbiaceae

Vernacular Name :Kattamanakku

Description :

Monoecious and the terminal inflorescences contain unisexual greenish yellow 17-105 male and 2-19 female flowers in loose panicle of cymes. The ratio of male to female flowers ranges from 13:1 to 29:1. The inflorescence is composed by a main florescence and a distinct coflorescence. There are nodes on the upper pedicels of male (staminate) flowers and no node on the upper pedicels of female (pistillate) flowers. The flowers are tiny (about 7 mm), unisexual, regular, petals are oblong and light green in colour and sepals are quinquepartite. Androecium is absent in female

flower, present in male flower with ten stamens. Stigma are six furcated, dorsifixed and introrse. Gynoecium is absent in male flowers but present in female flowers and is tricarpellary, syncarpous with trilocular and superior ovary. Flowers are pollinated by moths and bees. Fruits trilocullar, ellipsoidal, sudrupaceous. The exocarp remains fleshy until the seeds become mature, finally separating into three cocci. The fruit is 2.5-3.5 cm long to 2-2.5 cm wide. Seeds are black, oblong, 2.5-3 cm long and 1 cm thick, more or less spherical or ellipsoidal (Fig. 1). Seed weight (10 seed) ranges from 53-77 g which contains 13.06-42.41% oil content.

53. Botanical name :*Jatropha glandulifera* Linn.

Family: Euphorbiaceae

Vernacular name : Athalai

Description :

Shrubs . Often glandular, leaves, alternate,entire (or) palmately lobed. Stipules long. Flowers monoecious, in terminal cymes, calyx 5 often lobes obovate, petals 5, contorted. Stamens numerous, connate, anthers erect, ovate, the cells parallel, contiguous. Ovary 2-4 celled. Fruit is a capsule.

54. Botanical name: *Kalanchoe blossfeldiana* L.

Family: Crassulaceae

Description:

A succulent plant with flat, glossy, green leaves. Stems are 40-50 cm. Leaf blades are elliptic to ovate or oblong-spatulate, 3-10 cm, margins crenate or almost entire, apex obtuse or nearly acute. Cymes are dense, compound, glabrous, not glandular. Pedicels are 0.5-2 cm. Flowers are fragrant; sepals ascending, triangular-lanceolate, 4-10 mm; corolla scarlet, cylindric, tube approximately 8 mm, lobes wide-spreading

55. Botanical name: *Lawsonia inermis* L.

Family: Lythraceae

Vernacular name: Maruthani

Description:

A glabrous shrub, branches terete, branchlets sometimes tetragonous, ending in spines. Leaves opposite, entire, lanceolate; stipules minute, deciduous. Flowers small, in terminal panicles; bracts small, deciduous. Calyx tube short, lobes 4, spearding ovate. Petals 4, obovate, wrinkled and crenate, inserted on the top of the calyx- tube. Anthers oblong, the connective thick. Ovary subglobose, 2-4 celled; ovules many, on axile placentas; style long, thick; stigma capitates. Fruit a globose capsule, breaking irregularly, ultimately 1 celled. Seeds numerous, pyramidal, closely packed; testa spongy; cotyledons orbicular, flat.

56. Botanical name : *Lepitagathis pungens* Nees.

Family: Acanthaceae

57. Botanical name : *Leucas aspera* Spreng.

Family: Lamiaceae

Vernacular name : Thumbai

Discription :

Herbs , branches usually 4- gonous . Leaves whorled . Flowers usually white , in axillary few . Calyx-tube glabrous and membranous in the lower half; corolla large, the lower lip twice as long as the upper , mid lobe obovate ; whorls terminal and also sometimes in upper axils, dense up to 1 in. in diam ; leaves linear- or oblong – lanceolate, obtuse, entire or crenate, pubescent, up to 3 in. long, 5 in. broad, prtiole short.

58. Botanical name: *Luma apiculta* L

Family: Myrtaceae

59. Botanical name: *Mangifera indica* L.

Family: Anacardiaceae

Vernacular name: Mango

Description:

Trees. Leaves alternate, petioled. Coriaceous, simple, entire. Flowers small. Polygamous, in terminal panicles; pedicels jointed; bracts deciduous. Calyx 4; segments imbricate, deciduous. Petals 4-5, free, imbricate. Disk fleshy 4-5 lobed stamens 1-5. Inserted inside or on the disk. Ovary sessile, 1 celled, oblique; style lateral; stigma simple; ovule pendulous from a basal or lateral funicle. Fruit a large resinous drupe with a compressed fibrous stone.

60 Botanical name : *Manilkara zapota* L.

Family: Sapotaceace

Vernacular name : Sapota

Description:

Trees or shrubs, generally ever green, young parts often rusty tomentose. Leaves alternate, rarely subopposite, entire, prtioled stipules 0. Flowers hermaphrodite, axillary; pedicles clustered, rarely solitary; bracts0; bracteoles 0. Calyx lobes 4-8, imbricate with the outer ones valvate. Corolla tube short; lobes as smany or 2-4 times as many as those of the calyx. Stamens inserted on the corollatube as many as the lobes and opposite to them or 2-3 times as many, 1-3 seriate; filaments usually short; anthers lanceolate, the connective often produced; staminodes when present alternate with the stamens. Ovary superior, sessile, 2-8 celled; ovules solitary in each cell. Fruit an indehiscent 1-8 seeded berry. Seeds if single ellipsoid,

compressed; hilum conspicuous; testa usually crustaceous, shining; albuminous with large fleshy cotyledons or albuminous with flat cotyledons; radical inferior.

61. Botanical name: *Mirabilis jalaba L.*

Family: Nyctaginaceae

Vernacular name: Andhi Mandarai

Description:

The plants are erect and spreading, 2-3 ft tall and just as wide. They have numerous branches and opposite, pointed leaves 2-4 in long. The fragrant flowers are borne singly or in clusters, and can be red, magenta, pink, yellow or white, sometimes with more than one color on the same plant. Like Petunia, bicolored flowers can also be grown.

62. Botanical name: *Moringa oleifera* L.

Family: Moringaceae

Vernacular name: Murungai maram

Description:

Trees with soft white wood, leaves deciduous, alternate, usually 3 pinnate, opposite, leaflets ovoid. Flowers white, irregular, axillary panicles. Calyx cup-shaped, 5-cleft, the segments unequal, patals 5, unequal the 2 upper small. Stamens 5 perfect opposite the plants with 5-7 alternate, 1- celled; style slender , tubular, stigma truncate; ovules many, fruit an elongate, seeds many in the pits of the valves; testa corky radical very short, superior, plumule many.

63. Botanical name: *Murraya koenigii* Spr.

Family: Rutaceae

Vernacular name: Karivepilai

Description:

Small trees, unarmed. Leaves pinnate; leaf lets alternate, petiolate, oblique. Flowers solitary, axillary,calyx 5 lobed.Petals 5, free, imbricate. Disk stipitiform. Stamens10, inserted outside the disk; filaments linear- subulate, alternately shorter and longer; anthers small. Ovary seeded on the disk, 2-5 celled; style elongate, articulate, deciduous; stigma capitates; ovules solitary. Fruit a 1-2 celled berry, oblong. Seeds with a wolly testa; albumen 0; cotyledons thick, plano-convex; embryo small.

64. Botanical name : *Nerium odorum* S.

Family: Apocynaceae

Vernacular name : Arali

Description :

It rises up to 3 meters erect with its short branches and dark dusty green leathery narrow leaves, which grow in whorls. They are narrow lancelike, 5-21 cm long and 1-3.5 cm broad, with an entire margin. The flowers grow in clusters at the end of each branch; they are white, pink or yellow, 2.5-5 cm diameter, with 5 petals fringed at the base. They are often, but not always, sweetly scented. The fruit is a long narrow capsule 5-23 cm long.

65. Botanical name : *Ocimum thyrsiflorum B.*

Family: Lamiaceae

Vernacular name : Tirunittru pachilai

Description :

Erect annual herbs to 60 cm tall; stem obtusely 4-angular. Leaves 3.5-6 x 1.5-2.5 cm, ovate-elliptic, base cuneate, margin entire to distantly crenulate, apex acute, puberulous above, pubescent with sessile oil galnds beneath; petiole to 2 cm

long. Racemes to 14 cm long; bracts oblanceolate, ciliate; pedicel to 2 mm long. Calyx to 6 mm long; tube c. 3 mm long, sparsely strigose; upper lip c. 3 mm long, broadly ovate; lower lip to 4 mm long, hairy within. Corolla cream, 7-10 mm long; tube c. 4 mm long, inflated below; lobes 5. Stamens 4; filaments of posterior pair with a transverse process of tufted hairs. Nutlets 2-3 x 1-1.5 mm, ellipsoid, black, mucilaginous when wet. Fruiting calyx 6-8 mm long.

66. Botanical name : *Oldenlandia umbellata* L.

Family: Rubiaceae

Vernacular name : Chayaver

Description :

Diffuse or prostrate herbs; root-stock woody. Leaves sessile, 0.5-1.6 x 0.2-0.4 cm, linear-lanceolate, base decurrent, margin revolute, apex acute, scabrous, 1-nerved; stipules with several bristles, base triangular. Flowers in many-flowered terminal, umbellate cymes and also sometimes axillary. Calyx lobes 4, persistent, c. 1.5 mm long, ovate-acuminate. Corolla pinkish-white, c. 3 mm across, campanulate; lobes 4, lanceolate. Stamens 4, in the throat of the corolla tube, exserted; filaments linear. Ovary c. 1 mm across, globose, hairy; stigma 2-fid, recurved. Capsule 2-2.5 mm across, globose, didymous, scabrid. Seeds angular, reticulate.

67. Botanical name : *Passiflora foetida* L.

Family: Passifloraceae

Vernacular name : Mosukkattan, Poonaipiduku

Description :

Climbers. The stems are thin, wiry and woody, covered with sticky yellow hairs. The leaves are three- to five-lobed and viscid-hairy. They give off an unpleasant odour when crushed. The flowers are white to pale cream coloured, about 5-6 cm

diameter. Flower-cluster-stalks are 2-6 cm long, Bracts are 2-4 cm long, increasing in size as fruit develops, 2- or 3-piinately divided into gland tipped segments, usually closely interwoven. Flowers are white and mauve, 4.0-6.5 cm in diameter. Sepals are ovate-lanceshaped or lanceshaped, 1.5-2.8 cm long, 0.6-1 cm wide, Petals are oblong or lanceshaped, 1-2.5 cm long, 5-8 mm wide, thin-membranous, white on upper and lower surfaces. Corona filaments are in 5-7 series, the outer two series 1-1.8 cm long, thread-like, lower 1/3 to 1/2 part mauve or lilac, upper portion white, inner 3-5 series erect, 1-3 mm high, getting shorter towards base, white or white at base with mauve or lilac tip. The fruit is globose, 1.5-3 cm diameter, yellowish-orange to red when ripe,

68. Botanical name : *Pavonia zeylanica* C.

Family: Malvaceae

Vernacular name : Chirtamutti, Kurundotti

Description :

Herbs. Stems erect, branches pubescent with stellate hairs and sometimes glabrate. Leaves alternate, simple or lobed, orbicular-ovate to lanceolate-elliptic, base truncate to cordate, margins entire or crenate-dentate, apex acute to acuminate, petiolate, stipules linear subulate, filiform, persistent. Inflorescence usually axillary solitary, terminal panicles or racemes, by the reduction of upper leaves. Flowers bisexual, pedicel slender, jointed above the middle, epicalyx segments 5-12, base free or connate sometimes, calyx 5 lobed or toothed, campanulate or tubular, persistent, corolla showy, yellow, white, red, pink. Staminal column almost as long as petals, anthers basifixed, througout. Ovary 5 carpellate, ovules 1 per locule, style 10, 2 per carpel, stigma 10, capitate. Fruit indehiscent, schizocarp, oblate or discoid, not angled,

minutely pubescent or glabrous, mericarps 5, reniform, winged or not, veined reticulately. Seed 1 in each mericarp, reniform, glabrous or hairy

69. Botanical name : *Phalaris aquatica* L.

Family: Poaceae

Description :

Herb. Inflorescence panicle is narrow, 5-15 cm long, dense, spikelike, and unbranched. The glumes are 5-6 mm long with a scabrous (rough) keel. The fertile lemma is 4 mm long, ovate-lanceolate, and strigose (with sharp and stiff appressed straight hairs). There is usually one sterile lemma, about one-third as long as the fertile one.

70. Botanical name : *Phyllanthus acidus* L.

Family: Euphorbiaceae

Vernacular name : Aranelli

Description :

Trees, monoecious, 20–100 dm; branching phyllanthoid. Stems: main stems and ultimate branchlets terete, not winged, glabrous. Leaves on main stems deciduous, spiral, scalelike; stipules not auriculate, dark brown. Leaves on ultimate branchlets deciduous with branchlets, distichous, well developed; stipules not auriculate, dark brown; blade broadly ovate to ovate-lanceolate, (40–)50–90 × (20–)25–45 mm, base obtuse or rounded, apex acute, both surfaces glabrous. Inflorescences cymules on leafless short shoots, on old wood bisexual with 1–9 pistillate flowers and 25–40 staminate flowers, on new growth bisexual on proximal shoots with 1–2 pistillate flowers and 8–12 staminate flowers, staminate on distal shoots with 8–12 flowers. Pedicels: staminate 1.5–3 mm, pistillate spreading in fruit, 2.3–5(–6) mm. Staminate flowers: sepals 4, reddish purple with pink to white

margins, flat, 1.1–1.4(–1.5) mm; nectary extrastaminal, 4 glands; stamens (3–)4, filaments distinct. Pistillate flowers: sepals 4, green to reddish purple with pink to white margins, flat, (1–)1.2–1.4 mm, 1-veined; nectary annular, 4-lobed. Drupes greenish yellow to white, (12–)15–20(–25) mm diam., smooth. Seeds uniformly brown, 3.3–3.5 mm, smooth.

71. Botanical name : *Phyllanthus amarus* Kn.

Family: Euphorbiaceae

Vernacular name : Keelaneli

Description :

Annual herb reaching 12-18 in.high. Leaves small, alternate, distichous, the branchlets resembling pinnate leaves. Flowers very small, monoecious, solitary. Calyx lobes 5-6, impricate. Petals 0. Disk in male flower of small glands than in female flower of glands. Stamens 3, anthers oblong or didymous, dehicing vertically. Ovary 3-celled; styles 3. Fruit a capsule with 3 crustaceous . Seeds trigonous, rounded at back.

72. Botanical name : *Phyllanthus emblica* L.

Family: Euphorbiaceae

Vernacular name : Nellikai

Description :

Herbs or shrubs . Leaves small, alternate, distichous, the branchlets resembling pinnate leaves; stipules narrow. Flowers very small, monoecious, in axillary clusters , bracteates. Calyx lobes 5-6, imbricate. Petals 0. Disk in male of small glands , in female of glands or annular. Stamens 3, anthers oblong. Ovary 3 celled; styles 3, free or connate at the base, 2 fid. Fruit a capsule with 3 crustaceous or thin 2 valved cocci. Seeds trigonous, rounded at back.

73. Botanical name: *Plumeria alba* L.

Family: Apocynaceae

Vernacular name: Nela Sampangi

Description:

Shrubby or small plant with a vase-shaped canopy. Its leaves are strap-like, clustered at the end of branches. Its flowers are very fragrant, white with a small yellow center.

74. Botanical name: *Polyalthia longifolia Hk.F*.

Family: Annonaceae

Vernacular name: Nettilingam

Description:

Trees, erect or rarely scandent, dioecious. Leaves simple, alternate, glabrous or softly pubescent. Flowers bisexual, solitary or few, leaf opposed, axillary, supra-axillary, pubescent, pedicellate and bracteate. Sepals 3, usually valvate, Petals 6 in 2 series, valvate, free, subequal, variously shaped, flat, spreading, outer petals slightly smaller or larger than the inner petals. Stamens numerous, anthers cuneate, connectives rhomboidal or orbicular, apiculate on top. Carpels indefinite, oblong, angled or cylindrical, style long, short or almost absent, stigma dilated, sessile, ovules usually 1-2 sometimes up to 5. Ripe carpels or fruits apocarpous, monocarps many, globose or ellipsoid, fleshly, stalked or rarely subsessile, Seeds usually 1, sometimes up to 5, grooved.

75. Botanical name: *Probascidea parviflora* L.

Family: Martyniaceae

Vernacular name: Puli Nagam

Description:

Annual herb growing from a taproot and producing sprawling, spreading stems. The leaves have rounded, oval, or roughly triangular blades up to 15 centimetres (6 in) long which have smooth edges or faint lobes or teeth. The inflorescence is an array of several showy bell-shaped flowers with five lobes flaring several centimeters wide. The flower is white to pink or purple, sometimes with mottling or lines of spots in the throat, and often a purple blotch on the upper lip.

76. Botanica name: *Psidium guajava* L.

Family: Myrtaceace

Vernacular name: Koyya

Description:

A small tree. Bark smooth, thin. Leaves opposite, entire, not dotted. Flowers large,white, on 1 axillary peduncles. Calyx obovate.Petals 5, stamens many, inserted in several series on a wide disk. Ovary many celled with numerous ovules in each cell. Fruit a globose ovoid berry, usually crowned by the calyx-limb. Seeds many; embryo curved with short cotyledons.

77. Botanical name: *Punica granatum* L.

Family: Lytharaceae

Vernacular name: Mathulai

Description:

A shrub or small tree. Leaves are opposite, glossy, narrow oblong, entire. The flowers are bright red and 3 cm in diameter, with three to seven petals. Some fruitless varieties are grown for the flowers alone.The flowers hermaphrodite .Calyx bell shaped. The petals 5-9 are wrinkled, alternating with and longer than the sepals.

Filiform, yellowish bilocular anthers. Carpels 8. Ovary syncarpous. Fruit is a fleshy berry. Seeds many.

78. Botanical name: *Rhinacanthus nacutus* L.

Family: Acanthaceae

Vernacular name: Nagamalli

Description:

Erect shrubs, stem terete, tomentose. Leaves 8-12 x 4-8 cm, elliptic, acute at both ends, crenulate, minutely pubescent, nerves 7-10 pairs. Cymes terminal, panicled. Flowers sessile; bracts and bracteoles similar, 2 mm long, hispid; sepals 5, 5 mm long, linear-lanceolate, hispid; corolla white, tube 25 mm long, slender, hispid; upper lip entire, oblong, acuminate; lower lip broad, 3-lobed, obtuse; stamens 2, inserted near the throat of the tube, equal; one anther lobe lower than other, glabrous; cell 2-ovuled, style slender. Capsule 2 cm long, clavate, with a lower solid slender stalk, glabrous; seeds 1 or 2 in each cell, rugose.

79. Botanical name: *Ricinus communis L.*

Family: Euphorbiaceae

Vernacular name: Amanakku

Description:

Branched glaucous shrubs. Leaves alternate, palmately 6-8-lobed, peltate, to 20 x 24 cm; lobes 9-15 x 3-6 cm, lanceolate, margin coarsely serrate, apex acuminate; petiole to 18 cm long. Flowers in terminal paniculate racemes, pale yellow; male flowers below, female ones above. Male flowers: perianth cupular, 3-5-lobed, c. 4 mm long, lanceolate; stamens many, filaments connate, repeatedly branched. Female flowers: tepals 5, subequal, c. 5 mm long, lanceolate; ovary

globose, 3-locular, echinate; ovule 1-per locule; styles 3, papillose. Capsule 1.6-2 cm across, 3-lobed, prickly. Seeds oblong, smooth, marbled, carunculate.

80. Botanical name: *Roystonea regia* O.F.

Family: Arecaceae

Vernacular name: Pakkupanai

Description:

Slender, elegant and relatively fast-growing, single-stemmed evergreen palm tree that can grow from 7 - 30 metres tall. The unbranched stem can be 40 - 57cm in diameter; it is topped by a crown of 15 - 18 leave

81. Botanical name : *Ruellia tuberose* L.

Family: Acanthaceae

Vernacular name : December poo

Description :

Herbs. Leaves opposite, entire. Flowers sessile, solitary; bracts 0, bracteoles large, usually exceeding the calyx. Calyx 5 partite; lobes subequal, narrow, acute. Corolla tubular- ventricose, more or less oblique; lobes subequal, rounded, twisted to the left in bud, spreading in flower. Stamens 4, didynamous; filaments glabrous except at base; anthers subequal, 2-celled

82. Botanical name : *Rungia repens* N.

Family: Acanthaceae

Vernacular name : Kodaga Saleh

Annual herb, 10-30 cm tall. Slender stems are prostrate, rooting near the base, then they become erect. Oppositely arranged, short-stalked, oblong-lancelike leaves are 3-5 cm long. Stalkless flowers occur in an erect 1-sided spike, 3-7 cm long, at the end of the stems. Approximately elliptic, pointed, bracts are 6-8 mm long.

Flowers are 2-lipped bluish purple, with dark purple and white spots. The oblong upper lip is 3 mm long, while the larger lower lip is 5 mm, shallowly 3-lobed. The flowers have two stamens

83. Botanical name :*Russelia equsetiforimis* L.

Family: Acanthaceae

Description :

Multi-branched subshrub, able to grow up to about 1 - 1.5 m tall and with a spread of 2 - 4 m wide. Leaves are reduced to small scale-like leaflets, bright green, ovate to elliptic, measuring about 8.5 - 15 mm long by 6 - 9 mm wide. Branches start out erect and bend over as they grow longer, giving it a weeping form. Flowers slender, bright red, tubular flowers measuring about 2.5 cm long, borne on the tip of branches resembling firecrackers, usually in 1 - 3 flowered clusters. Fruit is dry, brown capsule, oval or globose in shape and measuring about 3 - 6 mm wide. Seeds are small, light brown and oval in shape.

84. Botanical name : *Solanum aculeatissimum* Jacq..

Family: Solanaceae

Description :

Shrubs, erect, 1-2(-3) m tall, copiously armed, minutely tomentose with simple, many-celled, mostly glandular hairs, often with a pinkish cast. Stems and branches terete, erect, loosely pilose with many-celled, simple and stellate hairs to 2 mm, armed with recurved flat prickles 1-5 × 2-10 mm and sometimes straight spines. Leaves sometimes unequal paired; petiole, stout, 3-7 cm, copiously prickly; leaf blade broadly ovate, 6-15 × 4-15 cm, with coarse, many-celled simple hairs and straight prickles on both surfaces, mixed with sparse, stellate hairs abaxially, base truncate to subhastate, margin 5-7-lobed or -parted, with angular or dentate sharp lobes, apex

acute or obtuse. Inflorescences extra-axillary, short, 1-4-flowered scorpioid racemes; peduncle obsolete or to 1 cm. Pedicel 5-10 mm, pilose. Calyx campanulate, ca. 5.5 cm; lobes oblong-lanceolate, 5 × 1.5 mm, hairy and sometimes prickly abaxially. Corolla white; lobes lanceolate, ca. 4 × 14 mm, pubescent as on calyx. Filaments 1-2 mm; anthers lanceolate, acuminate, 6-7 mm. Ovary glabrous or minutely stipitate glandular. Style 6-7 mm. Berry pale yellow, globose, 2-3 cm in diam. Seeds light brown, lenticular, 2-2.8 mm in diam. Fl. Mar-Aug, fr. Nov-Dec.

85. Botanical name : *Solanum torvum* SW.

Family: Solanaceae

Vernacular name : Sundaikai

Description :

Small trees. Leaves ovate or subrectangular in outline, scute, often cordate at base, with few large triangular lobes, softly fulvous-tomentose, up to 9 in. long, 7 in. broad; prickles very few, on stem and petioles. Flowers racemose. Calyx 5-10 lobed. Corolla rotate; rarely campanulate; tube short. Stamens 5. Anthers oblong. Ovary 2, rarely 3-4 celled; style columnar; stigma small. Fruit a globose. Seeds very many; testa crustaceous, often pitted; albumen fleshy; embryo peripheric.

86. Botanical name : *Solanum trilobatum* L.

Family: Solanaceae

Vernacular name : Thuthuvalai

Description :

Climbing undershrubs ; leaves alternate; flowers in dichotomous , cymes lateral with short peduncles and long pedicels , about 2-8 flowered ; calyx 5-10 lobed , ovate , corolla purple in colour , larsge rotate . Stamens 5 , attached to the throat of the corolla ; filaments short; anthers oblong . Ovary 2 celled ; style columner ; stigma

small .Fruit globose berry , scarlet , smooth. Seeds many , small ; albumen fleshy ; embryo peripheric , the cotyledons linear.

87. **Botanical name: *Solanum xanthocarbum* Sch.**

Family: Solanaceae

Vernacular name: Kandankathiri

Description :

Herbs or shrubs, rarely small trees, unarmed or prickly. Leaves alternate, entire . flowers in dichotomous. Calyx 5-10 lobed,rarely 4-lobed or sub entire, accrescent or not in fruit. Corolla rotate, rarely campanulate; tube short; limb plicate, usually 5-lobed. Stamens 5, rarely 4, attached to the throat of the corolla; filaments short; anthers oblong, often narrowed upwards, connivent in a cone, opening by terminal pores or short slites. Ovary 2-, rarely 3-4 celled; style columnar; stigma small. Fruit a globose. Seeds very many, small, usually discoid; testa crustaceous, often pitted; albumen fleshy; embryo peripheric, the cotyledons linear, radical terete.

88. Botanical name: *Tabernaemontana divaricata* L.

Family: Apocynaceae

Vernacular name: Nandiar vattai

Description :

Shrub very common in India, generally grows to a height of 6 ft. However, it can also grow into a small tree with a thin, crooked stem. Like many members of the Oleander family, stems exude a milky latex when broken. The large shiny leaves are deep green and are 6 or more inches in length and about 2 inches in width. Crape jasmine blooms in spring but flowers appear sporatically all year. The waxy blossoms are white five-petaled pinwheels that are borne in small clusters on the stem tips.

89. Botanical name: *Talinum indicum* A.

Family: Talinaceae

Vernacular name:Sedi Pasali

Description :

Erect annual herbs, 1 m tall, robust, glabrous with rootstock. Leaves simple, alternate, subsessile; lamina ca. 6-8 x 2-3 cm, obovate or oblanceolate, obtuse or round at base, mucronate at apex, entire, fleshy, glossy above, obscurely nerved. Inflorescences terminal, racemose or paniculate. Flowers ca. 1.5-2 cm across; bracts 1-6 mm long, linear; pedicels ca. 0.7- 1.5 cm long; Sepals 2, ca. 4-6 x 3 mm, ovate-lanceolate, acuminate, 3-nerved; petals 5, ca. 9-12 x 5-6mm, pink-purple or white, obovate to ovate-round; stamens many; filaments ca. 2-3.5 mm long, unequal, basally connate; anthers ca. 1 mm long, oblong; ovary superior, ca. 2mm long, 1-loculed; ovules many on free central placenta; styles 3-armed. Capsules ca. 5-7 mm in diam., globose, 3-valved. Seeds 35 in each capsule, ca. 1 mm long, ovoid or subreniform, black, shining, with concentric striations.

90. Botanical name: *Tamarindus indicus* L.

Family: Fabaceae

Vernacular name: Puzhiya Maram

Description:

Tree. Leaves abruptly pinnate; leaflets many, small, opposite; stipels0.Flowers in racemes at the ends of branches ; calyx-tube turbinate, lobes 4 lanceolate, membranous, imbricate. Petals 3, stamens 3, ovary stipitate, style filiform; stigma capitates. Pod linear-oblong, incurved , thick , seeds obovate-orbicular , compressed, testa hard, albumen 0. Usually oblong; ovules 1-2, basal and erect fruit a ring of one- seeded berries.

91. Botanical name : *Tecoma stans* (L.) Juss ex Kunth.

Family: Bignoniaceae

Vernacular name : Yellow bells

Description :

Trees. Leaves opposite, rarely alternate, very rarely simple; leaflets entire or sometimes toothed. Flowers hermaphrodite, irregular, bracts various. Calyx gamosepalous, campanulate; lobes 2-5, corolla 2 lipped, tubular ventricose; lobes 5, subequal, imbricate in bud. Stamens 4,didynamous, with often a 5^{th} usually imperfect, rarely perfect; inserted where the corolla tube is suddenly swollen; filaments glabrous; anthers 2 celled, the cells parallel. Disk usually thick. Ovary subsessile, 2 celled; ovules numerous, in many rows, anatropous; style long, glabrous; stigma 2 valvae capsule, the septum enlarging, deciduous with the placentas. Seeds compressed, discoid, the embryo in an interior membranous testa; albumen 0; cotyledons flattened, sometimes folded.

92. Botanical Name : *Tephrosoa purpurea* P.

Family : Fabaceae

Vernacular Name : kattukkolincai

Description:

Sub shrubs branchlets bubescerillous. Leaves base cuneate margin entrie, apex, obtuse, mucronate, petiole long, stipules lanceolate. Flowers equal to lower one. Ovary appressed.

93. Botanical Name : *Tithonia diversifolia A.*

Family : Asteraceae

Vernacular Name : Kattu Suryakanthi.

Description:

It is a tall shrub, 1-3 m high. Stem is stout, erect, densely hairy. Alternately arranged broadly ovate leaves (lobed or simple) are 15-25 cm long. Large single flower-heads are orange-yellow, 10-15 cm across. In Manipur, flower-heads are used for wounds and bruises.

94. Botanical name: *Trachys muricata* S.

Family: Poaceae

Description:

Annuals, creeping, rooting at lower nodes, nodes densely bearded. Leaves to 10 x 1 cm, apex acute, base cordate, margin undulate on one side, densely hispid; sheaths to 6 cm, hispid; ligule membranous. Racemes 1-3, stiff, to 6 cm; rachis broadly winged; spikelets clustered, glumes, to 6 mm long, glumes and lemmas woolly, scaly, awnless, lower florets epaleate.

95. Botanical name: *Tribulus terrestris* L.

Family: Zygophyllaceae

Vernacular name: Nerunji

Description:

Prostrate herbs. Leaves stipulate, opposite. Flowers solitary, pseudo axillary, yellow. Sepals 5, imbricate. Petals 5, spearding, imbricate. Disk annular, 10 lobed. Stamens 10; filaments bare. Ovary sessile, hirsute. 5-12 lobed, 5-12 celled; ovules 1-5 in each cell; stigmas 5-12. Fruit 5 angled, of 5-12 winged spinous. Embryo exalbuminous.

96. Botanical name: *Turnera diffusa* Wild. ex Schult.

Family : Passifloraceae

Vernacular name: Damiana

Woody herbaceous shrub to 1 meter in height. The leaves are arranged alternately, to 3 cm in length, oblanceolate with a pair of glands at the leaf base. The leaf has a crenate margin and an acute leaf apex. The abaxial surface of the leaves is pubescent. The foliage is pungent. The complete, perfect, actinomorphic flowers are arranged solitarily in leaf axils. The flowers are subtended by 3 bracts. The calyx has 5 fused green sepals. The corolla has 5 unfused yellow petals. There are 5 stamens, each fused to the base of a petal. The ovary is superior with a single locule and many seeds. The fruit is a capsule at maturity.

Floristic Diversity of Vagaikulam Village, Thoothukudi Distirct

PLATE I

Abutilon *indicum* G. Don.

Acalypha hispida Burm.f.

Acalypha indica L.

Achyranthes *aspera* L.

Adhatoda vasica N.

Aerva lanata Forsk .

Aloe vera L.

Amaranthus viridis L.

PLATE II

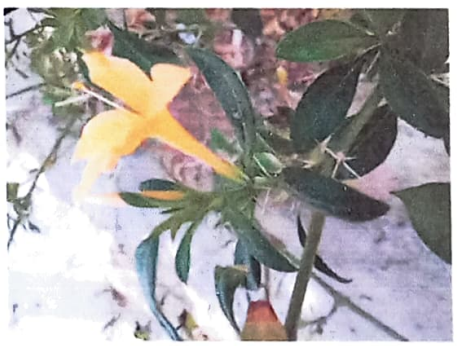
Anisomeles malabarica R.Br.

Annona squamosa L.

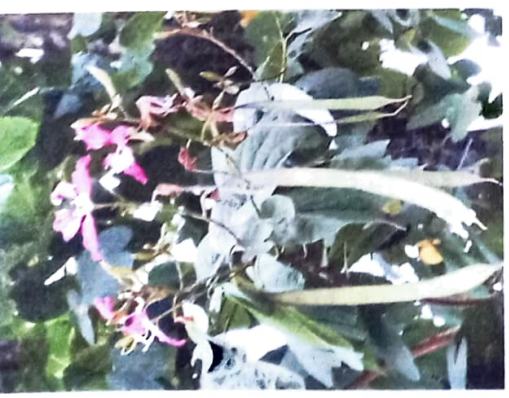
Aristida adscencionis L.

Artocarpus altillis (Parkinson)

Asparagus racemosus W.



Barleria prionitis L.



Bauhinia purpurea L.

Biophytum Poterioids Edgew. ex Hook. f.

PLATE III

Boerhavia diffusa L.

Bryonia cretica L.

Caesalpinia pulcherrima SW.

Calotropis gigantia R.Br.

Cassaia auriculata L.

Cassia alata L.

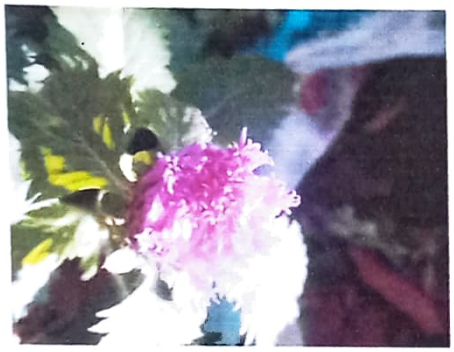
Cassia covessi A. Gray.

Catharathus roseus G Don.

PLATE IV

Celosia argentea L.

Celosia cristata L.



Centratherum punctatum cass.

Chloris barbata SW.

Cissus quadrangularis L.

Citrus limetta L.

Cleome viscosa L.

Clerodendron speciosum

PLATE V

Clitoria ternatea L.

Coleus amboinicus L.

Coleus plectranthus Lour..

Croton bonplandianum Bai ll.

Dactyloctenium aegyptium B.

Datura metel L.

Euphorbia heterophylla L.

Euphorbia hirta L.

PLATE VI

Euphorbia milli Des moul .

Euphorbia tirucalli L.

Evolvulus alsinoides L.

Gompherna serrata L.

Gossypium arboreum L.

Helliconia psittacorum L.f.

Hibiscus- rosa sinensis L.

Indigofera tinctoria L.

PLATE VII

Ipomoea carnea Jacq.

Ixora coccinea L.

Jasminum malabaricum w.

Jatropha curcas L.

Jatropha glandulifera Roxb.

Kalanchoe plossfeldiana L.

Lawsonia inermis L.

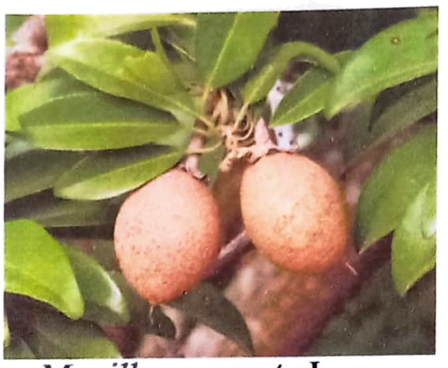
Lepitagathis pungens Nees.

PLATE VIII

Leucus aspera spr.

Luma apiculta L.

Mangifera indica L.



Manilkara zapota L.

Mirabilis jalaba L.

Moringa oleifera L.

Murraya koenigii Spr.

Nerium odorum S.

PLATE IX

Ocimum thyrsiflorum B.

Oldenlandia umbellata L.

Passiflora foetida L.

Pavonia zeylanica C.

Phalaris aquatica L.

Phyllanthus acidus L.

Phyllanthus amarus KN..

Phyllcanthus emblica L.

PLATE X

Plumeria alba L.

Polyalthia longifolia Hk.F..

Probascides parviflora L.

Psidium guajava L.

Punica granatum L.

Rhinacanchus nacutus L.

Ricinus communis L.

Roystonee regia O.F.

PLATE XI

Ruellia tuberosa.L

Raungia repens N...

Russelia equsetiforimis L.

Solanum aculeatissimum Jacq.

Solanum torvum SW.

Solanum trilobatum L.

Solanum xanthocarpum Sch.

Tabernaemontana divaricate L.

PLATE XII

Talinum indicum A.

Tamarindus indica L.

Tecomo stans (L)Juss exkundh.

Tephrosia purpurea p.

Tithonia diversifolia L.

Trachys muricata S.

Tribulus terrestris.L .

Turnera diffusa Wild. ex Schult.

RESULTS AND DISCUSSION

RESULT AND DISCUSSION

In the present study, a total of 96 angiospermic taxa belonging to 37 families are recorded from the Vagaikulam village of Thoothukudi District. This is the first taxonomic survey in this village. All the studied species are provided with legitimate name, citation followed by family name, vernacular name and short description. Vegetation of the study area is presented in the plates I-XII. Out of 38 families, 33 families are Dicotyledons and 4 families are Monocotyledons.

The members of 33 families of dicotyledons are further systematized into 75 genera including 87 species. Similarly, members of 4 families of monocotyledons are classified into 7 genera with 9 species. The conscription of 96 angiospermic taxa from the study area proves its species richness and plurality of the ecosystem (Table 1 and Figure 2).

Generic Diversity

Table 2 shows generic diversity of 37 families studied. Dicot families such as Fabaceae and Acanthaceae has more generic diversity (7 genera), when compared to Euphorbiaceae (6 species); Amaranthaceae and Poaceae (5 genera); Lamiaceae, Malvaceae (4 genera); Asclepidaceae (3 genera); Solanaceae, Liliaceae, Annonaceae, Apocyanaceae, Convolvulaceae, Nyctaginaceae, Myrtaceae, Passifloraceae, Rubiaceae, Rutaceae, Asteraceae and Lythraceae, (2 genera). Among monocotyledons, Poaceae represents more genera (5 genera). Families such as Asclepidaceae, Sapotaceae, Vitaceae, Moraceae, Martyniaceae, Anacardiaceae, Cucurbitaceae, Bignoniaceae, Oxalidaceae, Capparidaceae, Zygophyllaceae, Talinaceae, Moringaceae, Crassulaceae, Oleaceae, Verbenaceae, Arecaceae and Heliconiaceae (18 families).

Species Diversity

Species diversity of the study area is recorded in table 3. 96 species belonging to 37 families have been identified and studied. When compared to other families, Euphorbiaceae shows more species diversity (13 species) which is followed by Fabaceae (9 species); Acanthaceae (7 species); Amaranthaceae (6 species); Lamiaceae, Solanaceae, Poaceae (5 species); Malvaceae and Apocynaceae (4 species); Annonaceae, Convolvulaceae, Nyctaginaceae, Myrtaceae, Passifloraceae, Rubiaceae, Rutaceae, Asteraceae, Lythraceae, and Liliaceae (2 species). 18 families are monotypic families. They are Asclepidaceae, Sapotaceae, Vitaceae, Moraceae, Martinaceae, Anacardiaceae, Cucurbitaceae, Bignoniaceae, Oxalidaceae, Capparidaceae, Zygophyllaceae, Talinaceae, Moringaceae, Crassulaceae, Oleaceae, Verbenaceae, Arecaceae and Heliconiaceae.

Diversity of Habitat Forms:

Different habit of species in different families is recorded in table 4 and number of habitat forms in table 5. In general, vegetation is dominated by herbs (47.9 %) followed by shrubs (28.13%), trees (15.6 %) and climbers (8.3 %) (Figure 3).

Medicinal Taxa:

Many economically important plants are recorded in the study area. Among 96 species noted, 87 species are medicinal plants (Table 6).

The villagers used various medicinal plants to remediate variety of diseases and ailments like diabetes, skin disease, wounds, cuts, stomach pain, cough, cold, poisonous bites, body heat, body pain, bowl complaint, bronchitis, hair growth, intestinal worms, menstrual trouble, ulcer, tooth-cavities, urinary troubles, vomit, *etc.*,

The villagers used these medicinal plants in the form of juice, paste, powder, extract, decoction, cooked or raw forms.

The villagers used diverse parts of the medicinal plants based on their ability to cure disease such parts includes leaf, latex of roots, seed, fruit, flower, stem, *etc*

The major resources of medicines are arising from plants. The phytochemical constituents and medicinal properties of most of the medicinal plants were recorded in the last few decades by a number of workers (Nadkarni 1976; Sayed Nudrat and Usha, 2005). These medicinal plants are subjected to various processes and are then administrated to the patients. The survey and documentation of medicinal and aromatic plants in each and every place is mandatory for easy identification of local traditional healers, conservation and sustainable utilization. The most important utilization of these plants is through medicines (Sujatha and Pushparaj, 2017). However, plants and their parts and the pattern of administration vary from person to person. Thus, there is enormous scope for local medicines based on plant products which are yet to be studied, analyzed and documented.

Edible Taxa:

Among 96 taxa, 19 species are edible (Table 7). The different parts of plants such as stem, leaves, fruits, flowers and seeds are used as edible by local people.

Table 1: Distribution of Taxa in different classes of Angiosperms in the study area

S.no	Class	Families		Genera		Species	
		No	%	No	%	No	%
1.	Dicotyledonds	33	89.2	75	91.5	87	90.6
2.	Monocotyledons	4	10.8	7	8.5	9	9.4

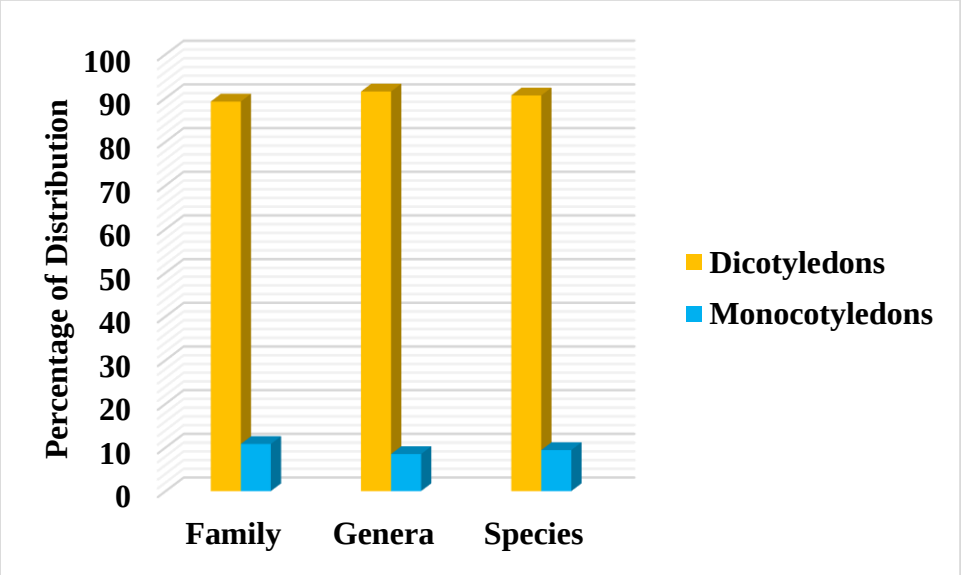


Figure 2: Percentage of Distribution of Taxa in different classes of Angiosperms

Table 2: Generic diversity in different families of dicotyledons and monocotyledons in Vagaikulam Village

Dicotyledons	Monocotyledons	No. of genera
Fabaceae, Acanthaceae	-	**7**
Amaranthaceae,	Poaceae	5
Euphorbiaceae,	-	6
Lamiaceae, Malvaceae, Apocynaceae	-	4
Solanaceae, Liliaceae, Annonaceae, Convolvulaceae, Nyctaginaceae, Myrtaceae, Passifloraceae, Rubiaceae, Rutaceae, Asteraceae, Lythraceae	-	2
Asclepidaceae, Sapotaceae, Vitaceae, Moraceae, Martyniaceae, Anacardiaceae, Cucurbitaceae, Bignoniaceae, Oxalidaceae, Capparidaceae, Zygophyllaceae, Talinaceae, Moringaceae, , Crassulaceae, Oleaceae, Verbenaceae	Arecaceae Heliconiaceae	1

Table 3: Species diversity in different families of dicotyledons and monocotyledons in Vagaikulam Village

Dicotyledons	Monocotyledons	No. of Species
Euphorbiaceae	-	13
Fabaceae	-	9
Acanthaceae	-	7
Amaranthaceae	-	6
Lamiaceae, Solanaceae	Poaceae	5
Malvaceae, Apocynaceae	-	4
Annonaceae, Convolvulaceae, Nyctaginaceae, Myrtaceae, Passifloraceae, Rubiaceae, Rutaceae, Asteraceae, Lythraceae,	Liliaceae	2
Asclepiadaceae, Sapotaceae, Vitaceae, Moraceae, Martyniaceae, Anacardiaceae, Cucurbitaceae, Bignoniaceae, Oxalidaceae, Capparidaceae, Zygophyllaceae, Talinaceae, Moringaceae, Crassulaceae, Oleaceae, Verbenaceae	Arecaceae, Heliconiaceae	1

Table 4: Habit forms of species from the study area

S.No	Botanical name	Family	Habit
1	*Abutilon indicum* G. Don	Malvaceae	Herb
2	*Acalypha hispida* Burm.f.	Euphorbiaceae	Herb
3	*Acalypha indica* L.	Euphorbiaceae	Herb
4	*Achyranthes aspera* L.	Amaranthaceae	Herb
5	*Adhatoda vasica* N.	Acanthaceae	Shrub
6	*Aerva lanata Forsk* .	Amaranthaceae	Herb
7	*Aloe vera* L.	Liliaceae	Herb
8	*Amaranthus viridis* L.	Amaranthaceae	Herb
9	*Anisomeles malabarica* R.Br.	Lamiaceae	Herb
10	*Annona squamosa L.*	Annonaceae	Tree
11	*Aristida adscencionis* L.	Poaceae	Herb
12	*Artocarpus altillis* (Parkinson) Fosberg	Moraceae	Tree
13	*Asparagus racemosus* W.	Liliaceae	Climber
14	*Barleria prionitis* L.	Acanthaceae	Shrub
15	*Bauhinia purpurea* L.	Fabaceae	Tree
16	*Biophytum Poterioids* Edgew. ex Hook. f	Oxalidaceae	Herb
17	*Boerhavia diffusa* L.	Nyctaginaceae	Herb
18	*Bryonia cretica* L.	Cucurbitaceae	Climber
19	*Caesalpinia pulcherrima* SW.	Fabaceae	Tree
20	*Calotropis gigantia* R.Br.	Asclepiadaceae	Shrub
22	*Cassia alata* L.	Fabaceae	Shrub
21	*Cassia auriculata* L.	Fabaceae	Shrub
23	*Cassia covessi* A. Gray	Fabaceae	Shrub
24	*Catharathus roseus* G Don.	Apocynaceae	Herb
25	*Celosia argentea* L.	Amaranthaceae	Herb
26	*Celosia cristata* L.	Amaranthaceae	Herb
27	*Centratherum punctatum cass.*	Asteracaee	Herb
28	*Chloris barbata* SW.	Poaceae	Herb
29	*Cissus quadrangularis* L.	Vitaceae	Climber
30	*Citrus limetta* L.	Rutaceae	Tree
31	*Cleome viscosa* L.	Capparidaceae	Herb
32	*Clerodendron speciosum*	Verbenaceae	Climber
33	*Clitoria ternatea* L.	Fabaceae	Climber
34	*Coleus amboinicus* L.	Lamiaceae	Shrub
35	*Coleus plectranthus Lour.*	Lamiaceae	Herb
36	*Croton bonplandianum* Baill.	Euphobiaceae	Herb
37	*Dactyloctenium aegyptium* B.	Poaceae	Herb
38	*Datura metel* L.	Solanaceae	Herb
39	*Euphorbia heterophylla* L.	Euphorbiaceae	Herb
40	*Euphorbia hirta* L.	Euphorbiaceae	Herb
41	*Euphorbia milli* Des Moul.	Euphorbiaceae	Herb
42	*Euphorbia tirucalli* L.	Euphorbiaceae	Shrub

43	*Evolvulus alsinoides* L.	Convolvulaceae	Herb
44	*Gompherna serrata* L.	Amaranthaceae	Herb
45	*Gossypium arboreum* L.	Malvaceae	Shrub
46	*Helliconia psittacorum* L.f	Heliconiaceae	Herb
47	*Hibiscus- rosa sinensis* L.	Malvaceae	Shrub
48	*Indigofera tinctoria* L.	Fabaceae	Herb
49	*Ipomoea carnea* Jacq.	Convolvulaceae	Shrub
50	*Ixora coccinea L.*	Rubiaceae	Shrub
51	*Jasminum malabaricum* w.	Oleaceae	Climber
52	*Jatropha curcas* L	Euphorbiaceae	Herb
53	*Jatropha glandulifera* Roxb.	Euphorbiaceae	Herb
54	*Kalanchoe blossfeldiana* L.	Crassulaceae	Herb
55	*Lawsonia inermis* L.	Lythraceae	Shrub
56	*Lepitagathis pungens* Nees.	Acanthaceae	Herb
57	*Leucus aspera* spr.	Lamiaceae	Herb
58	*Luma apiculta* L	Myrtaceae	Shrub
59	*Mangifera indica* L.	Anacardiaceae	Tree
60	*Manilkara zapota* L.	Sapotaceae	Tree
61	*Mirabilis jalaba* L.	Nyctaginaceae	Shrub
62	*Moringa oleifera* L.	Moringaceae	Tree
63	*Murraya konigii* Spr.	Rutaceae	Tree
64	*Nerium odorum* S.	Apocynaceae	Shrub
65	*Ocimum thyrsiflorum B.*	Lamiaceae	Herb
66	*Oldenlandia umbellata* L.	Rubiaceae	Herb
67	*Passiflora foetida* L.	Passifloraceae	Climber
68	*Pavonia zeylanica* C.	Malvaceae	Herb
69	*Phalaris aquatica* L.	Poaceae	Herb
70	*Phyllanthus acidus* L.	Euphorbiaceae	Tree
71	*Phyllanthus amarus* KN.	Euphorbiaceae	Herb
72	*Phyllanthus emblica* L.	Euphorbiaceae	Tree
73	*Plumeria alba* L.	Apocynaceae	Shrub
74	*Polyalthia longifolia* Hk.F.	Annonaceae	Tree
75	*Probascidea parviflora* L.	Martyniaceae	Herb
76	*Psidium guajava* L.	Myrtaceae	Tree
77	*Punica granatum* L.	Puniaceae	Shrub
78	*Rhinacanthus nacutus* L.	Acanthaceae	Shrub
79	*Ricinus communis* L.	Euphorbiaceae	Shrub
80	*Roystonea regia* O.F.	Arecaceae	Tree
81	*Ruellia tuberosa*.L	Acanthaceae	Shrub
82	*Rungia repens* N.	Acanthaceae	Herb
83	*Russelia equsetiforimis* L.	Acanthaceae	Shrub
84	*Solanum aculeatissimum* Jacq..	Solanaceae	Shrub
85	*Solanum torvum* SW.	Solanaceae	Shrub
86	*Solanum trilobatum* L.	Solanaceae	Climber
87	*Solanum xanthocarpum* Sch.	Solanaceae	Herb
88	*Tabernaemontana divaricata* L.	Apocynaceae	Herb
89	*Talinum indicum* A.	Talinaceae	Herb
90	*Tamarindus indica* L.	Fabaceae	Tree

91	*Tecomo stans* (L.) Juss. ex Kunth	Bignoniaceae	Shrub
92	*Tephrosia purpurea* p.	Fabaceae	Herb
93	*Tithonia diversifolia A.*	Asteraceae	Shrub
94	*Trachys muricata* S.	Poaceae	Herb
95	*Tribulus terrestris*.L	Zygophyllaceae	Herb
96	*Turnera diffusa* Wild. ex Schult.	Passifloraceae	Shrub

Table 5: Number of life forms of species from the study area

S. No	Habit	No of Species
1	Herb	46
2	Shrub	27
3	Tree	15
4	Climber	8

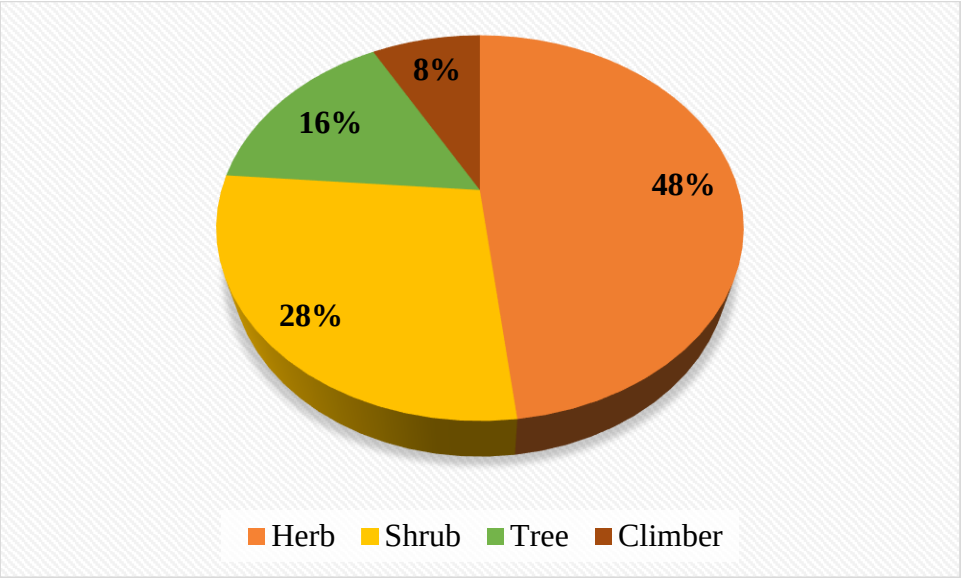


Figure 3: Percentage of distribution of species in different habits.

Table 7: Edible taxa of the study area

S. No	Plants	Family	Edible part
1.	*Anona squamosa*	Anonaceae	Fruit
2.	*Artocarpus altilis*	Moraceae	Fruit
3.	*Bauhinia purpurea*	Fabaceae	Seed
4.	*Celosia argentea*	Amaranthaceae	Leaf
5.	*Celosia cristata*	Amaranthaceae	Leaf
6.	*Cissus quadrangularis*	Vitaceae	Leaves
7.	*Citrus limetta*	Rutaceae	Fruit
8.	*Hibiscus rosa sinensis*	Malvaceae	Flower
9.	*Mangifera indica*	Anacardiaceae	Fruit
10.	*Manilkara zapota*	Zapotaceae	Fruit
11.	*Moringa oleifera*	Moringaceae	Fruit and leaves
12.	*Murraya koengii*	Rutaceae	Leaf
13.	*Phyllanthus acidus*	Euphorbiaceae	Fruit
14.	*Phyllanthus emblica*	Euphorbiaceae	Fruit
15.	*Psidium gujava*	Myrtaceae	Fruit
16.	*Punica granatum*	Puniaceae	Fruit
17.	*Solanum pychanthum*	Solanaceae	Fruit
18.	*Solanum torvum*	Solanaceae	Fruit
19.	*Tamarindus indica*	Fabaceae	Fruit

Table 6: Medicinal taxa of the study area

S.No	Botanical name	Family	Useful part	Medicinal uses
1.	*Abutilon indicum* G. Don	Malvaceae	Root, bark, flower, and seeds.	Decoction used in toothache and tender gums. Demulcents of leaves are locally applied to boils and ulcers.
2.	*Acalypha hispida* Burm.f.	Euphorbiaceae	Leaves	The leaves are laxative, diuretic and in the treatment of leprosy and gonorrhea.
3.	*Acalypha indica* L.	Euphorbiaceae	Leaves	Leaf paste with salt is used for allergy and rashes
4.	*Achyranthes aspera* L.	Amaranthaceae	Root	The root powder is used to treat skin disease
5.	*Adhatoda vasica* N.	Acanthaceae	Leaves,	Leaves are useful in treating bronchitis, tuberculosis, and other lung and bronchial disorders. -A decoction of the leaves of vasica may be used to help with cough and other symptoms of colds.
6.	*Aerva lanata Forsk* .	Amaranthaceae	Whole plant	The decoction of the plant is used to dissolve kidney stones and gall bladder stones.

7.	*Aloe vera* L.	Liliaceae	Leaves	May improve skin tone and prevent wrinkles.
8.	*Amaranthus viridis* L.	Amaranthaceae	Leaves	Antipyretic medicine as antipyretic agents, also for the treatment of inflammation ulcers, diabetic, asthma.
9.	*Anisomeles malabarica* R.Br.	Lamiaceae	Whole plant	The leaves and the roots are used for astringent carminative, tonic.
10.	*Annona squamosa L.*	Annonaceae	Leaves, stem and root.	Annona squamosa seed powder is utilized to abolish lice, leaf extract is used to pacify boils and treat ulcers, and the fruit acts as a sedative in cases involving heart ailment and can be used to alleviate vomiting and treat tumors.
11.	*Aristida adscencionis* L.	Poaceae	Whole plant	It is used in ethno-medicine as a lactation stimulant for women and to prevent itch and ringworm.
12.	*Artocarpus altillis* (Parkinson) Fosberg	Moraceae	Latex, leaf tips, and inner bark.	Bread fruit root leaves are applied to the skin for boils, burns, ear infections sore or tired eyes and thrush. Bread fruit latex is applied to the skin for bones, sprains sciatica. The seed and fruits are eaten as foods.

13.	*Asparagus racemosus* W.	Liliaceae	Root	Roots are effective in chronic fever and internal heat. This herb is highly effective in problems related with female reproductive system.
14.	*Barleria prionitis* L.	Acanthaceae	Whole plant	The whole plant has been utilized for treatment of toothache, catarrhal affections, whooping cough, inflammations, glandular swelling, urinary infection, jaundice, fever, gastrointestinal disorders and as diuretic and tonic.
15.	*Bauhinia purpurea* L.	Fabaceae	Bark	The plant is used traditionally in dropsy, pain, rheumatism, convulsions, delirium and septicaemia. The bark of the plant is used as an astringent in the treatment of diarrhoea.
16.	*Biophytum Poterioids* Edgew. ex Hook. f	Oxalidaceae	Leaves	The plant used for convulsions, cramps, chest-complaints, inflammation, tumours, chronic skin diseases.
17.	*Boerhavia diffusa* L.	Nyctaginaceae	Leaves	It is used in the treatment of anemia liver diseases. It has been identified to act as a diuretic antiflammatory hepatoprotective agent.

18.	*Bryonia cretica* L.	Cucurbitaceae	Root	It can be used to relive Constipation, upset stomach and fluid retention its also been used to treat chronic conditons such as artritis, cancer, and liver disease.
19.	*Calotropis gigantia* R.Br.	Asclepiadaceae	Leaves	Leaves with hot soil is kept on foot for 5 minutes to cure pain
20.	*Cassia alata* L.	Fabaceae	Leaves, flower and bark.	The plants is traditionally used in the treatment of typhoid, diabetes, malaria, asthma scabies, blotch, herpes, and eczema.
21.	*Cassia auriculata* L.	Fabaceae	Flower	Flower is boiled in water and is used to treat constipation
22.	*Cassia covessi* A. Gray	Fabaceae	Leaves& flowers	It is used medicinally as a stimulant and strong laxative. It is used to soften stool and induce bowel movement.
23.	*Catharathus roseus* G Don.	Apocynaceae	Whole plant	Plants are used in diabetes, leaf infusion used in menorrhagia, also found effective against blood cancer.
24.	*Centratherum punctatum cass.*	Asteracaee	Leaves	They are used in treating wound, in hair and skin care preparations. It is alsoused for pain killer

25.	*Chloris barbata* SW.	Poaceae	Leaves	Used to treat rheumatism, while juice from the plant is used as an antibacterial and antimicrobial to treat skin disorders.
26.	*Cissus quadrangularis* L.	Vitaceae	Roots and stem	It used for diabetes, obesity high cholesterol, bone fractures, allergies cancer, as body building supplements as an alternative to anabolic steroids
27.	*Citrus limetta* L.	Rutaceae	Fruit	Daily intake of sweet lime is curing digestive issues, throat pain and viral infection.
28.	*Cleome viscosa* L.	Capparidaceae	Leaves	Used to treat rheumatic, arthritis, hypertension, malaria, Neurasthenia and would healing.
29.	*Clerodendron speciosum*	Verbenaceae	Bark, roots and leaves,	Traditionally it has been used in the treatment of inflammation, rheumatism, arthritis, diabetes, dropsy, swelling edema and gout.
30.	*Clitoria ternatea* L.	Fabaceae	Flower and leaves	The flower tea used as regulate the absorption in blood that maintain blood sugar level. It can reduce the blood pressure. Paste of a hand full of leaves with salt is applied to treat tumour

31.	*Coleus amboinicus* L.	Lamiaceae	Leaves	it is widely used in folk medicine to treat conditions like cold, asthma, constipation, headache, cough fever and skin diseases.
32.	*Coleus plectranthus Lour.*	Lamiaceae	Root	It is widely used in the treat the conditions like cold, asthma, constipation, headache, cough and fever.
33.	*Croton bonplandianum* Baill.	Euphobiaceae	Leaves	Used for controlling high blood pressure and for the treatment of skin diseases and cuts and wounds
34.	*Dactyloctenium aegyptium* B.	Poaceae	Whole plant	Used for treating small pox, wounds and ulcers.
35.	*Datura metel* L.	Solanaceae	Leaf, flower, fruit and root.	They are used in the treatment of the stomach and intestinal pain that result from worm infestation, toothache, and fever from the inflammation. The juice of its fruit is applied to the scalp, to treat dandruff and falling hair.
36.	*Euphorbia heterophylla* L.	Euphorbiaceae	Leaves	They are widely used for the treatment of the constipation, bacterial and inflammatory disease conditions like arthritis and rheumatism.

37.	*Euphorbia hirta* L.	Euphorbiaceae	Aerial parts	Used in treating worms, severe diarrhoea (dysentery), gonorrhoea, and digestive problems
38.	*Euphorbia milli* Des Moul.	Euphorbiaceae	Leaves	It has been used to treat hepatitis warts. It has antiviral, antifungal properties.
39.	*Euphorbia tirucalli* L.	Euphorbiaceae	Whole plant	Latex is used for rheumatism warts, cough, asthma, earache, toothache, milky juice is alexiteric carminative & purgative.
40.	*Evolvulus alsinoides* L.	Convolvulaceae	Whole plant	The plant is useful as blood purifier and in bleeding piles. The fresh flowers with sugar are eaten as a brain tonic.
41.	*Gompherna serrata* L.	Amaranthaceae	Whole plant	It is used for treatment of several liver related and dermatological diseases dysmenorrhea bronchial infection, renal disorders and also as an analgesic.
42.	*Gossypium arboreum* L.	Malvaceae	Leaves and roots.	The root is considered and emmenagogue and to cause uterine contractions.
43.	*Helliconia psittacorum* L.f	Heliconiaceae	Flower	It acts as anti- diarrheal agents and anti-inflammatory agents.

44.	*Hibiscus- rosa sinensis* L.	Malvaceae	Leaves and flower.	Hibiscus is also used as an herbal medicine to treat hypertension cholesterol production and cancer progression.
45.	*Indigofera tinctoria* L.	Fabaceae	Shrub	It is used to treat to nervous disorders, asthma, fever, stomach pain, liver disease, kidney and spleen disease.
46.	*Ipomoea carnea* Jacq.	Convolvulaceae	Whole plant	It has anti- cancer, anti- inflammatory, anti-sleeping and anti- cardiovascular properties.
47.	*Ixora coccinea L.*	Rubiaceae	Roots, flower and leaves.	Roots and flowers are used in dysentery, dysmenorrhea, leucorrhoea and catarrhal bronchitis
48.	*Jasminum malabaricum* w.	Oleaceae	Leaves and flower.	It is used for a treatment of cataract, as a blood purifier and in cosmetic and detergent industries.
49.	*Jatropha curcas* L	Euphorbiaceae	Seeds, leaves and bark.	It is traditionally used to treat bacteria and fungi infections or febrile diseases, muscle pain or jaundice.
50.	*Jatropha glandulifera* Roxb.	Euphorbiaceae	Roots	Roots and oil from seed used externally for ringworm and chronic ulcers.

51.	*Kalanchoe plossfeldiana* L.	Crassulaceae	Leaves	It has to been used to ailments such as infections, rheumatism and inflammation.
52.	*Lawsonia inermis* L.	Lythraceae	Leaves	It is used as an anti-microbial, anti-oxidant, anti-inflammatory, diuretic, tuberculosis and anti-parasitic actions.
53.	*Leucus asspera* spr.	Lamiaceae	Leaves and Flower	It is used in treating cough, cold, bronchitis, asthma, sinus and sore throats. It helps to treat digestive disorders such as diarrhoea, constipation and stomach ulcers.
54.	*Mangifera indica* L.	Anacardiaceae	Seed& fruit	The plant to treat diarrhoea, dysentery, anaemia, asthma, cough and piles.
55.	*Mirabilis jalaba* L.	Nyctaginaceae	Fruit& Flower	The plant may be used as a diuretic, purgative purposes.
56.	*Moringa oleifera* L.	Moringaceae	Leaves and Flower	They have been used to treat various disease like skin infections, asthma, headache, heart problems, fever and wounds.
57.	*Murraya konigii* Spr.	Rutaceae	Leaves	The green leaves are used in treating piles, inflammation, itching, fresh cuts and dysentery.

58.	*Nerium odorum* S.	Apocynaceae	Leaves and Flower	It is used for heart conditions asthma, cancer, painful menstrual periods and malaria.
59.	*Ocimum thyrsiflorum B.*	Lamiaceae	Whole plant	The whole plant is used to treat in asthma, bronchitis and skin disease.
60.	*Oldenlandia umbellata* L.	Rubiaceae	Root& leaves	The plant has been used in diverse applications for instance decotion of leaves is used to treat poisonous bites. The roots are used asthma.
61.	*Passiflora foetida* L.	Passifloraceae	Stem& Leaves	Used to treat skin diseases, erysipelas and inflammation.
62.	*Pavonia zeylanica* C.	Malvaceae	Root& leaves	The plant used in the treatment of stubborn chronic rheumatoid arthritis, skin disease.
63.	*Phyllanthus acidus* L.	Euphorbiaceae	Bark& leaf	It is used to treat a wide spectrum ofdisease such as inflammatory, rheumatism, bronchitis, asthma, respiratory disorders, hepatic diseases and diabetes.
64.	*Phyllanthus amarus* KN.	Euphorbiaceae	Leaves	Leaf is given allergic problems and plant extract is used in jaundice.
65.	*Phyllanthus emblica* L.	Euphorbiaceae	Fruit	It is useful in gastropathy diarrhoea, dysentery, intermittent fevers, scabies, ulcers and wounds.

66.	*Plumeria alba* L.	Apocynaceae	Bark &Seed	It is a traditional folkloric medicinal herb used to treat cardiovascular disorders.
67.	*Polyalthia longifolia* Hk.F.	Anonaceae	Whole plant	It is used in the treatment of fever, helminthiasis, diabetes and various cardiac problems.
68.	*Psidium guajava* L.	Myrtaceae	Fruitsand leaves	it is the most common and popular traditional remedy for gastrointestinal infections such as diarrhoea, dysentery, stomach pain and indigestion.
69.	*Punica granatum* L.	Lythraceae	Root & Fruit	Pomegranates can helped to prevent or treat various disease risk factors including high blood pressure, high cholesterol, oxidative stress and inflammatory activities.
70.	*Rhinacanthus nacutus* L.	Acanthaceae	Whole plant	The root are used for snake bite. The leaves applied skin infections .Seeds and leaves used against eczema.
71.	*Ricinus communis* L.	Euphorbiaceae	Leaf &Root	It has been widely used in traditional medicine such abdominal disorders, arthritis, backache, muscle ache, headache, period pain and insomnia.

72.	*Ruellia tuberosa*.L	Acanthaceae	Leaves &Fruit	In Herbal medicine, this plant has been widely used as an anti-diuretic, anti-diabetic, analgesic.
73.	*Rungia repens* N.	Acanthaceae	Whole Plant	The herb is dried and pulverized for use in the treatment of cough and fever.
74.	*Russelia equsetiforimis* L.	Acanthaceae	Whole plant	It has anti-malarial effect which supports the folk medicine clime of it is use in the treatment of malaria.
75.	*Solanum aculeatissimum* Jacq..	Solanaceae	Fruit& Leaves	The juice of the plant is used on ulcers and other skin diseases. The fruit are used as a tonic, laxative, appetite, stimulant, and for treating asthma.
76.	*Solanum torvum* SW.	Solanaceae	Leaves& Fruit	Whole plant used to sedative andstomachic.
77.	*Solanum trilobatum* L.	Solanaceae	Leaves	It is used in the treatment of respiratory diseases like bronchial asthma.
78.	*Solanum xanthocarpum* Sch.	Solanaceae	Leaves& Fruit	It has been traditionally used for the treatment of bacterial infection, cough and indigestion. The fruit as anti-oxidant, anti-cancer and anti - HIV agents.

79.	*Tabernaemontana divaricate* L.	Apocynaceae	Root & Leaves	It medicinal benefits such as an anti-epileptic, anti-mania, brain tonic, and anti-oxidant.
80.	*Talinum indicum* A.	Talinaceae	Leaf & Flower	The leaves used for preventing gastrointestinal disorders such as indigestion, constipation, flatulence, and irritable bowel syndrome.
81.	*Tamarindus indica* L.	Fabaceae	Fruit	In traditional medicine, It is used in wound healing, abdominal pain, diarrhoea, dysentery, parasitic infestation, fever, malaria and respiratory problems.
82.	*Tecomo stans* (L.) Juss. ex Kunth	Bignoniaceae	Root & Flower	It is used to traditional medicine as a remedy for diabetes mellitus, digestive problems, stomach pain, intestinal worms and snake bite.
83.	*Tephrosia purpurea* p.	Fabaceae	Root	It is widely used in ayurveda and siddha medicines treat various disorders like Jaundice, kidney disorder and to reduce thirst in diabetes mellitus.
84.	*Tithonia diversifolia A.*	Asteraceae	Leaves & Flower	Leaves and flowers extract are traditionally used for the treatment of diabetes, diarrhoea.
85.	*Trachys muricata* S.	Poaceae	Whole plant	It has anti-cancer, Anti-bacterial, Anti-fungal, Anti- viral, Anti-inflammatory properties.

86.	*Tribulus terrestris.*L	Zygophyllaceae	Whole plant	Tribulus is primarily used as booster for better sexual health. It reduced redness and skin lesions. It is also used to treat anemea.
87.	*Turnera diffusa* Wild. ex Schult.	Passifloraceae	Leaf & stem	It is used to treat headache, depression and constipation. Boosting and maintain mental physical stamina.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

Biodiversity conservation is a major problem of the day and taxonomic knowledge is crucial to meet the challenges of biodiversity conservation in the 21st century. It is of fundamental importance for understanding biodiversity and ecosystem functioning, as it provides us with the data to explore and describe biodiversity through scientific analysis. The present study provides the basic information about the different plant species of Vagaikulam village, Thoothukudi District, revealed that this area is rich in diversity of wild plants as well as cultivated plants, and in present work a total 96 species belongs to 75 genera and 37 families have been recorded with majority formed by herbs and shrubs. The Euphorbiaceae is represented the most dominant family with 13 species.

87 medicinal plants are reported from this area which are depleting rapidly because of unsustainable harvesting, lack of awareness, and unrestricted grazing by domestic animals from nearby villages. So, proper conservation and establishment plans are needed to protect the medicinal plant resources of this area. Hence, such a study could play an important role for the local and regional authorities interested in to conserve this precious diversity for better future use in welfare of coming generations and sustainable development of the area.

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PHYTOCHEMICAL SCREENING, FTIR, ANTIBACTERIAL AND ANTHELMINTIC ACTIVITIES OF LEAF AND FLOWER EXTRACTS OF *CATHARANTHUS ROSEUS* (L.) G. DON

A Short term Project work Submitted to St. Mary's College (Autonomous)

Affilitated to Manonmaniam Sundaranar University

In Partial fulfillment for the Degree of

BACHELOR OF SCIENCE IN BOTANY

By

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P. SANTHA HELENA	-	**20AUBO35**
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2022 -2023

CERTIFICATE

It is certified that this short term project work entitled **"PHYTOCHEMICAL SCREENING, FTIR, ANTIBACTERIAL AND ANTHELMINTIC ACTIVITIES OF LEAF AND FLOWER EXTRACTS OF *CATHARANTHUS ROSEUS* (L.) G. DON"** submitted to St. Mary's College (Autonomous) affiliated to **MONONMANIAM SUNDARANAR UNIVERSITY** in partial fulfillment of the requirements for the degree of Bachelor of Science in Botany, and is a record of work done in the Department of Botany, St. Mary's college (Autonomous), Thoothukudi during the year 2022-2023 by the following students.

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It is our humble attempt to present this project "**PHYTOCHEMICAL SCREENING, FTIR, ANTHELMINTIC ACTIVITIES OF LEAF AND FLOWER EXTRACTS OF *CATHARANTHUS ROSEUS*** (L.) G. DON**"** First and foremost our sincere gratitude belongs to **Dr. Sr. A.S.J. LUCIA ROSE., M.Phill., PGDCA., Ph. D.,** principal, St. Mary's College (Autonomous) for providing us an opportunity to do this project.

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CONTENTS

INTRODUCTION

CHAPTER – 1

INTRODUCTION

Nature has been bestowed upon as a vast botanical wealth with a large number of diverse plant species growing in various part of the world. Plants mainly used for variety of disease related to cancer treatment, plant produce several secondary metabolites including alkaloids, flavonoids, saponins, steroids cyanogenic glycosides and terpenoids to protect themselves from the attack of naturally occurring pathogen, insects, pests and environmental stresses. Medicinal plant products could prove useful in minimizing the adverse effect of various chemotherapeutic agents as well as in prolonging longevity and attaining positive general health. Since ancient times plants have been widely recognized as an important source of novel therapeutic compounds for the treatment of various diseases and had been reported in traditional medicine system. According to the World Health Organization (WHO), the majority of the world population depends on traditional medicine for healthcare so that medicinal plant explorations were continuously held to meet community needs. The interest enhancement toward medicinal plant and its active substance has been happened because of its great potency as medicine and no negative side effect.

Catharanthus roseus is used to treat many fatal diseases. It is one of the chief herbs for treating dermatitis, abscesses, eczema, psoriasis, sores, corns, ringworms, scabies, epilepsy, malaria, heart tonics and tumour. Mainly leaves and flowering tops of the plants are used for the extraction of oil. This oil has been found to have antibacterial and anti-yeast action. Researchers have been found that it can kill some intestinal parasites and have mild antibiotic effects. It was also observed that the leaves are used extensively in folk medicine for decreasing sugar level (Jain *et al.,* 1965)

The plant contains significant amounts of volatile compounds including caffeoylquinic acids and flavones glycosides which are known to posses antioxidant activity. It has an important role in the body defense system by acting as an antioxidant against reactive oxygen species (Saranjot *et al.,* 2014).Vincristine and vinblastine are the major alkaloids play an important role in western medicine as potent as anticancer agents. Generally, phytochemicals act as poisonous agent and protect the plant against insect and herbivores. Some act as regulatory growth factors of growing plants.

Catharanthus roseus is an evergreen sub herb plant growing to 1m tall. The leaves are oval to oblong 2.5-9.5cm long and1-3.5cm, Broad glossy green hairless with a pale midrib and a short petiole about 1-1.8cm long and they are arranged in the opposite pairs. It is an important medicinal plant belong to the family apocynaceae. (Monika sain *et al.,* 2013). *Catharanthus roseus* commonly known as graveyard vine, bright eyes, madagascar periwinkle, cape periwinkle etc. Pentamerous flowers are present with different colors such as pink, purple, white, peach, scarlet and red. It is a important medicinal plant which is native to Madagascar but cultivated in various parts of the world. *Catharanthus roseus* are commonly known Nayanfara or Sadabahar. *Catharanthus* derives from the greek language meaning pure flower while roseus means red, rose or rosy (Hemalini *et al.,* 2014)

Natural products have an important role to play in drug development programme in the pharmaceutical industry (Baker *et al.,* 1995).

The leaf juice of *Catharanthus roseus* shows the presence of various alkaloids, namely vincristine, which bind to tubulin dimmers, inhibiting the assembly of microtubules structures. Disruption of the microtubules arrests mitosis in metaphase. The vinca alkaloids, therefore, affect all rapidly dividing cell types including cancer cells but also intestinal epithelium and bone marrow. (Levision *et al.,* 2000)

Plants supply minerals, vitamins, and certain hormone precursors in addition to protein and energy to human body. Trace elements have significant roles in combating a variety of human aliments and disease was observed by the study of elements with respect to indigenous medicinal plants (Shirin*et al.,* 2010).The different parts of *Catharanthus roseus* (leaf, stem, flower and root) were used and extracts were subjected to antibacterial assay.

Researcher investigating its medicinal properties discovered that it contained a group of alkaloids that, though extremely toxic, had potential uses in cancer treatment. Plants have the ability to synthesize a wide variety of chemical compounds that are used to perform important biological functions, and to defend against attack from predators such as insects, fungi and herbivorous mammals. Alkaloids are the most potentially active chemical constituents of *Catharanthus roseus.* More than 400 alkaloids are present in the plant, which are used as pharmaceuticals, agrochemicals, flavor and fragrance, ingredients, food additives and pesticide.

Crusted *Catharanthus roseus* leaves have been used recently to relive pain (Chopra *et al.,*1986; Ngyyen and Doan, 1989) with the advent in science and technology many natural and

synthetic drugs have been discovered resulting in remarkable success in the field of medicine. Antibiotic are undoubtedly one of the most significant medicinal advances of the twentieth century with potent antibacterial properties. Antibiotic micro-organism have become immune as a result of continued use. In addition to this problem antibiotic have been linked to host side effect such as hypersensitivity, immune suppression and allergic reaction. This has resulted in a slew of clinical issue with infectious disease treatment. Screening local medicinal plants for antimicrobial property is one process. Plants have been observed developing a number of compounds to protect themselves from pathogens. Plant extract with target sides other than those used by antibiotics are expected to be effective against drug resistant pathogens for thousands of years and in many part of the world. Therefore the current study aimed to validate the phytochemical, antibacterial and anthelmintic activity of *Catharanthus roseus.*

SCOPE
AND
OBJECTIVES

CHAPTER- II

SCOPE AND OBJECTIVES

Medicinal plants have started to consider an essential source in preventing a various kind of disease. Each plant consists of several important ingredients that can be used in medical field, and can be involved in the development of different kind of drugs. A lot of under developed countries or even developed countries are using herbal medicine in maintain human well-being, personal health condition, and treading certain type of disease such as cancer. Some plant species are considered as a weed, but they are also medicinally important too. In current era, the trend of using herbal medicine is in scope. New drugs are discovered by the invention of modern biotechnological and bio informatics techniques. In current era, herbal medicine are used more often as human believe in natural therapies is increase day by day. Natural products play a dominant role in the development of novel drug leads for the treatment and prevention of disease. Knowledge of the chemical constituents of plant is helpful in the discovery of therapeutic agent. However it is essential to work on locally available resource to bring out their pharmaceutical values and anti-microbial in medicine. Hence the present investigation was under taken with the following objectives.

- To identify the phytochemicals present in root, stem, leaf and flower of *Catharanthus roseus*
- Elucidating the effectiveness of medicinal plant (*Catharanthus roseus*) in controlling human pathogenic bacteria such as *Escherichia coli*, *Bacillus subtilis* and *Staphylococcus aureus*
- To evaluate the anthelmintic activity in leaf and flower extracts (benzene, methanol, ethanol, acetone, aqueous) of *Catharanthus roseus*
- To identify the functional group present in leaf and flower extract of *Catharanthus roseus* by Fourier Transform Infra-red Spectroscopy.

The results of the study also underline the cost effective, bio friendly resources which would be tapped for development of effective drug in future.

REVIEW OF LITERATURE

CHAPTER – III

LITERATURE REVIEW

Medicinal plants have been proved important therapeutic aid for levitating the ailments of human kind. The search for longevity and remedies of pain and discomfort drove early man to look into immediate natural surroundings to make the use of plants, animal's products and minerals etc.

Medicinal plants contain many of natural products with varying level of bioactivities. Now-a-days, there is a renewal interest in traditional medicine and herbal drugs. Because green medicine are considered as safe as and more dependable than synthetic drugs. Many synthetic drugs have adverse side effects (Nair and Chandra, 2007).

Plants are a source of many potent and strong drugs that are used medicinally in various countries (Srivastava *et al.,* 2008). In various traditional literature a variety of herbs with significant antimicrobial activity have been published (Jones *et al.,* 1996; Sathish *et al.,* 1999). Ayurvedic traditions use a variety of medicinal plants on a regular basis. More than 7000 medicinal plants have been identified in medicine meets the primary healthcare needs of more than 805 of the world's population (Uma maheswari *et al.,* 2008). Because of the lack and high cost of new generation antibiotics, researchers are turning to alternative medicine for anti-microbial action (Poovendran *et al.,* 2011)

DISTRIBUTION AND MEDICNAL VALUES

Catharanthus roseus is a highly potent apocynaceae plant that is widely used as a medicinal in Ayurveda. Its various parts (stems, leaves flower and root) have remarkable antibacterial and antifungal properties against Gram negative bacteria and Gram positive bacteria, as well as fungal pathogenic microbes. Also, its plant parts have anthelmintic, anti-convulsant, wound healing, anti-asthmatic, hypoglycemic, anti-oxidant and cytotoxicity. Chemical constituents such as alkaloids, saponins, steroids, tannins, flavanoids, glycosides, protein, phenolic compounds have been extracted and reported using enriched proof. (Sahar, 2018).

Catharanthus roseus is a native of the Indian Ocean island of Madagascar. It compromises eight species, seven endemic to Madagascar (*C. coriaceus, C. lanceus, C. longifolius, C. ovalis, C. scitulus, C. trichophyllus)* and one*, C. pusillus* from India. In the wild, it is found to be an endangered plant and the main cause of their decline is the habitat destruction by the slash and

burn agriculture. Abundantly natural grow in many region, particularly in arid coastal location. It is grown commercially for its medicinal plant almost throughout the tropical and subtropical regions world-wide (Yuvan *et al.,* 2011).

In the wild, it is found to be an endangered plant and the main cause of their decline is the habitat destruction by the slash and burn agriculture. Abundantly natural grow in many region, particularly in arid coastal location. It is grown commercially for its medicinal plant almost throughout the tropical and subtropical regions world-wide (Yuvan *et al.,* 2011).

PHYTOCHEMICAL AND ANTIBACTERIAL ACTIVITY

Phytochemicals are non-nutritive plant chemicals that have protective or disease preventive properties. They are non-essential nutrients, meaning that the human body does not require them for sustaining life. It is well known that plants produce these chemicals to protect themselves but recent researches demonstrate that they can also protect human against diseases. They are more than a thousand known phytochemicals. (Patil *et al.,* 2015)

Phytochemicals have the potential to modulate human metabolism in a manner beneficial for the prevention chronic and degenerative diseases (Mishra *et al.,* 2011).

Kabesh *et al.,* 2015 investigated the phytochemical analysis and anti-microbial activity of aqueous and methanol extracts of *Catharanthus roseus.* The enzymatic and non-enzymatic (DPPH) method was employed to analyze the anti-oxidant property. Qualitative analysis of phytochemical screening reveals the presence of Alkaloids, Phenol, saponins and Protein. Further presents of phytochemicals were detected by Thin Layer Chromatography (TLC), which the standard technique for separating organic compounds. The extracts were purified using Column chromatography (silica gel).

Asma Nisar *et al.,* 2016 reported many famous phytochemicals such as vincristine and vinblastine were isolated from this medicinal plant. It has many pharmacological properties such as anti-oxidant, anti- microbial, anti-diabetic, wound healing, anti-ulcer, hypotensive,anti-diarrhoeal, hypolipidemic and memory enchancement. Alkaloids are one of major phytochemicals responsible for its anti-cancer properties followed by phenolic compounds such as flavonoids. The purpose of the current study is to document updated data about is traditional uses, isolated bioactive compounds and pharmacological activites.

Salman *et al.,* 2001 reported that it has been used in traditional medicine as ahypoglycemic agent. The present interest in this plant is due to the fact that it is a source of chemotherapeutic agent with activity agent several kind of the cancer. Schmeller and Wind in 1998 his, produces a great variety of terpenoid alkaloids most of them with pharmacological activity. It is a perennial, evergreen herb, 30-100cm height that was originally native to the island of Madagascar. The leaves are glossy, dark green, oblong-elliptic, acute, rounded apex, flowers fragrant, white to pinkish purple in terminal or axillary cymose clusters, follicle hairy, many seeded, 2-3cm long, seed along, minute black. The plant is commonly grown in gardens for bedding, borders and for mass effect. Further study has to be carried out to determine the bioactive components in the long leaves of *Catharanthus roseus* (L). In these phytochemical analysis recorded no of chemical constituents, which may be responsible for many pharmacological activities. Further work required to investigate the extract of leaves for various pharmacological activities. The plant studied here can be seen as source of useful drug. It also justifies the folklore medicinal uses and claims about the therapeutic values of this plant as curative agent.

Don et *al.,* 2021 aimed at determining the phytochemical profile of *Catharanthus roseus* L.G. Don by standard qualitative and quantitative methods. The extract was prepared by finely ground drived leaves and 80% methanol, followed by concentrating at low temperature. The analysis revealed the presence of a good amount of alkaloids, saponins, phenols and steroids in the methanolic leaf extract. Along with them other compounds are also found which includes the flavaonoids, glycosides, and tannins. All these bioactive compounds that are found to be present in this plant have very potential medicinal roles and are widely used for the treatment of various ailments. It is the presence of these phytochemicals that impart the medicinal properties in the plants and increase its importance. The study just revealed a phytochemical profile, future studies could consider determining the profile in other solvents followed by purification of compounds and evaluation of their medicinal application on animal models.

Shohel Hossain *et al.,* 2014 aimed at confesing the comparative abundances of ten different phytochemicals (alkaloids, polyphenols, flavonoids, tannins, saponins, sterols, and vitamins-C, coumarins, terpenoids, and cardiac glycosides) from leaves of *Catharanthus roseus* and *Ficus racemosa*. The color strength or the precipitate formation was used as analytic answers to these tests. Seven phytochemicals viz. alkaloids, polyphenols, tannins, saponins, sterols, terpenoids, and cardiac glycosides in *Catharanthus roseus* leaves, whereas saponins in *Ficus racemosa* leaves

were also acknowledged as highest concentration category in this study. It is anticipated that the vital phytochemical properties *documented* in our study in the native medicinal plant of *catharanthus roseus* and *Ficus racemosa* will be beneficial for explanation and groundwork of pharmacognosy profiling of medicinal plants.

Vikash Kumar *et al.,* 2021 conducted to screen the phytochemical constituents and to determine the levels of the major and trace elements of five medicinal plants used for the treatment of diabetes mellitus namely; *Aegele marmelos*, *Catharathus roseus*, *Garcinia pedunculata*, *Musa paradisiacal* and *Ocimum sanctum*. The air dried leaves of the plants were subjected to soxhlet extraction using ethanol, petroleum ether, and chloroform and aqueous. The crude extracts were obtained and subjected to screening for their phytochemical constituents such as alkaloids, tannins, terpenoids, reducing sugar, flavonoids, saponins, phenolic compounds and steroids using various standard methods and reagents. Trace metals in the five medicinal plants were analyzed quantitatively using Flame Atomic Absorption Spectroscopy. A digestion procedure to involving the use of 4ml of perchloric acid and 10ml of aquaregia was performed to digest the medicinal plants. Sterols, tannins, terpenoids, flavonoids, alkaloids, saponins and reducing sugars were identified in the leaves of all the five plants. Elemental concentrations of some of the elements were obtained from the leafy materials in varying quantities. Ten heavy metals (Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, Zn, and V), two alkali metals (K and Na) and three alkaline earth metals (Ca, Mg, and Al) and two halogens (Cl and Br) were quantitatively anaysed.

Shahin Aziz *et al.,* 2014 confirmed the presence of various phytochemicals like alkaloids, flavonoids, terpenoids, saponins, steroids, carbohydrates, anthoquinone glycosides etc in different extract of its leaves and flowers. Some minerals have also been identified in the leaves and flowers of the extracts.

Prajakta *et al.,* 2010 investigated the anti-microbial properties of this plant. The anticancer properties of *Catharathus roseus* has been the major interest in all investigations. The antimicrobial activity has been checked against microorganism like *Pseudomonas aeruginosa*, *Salmonella typhimurium* and *Staphylococcus aureus*. The findings show that the extracts from the leaves of this plant can beused as prophylactic agent in many of the diseases, which some time are of the magnitude of an epidemic.

Mansi Srivastava *et al.,* 2013 studied illustrates the antibacterial property of this plant against opportunistic organisms like *Escherichia coli* and *Staphylococcus aureus*. The *Catharathus*

flowers and purified extracts have antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*. Therefore providing protection to the flowers against pathogen invasion. This study also shows that an antibacterial compound has been isolated and detected.

Muhammad Liaquat Raza *et al.,* 2009 studied he carried out the screening of this plant for its antibacterial potential adopting the antibacterial assay. The different parts of *Catharathus roseus* (leaf, stem, flower and root) were subjected to antibacterial assay. The extracts of *Cathratharanthus roseus* is not exhibit antibacterial activity against *Staphylococcus aureus*. Moreover, leaf, stem and flower extracts were also ineffective against *Pseudomonas aeruginosa*. The leaf extract did not exhibit activity against *Corynebacterium diphtheriae*, similarly, the crude extract of stem did not shown activity against *Shigella boydii*. The most effective was the root extract, which exhibited broad spectrum antibacterial activity against *Salmonella typhii* and *S.boydii* the zone of inhibitions measuring 24mm and 22mm, respectively. The flower extract also showed activity against *C. diphtheria.*

Sheeraz ahmad wagay *et al.,* 2013 investigated the antimicrobial activity of *Catharanthus roseus* whole plant against the wound isolates. Two different solvent such a ethanol and methanol were used to extract the bioactive compounds from the whole plant of *Catharanthus roseus* and screened their antimicrobial activity against the isolated wound pathogens under well diffusion method. The maximum antibacterial activity was observed in crude ethanolic extract of *Catharanthus roseus* against *pseudomonas aeruginosa*.

Verma *et al.,* 2010 antibacterial activity of the aqueous and alcoholic leaf extracts of the plants was investigated against medicinally important bacteria. The mutant leaf extracts showed enhanced antibacterial activity against all the tested bacteria except *Bacillus subtilis.*

Sathyapriya *et al.,* 2021 evaluvated the antimicrobial property of *Catharanthus roseus* plant extracts. This study was conducted to determine the effect of ethyl acetate and methanol extract on *Bacillus subtilis*, *Staphylococcus aureus, Salmonella typhii* and *Candida abicans.* The ethyl acetate extract of *Catharanthus roseus* showed no activity against all 4 pathogens. The 10ul methanolic extract showed good activity against *Staphylococcus* comparing to other organisms.

Roy *et al.,* 2020 reported the bioactive secondary metabolities and antimicrobial activities of organic extracts of *Catharanthus roseus* flower parts were investigated. Agar well diffusion method was used for antimicrobial testing of organic extracts against multi drug resistant food-

borne Gram positive (*Staphylococcus*) Gram negative (*Citrobacter freundii, E.Coli*) bacteria. This study supports the impotance of using medicinal plant as an alternative source for the treatment of bacterial diseases and other pharmaceutical purpose such as preservative due to minor side effects, effectiveness and development of resistance to antibiotics.

Nidhisheokand *et al.,* 2019 evaluated the antibacterial activity against microorganisms like *Pseudomonas aeruginosa*, *Staphylococcus*, *E. coli*, *Rhizopus arrhizus, Aspergillus sydowi* and *Aspergillus fumigates*. The strongest inhibition activity of the leaf extract was observed against *B. Subtilis*, (20 mm zone of inhibition).

Shamugaraju *et al.,* 2016 observed the plant leaf extracts were prepared by using solvent such as acetone, ethanol, and chloroform and tested against the pathogenic microorganism to determine their antimicrobial potential. *Catharanthus roseus* leaf extract showed maximum antibacterial activity against all the pathogenic microorganism, among the solvents tested ethanol showed maximum antibacterial activity of plant extract. *Catharanthus roseus* when compared to acetone and chloroform extract,. The results of the present study clearly suggested the importance of *Catharanthus roseus* in treatment against infection disease causing pathogenic microorganism. Moreover, the therapeutic potential of the plant should also be checked when used in combination with herbal drugs.

Rajalashmi *et al.,* 2012 reported the antibacterial potential of dry leaves of *Catharanthus roseus* was conducted using agar disc diffusion method. The maximum activity was observed against all the microorganism, the minimum inhibitory concentration was determined depending on microorganisms. *Catharanthus roseus* was observed to have antibacterial activity.

Hong Ngoc Thuy*et al.,* 2020 explored the *Catharanthus roseus* leaf exhibited *in vitro* antibacterial activity.

Sakthisaravanan *et al.,* 2011 evaluated the possibility for the presence of bio-active compounds against pathogenic bacteria as most of the pathogens develops during resistant against commonly used anti- biotics. To determine the antimicrobial activity, crude extracts from leaves of *Catharanthus roseus* were tested against bacterial and fungal stains against of clinical significance. Extraction of bioactive components in appropriate solvent was followed by the evaluation of antimicrobial activity by cup plate method against selected bacterial and fungal

stains. Extract prepared from leaves showed significantly higher efficacy. Among the extract that were significantly active. The extract obtained using chloroform exhibited maximum activity against bacterial and fungal stains tested. Gram (+) stains and fungal stains were more sensitive when compared to Gram (-) bacteria. The study implicates that bio-active compounds of *Catharanthus roseus* could potentially explored as antimicrobial agents.

Sara E Gomma *et al.,* 2019 *a*ssessmented the plant extracts to be used as prophylactic against certain human pathogens. Leaf extract have strong antibacterial activity.

ANTHELMINTIC ACTIVITY

Swati Agarwal *et al.,* 2011 studied the Helminthes infections are chronic illness in human being and in cattle.*Pherithema postuma* a helminthes is commonly known as earth-worms. Although the use of alternate drugs has been as a remedial measure against the resistant stains of helminth parasites, and as a means of reducing the cost of controlling helminthic diseases. *Catharanthus roseus* is a medicinally valuable plant and posses various pharmacological properties. *Catharanthus roseus* has been traditionally used as an anthelmintic agent. Piperazine citrate was used as a standard reference. Among the various concentrations tested, ethanol extract at 200 mg/ml showed efficient paralysis effect (6.67 min) than other treated groups, whereas ethanol extract 250 mg/ml showed significant anthelmintic activity with death time of 46.33min. Standard drug at 50 mg/ml showed paralysis at 31.33 min and death time was 40.67 min. This investigation supported the ethanomedical claims of *Catharanthus roseus* as an anthelmintic plant.

Kamaraj *et al*., 2011 evaluated the efficacy of ethyl acetate, acetone, and methanol dried leaf and seed extract of five medicinal plants were tested *in vitro* ovicidal and larvicidal activities on *Haemonchus contortus*. The *in vitro* assay was based on egg hatch assay and larval development assay, all plant extracts were evaluated at five concentrations 50, 25, 12.5, 6.25 and 3.13 mg/ml. The leaf and seed ethyl acetate, acetone and methanol of *Catharanthus roseus*, showed complete inhibition (100%) at the maximum concentration tested (50mg/ml). The overall findings of the present study have shown that our experimental plant extracts contain possible anthelmintic activity.

Shambaditya Goswami *et al.,* 2018 reported the different concentrations (25, 50 and 100 mg/ml) of petroleum ether, acetone, chloroform, ethanol, and aqueous extracts of the leaf were used to examine the effects. For the evaluation of *in vitro* anthelmintic activity, several earthworms

(*Eisenia fetida*, *Perionyx excavates* and *Pheretima posthuma*) we taken, while albendazole was used as standard drug and Tween 80 (3%)and saline (0.9%) NaCl was considers as a control treatment. Ethanolic and aqueous extracts of leaf showed the maximum presence of anthelminthic activity. Ethanolic extract has the value of 36.33 mg/ml and aqueous extract has the value of 73.94 mg/ml respectively, when compared to standard acarbose.

Sayyad *et al.,* 2014 evaluate anthelminthic activity of ethanolic extract of *Catharanthus roseus* .Various concentration (25, 50, 75 mg/ml) of all the extracts were tested and results were expressed in terms of time for paralysis and time for death of worms. Albendazole was used as a reference standard, in saline as a control group. Dose dependent activity was observed in all extracts.

MATERIALS AND METHODS

CHAPTER - IV

MATERIALS AND METHODS

Collection and processing of the plant materials

The leaves flowers roots stems of *Catharanthus roseus* were collected from in and around Thoothukudi district in Tamil Nadu, during December 2022. The plant parts were collected, then washed carefully with water to remove dust and foreign materials.

The plant parts were dried under shade and coarsely powered.

Preparation of extracts:

10 grams powdered sample was sequentially extracted with 200ml of benzene, acetone, ethanol, methanol and aqueous solution using in soxhlet apparatus. The prepared extracts were tested for phytochemical screening, anti-bacterial, FTIR and anthelminitic activities

Phytochemical qualitative analysis:

The phytochemical tests were done for analysing different chemical groups present in the extracts. These were done to fine out the presence of bioactive chemical constituents such as alkaloids, flavonoids, tannins, phenols, terpenoids, quinine, sugar, protein steroids and saponins. Detection of achieve phytochemical constituents was carried out for all the extracts using standard procedures. (Kokatte, 2005, Harbone,. 1984).

Test for alkaloids;-

Mayer's Test:-

3 ml of extracts was added to 1% HCL and then allowed to steam bath. Few drops of mayer's reagent was added to the mixture. Turbidity indicates the presence of alkaloids.

Plate1: *Catharanthus roseus*

Class : Dicotyledans

Sub-class : Gamopetalae

Series : Bicarpellatae

Order : Gentianales

Family : Apocynaceae

Genus : *Catharanthus*

Species*:roseus*

Catharanthus roseus is an evergreen sub herb plant growing to 1 m tall. The leaves are oval to oblong, 2.5-9.5 cm. long and 1-3.5 cm. broad glossy green hairless with a pale midrib and a short petiole about 1- 1.8 cm. long and they are arranged in the opposite pairs. The flowers are white to dark pink with a dark red centre, with a basal tube about 2.5-3 cm. long and a corolla about 2-5 cm. diameter with 5 petal like lobes. The fruit is a pair of follicles about 2-4 cm. long and 3 mm broad.

Test for Flavonoids:-

Lead acetate Test:-

To 1 ml of extracts, 1 ml of 10% lead acetate was added. Formation of yellow precipitate showed the presence flavonoids.

Detection of phenols:-

Fecl3 Test:-

About 2 ml of plant extracts was taken and warmed at 45-50°c. Then 2 ml of 0.3% Fecl3 was added. Formation of green or blue colour indicates the presence of phenols.

Test for Terpenoids:-

Salkowski Test:-

About 2 ml of chloroform was added to 1 ml of the extracts. Then 3 ml of concentrated H2So4 was carefully added to form a layer. A reddish brown coloration of the interface indicates the presence of terpenoids.

Test for sugar:-

To 1 ml of extracts added 1 ml of Fehlings A solution and 1 ml of Fehlings B solution. Formation of red colour indicates the presence of sugar

Test for quinine:-

To 1 ml of extract added 1 ml of 1% NaOH and mixed well. Appearance of blue green or red indicates the presence of quinines.

Test for protein:-

To 1 ml of extract added few drop of mercuric chloride. Formation of yellow colour indicates the presence of protein.

Test for steroids:-

Salkowski Test:-

To 2 ml of extracts was dissolved in chloroform, 2 ml of concentrated sulphuric acid was added to the mixture. Red colour formation indicates the presence of steroids.

Test for Saponins:-

Foam test:-

1ml of extracts dilute with 5 ml of distilled water and warmed. The formation of stable foam indicates the presence of saponins.

ANTIBACTERIAL ACTIVITY

Bacterial strains used

The test organisms were obtained from the department of microbiology, St.Mary's college (Autonomous), Thoothukudi. The two gram positive bacteria viz, *Bacillus subtilis* G +ve , *Staphylococcus aureus* G +ve and one gram negative bacteria *Escherichia coli* , were used in the present study. *Bacillus subtilis* is responsible for causing food borne gastroententis. *E.coli* and *Staphylococcus aureus* cause diseases like mastitis abortion and upper respiratory complications.

Disc diffusion assay (Bauer *et al*., 1966)

Anti-bacterial activity was evaluated by agar disc diffusion method. Test solution were prepared known weight of different solvent extracts dissolved in 5% dimethyl sulphoxide (DMSO). What man No. 1 sterile filter paper discs (5mm) were impregnated with 20 ul of these extracts and allowed to dry at room temperature. The spread plates were prepared by proper concentration of inocula. Each sample loaded disc was placed in the seeded agar plate. After 24 - 48 hours of 37°c incubation, the diameter of the inhibition zone was measured. For positive control, amphicillin disc (100 mg/ml) was used, whereas for negative control, respective solvents were loaded on the sterile disc.

FT-IR (Fourier transforms infra-red spectroscopic analysis

(Vijayabasker and Shiyamala, 2012)

Ten milligram of *Catharanthus roseus* leaf and powder with 100 mg of dry potassium bromide (FI-IR grade) and then compressed into a pellet using hydraulic press

(5000 – 10000 psi). The pellet was immediately put into the sample holder and FT – IR (Systronics 166) spectra were recorded in the range of 400 to 4000 cm -1.

ANTHELMINTIC ACTIVITY:

This antheminthic activity assay was carried as per the method followed by Islam *et al.,* 2015 with minior modification.

Preparation of extracts:

Dried powder of *(Catharanthus roseus*) 1 (Grams) was extracted with 10 ml of various type of solvent extracts (acetone, ethanol, methanol, benzene and aqueous). The filtrate was collected and concentrated till a syrupy mass was obtained and dried at room temperature. The dried extracts were dissolved in normal saline and used for anthelmintic activity.

Experimental animal:

Anthelmintic activity was performed on adult earth worm *Pheretima posthuma* due to its anatomical and physiological resemblance with the intestinal round warm parasite of human beings (Chatterjee, 1967). The Indian adult earthworms were collected from moist soil of the field and washed with normal water identified from the Department of Zoology, St. Mary's college (Autonomous), Thoothukudi. The earthworms of 10-15 cm in length and 0.22-0.3 cm in width were used for all experimental parameters.

Experimental design:

In the present investigation the earthworms were divided into the following 12 group consists of 3 earthworms.

Group I: Earthworms were placed in normal saline and served as control.

Group II: Earthworms were placed in standard drug of albendazole at the dose of 100mg/ml served as standard.

Group III: Earthworms were placed in ethanol extracts of *Catharanthus roseus* leaf at the dose of 100mg/ml.

Group IV: Earthworms were placed in ethanol extracts of *Catharanthus roseus* flower at the dose of 100mg/ml.

Group V: Earthworms were placed in benzene extracts of *Catharanthus roseus* leaf at the dose of 100mg/ml.

Group VI: Earthworms were placed in benzene extracts of *Catharanthus roseus* flower at the dose of 100mg/ml.

Group VII: Earthworms were placed in methanol extracts of *Catharanthus roseus* leaf at the dose of 100mg/ml.

Group VIII: Earthworms were placed in methanol extracts of *Catharanhus roseus* flower at the dose of 100mg/ml.

Group IX: Earthworms were placed in acetone extracts of *Catharanthus roseus* leaf at the dose of 100mg/ml.

Group X: Earthworms were placed in acetone extracts of *Catharanthus roseus* flower at the dose of 100mg/ml.

Group XI: Earthworms were placed in aqueous extracts of *Catharanthus roseus* leaf at the dose of 100mg/ml.

Group XII: Earthworms were placed in aqueous extracts of *Catharanthus roseus* flower at the dose of 100mg/ml.

RESULT AND DISCUSSION

CHAPTER V

RESULT AND DISCUSSION;

Phytochemical constituents in plant samples are considered to be biologically active compounds with a variety of functions including antioxidant, antimicrobial, antifungal,hypoglycemic, anti-diabetic, anti-inflammatory anticarcinogenic properties. (Hossain and Nagooru, 2011, Suresh and Nagaran, 2009).

The leaf, stem, flower and root extracts of *Catharanthus roseus* prepared in five different solvents such as ethanol, methanol, benzene, acetone and aqueous were evaluated for the presence of different phytochemicals and the result obtained were presented in table 1, 2, 3, 4. The phytochemical analysis of *Catharanthus roseus* showed good result for all major phytoconstituents. The qualitative analysis revealed the presence of alkaloid, terpenoid, phenol, tannins, sugar, saponin, flavanoid, quinine, proteins and steroids. The medicinal value of these plants rich in some chemical substances that have a definite physiological action on human body. Methanol, benzene and aquous extracts of *Catharanthus roseus* leaf states the presence of alkaloid. Ethanol, methanol, acetone, aqueous extracts of *Catharanthus roseus* flower revealed the presence of alkaloid. Ethanol, methanol, benzene, acetone and aqueous extracts of *Catharanthus roseus* root revealed the presence of alkaloid. Ethanol and acetone extract of *Catharanthus roseus* stem reported the presence of alkaloid compounds.

Alkaloid had been reported as cytotoxicity (Thite *et al.,* 2013), antimalarial (Dua *et al.,* 2013) sympathomimetic, vasodilator, antihypertensive, and antipyretic (Hesse *et al.,* 2002) and some psychoactive drugs namely methamphetamine, mphetamine and so on produced from isolated alkaloids (Veselovskaya and kovalenko, 2000).

Ethanol, methanol,benzene and acetone extract of *Catharanthus roseus* leaf gives the presence of terpenoid. Ethanol, methanol, benzene, acetone and aqueous extract of *Catharanthus roseus* flower revealed the presence of terpenoids. Ethanol, benzene and acetone extract of *Catharanthus roseus* root states the presence of terpenoid. Plant terpenoid served as anti-microbial, anti-oxidant, anti-cancer, neuro-protective and chemo-protective properties (Malik *et al.,* 2012)

Terpenoid had been reported as anti-microbial, anti-oxidant and blood purifying compounds (Ravikumar *et al.,* 2014). Anti-diabetic properties (Zengin*et al.,* 2014).Anti-cancer properties (

Bidarigh *et al.,* 2011). Anti-oxidant, anti-bacterial and anti-cancer compounds (Hamidpour *et al.,* 2015). Cancer, cognitive dysfunction, epilepsy, insomnia, rheumatism, gout and dyspepsia (Lekha *et al.,* 2010). Anti-cancer agents in clinical traits cytotoxicity, anti-cancer (Roslin Thoppil and Avpam Bishayee 2011)

Catharanthus roseus root extract in ethanol, methanol and acetone concealed the presence of phenol and tannins. *Catharanthus roseus* leaf extract in ethanol and methanol, benzene and aqueous extract showed the presence of phenol and tannins. *Catharanthus roseus* flower extract in ethanol, methanol, acetone and aqueous revealed the presence of phenol.

Several epidemiological studies have shown beneficial effect of polyphenol in cancer, cardiovascular and neurological disease. The health benefits associated with polyphenol containing preparation consumption have also been corroborated in animal studies of cancer chemoprevention, hyper cholesterolemia, antherosclerosis, Parkinson's disease, alzheimer's disease (Zaveri *et al., 2003*)

Tannins have astringent properties, accelerate the healing of wounds and inflamed mucous membrane. Tannins are also testified to have various physiological effect like anti-parastic, anti-irritant, ant-iscretolytic and anti-microbial activities.Plant containing tannin are used to treat non-specific diarrhea and inflammation of the mouth. (Ojewole, 2005)

The ethanolic extract of *Catharanthus roseus* leaf conclude the presence of sugar. The methanol extract of *Catharanthus roseus* stem reveals the presence of sugar. The aqueous extract of *Catharanthus roseus* root gives the presence of sugar. Sugar had been reported as anti-hypersensitive properties (Aumeeruddy and Aumeerdy-Elafiz- 2019)

The benzene and ethanol extract of *Catharanthus roseus* root and stem reveals the presence of saponin. The benzene extract of *Catharanthus roseus* stem reveals the presence of the saponin. The Benzene and aqueous extract of *Catharanthus roseus* flower reveals the presence of the saponin. The ethanol and benzene extract of *Catharanthus roseus* leaf reveals the saponin. The saponins possess both beneficial (cholesterol-lowering) and deleterious (cytotoxic permeabilization of the intestine) properties and also exhibit structure dependent biological activities (Van Burden *et al ., 1*981) saponins cause a reduction of blood cholesterol by preventing its reabsorbtion which makes it useful in cardiovascular disease (Osagie *et al.,* 1998)

Saponins have antitumor and anti- mutagenic activities and can lower the risk of human cancers, by preventing cancer cells from growing. Human Saponins serves as immune system booster and also protect against viruses and bacteria. The non-sugar part of saponins has a direct antioxidant activity which may result in reduced risk of cancer and heart diseases (Rao *et al.,* 2012)

Saponin was in highest concentration categories among two selected plants and has the property of precipitating and coagulating red blood cells. (Francis *et al.,* 2002)Some of the characteristics of Saponins; Include formation of foams in aqueous solutions, haemolytic activity, and cholesterol binding properties and bitterness (Okwu*et al.,* 2004).

Stem of *Catharanthus roseus* showed the presence of flavonoid in ethanol, methanol and aqueous extract. Methanol extract of *Catharanthus roseus* root tell the presence of flavanoids. Acetone, ethanol,methanol and benzene extract of *Catharanthus roseus* flower exposed the presence of flavanoids. Flavanoids are powerful antioxidants and free radical scavengers that protect cells from oxidative damage *(*Salah *et al.,* 1995).

Flavanoids have several functions as an antioxidant, antibacterial, anti-inflammation, anti-allergy and anti-mutagenic (Alan,*et al.,* 1996) .

Ethanol extract of *Catharanthus roseus* root divulge the presence of quinine. Ethanol extract of *Catharanthus roseus* flower reveals the presence of quinine. Benzene extract of *Catharanthus roseus* leaf reveals the presence of quinine. Diabetic and wound healing property (Zhou *et al.,* 2009)

Ethanol, benzene and aqueous extract of *Catharanthus roseus* flower revealed the presence of protein. Benzene and aqueous extract of *Catharanthus roseus* stem revealed the presence of protein. Methanol extract of *Catharanthus roseus* root revealed the presence of protein. Ethanol, methanol and aqueous extract of *Catharanthus roseus* leaf reveals the presence of protein. Protein serve as an alternative source of energy. (Schoonhaven *et al.,*2005).

Methanol, ethanol and aqueous extract of *Catharanthus roseus* flower states the presence of steroid. Benzene extract of *Catharanthus roseus* stem reveals the presence of steroid. Ethanol, methanol and acetone extract of *Catharanthus roseus* leaf reveals the presence of steroids. Ethanol extract of *Catharanthus roseus* root reveals the presence of steroids. Steroid have analgesic and antibacterial, insecticidal properties. (Sayyah*et al.,*2000).

Alkaloids, sugar, tannin, phenols, flavanoids, steroid and saponin are these secondary metabolities found in *Catharanthus roseus*. They have a high therapeutic value and are commonly used in pharmacy and drug industries.

Preliminary phytochemical anaylsis of *Catharathus roseus* leaf:

Phytochemical anaylsis of *Catharanthus roseus* leaf extract was carried out in ethanol, methanol, benzene, acetone and aqueous extracts and results are shown below

Figure1: Phytochemical test of Ethanol extract

Figure 2: Phytochemical test of Methanol extract

Figure 3: Phytochemical test of benzene extract

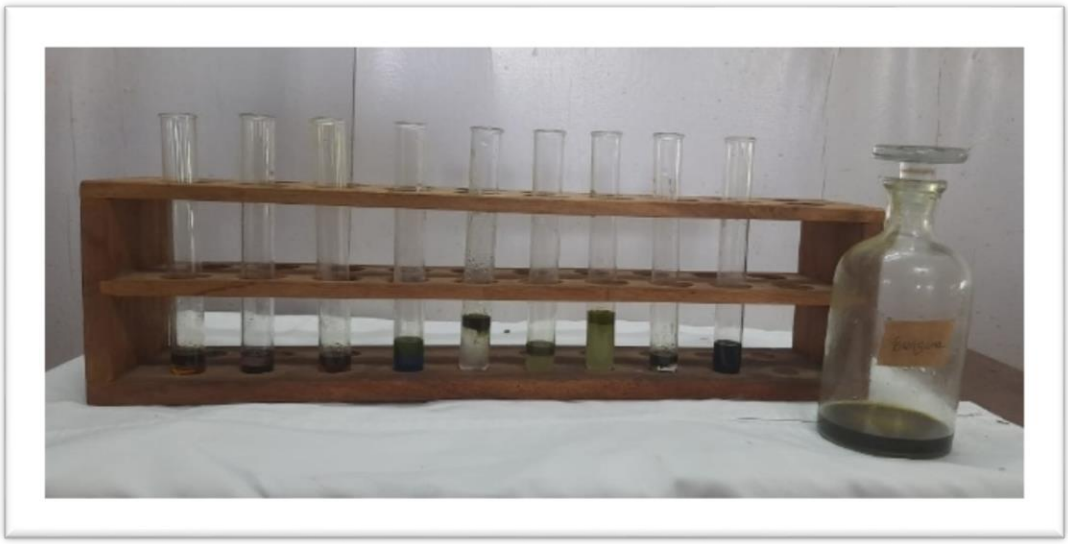


Figure 4: Phytochemical test of acetone extract

Figure 5: Phytochemical test of aqueous extract

Preliminary phytochemical anaylsis of *Catharanthus roseus* flower:

Phytochemical anaylsis of *Catharanthus roseus* flower extract was carried out in ethanol, methanol, benzene, acetone and aqueous extracts and results are shown below

Figure 6: Phytochemical test of Ethanol extract

Figure 7: Photochemical test of Methanol extract

Figure 8: Phytochemical test of benzene extract

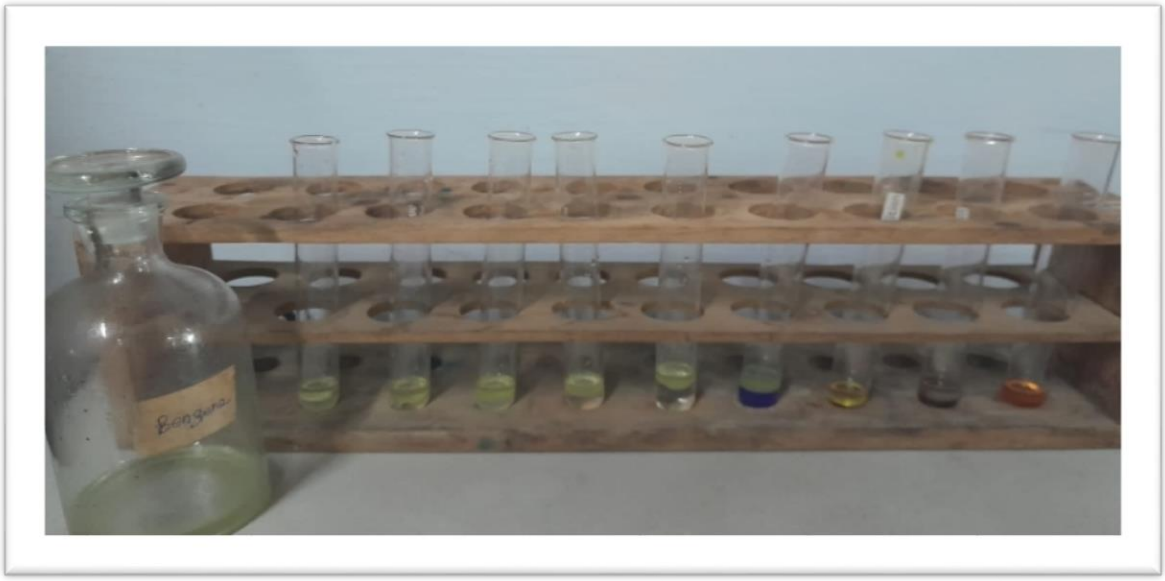


Figure 9: Phytochemical test of acetone extract

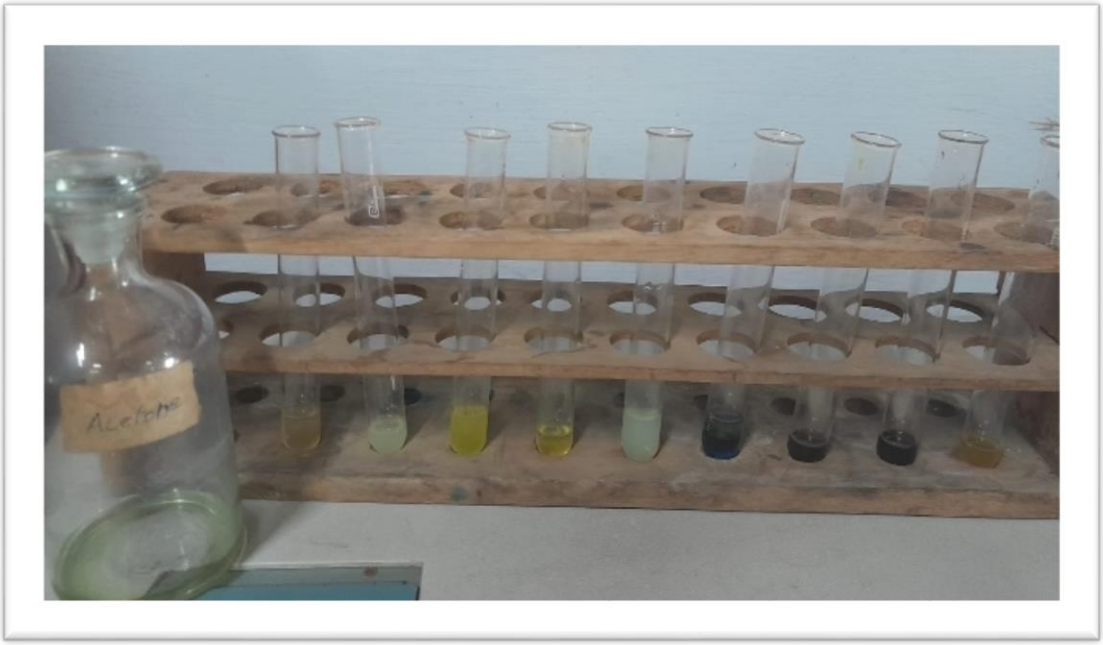


Figure 10: Phytochemical test of aqueous extract

Preliminary phytochemical anaylsis of *Catharathus roseus* stem:

Phytochemical anaylsis of *Catharanthus roseus* stem extract was carried out in ethanol, methanol, benzene, acetone and aqueous extracts and results are shown below

Figure11: Phytochemical test of Ethanol extract

Figure 12: Phytochemical test of Methanol extract

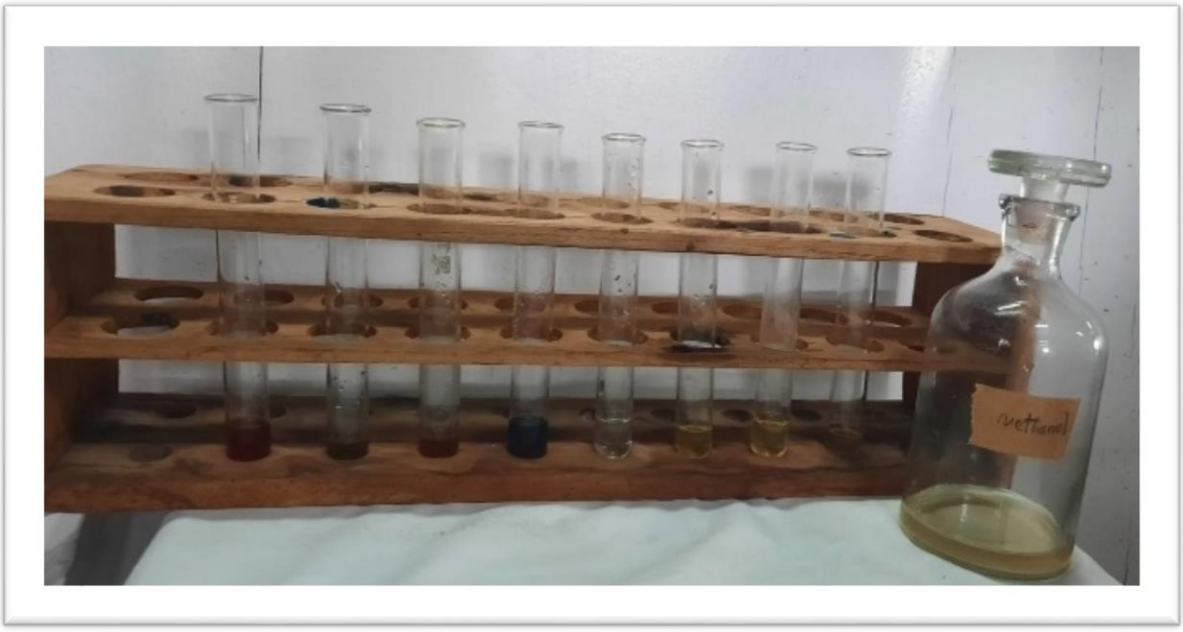


Figure 13: Phytochemical test of benzene extract

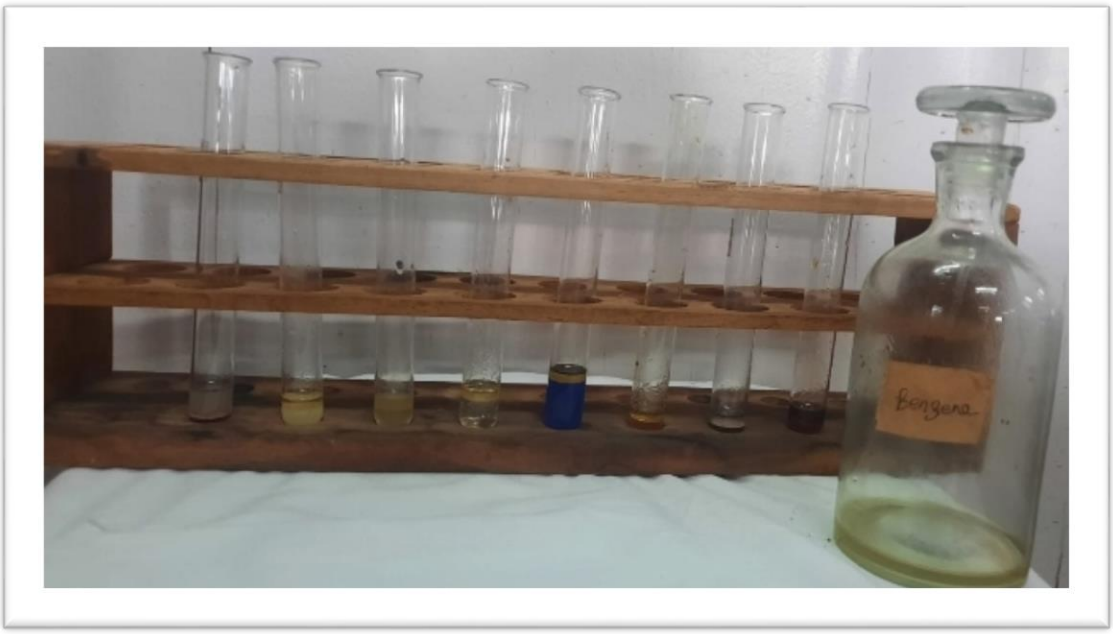


Figure 14: Phytochemical test of acetone extract

Figure 15: Phytochemical test of aqueous extract

Preliminary phytochemical anaylsis of *Catharanthus roseus* root:

Phytochemical anaylsis of *Catharanthus roseus* root extract was carried out in ethanol, methanol, benzene, acetone and aqueous extracts and results are shown below

Figure16: Phytochemical test of Ethanol extract

Figure 17: Phytochemical test of Methanol extract

Figure 18: Phytochemical test of benzene extract

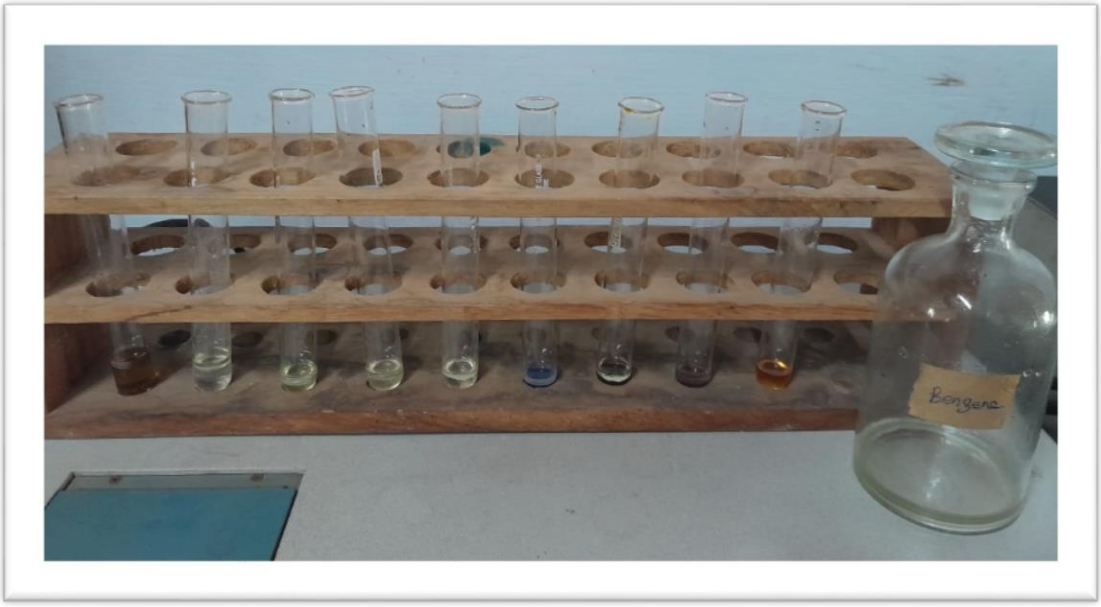


Figure 19: Phytochemical test of acetone extract

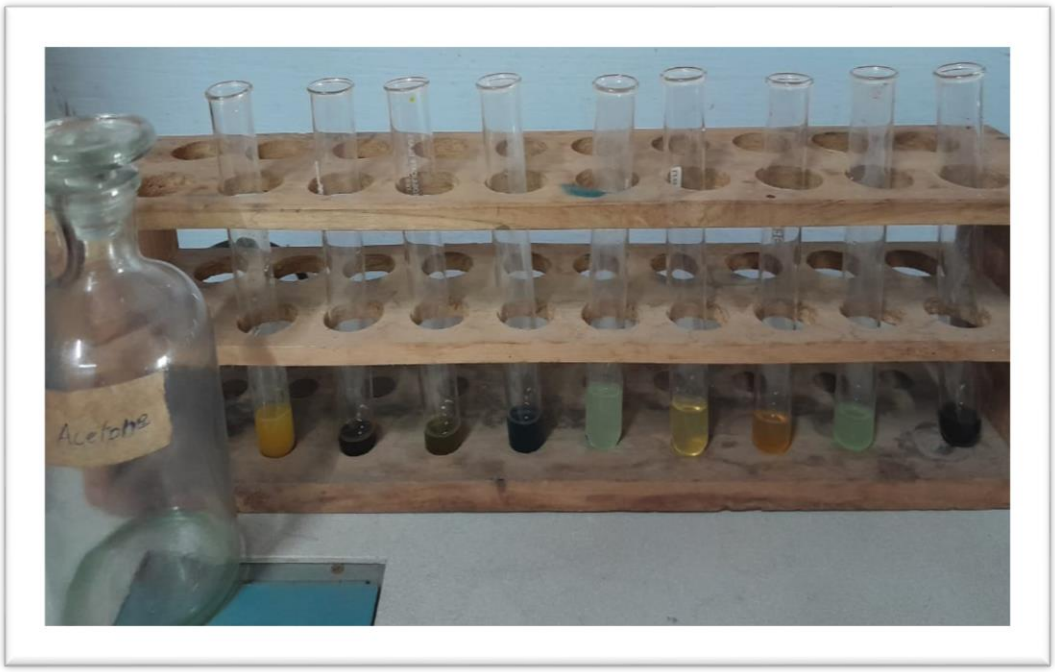


Figure 20: Phytochemical test of aqueous extract

Table 1 : Preliminary phytochemical analysis of *Catharanthus roseus* leaf

S.NO	Phytochemical	Extracts				
		Ethanol	Methanol	Benzene	Acetone	Aqueous
1.	Alkaloids	_	++	+	_	++
2.	Terpenoids	+++	++	+++	+ +	_
3.	Phenols and Tannins	+ ++	+ ++	++	_	++
4.	Sugar	+	_	_	_	_
5.	Saponins	+++	_	+++	_	_
6.	Flavonoids	_	+	+++	_	++
7.	Quinine	_	_	+++	_	_
8.	Protein	+	+	_	_	+++
9.	Steriods	+	++	_	++	_

+ + + High
+ + Moderate
+ Low
_ Absence

Table 2 : Preliminary phytochemical anaylsis of *Catharanthus roseus* flower

S.NO	Phytochemicals	Extracts				
		Ethanol	Methanol	Benzene	Acetone	Aqueous
1.	Alkaloids	+	+	_	+	+
2.	Terpenoids	+++	+++	+++	+	+++
3.	Phenols and Tannins	+++	+++	_	+++	+++
4.	Sugar	_	_	_	_	_
5.	Saponins	_	_	+++	_	+
6.	Flavonoids	+	+++	+	+++	_
7.	Quninine	+	_	_	_	_
8.	Protein	+	_	+	_	+
9.	Steroids	+	+	_	_	+

Table 3: Preliminary photochemical analysis of *Catharathus roseus* stem

S.NO	Phytochemical	Extracts				
		Ethanol	Methanol	Benzene	Acetone	Aqueous
1.	Alkaloids	+++	_	_	+	_
2.	Terpenoids	_	_	_	_	_
3.	Phenol and Tannins	_	_	_	_	_
4.	Sugar	_	++	_	_	_
5.	Saponins	_	_	+	_	_
6.	Flavonoids	++	++	_	_	+
7.	Quninine	_	_	_	_	_
8.	Protein	_	_	+	_	+
9.	Steroids	_	_	+	_	_

+ + + High

+ + Moderate

+ Low

- Absence

Table 4 : Preliminary phytochemical analysis of *Catharanthus roseus* root

S.NO	Phytochemical	Extracts				
		Ethanol	Methanol	Benzene	Acetone	Aqueous
1.	Alkaloids	+++	+++	+	++	++
2.	Terpenoids	+	_	+	+	_
3.	Phenols and Tannins	+ +	++	_	+	_
4.	Sugar	_	_	_	_	+
5.	Saponins	+	_	+	_	_
6.	Flavonoids	_	++	_	_	_
7.	Quinine	+	_	_	_	_
8.	Protein	_	+	_	_	_
9.	Steroids	++	_	_	_	_

+ + + High

+ + Moderate

+ Low

\- Absence

ANTIBACTERIAL ACTIVITY OF *CATHARANTHUS ROSEUS* FLOWERS AND LEAVES:

Bacterial infection causes life threatening diseases and a high incidence of mortality in both animals and humans. *Bacillus subtilis* is gram +ve bacteria is responsible *for* food borne diseases gastroenteritis, sinus and urinary tract infections. *E. coli* and *Staphylococcus aureus* are cause diseases like mastitis, urinary tract infections and endocarditis.

Alkaloids are the most potent active chemical constituents of *Catharanthus roseus.* More than 400 alkaloids are present in the plant, which used as pharmaceuticals, agrochemicals, flavor and fragrance, ingredients, food additives, and pesticides (Satyarsa, 2019). The alkaloids like active plastidemeric, vinblastine, vincristine, vindesine. Rosindin is an anthocyanin pigment found in the flower of *Catharanthus roseus* (Sain and Sharma 2013). Hence in this investigation bacterial property of *Catharanthus roseus* leaf and flower were extracted with various solvents (ethanol, methanol, benzene, acetone and aqueous) were tested against human pathogens such as *E.coli, Bacillus subtilis* and *Staphylococus aureus* and were presented in the table (5 to 6). The diameter of the inhibition zones against these species ranged from 5 to 25mm. The study revealed that all extracts inhibited the growth of all the pathogens tested. As shown in Table 5. Ethanolic extracts of *Catharanthus roseus* leaf exhibited maximum activity against *E.coli* (11 mm). Similarly benzene and aqueous extract of *Catharanthus roseus* inhibited the growth *of E.coli* by showing (8 mm) of inhibition zone. The moderate sensitivity was noted in acetone and aqueous extract against *Staphylococus aureus* and *Bacillus subtilis* (6 mm). The acetone extract of *Catharanthus roseus* leaf showed less sensitivity and resistant to *Bacillus subtilis* (5 mm).

Antibacterial activity of *Catharanthus roseus* flower is represented in Table (6). Aqueous extract of *Catharanthus roseus* flower was more active against *Staphylococus aureus* (11 mm). It was found that acetone extract of *Catharanthus roseus* flower was ineffective in controlling all the three pathogens tested. However methanol and benzene extracts of *Catharanthus roseus* flower had insignificant impact over the *E.coli* and *Bacillus subtilis*. Benzene extract portrayed higher inhibition on *Staphylococcus aureus* (9 mm). Aqueous extract of *Catharanthus roseus* flower showed less inhibitory activity against *E.coli* (6 mm).

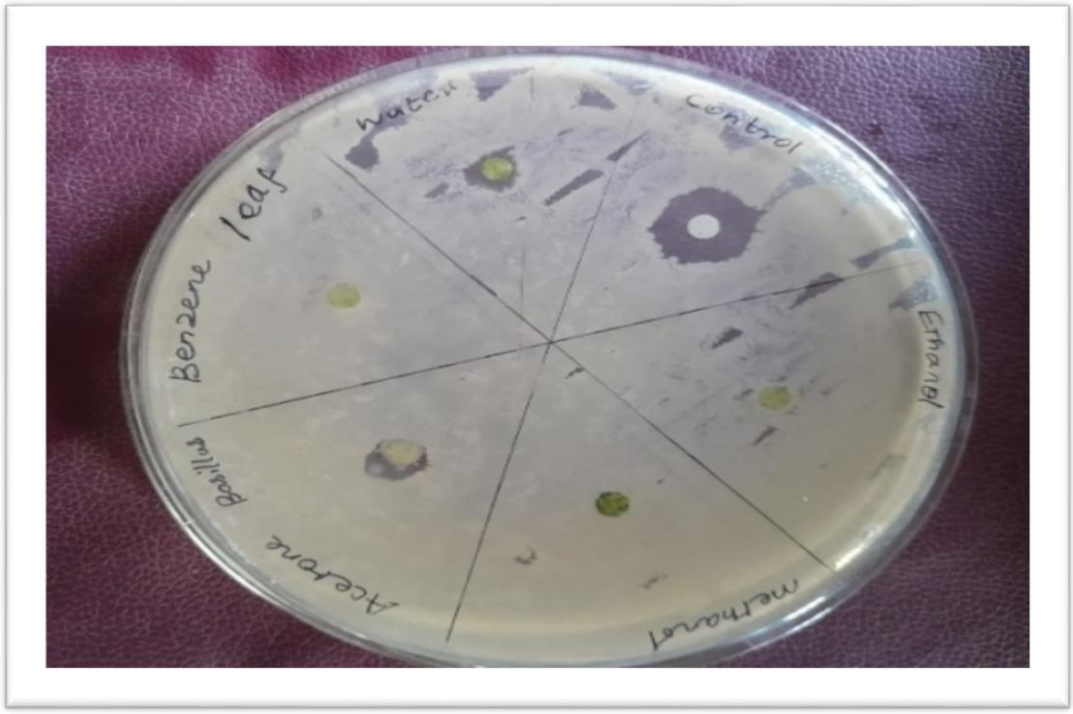
According to Prasanna and Ragunanthan 2014 in most cases the ethanol extracts exhibited higher antibacterial effects than the corresponding extracts. The high antibacterial activity in both

extract due to the presence of tannins, flavonoids and terpenoids. Antimicrobial activity is elicited by these medicinally bioactive components through a variety of mechanisms. Tannins stop cell wall synthesis in its tracks by forming irreversible complexes with proline rich proteins (Mamtha *et al.,* 2004). Saponins have the potential to induce protein leakage (Zablotowicz *et al.,*1996). Terpenois cause the breakdown of a microorganism cell wall by compromising the membranous tissue (Hemandez *et al.,* 2000). Flavonoids are known to be synthesized in response to microbial infection by plants and have been shown to the effective antimicrobial substances against a wide range of microorganisms *in vitro.*

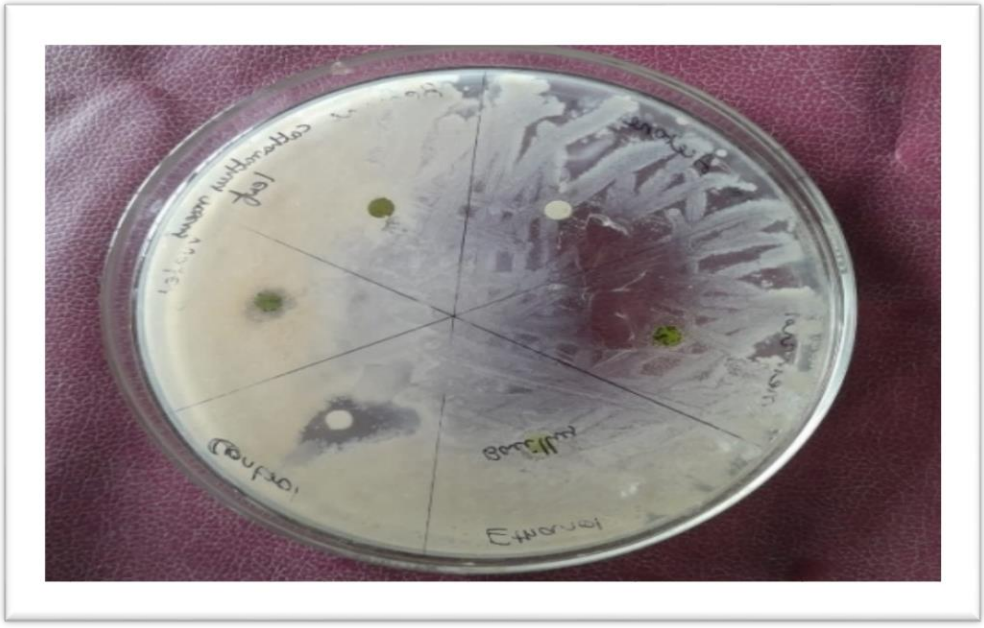
They can form complexes with extra cellular and soluble proteins as well as bacterial cell walls (Marjore, 1999). Steroids also known for their antibacterial activity which is related to membrane lipids and induce liposome leakage (Epand *et.al* 2007). It is observed that the leaf content has more phytochemicals as compare to other plant parts (Jamdhade *et.al.* 2010). (Mekonnen *et al.,* 2018) reported that the antibacterial mechanism of metabolite compound includes denaturation of bacterial protein, disturption of the bacterial cell membrane and inhibition of nucleic acid synthesis process will cause DNA damage thus disturbing bacterial growth. Antibacterial properties of *Catharanthus roseus* extract could breakdown the bacterial cell walls thus inhibiting the growth of bacteria *E. coli* and *Staphylococcus aureus*. (Paikara *et.al* 2017) *Catharanthus roseus* leaf extract consisting of alkaloids, which have antimicrobial activity through the mechanism of structural changes and the overall of the structure of amino acids in the body of microbes. As a result of this, a clear zone was forming as antimicrobial parameters. The presently study *Catharanthus roseus* leaf and flower could be of considerable infers to the development of new life saving drugs. However, further research is required to isolate the bioactive principle of this species as well as further studies on its bio efficiency against human pathogens. Further studies need to conform to identify the particular compounds to used as a drug as the main ingredient in traditional medicine

Plate 1: *Invitro* antibacterial activity of *Catharanthus roseus* leaf against human pathogens

Catharanthus roseus leaf extract aginst *Staphylococcus aureus*



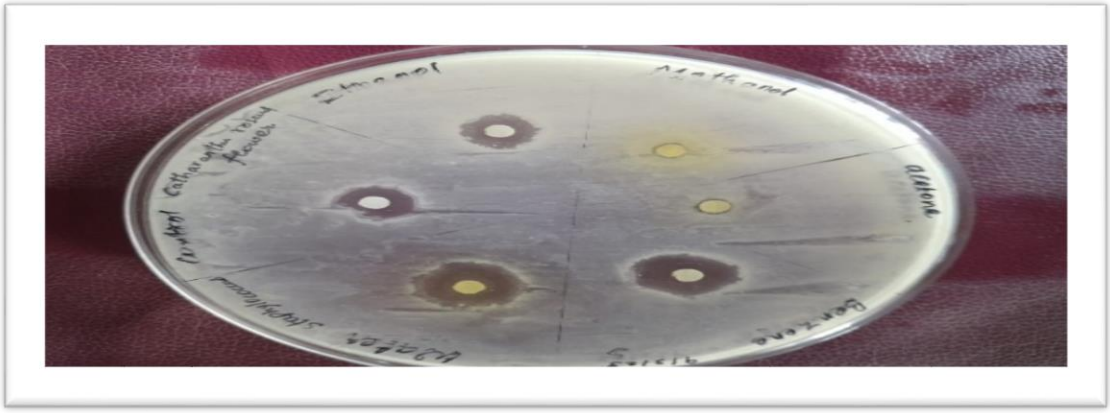
Catharanthus roseus leaf extract against *Bacillus subtilis*



Catharanthus roesus leaf extract against *E.coli*

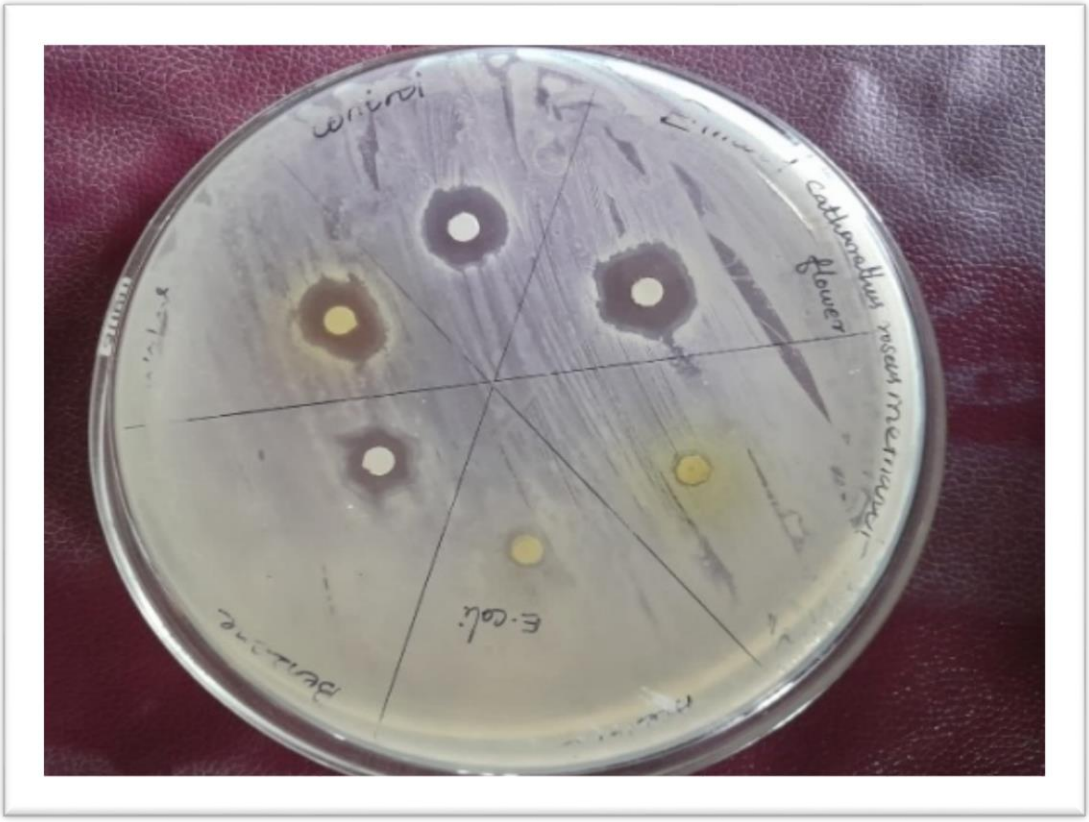
Antibacterial activity is revealed as clear zone around the disc and is represented as zone of inhibition. Ethanol,methanol,benzene,acetone and aqueous extracts of leaf (2.5mg/ml). Amphicillin (100µg/ml) positive control.

Plate 6: *Invitro* antibacterial activity of *Catharanthus roseus* flower against human pathogens



Catharanthus roseus flower extract against *Staphylococcus aureus*

Catharanthus rosus flower extract against *Bacillius subtilis*



Catharanthus roseus flower extract against *E.coli*

Antibacterial activity is revealed as clear zone around the disc and is represented as zone of inhibition. Ethanol, methanol, benzene acetone and aqueous extracts of flower (2.5mg/ml). Amphicillin (100µg/ml)-positive control.

Table 5: Antibacterial activity of different solvents in leaf extracts of *Catharanthus roseus*

S.No	Solvent	Inhibition zone (mm)			
			E.coli	*Bacillus subtilis*	*Staphyloccocus aureus*
1.	Methanol		NS	NS	NS
2.	Benzene		8	NS	NS
3.	Ethanol		11	NS	NS
4.	Acetone		NS	5	6
5.	Aqueous		8	6	NS
6.	Amphicillin		8	9	8

Table 6: Antibacterial activity of different solvents in flower extracts of *Catharathus roseus*

S.No	Solvent	Inhibition zone (mm)		
		E.coli	*Bacilius subtilis*	*Staphyloccous aureus*
1.	Methanol	NS	NS	8
2.	Benzene	NS	NS	9
3.	Ethanol	7	NS	7
4.	Acetone	NS	NS	NS
5.	Aqueous	6	7	11
6.	Amphicillin	7	10	25

Control - Amphicillin (100 mg/ml)

Leaf extract (2.5 µg/ml)

Flower extract (2.5 µg/ml)

NS - No sensitivity

Anthelmintic activity:

Anthelmintic drugs are known to work by paralyzing worms or destroying their cuticle, causing partial digestion or injection through the immune system. It also disturbs worm metabolism, as the metabolic needs of these parasites differ greatly from one species to the next (Aisawanya *et al.,* 2010). Albendazole has been shown to have an effect on worms by destroying the worm's cytoskeletal system, resulting in paralysis (Nikesh *et al.,* 2011). Ethanol, acetone, benzene, methanol and aqueous extract of *Catharanthus roseus* leaves and flowers were used for anthelmintic activity. *Pheretima posthuma* worms can be successfully used for anthelmintic activity research because they are simple, visible, adaptable to laboratory conditions, and reproducible in all aspects, such as worm age, size, and weight (Murugamani *et al*., 2012) In the present anthelmintic activity study, when the time of paralysis and time of death of earthworms were compared between plants exract and standard, the results showed that the time taken for paralysis and death is more closely to standard. Five extracts were tested at 100 mg/ ml concentrations and showed Significant results that were similar to standard and some of the extracts take less time to paralysis and death. Among the leaves and flower extract of *Catharanthus roseus* flower was showed higher significant performance (Table 8) compare to *Catharanthus roseus* leaf (100mg/ml) (Table 7). Acetone methanol, and ethonal leaf extract of *Catharanthus roseus* is showing paralysis at 5 minutes and death of worms at 17 minutes. While death is comparable with that of albendazole as death of worm as observed at 17 minutes.. Anthelmintic activity (Table 7 and 8) and could be promising alternative approach to control helminth infections (Bauri *et al.,* 2015; Sutthaya Poolperm and Wannee Jiraung koorskul, 2017). Alkaloids have been confirmed to have neurotoxic effects, causing worm paralysis by affecting acetylcholinesterase inhibitor. Because glycosides have an antiparasitic effect due to their neurotoxic potential, low concentrations of glycosides in plant materials, when ingested by humans, can contribute to the killing of gastrointestinal worms through its toxic effects (Jain *etal.,* 2013; Velebny, 2013). Phenol and tannis (phytoconstituents) are the active ingredients in anthelmintics.

Tannis can bind to free proteins in the host animal's gastrointestinal tract or glycoprotein on the parasite's cuticle (earthworms) and cause death (Kane, 2009; Gnaneswari *et al.,* 2013). Flavonoids found in this study can inhibit larval growth and arachidonic acid metabolism, which can lead to neurodegeneration in the worm's body and death. (SutthayaPoolperm and Wannee

Jiraung koorskul, 2017). Saponin works as on anthelmintic by inhibiting the enzyme acetyl cholinesterase, which causes worms to become paralyzed and die. They have been effect on the permeability of worm cell membranes and can irritate the gastrointestinal mucous membrane channel of worms, interfering with food absorbtion. (Melzig *et al*., 2001). The wormicidal activity is due to the presence of alkaloids, glycosides, flavonoids, saponin, phenol and tannin content in both plants. Further, in future it is necessary to identify and isolate the possible active phytoconstituents responsible for the anthelmintic activity.

Plate 3: Invitro anthelminthic activity of *Catharanthus roseus* leaf

Control – normal saline

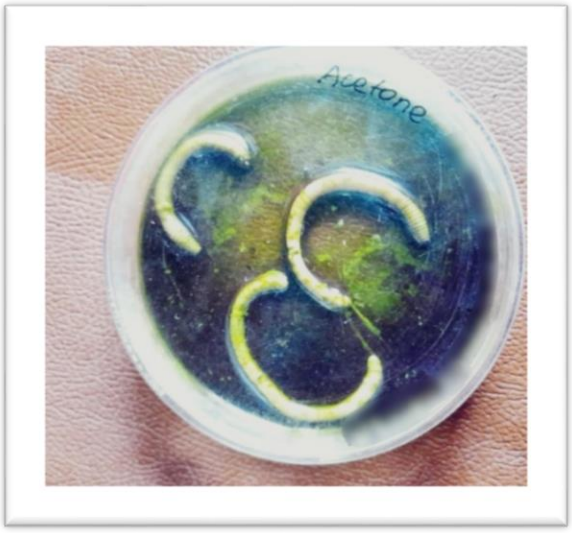
Standard drug Albendazole (100mg/ml)

Aqueous extract of *Catharanthus roseus* leaf (100mg/ml)

Benzene extract of *Catharanthus roseus* leaf (100mg/ml)

Methanol extract of *Catharanthus roseus* leaf(100mg/ml)

Ethanol extract of Catharanthus roseus leaf(100mg/ml)



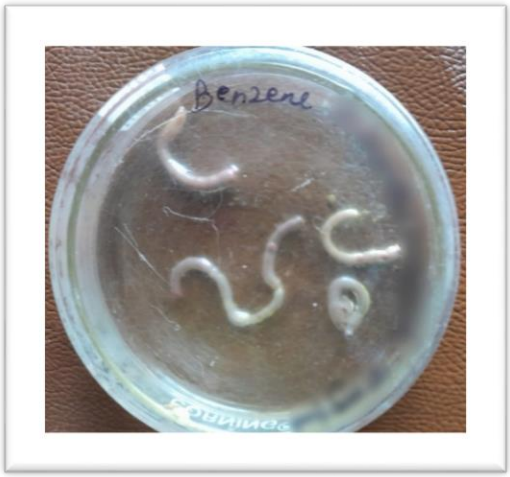
Acetone extract of *Catharanthus roseus* leaf (100mg/ml)

Plate 4: *Invitro* anthelmintic activity of *Catharanthus roseus* flower

Control – normal saline

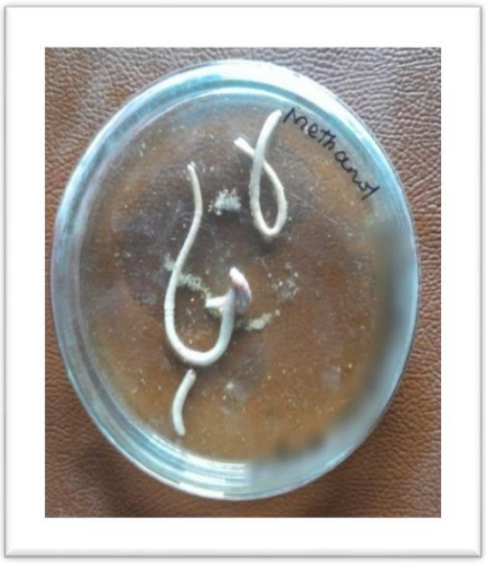
Standard drug Albendazole (100mg/ml)

Aqueous extract of *Catharanthus roseus* flower (100 mg/ml)



Benzene extract of *Catharanthus roseus* flower (100 mg/ml)

Acetone extract of *Catharanthus roseus* flower (100 mg/ml)



Methanol extract of *Catharanthus roseus* flower (100 mg/ml)

Ethanol extract of *Catharanthus roesus* flower (100mg/ml)

Table 8: Anthelimintic activity of flower extracts of *Catharathus roseus*

Treatment	Group	Concentration Mg/ml	Time taken Paralysis (min)	Time taken for death (min)
Control (Saline)	I	-	-	-
Standard (Albendazole)	I	50mg/ml	10	15
Ethanol	I	50mg/ml	5	10
Benzene	I	50mg/ml	10	15
Methanol	I	50mg/ml	5	10
Acetone	I	50mg/ml	5	10
Aqueous extract	I	50mg/ml	15	20

Table 9 : Anthelmintic activity of leaf extracts of *Catharathus roseus*

Treatment	Concentration Mg/ml	Time taken Paralysis (min)	Time taken for death (min)
Control (Saline)	–	–	–
Standard (Albendazole)	100mg/ml	15	17
Ethanol	100mg/ml	18	23
Benzene	100mg/ml	10	24
Methanol	100mg/ml	5	17
Acetone	100mg/ml	8	25
Aqueous extract	100mg/ml	15	29

Fourier Transform Infra – red spectroscopy analysis:

Fourier Transform Infra – red spectroscopy measurement spectrum were carried out to identify the possible biomolecules responsible for the antimicrobial properties. The FTIR spectra to medicinal plant were depicted in table 9 and 10. The representive spectrum of *Catharanthus roseus* flower showed the absorption peaks located at 3277.8, 2925.81, 2853.49, 2375.17, 2314.42, 1746.42, 1656.74, 1606.59, 1546.8, 1511.12, 1456.16, 1364.54, 1317.29, 1234.36, 1163.96, 1106.1, 1027.99, 894.91, 831.26, 781.12, 699.15, 638.39, 541.96, 516.89. Showing the presence of biomolecules such as Alkyne (strong), Alkane (medium), Carbon-di oxide (strong), Secondary amides (strong), Aromatics (medium), Alkene 1 propane (strong), Carboxylate (strong), Diketone (medium), Amide (strong), Vinyl terminal (medium), Alkyl (strong), Alkyl amine (weak), Secondary alcohol (strong), Cycloalkanes (medium), Alkene (medium), Alkane (strong), Secondary amides (strong), Aromatic methane (strong), Halogen compound (weak), Amide (strong). FTIR spectrum of *Catharanthus roseus* leaf showed the peak at 3422.45, 2934.49, 2360.71, 1748.35, 1656.74, 1546.8, 1511.12, 1419.51, 1318.25, 1234.36, 1047.27, 781.12, 698.18, 618.14, 517.85cm, Secondary amides (strong), Aromatic methane (strong), Halogen compound (weak), Amide (strong). FTIR spectrum of *Catharanthus roseus* leaf showed the peak at 3422.45, 2934.49, 2360.71, 1748.35, 1656.74, 1546.8, 1511.12, 1419.51, 1318.25, 1234.36, 1047.27, 781.12, 698.18, 618.14, 517.85cm-1. Showing the presence of Primary amine (weak to medium), Aldehydic (variable), Aldehyde (strong), Acid anyhydrides (strong), Diketone (strong), Secondary amines (weak), Vinyl terminal (medium), O-H bending (medium), Amine (strong), C-O bond (medium), Alkyl (strong), Aromatic band (very broad), C-H bending vibration (medium), Halogen compound (strong). Alkyne, Alkane belongs to the class of unsaturated aliphatic hydrocarbons, present in both the sample. Alkyl compounds are extremely toxic to insects but not as toxic to mammals, especially, humans.so it has antifungal, antimicrobial, anti helminthic properties.

Figure : 9 FTIR spectrum of *Catharanthus roseus* leaf

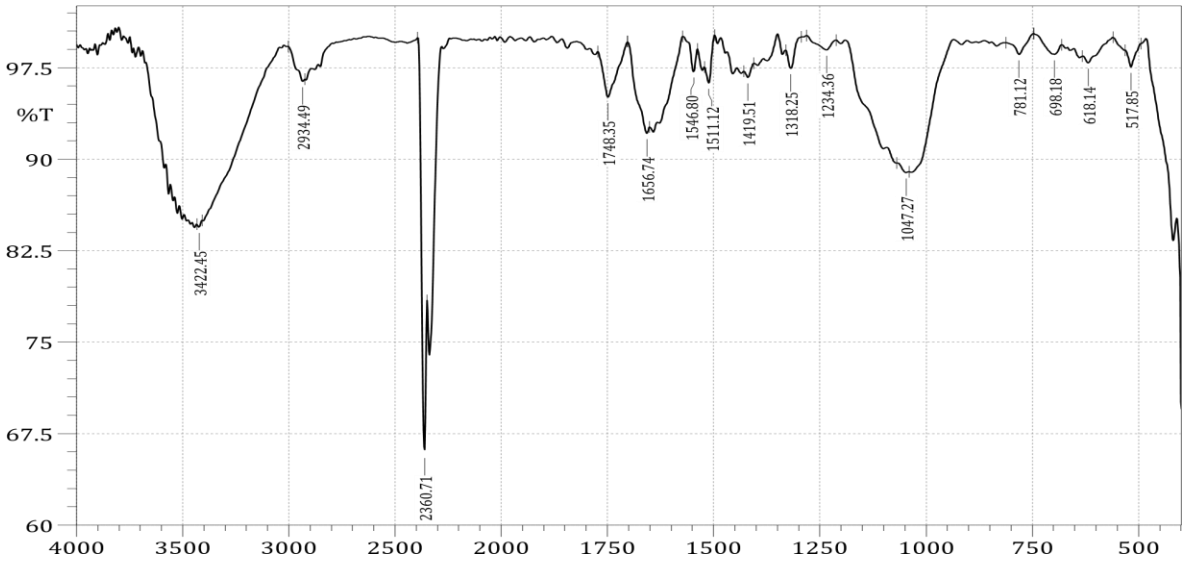


Table : Interpretation

FTIR spectral qualities interpretation of the compararative shift in functional peaks of critical value (*Catharanthus roseus*) leaf.

S.NO	Absorption freqncy cm-1	Intensity
1	517.85	Halogen compound (strong)
2	618.14	C-H bending vibration (medium)
3	698.18	Aromatic band (very boad)
4	781.12	Alkane (strong)
5	1047.27	C-O bond (medium)
6	1234.36	Alkyl (strong)
7	1318.25	O-H bending (medium)
8	1419.51	Vinyl terminal (medium)
9	1511.12	Secondary amine (weak)
10	1546.8	Secondary amine (strong)
11	1656.74	Diketone (weak)
12	1748.35	Acid anyhydrides (strong)
13	2360.71	Aldehyde (strong)
14	2934.49	Aldehydic (variable)
15	3422.45	Primary amines (weak to medium)

Figure : 10 FTIR spectrum of *Catharanthus roseus* flower

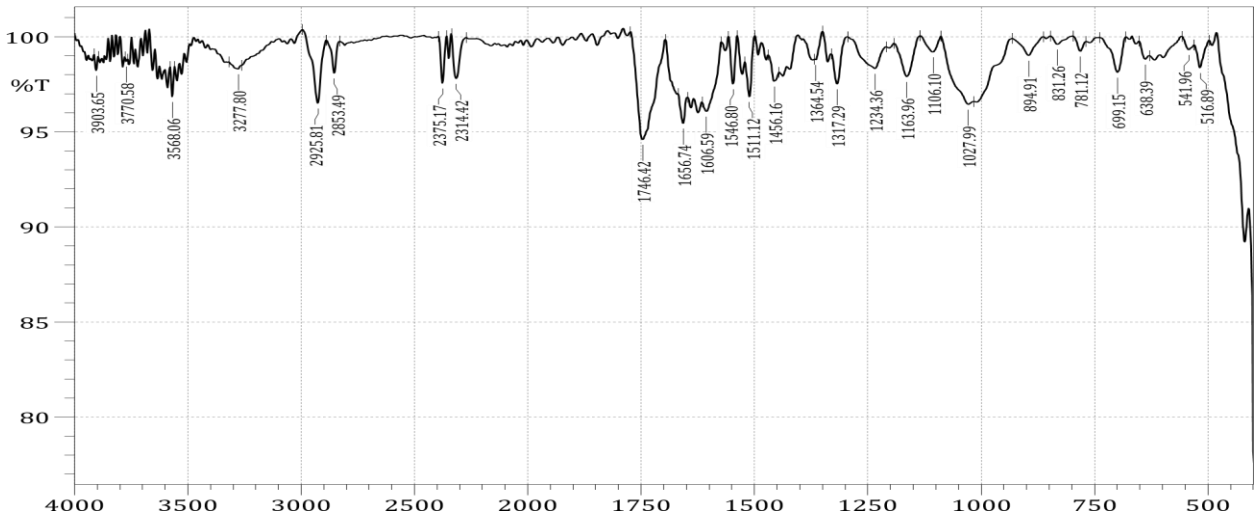


Table : Interpretation

FTIR spectral qualities interpretation of the comparative shift in functional peaks of critical value (*Catharanthus roseus*) flower

S.NO	Absorption frequency (cm)	Intensity
1	516.89	Amide (strong)
2	541.6	Halogen compound (weak)
3	638.39	Aromatic methane (strong)
4	699.15	Secondary amides (strong)
5	781.12	Alkene (strong)
6	831.26	Alkene (medium)
7	894.91	Cycloalkanes (medium)
8	1027.99	Secondary alcohol (strong)
9	1106.1	Alkyl amine (weak)
10	1163.96	Isopropyl (strong)
11	1234.36	Alkyl (strong)
12	1317.29	Carboxylates (strong)
13	1364.54	Isopopyl group (strong)
14	1456.16	Vinyl terminal (medium)
15	1511.12	Amide (strong)
16	1546.8	Diketone (medium)
17	1606.59	Carboxylate (strong)
18	1656.74	Alkene 1 propane (strong)
19	1746.42	Aromatics (medium)
20	2314.42	Secondary amides (strong)
21	2375.17	Carbon-di- oxide (strong)

22	2853.49	Methoxy (medium)
23	2925.81	Alkane (medium)
24	3277.8	Alkyne (strong)

SUMMARY AND CONCLUSION

CHAPTER – VI

SUMMARY AND CONCLUSION

India is richly endowed with a wide variety of plants having medicinal value. These plants are commonly used by people from all walks of life, either as folk remedies or as medicinal preparations for modern medicine. Phytochemicals with biological activity have a lot of applications in terms of pharmaceuticals and pharmacological effects. The preliminary phytochemical studies revealed the presence of phytoconstituents such as alkaloids, terpenoids, phenols, tannins, sugar, saponins, flavanoids, quinine, protein and steroids.

Medicinal plants have antimicrobial properties. The leaf and flower extract of *Catharanthus roseus* have the antibacterial activity. As shown in Table 5, ethanolic extracts of *Catharanthus roseus* leaf exhibited maximum activity against *E. coli* (11 mm). Similarly benzene and aqueous extracts of *Catharanthus roseus* inhibited the growth of *E. coli* by showing 8mm of inhibited zone. The moderate sensitivity was noted in acetone and aqueous extract against *Staphylococcus aureus* and *Bacillus subtilis* (6 mm). The acetone extract of *Catharanthus roseus* leaf showed less sensitivity and resistant to *Bacillus subtilis* (5 mm). Leaf and flower extract showed the functional groups such as amines, aromatic acid, methane and cyclokanes, alkyl, alkane that are responsible for antimicrobial activity. Five extracts were tested for anthelmintic activity at 100 mg/ml concentrations and showed significant results that were similar to standarad and some of the extracts take less time to paralysis and death. Among the leaves and flower extract of *Catharanthus roseus* flower was showed higher significant performance (Table 8) compare to *Catharanthus roseus* leaf (100 mg/ml) (Table 7). Acetone, methanol, and ethanol leaf extract of *Catharanthus roseus* is showing paralysis at 5 minutes and death of worms at 17 minutes. Anthelmintic activity (Table7 and 8) and could be promising alterntaive approach to control helminth infections. It is concluded in that present study extract of *Catharanthus roseus* contain potential components that may be useful for evolution of pharmaceutical for the therapy of ailments. Although the extract have active plant principle such as alkaloids, flavonoids, terpenoids, phenols, tannins were observed in these extracts. The study has justified the use of the plant is ethanomedicine. Further studies need to conform to identify the particular compounds to use as a drug as the main ingredient in traditional medicine.

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CHAPTER- VII

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