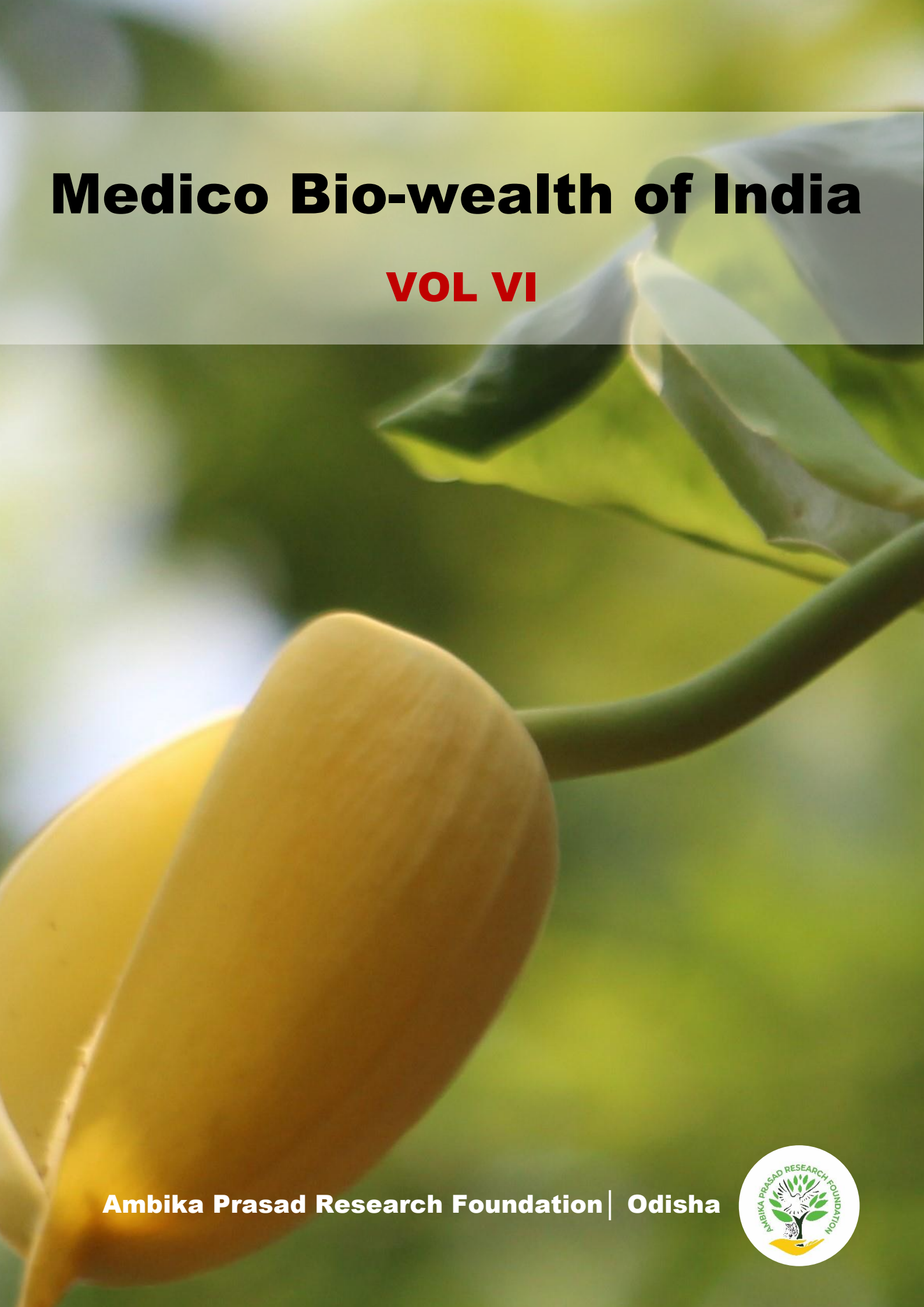
Medico Bio-wealth of India

VOL VI



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He is the founder and CEO of Ambika Prasad Research Foundation (APRF), Odisha & Institute of Biological Sciences (IBS), Odisha. He has work experience with many organizations & institutes like RPRC (Regional Plant Resource Centre), Odisha. RIE (Regional Institute of Education), Odisha, IBSD (Institute of Bioresources and Sustainable Development), Imphal, Manipur, NIT (National Institute of Technology), Odisha and Forest & Environment Department, Odisha etc. His research interests are plant taxonomy, medicinal plants, biodiversity and conservation, restoration of floral wealth, phytochemistry and microbiology. He has published about 120 research papers in the journals of national and international repute and 17 books (IntechOpen, Apple Academic Press, APRF, LAP Lambert Academic Publishing) and many book chapters along with popular articles. 03 PhD scholars are working under his guidance and 45 M.Sc students submitted their Project work under his able supervision.

PREFACE

From last two to three decades, we are facing lots of infectious diseases and pandemic. It reveals that we are forgetting our traditional food, medicine and practices. People globally were consuming their food as per climates, seasons and landscapes, but due to urbanization adopting junk and unsuitable foods. The metallic life also leading to poor immunity and therefore, the documentation of such traditional plants having food and medicinal values associated with a particular boundary is the need of hour. Now also need the culture of – "Let food be the medicine and medicine be the food". In this aspect, the published book chapters in the book entitled "Medico-Biowealth of India" Vol VI, will provide a baseline data for future advance research works in mitigating the contemporary health problems. I wish the book will be helpful to the researchers, academicians and intellectuals.

Sanjeet Kumar

CONTENTS

Chapter 1

Medicinal Plants used by the ethnic people of Tiun Hill Range of District Bilaspur, Himachal Pradesh, India

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Abstract: *The present study deals with the documentation of field observations on the traditional use of medicinal and aromatic plants by the inhabitants of the ethnic people of villages of Tiun hill range of District Bilaspur of Himachal Pradesh. The hill range is inhabited by different ethnic groups. A large number of plants of local flora are used to cure various ailments of humans and livestock. Total of 22 plant species are explored for the treatment of various diseases and other purposes. Some plants which are found common in the hill range are Acacia catechu, Acorus calamus, Andrographis paniculata, Citrus lemon, Juglens regia, Sapindus mukorssi, Withania somnifera etc. This study documents valuable information for traditional remedies and contributes to the usage of medicinal plants in the study area.*

Keywords: Ailments, Aromatic, Diseases, Local communities, Plant diversity

Introduction: Himachal Pradesh is known as Devbhoomi and a land with rich biodiversity. It is a treasure house of traditional knowledge. It has many rare medicinal plants. The people of the Shivalik region are also well known for the use of traditional knowledge to cure different ailments. Tiun hill range is one of the high hill ranges of the district Bilaspur and fall under Shivalik hill region, also known for its rich source of plant diversity. The paper is an attempt to highlight the worth of plant diversity used to cure the different ailments by the local people from time immemorial inhabiting the Tiun hill range of District Bilaspur, Himachal Pradesh. It is an established fact that ethnobotany (the ancient science) of human health had its origin in the state of Himachal Pradesh, the land of 'Rishies' and 'Munies' having a geographical extent of 55,673 sq kms ranging from 244-6,750m elevation under the lesser Himalayas. Altitudes in the district vary from the lowest 305 meters to the highest 1944 meters. The state has a rich diversity of plants that are being used in various Ethno botanical practices by the indigenous people since time immemorial. However, information pertaining to documentation of indigenous knowledge and practices relating to the utilization of the plant species of the state is very meager (Cook 1996, Srivastava 2003a, b; Seth 2006).

The Study Area: The Tiun hill range is situated in the Shivalik range of lower Himalaya. The Tiun hills are famous for Tiun fort, Sariun fort, Naurangarh fort, Hadimba temple and Sidh Gurumath. district Bilaspur of Himachal Pradesh has an area of 1,167 Km^2, and a population of 381,956. As of 2011, it is the 3rd least populous district of Himachal Pradesh (Kumar & Vyas 2019). The people who are residing in the villages of the hill range try to take a lot from the plant

resources because cities are very far from their reach (villages). This is a small attempt which is made to explore and document their valuable knowledge on use of different plant parts.

Methodology: This paper is based on the methodology outlined by Jain (1987) and herbarium sheets of the plants were made as per the known herborizing practices outlined by Jain & Rao (1977). Botanical identification of the collected species was done with the help of regional floras (Chauhan 1999; Chowdhery & Wadhwa 1984; Collett 1902; Dhiman 1976, Polunin & Stainton 1984; Stainton 1988) and later carefully matched with the authenticated specimens at the herbarium of Botanical Survey of India, Dehradun, India.

Collection of data: Extensive field surveys were conducted in various villages situated in Tiun Hill range of District Bilaspur of Himachal Pradesh during the study period. The information pertaining to the data has been collected from the elders and knowledgeable persons who are a permanent resident of different villages and making use of the plant diversity of the hill range. Prior to the visit to research sites, a questionnaire was designed. The traditional usage of plant resources was accumulated with the questionnaire and through participatory techniques. Participation was fascinated by how people utilize plant material. The ethnomedicinal importance of the collected plants containing the information about the vernacular name of the plants, part used, and medicinal use was recorded through detailed discussion with local people and traditional healers (Jaiswal et al. 2021).

Results and discussion: The results of the study are presented in Table 1. The genera of plant species from the study area are arranged in alphabetical order. For each species, scientific name, family, vernacular name, part used, traditional mode of its use as edible and medicinal, as well as diseases treated, are provided. A total of 22 plant species in 16 families are documented for the treatment of various chronic ailments in the studied area. The local people and traditional healers are using these plants to treat various diseases of humans. The greater number of ethnomedicinal plants are recorded from the families Acanthaceae, Anacardiaceae, Fabaceae, Liliaceae, Rutaceae and Zingiberaceae having 2 plant species each. Ten families namely Amaranthaceae, Araceae, Asteraceae, Juglendaceae, Lamiaceae, Lytheraceae, Meninspermaceae, Oxalidaceae, Rosaceae and Solanaceae species each. Figure 1 showing the ascending order of the no. plants parts employed for medicinal purposes. All the delineated species hold great potential for overall exploration for the welfare of mankind.

Table 1: Plants used by Ethnic people for various uses

Plant Name/ Vernacular name	Family	Parts Used	Folk uses
Acacia catechu (L.f.) Willd. (Khair)	Fabaceae	Leaf & wood	Dry leaf powder mixed with amla and reetha powder is used to dye hair naturally and also increase the volume and shine of hair. Katha (wood part) is used to cure oral sores and blisters.

Achyranthes aspera Linn. (Puthkanda)	Amaranthaceae	Whole plant & Seeds	Whole plant powder mixed with honey taken on an empty stomach regulate digestion. Seeds taken regularly help to reduce body weight. Stems are used as to clean teeth and for the prevention of gum problems.
Acorus calamus Linn. (Barae)	Araceae	Rhizome & leaf	Rhizome powder taken with honey at bedtime good remedy for constipation and also stimulate appetite. Paste of leaf with rose water and honey is good for skin diseases like acne, dark spots.
Adhatoda vesica Nees (Bassuty)	Acanthaceae	Leaf	Decoction of leaves prepared in water is good remedy for rheumatic fevers. The decoction is also good in dysentery.
Aloe-barbadensis Mill. (Dwarya)	Liliaceae	Leaf	Aloe vera gel is good for constipation. Gel is good for hair growth.
Andrographis paniculata (Burm. f.) Wall. *ex* Nees (Kalmegh)	Acanthaceae	Whole plant	Decoction prepared by whole plant in water is used to treat body infection and fever. Decoction prepared with kali mirch, methi, saunf, laung in water is useful in sore throat, coughs and allergies.
Asparagus officinalis L. (Sansaerbai)	Liliaceae	Roots	Root powder mixed with milk taken orally at bedtime treats constipation. Root powder with water provides relief during upset stomach. Dry leaf powder taken with honey thrice a day gives relief in cough.
Bauhinia purpurea Wall. (Karyala)	Fabaceae	Leaf	Leaves infusion is used for treating piles and as a laxative. Bark juice is used in diabetes and for expelling worms.
Citrus lemon Linn. (Neembu)	Rutaceae	Fruit	Lemon juice mixed with Mentha leaf juice is used to cure vomiting, headache, and stomach disorders and improve digestive problems of the body. Lemon juice with honey taken empty stomach in the morning help to control body weight.
Curcuma longa Wall. (Haldi)	Zingiberaceae	Rhizome	Turmeric powder boiled in hot milk is used as a treatment for internal injuries, stomachache and abdominal bloating. Turmeric powder mixed with gram flour, honey, and lemon juice is used to prevent acne and skin problems. Turmeric powder mixed with sarson oil is applied on the wound to prevent infection and to heal the wound early. Gargals of turmeric powder is used for the

			treatment of throat sores and mouth ulcers.
Juglens regia Linn. (Khod)	Juglendaceae	Fruit	Dry part of fruit soaked in water overnight and consumed in the morning for brain development, good for skin disorders and arthritis problems. Green portion of fruit is good to cure teeth problems and mouth sores. Leaf juice is used for the treatment of intestinal worms.
Mangifera indica Linn. (Aamb)	Anacardiaceae	Leaf	Mango leaf juice helps to cure diabetes, flatulence and blood pressure. Decoction prepared by boiling mango leaves in water with dalchini and Kali mirch with little honey used to cure cough and sore throat.
Murraya koenigii (Linn.) Spreng. (Gandhelu)	Rutaceae	Leaf	A tea prepared by curry leaves increase digestion and improves bowel movement and treats piles. Juice of leaves is consumed to relieve kidney pain and help to control high uric acid.
Ocimum sanctum Linn. (Ram tulasi)	Lamiaceae	Leaf	Juice prepared by tulasi leaves consumed in an empty stomach is good appetizer, prevent gas problems, constipation and removes kidney stones. Decoction prepared by tulasi leaves, kali mirch, laung with sendha namak is used to cure cold and chest congestion.
Oxalis corniculata Linn. (Khati-amli)	Oxalidaceae	Leaf	Poultice of leaves made with bhringraj oil to cure headaches. Raw leaves are chewed to treat mouth sores.
Psidium guajava Linn. (Amrood)	Myrtaceae	Fruit	Ripe fruit is eaten before meal is used to give relief in constipation. Guava leaf is used for stomachache and mouth sores.
Punica granatum Linn. (Anaar)	Lythraceae	Seed	Seed juice is used by anemic people to increase the blood level, also increase the functioning of heart. Bark juice used to expel intestinal worms.
Sapindus mukorossi Gaertn. (Ghandhela)	Anacardiaceae	Seed	Seed form natural lather like soap used to wash hair and cloths. Paste of fruits prepared with amla powder in sarson oil apply on head to remove lice, control greying of hair and stimulate hair growth.
Spilanthes paniculata Wallich *ex* DC. (Akarkara)	Asteraceae	Flower	Flowers chewed for the treatment of toothache. A medicine is prepared from flowers with the kali mirch, ajwain, laung and tulasi for the

			prevention of mouth problems in infants. Flower tea is used to treat cough, cold and digestion problems.
Tinospora cordifolia (Willd.) Hk. F. & Th (Giloy)	Meninsparmaceae	Leaf & stem	Paste prepared from stem and leaf powder with amla and shikakai powder is good for hair growth. Decoction prepared from stem in water boost the immune system, cure diabetes, reduces fever and joint pain.
Withania somnifera Linn. (Ghodgandh)	Solanaceae	Leaf	Dry powder of leaves mixed with honey taken orally thrice a day is used to treat joint pains. Decoction prepared by leaves with ginger is used for breathing problems.
Zingiber officinale Rosc. (Aaddah)	Zingiberaceae	Rhizome	Juice of ginger rhizome with lemon juice and salt is used to treat nausea, vomiting, stomachache and intestinal infection. Zingiber tea is used to relieve menstrual cramps, migraine headaches and muscle pain.

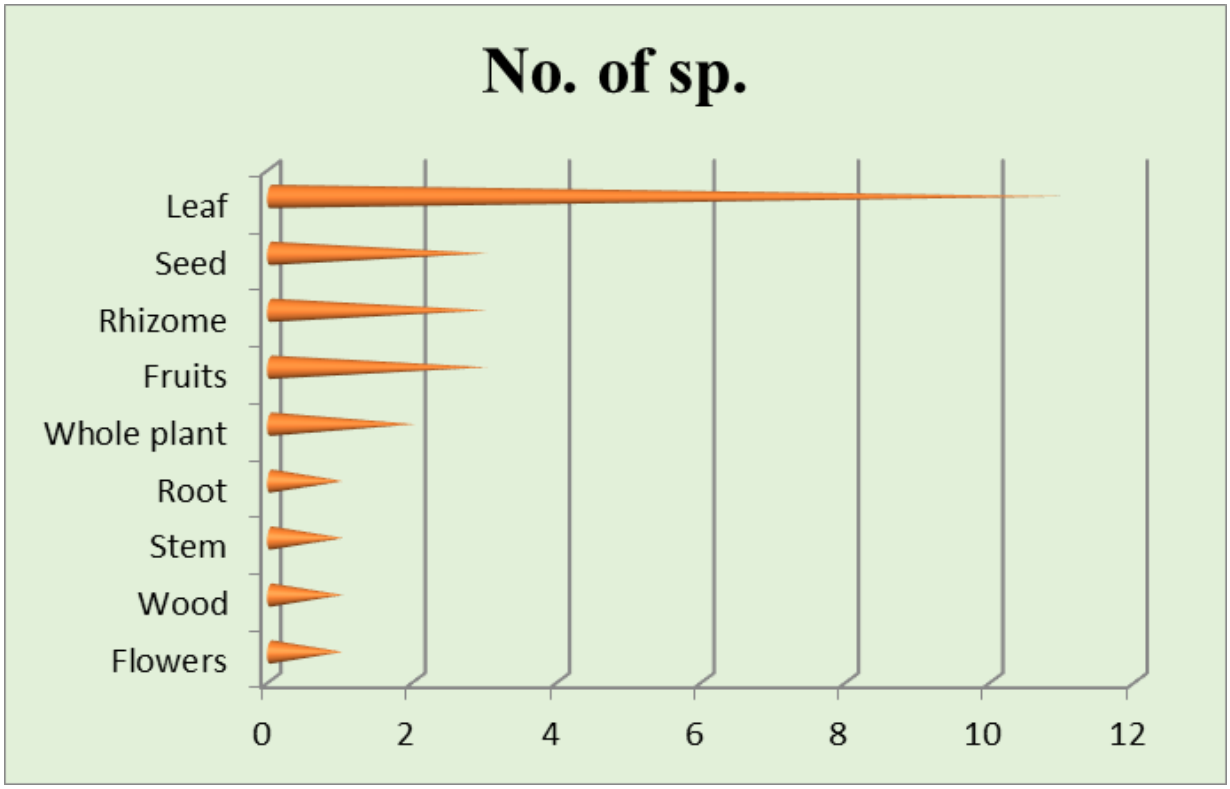

Figure 1: Histogram showing the number of plant parts used by the Ethnic People

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Chapter 2

Ethno-medicinal uses and HPTLC profiling of *Tamarindus indica* and *Pongamia pinnata*

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***Abstract**: Tamarindus indica and Pongamia pinnata of the family Fabaceae are selected for exploration works on their ethnomedicinal uses followed by HPTLC profiling due to various uses and local availability in Konkan areas. Results revealed that the densitometric analysis shows fingerprinting, Rf values, peaks of densitogram and chemical variation. HPTLC fingerprint analysis showed different peaks of these two selected plant leaf extracts. HPTLC fingerprint analysis of these tree species will be helpful for drug identification and adulteration. Present study bring attention on the importance of biomarker from plant in pharmaceutical industry.*

Keywords: Fabaceae, Local tree species, HPTLC

Introduction: The medicinal plants are useful for curing various human diseases due to presence of different phytochemical constituents. Due to antimicrobial resistance problems in drug formulation, researchers globally searching medicinal agents. Keeping this in view, two common tree species (*Tamarindus indica* and *Pongamia pinnata*) of Konkan regions are selected for collection of medicinal uses and HPTLC profiling. *Tamarindus indica* is locally known as chinch and commonly known as tamarind, a medium-sized tree, leaflets 10-20 pairs, racemose flower, petals yellow, stripped with red, stamens 3, monadelphous pods sub compressed brown up to 12 seeded. Fruit and leaves are edible and used in making curries, salads, stews and soups in many countries, especially in times of scarcity (Present study). Tamarind leaves are considered to be very effective in easing joint pain and swelling. It is rich in ascorbic acid, Vitamin C and tartaric acid that help in building your immunity naturally. Tamarind tea can help in relieving cold, cough and sore throat (Buchholz 2011; Bhadoriya 2016; Erma et. al 2022). *Pongamia pinnata* is a small or middle-sized fast-growing tree, known as Karanj, leaves pinnate, leaflets opposite, 5-7, broadly ovate, flowers in axillary racemes, shorter than leaves, corolla pinkish-white, pods woody, seed solitary, reniform, brown. All plant parts are used as a crude drug for the treatment of tumors, piles, skin disease, wounds, ulcers, and cleaning teeth. The seed powder of the plant is used in the treatment of bronchitis. An infusion of leaves is used to relieve rheumatism. Flower used to treat bleeding haemorrhoids, or piles Fruit Aid treatment of abdominal tumours, female genital tract infections, ulcers, and haemorrhoids. Seed extracts used to heal scar tissue tumors, treat high blood pressure, and treat anaemia Powder reduces fever and helps in treating bronchitis and whooping cough, leaves are used as a digestive and laxative and to treat inflammation and wounds (Sowjanya et al. 2018; Sarje et al. 2020). Leaf paste is used in the treatment of leprosy (Present study). The above-mentioned medicinal values of the selected two plant encouraged to do HPLC profiling of their leaves extract.

Material and methods: Preliminary phytochemical analysis of *Tamarindus indica*.is done as per method described by Wagner et al. (1908), Harborne (1988) and Eike and Anne (2006). HPTLC profiling is done by using CAMAG HPTLC System with WIN CATS software.

Collection of plant material: The leaves of *Tamarindus indica* and *Pongamia pinnata* were collected from Poladpur of district Raigad, Maharashtra and brought to the laboratory for further analysis. Leaves washed gently with running tap water to remove surface dust and pollutants. The dried plant material was made of powder using a mixture grinder.

Extraction of plant materials: About 10 g of powder of *Tamarindus indica* and *Pongamia pinnata* were extracted separately using 70 % ethanol in a Soxhlet Extractor. After extraction the extracts were evaporated. The dried extracts were dissolved in 5 ml ethanol and filtered using Whatman filter. The filtered extracts were later used for further phytochemical and HPTLC analysis (Pawar et al. 2011).

Results and discussion: The qualitative analysis of phytochemicals showed richness of diverse bioactive compounds in the leaf of both selected tree species. The HPTLC analysis obtained high resolution and showed that different peak leaf extract of *Tamarindus indica* was run along with the standard and it was perceived to validate the presence of phytochemical compounds from chromatograms after derivatization. The results are given in Table 1 and Figure 1. The graphical representation shows different peaks of polyvalent phytoconstituents. The Rf value starts from 0.1 to 218.1 in which highest concentration of phytoconstituents were found and maximum percentage stars from 5.92 to 59.26 %, and maximum height from 0.00 to 2.8. The HPTLC analysis obtained high resolution and shows different peak leaf extract of *Pongamia pinnata* was run along with the standard and perceived to validate the presence of phytochemical compounds from chromatogram after derivatization. The result from HPTLC fingerprint scanned at wavelength 254 nm for *Pongamia pinnata* shows polyvalent phytoconstituents and corresponding ascending order of Rf value are from 0.01 to 0.97 in which highest concentration of the phytoconstituents was found to be 32.66 % and its corresponding RF value was found to be 0.01 respectively. Results represented in Table 2 and Figure 2. The graphical representation shows different peaks of polyvalent phytoconstituents. The Rf value starts from 0.1 to 218.1 in which highest concentration of phytoconstituents were found and maximum percentage starts from 5.92 to 59.26% and maximum height from 0.00 to 2.8 control. The peak retention in ethanol extracts and is found with Rf start with 0.01, 0.33, 0.42, 0.86 and end with 0.03, 0.39, 0.48, 1.00 and maximum percentage is 59.26, 5.82, 6.30, 28.63.

Table 1: Rf value of the peak formed of *Tamarindus indica* leaf at UV 254 nm

Peak	Start Position	Start Height	Max position	Max height	Max %	End Position	End Height	Area	Area %
1	0.01	201.8AU	0.01Rf	218.1AU	59.26%	0.03Rf	0.0AU	1134.4 AU	16.20%
2	0.33	5.2AU	0.37 Rf	21.8 AU	5.92%	0.39Rf	0.1AU	497.5AU	7.11%
3	0.42	3.4 AU	0.44 Rf	22.8AU	6.20%	0.48Rf	1.4AU	501.4AU	7.16%
4	0.86	0.5 AU	0.98 Rf	105.4AU	28.63%	1.00Rf	2.8 AU	4868.1AU	69.53%

Other researchers have also done some works on selected plants for present study. The report of diabetic rats shows significant anti hyperglycaemic and anti-lipid peroxide effects with the leaf extract. It shows that the treatment of *Pongamia pinnata* extract could be used as a safe alternative anti-hyperglycaemic drug for diabetic patient's antiplasmodial activity, and

also shows action on infectious diarrhoea (Joy et al.1998). HPTLC fingerprinting is a valuable quality assessment tool for the evaluation of botanical materials, it allows for the analysis of a large number of compounds both efficiently and cost effectively. These studies have shown that it is more versatile than ordinary TLC methods as the spots are well resolved. The HPTLC method is simple, rapid, accurate, reproducible, selective and economical for quality and quantitative determination of plant materials.

Table 2: Rf Value of leaf extract of *Pongamia pinnata* leaf at UV 254 nm

Peak	Start Position	Start Height	Max position	Max height	Max %	End Position	End Height	Area	Area %
1	0.00	29.2AU	0.01Rf	201.7AU	32.66 %	0.03Rf	0.0AU	1655.1AU	11.89 %
2	0.18	0.2AU	0.20Rf	13.7AU	2.21%	0.24Rf	1.5AU	347.1AU	2.49%
3	0.29	5.1AU	0.32Rf	23.9AU	3.87%	0.34Rf	5.2AU	535.7AU	3.85%
4	0.34	14.6AU	0.37Rf	85.6AU	13.86 %	0.39Rf	6.8AU	1669.1AU	11.99 %
5	0.39	7.3AU	0.44Rf	87.1AU	14.11 %	0.48Rf	3.6AU	1879.1AU	13.50 %
6	0.55	0.4AU	0.57Rf	21.7AU	3.51%	0.60Rf	1.3AU	396.8AU	2.85%
7	0.61	0.1AU	0.63Rf	22.5AU	3.65%	0.65Rf	3.9AU	421.0AU	3.02%
8	0.69	8.8AU	0.72Rf	16.5AU	2.68%	0.75Rf	0.9AU	462.5AU	3.32%
9	0.78	1.9AU	0.81Rf	17.8AU	2.89%	0.85Rf	0.1AU	370.1AU	2.66%
10	0.86	0.1AU	0.97Rf	127.0AU	20.56 %	1.00Rf	3.9AU	6183.6AU	44.42

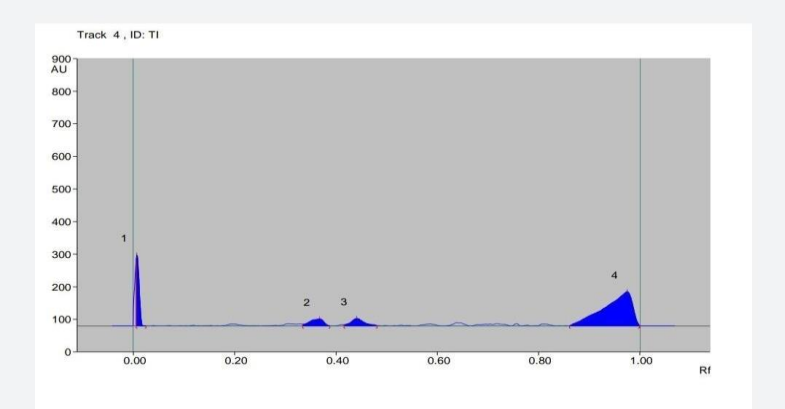

Figure 1: Chromatogram of *Tamarindus indica* leaf extract

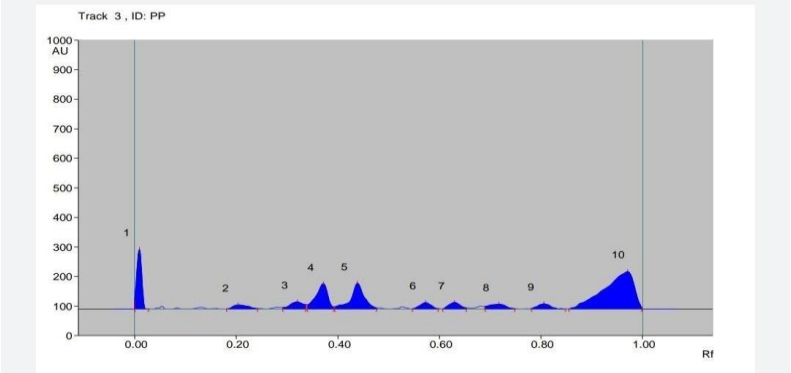

Figure 2: Chromatogram of *Pongamia pinnata* leaf extract

Conclusion: The present study conclude that the selected plants are used to cure many diseases and disorders by the local people. HPTLC fingerprints profile of *Tamarindus indica* and *Pongamia pinnata* will be useful to determine the quality of crude drugs. It will be is also useful for separation of secondary metabolites which can be used to understand biochemical and physiological mechanisms of selected plants.

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Chapter 3

Some common medicinal lianas of India

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Abstract: *Lianas are abundantly available around the world. They are an indicator for healthy forest as they help in regeneration of forest, carbon sequestration, in understanding environmental and climatic changes. They play a vital role in forest ecosystems. They provide food for human beings and wildlife as well as used for medicinal purposes but lack of scientific knowledge is observed. Keeping this in view, an attempt has been to enumerate the common lianas of India to bring attention towards their importance. The chapter also highlights the medicinal values of some common lianas of the country.*

Keywords: Lianas, forest ecosystem, medicinal, tribal communities

Introduction: Lianas are woody climber that rooted in the ground level and uses tree species for vertical support to climb up the canopy in search of direct sunlight. They are distinguished by the twining pattern towards there curious growth form in the plant world. They use variety of climbing mechanisms to attach themselves to the plant species like twining around the stem, grasping, through thorns, spines and adventitious root. They also act as a bridge of many faunal and avifaunal species.

Plate1: Some lianas in wild inside forest areas of Odisha, India

They play a vital role in forest ecosystems (Plate 1) and helpful in regeneration, carbon sequestration, providing food for faunal species, host plant for many epiphytic species and give information through morphological modifications about the climate changes in a particular landscape (Schnitzer and Bongers 2002). In many tribal areas, the lianas are the source of livelihood. The local communities collect them from the near forest and as a food and medicinal agents, they used to sell in local markets. Very less reports are available and need more exploration works to document them and their importance. Keeping this in view, an attempt has been made to document the uses of some common medicinal lianas of India.

Methodology: The survey was carried out in the year 2021-2022 in Odisha, Jharkhand, Uttarakhand and West Bengal. A random questionnaire was conducted. The information enumerated in tabular form including the plant name. The plants were identified by the authors using vegetative parts.

Results and discussion: Authors enumerated 16 common medicinal lianas belong to 10 families. It was observed that 7 plants species belong to Fabaceae, 2 plants species belong to Vitaceae and 1 plant belongs to each family of Convolvulaceae, Rhamnaceae, Malpighiaceae, Araliaceae, Araceae, Menispermaceae and Annonaceae. It was noticed that mainly root, leaves, seed, fruit and stem are used in the form of infusion, juice & pounded to treat many healthcare problems (Figure 1). The root of *Argyreia nervosa* is used to treat nervous system disorders, the root juice of *Phanera vahlii* is used to treat diarrhoea, pounded root of *Cissus adnata* is used to treat cough, the root of *Millettia extensa* is chewed to get relieve from food poisoning and the root decoction of *Spatholobus parviflorus* is used to treat liver problems. It was also observed that the leaves of *Cayratia pedata* is used to treat ulcer. The leaf paste of *Gouania leptostachya* is to treat eczema whereas seed oil of *Derris scandens* is used to cure fungal infections. Seed powder of *Entada rheedii* is used to kill stomach worms. The seed powder of *Mucuna pruriens* is used to treat mental disorder. The fruit powder of *Hiptage benghalensis* is used to cure stomach worm. Flower infusion of *Uvaria hamiltonii* is used to enhance health of the heart (Plate 2; Figure 2). Many researchers also have done some works on lianas. In 2014, Darlong and Bhattacharyya reported the lianas of Tripura. In 2015, Krishnamani reported some lianas in Western Ghats of India like *Entada rheedii*, *Gnetum ula*, *Erycibe paniculata*, *Hiptage benghalensis*, *Olax scandens*, *Schefflera venulosa* and *Spatholobus parviflorus*. In 2015, Barik et al. reported diversity of lianas in Eastern Himalayas and Northeastern India like *Argyreia nervosa*, *Phanera vahlii*, *Cayratia pedata* and *Gouania leptostachya*.

Table 1: Some common medicinal lianas of India

Botanical name	Family	Common name	Medicinal uses
Argyreia nervosa	Convolvulaceae	Brudhha taraka	The root is used as a stimulant and in nervous system disorders.
Phanera vahlii	Fabaceae	Siyali	Root juice is used in diarrhoea.
Cayratia pedata	Vitaceae	Pitapotala	The leaves are used to treat ulcer.
Cissus adnata	Vitaceae	Bana angur	A cold infusion of the pounded root is taken for the treatment of cough.
Derris scandens	Fabaceae	Kentia	The seed oil is used to cure fungal infection during paddy cultivation.
Entada rheedii	Fabaceae	Gilo	The seed powder is used to kill the stomach worm.

Gouania leptostachya	Rhamnaceae	Raktapitchali	The leaf paste is used to cure eczema.
Hiptage benghalensis	Malpighiaceae	Boromali	The fruit powder is used to kill the stomach worm.
Millettia extensa	Fabaceae	Guadhuni	The root is chewed to cure food poisoning.
Mucuna pruriens	Fabaceae	Baidonko	The seed powder is used to treat mental disorder.
Schefflera venulosa	Araliaceae	Takua jari	It is used to promote blood circulation.
Scindapsus officinalis	Araceae	Gaja pipali	It is used to treat skin diseases.
Spatholobus parviflorus	Fabaceae	Lata polasa	The root decoction is used in liver problems.
Tinospora cordifolia	Menispermaceae	Guduchi	The stem juice is used to enhance the immunity.
Uvaria hamiltonii	Annonaceae	Lakankuli	Flower infusion is used to enhance the health of heart.
Pueraria tuberosa	Fabaceae	Handiphuta	Tuber decoction is used as tonic.

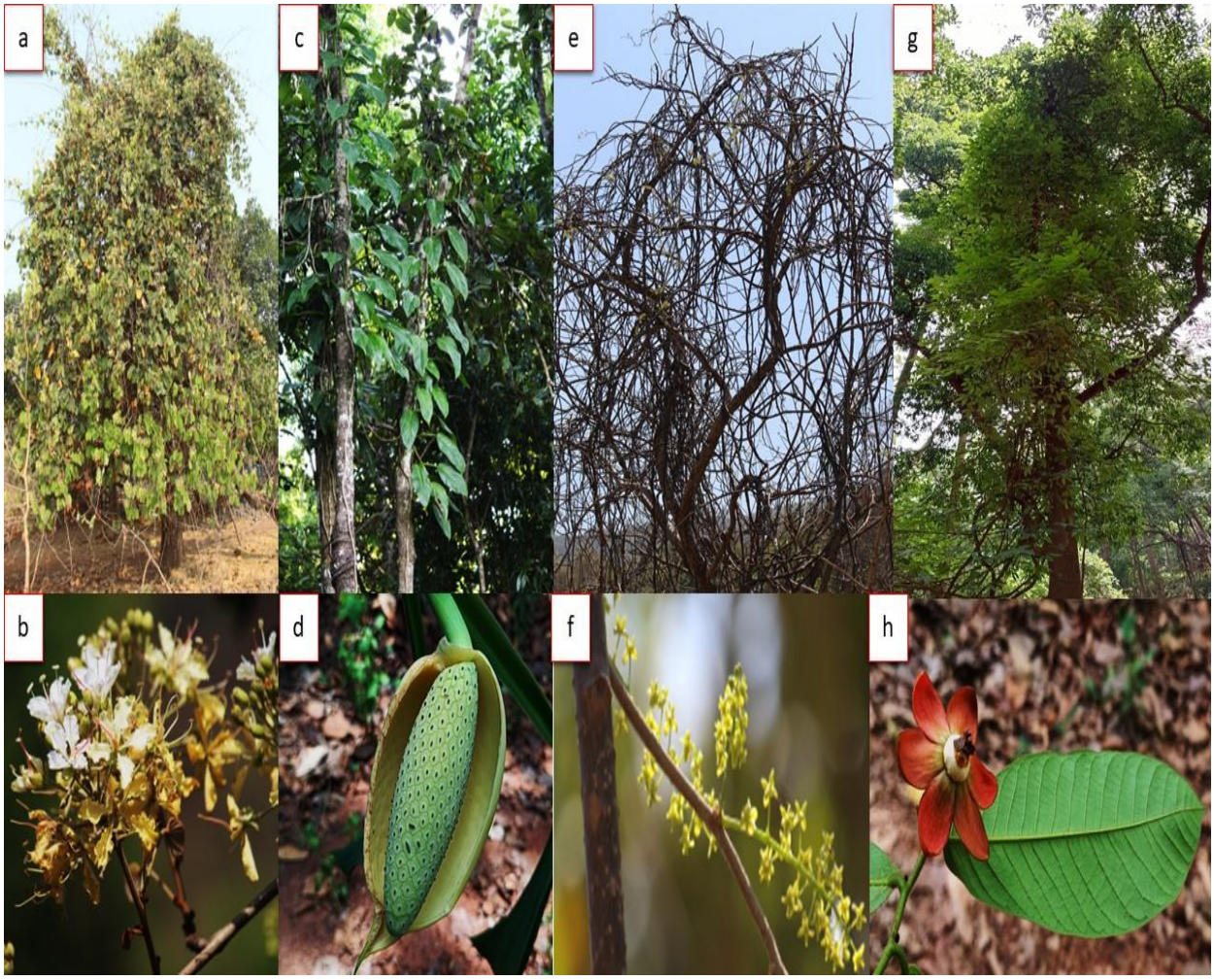

Plate 2: Medicinal lianas of India (a) *Phanera vahlii*, (b) Flower of *Phanera vahlii*, (c) *Scindapsus officinalis*, (d) Flower of *Scindapsus officinalis*, (e) *Tinospora cordifolia*, (f) Flower of *Tinospora cordifolia*, (g) *Uvaria hamiltonii*, (h) Flower of *Uvaria hamiltonii*

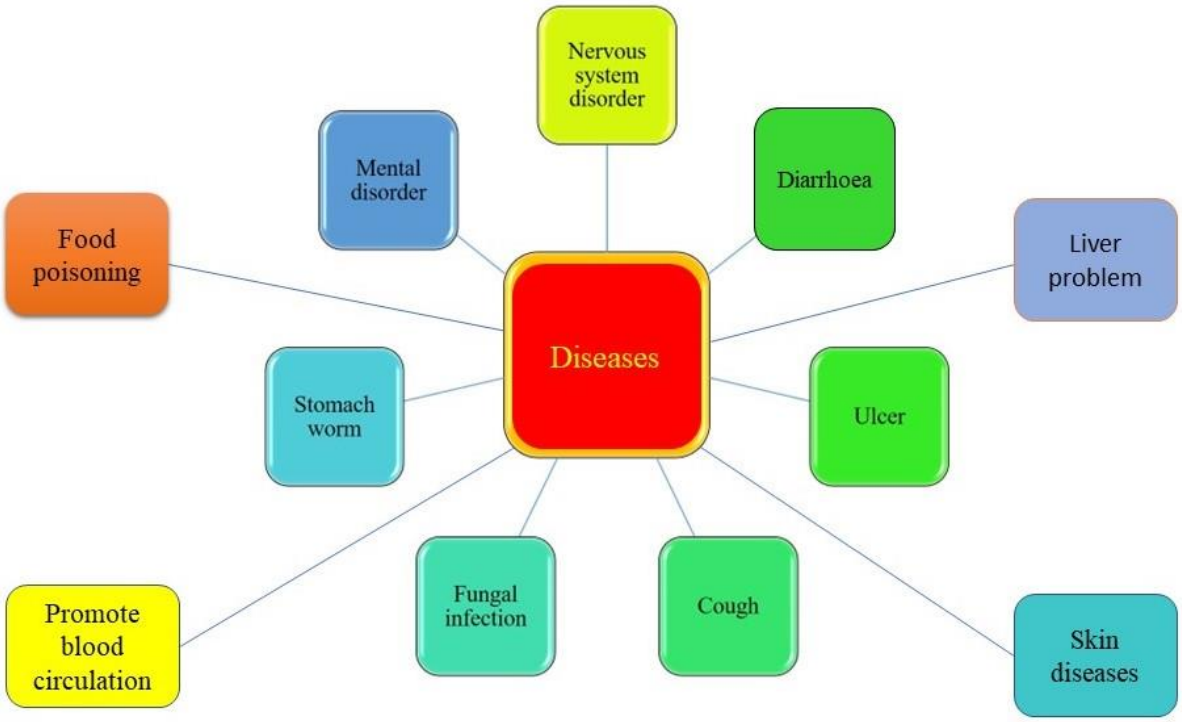

Figure 1: Diseases which can be cured by using the lianas

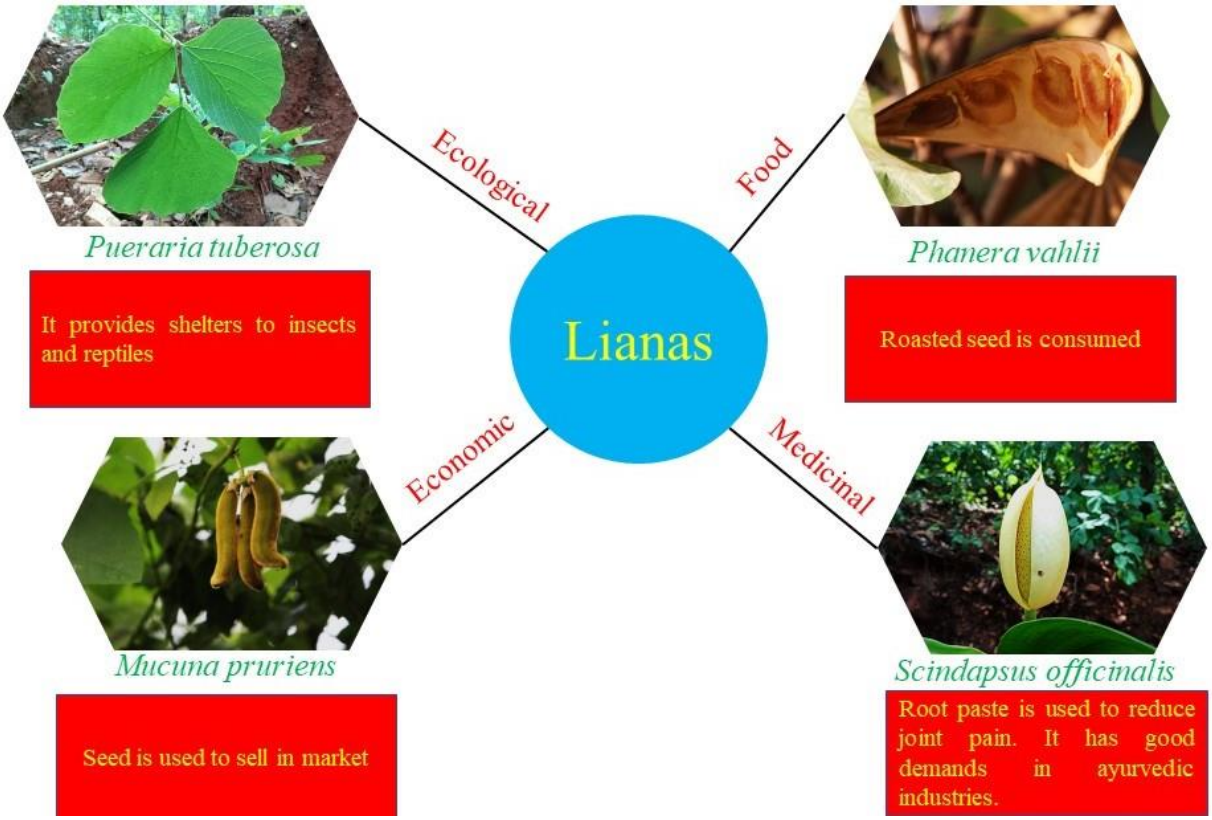

Figure 2: Future aspects of lianas species of India

Conclusion: The present study concluded that lianas are used as a food and medicine by the rural and tribal communities of the country but less exploration has done. They also play important role in ecological balance and provide food and shelters for wildlife. There is more advance works are needed in pharmacological aspects of lianas.

Acknowledgement: The authors are thankful to the forest officials of study areas and local communities.

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Chapter 4

Medicinal and economic values of *Cissampelos pareira* (Menispermaceae)

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Abstract: *Tribal communities play a vital role in the conservation of traditional knowledge as they have immense knowledge of economically important medicinal plants and how to consume them. Traditional healers use many medicinal plants to treat various ailments. Cissampelos pareira is one of the medicinal plants used by the tribals to cure many diseases and disorders. It has a wide range of medicinal uses, but apart from therapeutic uses, it is extensively used for economic purposes. In the local market, the root of C. pareira is sold in the forms of raw and pills. Keeping the importance of C. pareira, an attempt has been made to do a field and literature survey on medicinal and economic values of C. pareira. Results revealed that tribal communities used its plant parts to cure a various health problems and as a source of livelihood. The chapter highlights the importance of local flora and the need for value addition to provide livelihood opportunities to the local populace.*

Keywords: tribal communities, traditional knowledge, medicinal uses, economic uses

Introduction: The world's population wishes to settle in cities in search of good education, employment, and health-care facilities. Most youth from rural and tribal areas migrate to urban jungles to obtain the same, resulting in poor immunity, a platform for infectious disease transmission, urbanisation impacts in village areas, and the loss of traditional practices, including traditional therapeutic systems based on local plants. Slowly we are losing our scientific cultural practices based on nature and climate. Researchers throughout the world working on value additions of locally available plants to develop livelihood opportunity to get the sustainability and reestablishment of harmonical relationship between community and biowealth. They are screening the agents from the forest which are used in day-to-day life of communities to mitigate the above-mentioned problems. *Cissampelos pareira* (Plate 1) is a climbing herb, easily available and has medicinal and economic values. *C. pareira* belongs to the family Menispermaceae. Commonly, it is known as Musakani, Akanabindhi, Patha, Kijri, Batindu and Ghodakur. It is a climbing plant that mostly grows in damp to dry habitats. It is widely distributed in India (Himachal Pradesh, Tamil Nadu, Bihar, West Bengal, Punjab and Rajasthan). Its fruiting and flowering period is from June to November. *C. pareira* is a slender climber supported by trees. The leaves are simple, alternate, peltate and velvet. The flowers, which are tiny and greenish yellow in colour, are grouped in the axils. The seeds are horseshoe shaped. The root of *C. pareira* is used to treat many diseases and disorders. Root paste is also used in muscular swellings. It has a rich source of bioactive compounds like alkaloids. The root is also used to make country liquor and sold in the local markets as a fermenting agent. Hence, it is a good agent for doing value addition for the creation of livelihood options. Keeping the importance and easy availability of *C. pareira* in mind, an attempt has been made to document the medicinal and economic values of the plant.

Methodology: The field and literature surveys were carried out during 2018-2022 in selected areas of India (Odisha, Jharkhand, Punjab, Himachal Pradesh, West Bengal and Uttarakhand). A series of random interviews were conducted with local communities. The information gathered was from traditional healers and shops of medicinal plant parts. The plant was identified by the authors.

Results and discussion: The results revealed that *C. pareira* has a wide range of medicinal uses. It is used to treat irregular menstrual cycles, menstrual cramps and stomach pain. The leaves are used to treat abscesses and wounds. Details are listed in the Table 1. It was observed that apart from medicinal uses, it has a wide range of economic values. It was noticed that local communities of Odisha make a pill using root powder and rice powder called Ranu. The pills are used to make country liquor (Plate 3) like Mahua or Mahula (liquor made up of the flowers of *Madhuca longifolia*) and Handia (Fermented rice beer). The pills are used to sell in the local markets (Plate 2). Details are listed in Table 2. In other states, it was observed that dried roots are used to sell for medicinal purposes. A good amount was observed in Haridwar, Uttarakhand. Some other researchers also reported the medicinal and pharmacological values of *C. pareira*. In 2011, Jhuma and Bhattacharya reported it as an antifertility agent. In 2013, Thavamani et al. reported the pharmacological values of *C. pareira*. Sood et al. (2015) reported that it is used as a potent antiviral agent against dengue virus. Njeru et al. (2015) reported the bioactivity of *C. pareira* against *Mycobacterium tuberculosis*. In 2017, Saha et al. reported ethnomedicinal uses, phytochemistry, and pharmacological potential of *C. pareira*. It was noticed that during 2002–2019, more work was done but less work has been done after 2019.

Table 1: Ethnomedicinal and pharmacological values of *C. pareira* (2018-2022)

Year	Plant parts	Mode of uses	Uses	Source
2018	NIL or less	NIL or less	NIL or less	NIL or less
2019	NIL or less	NIL or less	NIL or less	NIL or less
2020	Leaf, stem and root	Extract	Antimalarial activity	Bhatt et al. (2020)
2021	Whole plant	Decoction	Antidiabetic, antifertility	Kumari et al. (2021)
2022	NIL or less	NIL or less	NIL or less	NIL or less
2022	Root	Juice	Irregular menstrual cycles	Present study
2022	Root	Juice	Menstrual cramps	Present study
2022	Root	Decoction	Stomach pain	Present study
2022	Root	Paste	Wounds	Present study
2022	Leaf	Decoction	Wounds	Present study
2022	Leaf	Decoction	Fever	Present study
2022	Leaf	Decoction	Fever	Present study
2022	Whole plant	Decoction	Fever	Present study
2022	Whole plant	Paste	Jaundice	Present study
2022	Whole plant	Decoction	Stomach pain	Present study
2022	Flowers	Decoction	Irregular menstrual cycles	Present study
2022	Flowers	Decoction	Menstrual cramps	Present study

Table 2: Economic values of *Cissampelos pareira*

Year	Parts	Rate	Purposes	Collection site and Source
2018	Roots	Rs 10 (Ten) per bundle	Making Ranu pills	Mayurbhanj, Odisha; Present study
			For preparation of Mahua (Country liquor made up by the flowers of *Madhuca longifolia*)	Mayurbhanj, Odisha; Present study
2019	Roots	Rs 12 (Ten) per bundle	Making Ranu pills	Mayurbhanj, Odisha; Present study
			For medicinal purposes	Mayurbhanj, Odisha; Present study
2020	Roots	Rs 15 (Ten) per bundle	Making Ranu pills	Mayurbhanj, Odisha; Present study
			For medicinal purposes	Mayurbhanj, Odisha; Present study
2021	Roots	Rs 15 (Ten) per bundle	Making Ranu pills	Sundargarh, Odisha; Present study
			For medicinal purposes	Sundargarh, Odisha; Present study
2022	Roots	Rs 20 (Ten) per bundle	Making Ranu pills	Sundargarh, Odisha; Present study
			For preparation of Mahua (Country liquor made up of flowers of *Madhuca longifolia*)	Sundargarh, Odisha; Present study

Plate 1: Vegetative parts of *C. pareira*, a-b) Flower of *C. pareira*, c) Habit, d) Root of *C. pareira*

Plate 2: Ranu is being sold in local markets

Plate 3: Making of Mahua with the fermenting agent, Ranu

Conclusion: Present works on *C. pareira* conclude that there are number of plants available in & around our areas having food, medicinal and economic values but they are unexplored due to lack of documentation and no value addition. *C. pareira* is used to treat various diseases and its root is used to make country liquors. Formulation against claimed on *C. pareira* by the communities against diseases could be done and a fermenting agent can be manufactured through the value addition of *C. pareira*. Such work could also be helpful to minimise the migration of youth from tribal and rural areas to urban and sustainable development.

Acknowledgement: Authors are thankful to the forest officials and local communities of the study areas.

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Food and medicinal values of some *Ficus* species

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Abstract: *In Indian mythology, the Ficus species play an important role in India. Some Ficus species play a vital role and have a religious significance in rituals like the peepal tree (Ficus religiosa) which is worshipped in India. The Ficus species have many food and medicinal values. It has some bioactive compounds which is used to treat many aliments like diabetes, piles, toothaches, gum problems and skin infections. Figs are consumed by many avian species. The conservation of Ficus species is also the conservation of wasp and avian species. A particular wasp pollinates specific Ficus species. Keeping the importance of Ficus species as food, medicine and in ecological balance, an attempt has been made to enumerate some common Ficus species of India along with their food and medicinal values. A total of 20 species of Ficus are reported here with their importance. The chapter highlights the importance of Ficus species as a source of optional food and medicinal agents.*

Keywords: Bioactive compounds, mythology, avian species, medicinal value

Introduction: The genus *Ficus*, commonly known as fig, belongs to the family Moraceae, which includes a large number of species comprising about 1,100 species including trees, shrubs, climbers, and creepers. It is mostly found in tropical and sub-tropical regions. The Moraceae family is characterized by the presence of buttress and prop root. They have stipules. The also show presence of milky latex. The main key character is fruit that have many seeds and an inflorescence inside them known as syconium. The genus is very important due to its high ecological, nutritional, medicinal and economic values. It is also important for avian species as they consume the fruit of many *Ficus* species. Some *Ficus* species are edible, and some have medicinal values. Apart from food and medicinal values, *Ficus* species are known for their mythological importance and availability in sacred groves (Satapathy and Kumar 2017). The peepal tree (*Ficus religiosa*) is worshipped in most parts of India. Ancient history shows a range of information regarding *Ficus* species. It is believed that peepal is considered as an incarnation of Vishnu and Buddha (Kumar et al. 2021). From that day onwards, it has been a sacred tree in India particularly among the Hindus. Fruits are edible by the local communities as a vegetable and in dried form. Fruits are also consumed by many avian species. They also form shelter in species of *Ficus*. The fruit is mostly fleshy, hollow and vessel. Leaves are alternate, simple, entire and spirally arranged. Flowers are unisexual. *Ficus* species is different from other species because the reproduction systems are exclusive. It can only be pollinated by the wasp that are associated with it, and the wasp can only lay eggs within the fruit that is associated with it. The *Ficus* species is also used to cure many diseases since long. Some fruits are used to improve the immunity and to reduce the stomach problems. There might be a number of secondary metabolites responsible for the therapeutic potential of *Ficus* species, like phenolic compounds, phytosterols, volatile compounds etc. Keeping the importance of food, medicinal and ecological importance of *Ficus* species in mind, an attempt has been made to document the importance of some common *Ficus* species of India.

Methodology: The study was carried out in the year 2021-2022 in selected states of India (Odisha, Jharkhand, West Bengal, Punjab, Himachal Pradesh, Andhra Pradesh). Thorough a random questionnaire data was collected. The plant species was identified by the authors and some species were identified by Dr. Rajeev Kumar Singh, Botanical Survey of India, India.

Results and discussion: The survey work enumerated 20 common *Ficus* species of India having medicinal and food values (Figure 1 & Figure 2; Plate 1 & Plate 2). It was observed that the fruits of *Ficus amplissima, Ficus auriculata, Ficus racemosa,* and *Ficus tinctoria* are used as vegetables, whereas the latex of *Ficus benghalensis* is applied to treat tooth decay. The latex of the fruit of *Ficus benjamina* is used to treat piles. The latex of *Ficus nervosa* is used to treat gum problems. The roots of some *Ficus* species are also used as medicinal agents, like the root of *Ficus arnottiana*, which is used as an astringent.

Table 1: *Ficus* species used as a food and medicine

Botanical name	Common/Local name	Use(s)
Ficus amplissima	Indian bat tree	Fruits are edible; they are consumed by birds; their juice is used to treat mouth ulcers.
Ficus arnottiana	Paras pipal	The root of the plant is used as an astringent.
Ficus auriculata	Roxburgh fig	Fruit is used as a vegetable; fruit is used to treat diabetes.
Ficus benghalensis	Banyan	The latex is applied to treat tooth decay.
Ficus benjamina	Weeping fig	Latex from fruit extracts is used to treat piles.
Ficus concinna	Baidimri	Stem is chewed to get relief from toothache.
Ficus drupacea	Brown woolly fig	Root powder is mixed with oil of *Pongamia pinnata* and applied externally to cure skin infections.
Ficus elastica	Rubber fig	The fruit pulp is used for digestive problems.
Ficus exasperata	Sandpaper tree	The bark and root decoction are used against cough.
Ficus hederaceae	Climbing fig	NIL
Ficus heterophylla	Bada dimri	Bark powder is mixed with mustard oil and boiled. The filtered oil is applied to microbial infections.
Ficus hispida	Dimiri	The fruit is edible; the bark decoction is used to treat fever and colds.
Ficus mollis	Soft fig	The tender leaves are consumed as a preventive agent against diabetes.
Ficus nervosa	Sanadimri	Latex is used to reduce gum problems.
Ficus palmata	Wild fig	Grounded leaves and fruits are combined with herbal tea to combat diabetes.
Ficus racemosa	Dimbri	Fruits are used as a vegetable; fruits are also used to treat leucorrhea.
Ficus religiosa	Pipal	Bark of *Ficus religiosa* and fruits of *Syzygium cumini* are boiled in water and the extract is used to treat diabetes.
Ficus rumphii	Variegated rumph's fig	Formulations are prepared with leaves of *Ficus rumphii*, *Ocimum sanctum*, *Moringa oleifera*, and *Marsilea minuta*. The juice of the formulated powder is used to treat sleeping disorders and to improve immunity.
Ficus semicordata	Bhuin dimri	The paste of Bark is mixed with leaves of *Curcuma longa* and applied on leach bites.
Ficus tinctoria	Kharsara	Fruits are edible; fruits are used against indigestion.
Ficus virens	White fig	Tender leaves and fruits are grounded and the juice is taken against diabetes.

Plate 1: Some common *Ficus* species having medicinal values, a) Leaves of *Ficus benghalensis*, b) Bark of *Ficus benghalensis*, c) Fruit of *Ficus benghalensis* d) Leaves of *Ficus benjamina*, e) Bark of *Ficus benjamina*, f) Fruit of *Ficus benjamina*

Plate 2: Some *Ficus* species having ecological values, a) Leaves of *Ficus arnottiana*, b) Bark of *Ficus arnottiana*, c) Fruit of *Ficus arnottiana*, d) Leaves of *Ficus concinna*, e) Bark of *Ficus concinna*, f) Fruits of *Ficus concinna*

Plate 3: Habit of *Ficus hederaceae* (Climbing fig) collected from Bonai Forest Division, Odisha

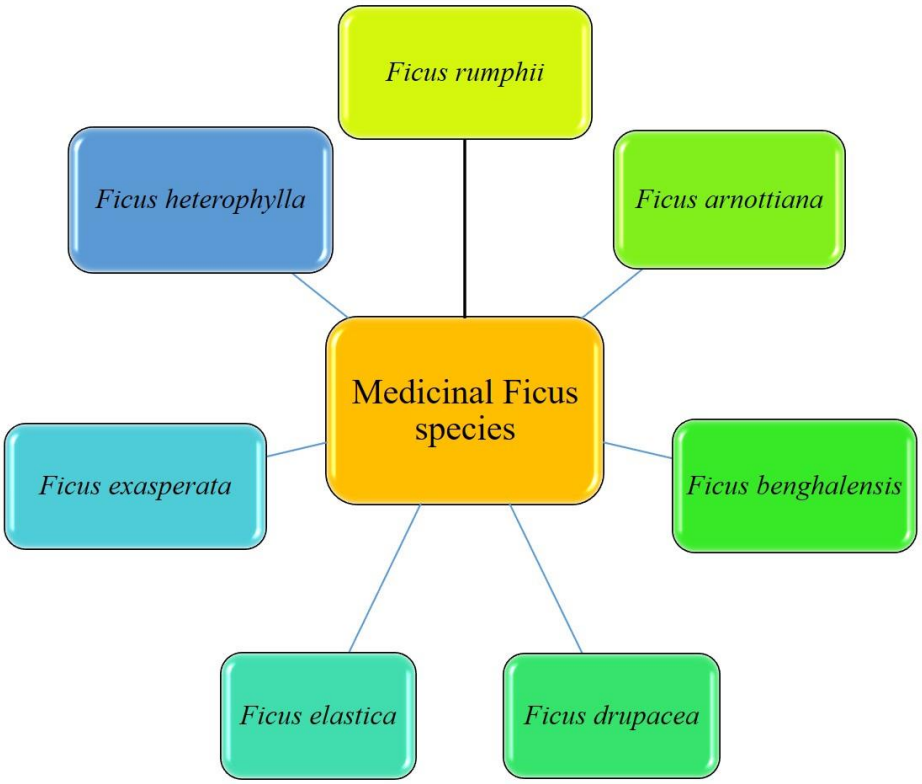

Figure 1: Common medicinal *Ficus* species of India

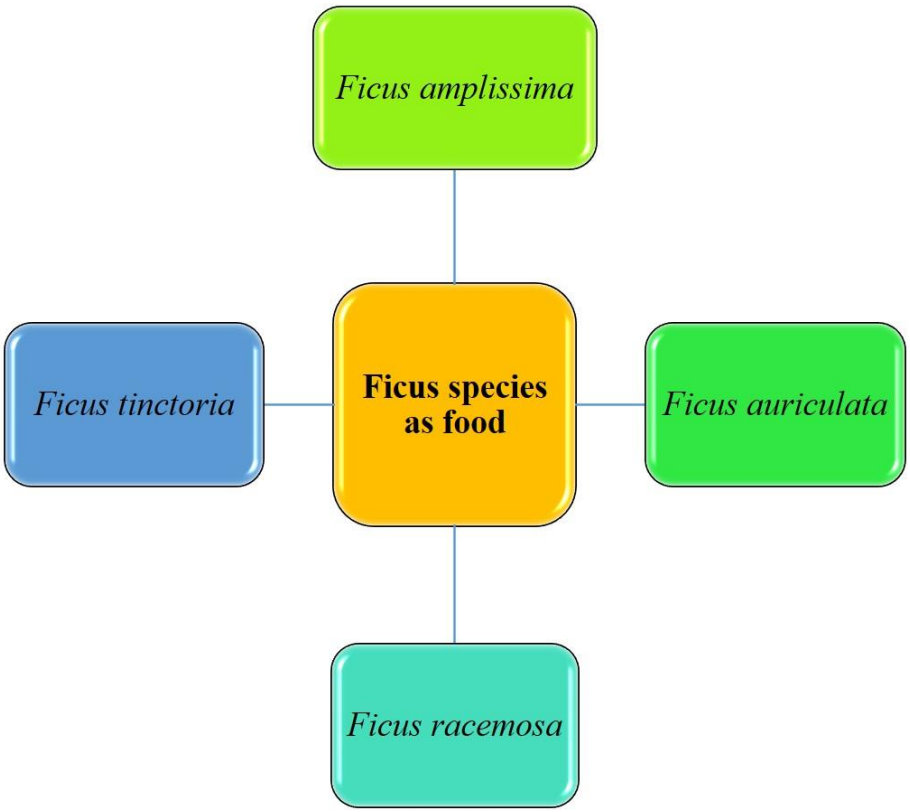

Figure 2: Common *Ficus* species having food values.

The root powder of *Ficus drupacea* with the oil of *Pongamia pinnata* is applied to treat skin infections. The bark powder of *Ficus heterophylla* is mixed with mustard oil and boiled. The oil is applied to cure microbial infections. The decoction of the bark of *Ficus hispida* is used to treat fever and cold. Diabetes can be treated with the bark of *Ficus religiosa* and the leaves and fruit of *Ficus virens*. Details are listed in Table 1. A large number of studies have been carried out on *Ficus* species. In 2021, Kumar et al. reported the diversity and distribution of *Ficus* species in Dehradun, Uttarakhand. In 2014, Sharma et al. reported that in Mizoram the wood anatomy of *Ficus* species with reference to their identification. In 2012, Dhanya et al. reported *Ficus* trees in Karnataka. In 2022, Kumar et al. reported a note on *Ficus hederacea* (Plate 3) in Odisha. Many researchers have worked on *Ficus* species, but the medicinal and food values are still not documented in a proper way. Therefore, more exploratory cum laboratory work is needed on *Ficus* species of India.

Conclusion: *Ficus* species have a wide range of medicinal value as it is used to treat many diseases like diabetes, piles, toothache, skin infections etc. The latex part is mostly used. Through this preliminary study, it is observed that *Ficus* species are widely distributed but their medicinal and food value are still not documented in a scientific manner. Therefore, we need sound proof documentation on the identification of *Ficus* species and exploring their medicinal and food values.

Acknowledgement: Authors are thankful to the forest officials & local communities of study areas.

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Common medicinal ferns of India

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Abstract: *Ferns are not considered as economically and medicinally important plants compare to other angiosperms. They are equally important as flowering medicinal plants because of the compounds that is extracted from them is used to cure many aliments. They are flowerless plants with leafy fronds and reproduce by spores which are released from the underside of the fronds. Ferns have vascular system for the transportation of water and nutrients. Ecologically, the ferns are found mostly in shaded damp areas near the fringes of perennial streams, near river side and they also grow on the rocks. They are used to cure many diseases like stomach ache, sleeping disorder, dysentery, cough etc. The present study highlights the medicinal ferns reported throughout India. It is a compilation of medicinal values of some common ferns of India.*

Keywords: Ferns, medicinal, leafy fronds, tribal communities

Introduction: Ferns are second largest group of plants in Indian flora. Ferns are members of a group of vascular plants have neither seeds nor flowers. They differ from mosses and other bryophytes. Ferns are classified as pteridophytes and are reported as the first non- flowering vascular plants on land that reproduce and disperse through spores. They are having ability to produce spores which are released from the underside of their leaves. They include both ferns and fern allies. They are divided into two classes namely Lycopodiophyta (Fern allies) and Pteridophyta (true ferns). They are mostly found in the damp areas, river and perennial stream fringes. In India, they are represented by about 33 families with about 130 genera and about 1267 species. Among them about 70 ferns are endemic to India (BSI 2022). Ferns are consumed as a vegetable and also leaves, young fronds, stems and rhizomes are also consumed to treat many diseases (Keller and Prance 2015). Local communities of India consumed them as a traditional food which was a vital source of health care and have economic values (Liu et al. 2012). The present study was to compile and evaluate the currently available information on the common medicinal ferns that are traditionally used as a therapeutic agent. In this study, we brief the data collected from local communities about the medicinal ferns consumed by them.

Methodology: The survey was carried out in the period of 2017-2022 in different parts of India (Odisha, Manipur, Jharkhand, Uttarakhand). The data was collected from local people during the trips in various project works and local travelling. The plant was identified by Dr Sanjeet Kumar, APRF, Odisha, India.

Results and discussion: The current comprehensive survey work recorded nearly 21 common medicinal ferns used to treat many aliments by the local communities of India (Plate 1, Figure 1). Out of 21 fern species, it was found that *Adiantum philippense, Angiopteris*

evecta, *Diplazium polypodioides* are used to treat dysentery. *Blechnum orientale*, *Ceratopteris thalictroides*, *Christella dentata* and *Dryopteris cochleata* are used to treat skin diseases. *Asplenium trichomanes* and *Diplazium esculentum* are used to treat cough. Many researchers describe the medicinal uses of ferns throughout India. Sathiyaraj et al. (2015) reported that tribal people of Palani hills of Western Ghats of South India used ferns for medicinal purposes. In 2016, Yumkham et al. reported that ferns are edible in North-East India and are consumed as leafy vegetables as a tonic. Giri and Uniyal 2022, reported that many ferns are consumed as vegetables and are also used to treat various diseases. In 2022, Dey and Bhandari have reported the diversity of ethnomedicinal pteridophytes in Jalpaiguri district of West Bengal.

Plate 1: Medicinal ferns available in India, a) *Cheilanthes tenuifolia*, b) *Adiantum philippense*, c) *Cyclosorus terminans*, d) *Ceratopteris thalictroides*

Table1: **Some common medicinal ferns of India**

Botanical name	**Family**	**Medicinal uses**
Adiantum philippense	Pteridaceae	Juice of the fresh leaves are used in dysentery.
Alsophila gigantea	Cyatheaceae	Leaves paste is used to treat inflammation.
Ampelopteris prolifera	Thelypteridaceae	Leaf decoction is used in stomach ache.
Angiopteris crassipes	Marattiaceae	Leaf paste is used to treat leucoderma

Angiopteris evecta	Marattiaceae	Leaf decoction is used to treat diarrhoea and dysentery.
Asplenium dielfalcatum	Aspleniaceae	Leaf decoction is used to cure jaundice.
Asplenium trichomanes	Aspleniaceae	Leaf decoction is used in cough remedy.
Azolla pinnata	Salviniaceae	The leaf powder paste is used as mosquito repellent during working in wetland areas by the local communities of Manipur.
Blechnum orientale	Blechnaceae	Leaf paste is used to treat skin diseases.
Botrychium lanuginosum	Ophioglossaceae	Leaves are boiled and ground into paste and applied for wound healing.
Ceratopteris thalictroides	Pteridaceae	The whole plant parts are ground into paste and mixed with turmeric to cure skin diseases.
Cheilanthes tenuifolia	Pteridaceae	Juice obtained from the leaves is mixed with hot water and taken orally along with honey to treat throat pain.
Christella dentata	Thelypteridaceae	Leaf paste is used to treat skin problems.
Cyclosorus terminans	Thelypteridaceae	Leaf paste is used as a mosquito repellent.
Dicranopteris linearis	Gleicheniaceae	Leaf decoction is used to treat stomach worm.
Diplazium dilatatum	Athyriaceae	Warm leaf decoction is used to wash the penis cure sore.
Diplazium esculentum	Athyriaceae	Juice of the leaves is taken orally to cure cold and cough.
Diplazium polypodioides	Athyriaceae	Fronds are roasted and chewed to relieve dysentery.
Dryopteris cochleate	Dryopteridaceae	Leaf paste is used to treat leprosy.
Lygodium flexuosum	Lygodiaceae	Leaf paste is used in insect bites.
Marsilea minuta	Marsileaceae	Leaves are consumed as a leafy vegetable to cure sleeping disorder.

Figure 1: Some common ferns used to treat many aliments

Conclusion: Ferns are not as important as angiosperms in most of the countries but some local communities of India consumed them as leafy vegetables and are also used to cure many aliments. Hence, more exploration works on medicinal ferns are needed. Also need a scientific validation on medicinal claims through pharmacological evaluation to develop the future drugs.

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Chapter 7

Role of nanoparticles & plant extracts in microbial infections

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Abstract: *In recent years, interest in the development of novel drug delivery systems using nanoparticles has gained more attention. The nanoparticles offer several advantages over other conventional drug delivery systems. Nanoparticles have gained importance in technological advancements due to their modifiable physical, chemical and biological properties with improved performance over their bulk foils. Nanoparticles can simply move in the body due to their small size and reach to complex organs through diverse routes. The high stability and controlled drug release make nanoparticles the most suitable drug delivery system. Synthesis of metal nanoparticles using plant extracts is one of the most simple, convenient, economical, and environmental-friendly methods that mitigate the involvement of toxic chemicals. Hence, in recent years, several eco-friendly processes for the rapid synthesis of silver nanoparticles have been reported using aqueous extracts of plant parts such as the leaf, bark, roots, etc. Extracts of a diverse range of plant species have been successfully used in making nanoparticles against pathogenic microbes. This capacity by plants to intrinsically utilize their organic processes to reorganize inorganic metal ions into nanoparticles has thus led to extensive studies into this area of biochemical synthesis and analysis. This review shows the importance of rapid screening of plant-based microbial agents and enhancing their activities to understand the role of nanoparticles of plant extract against microbial pathogens.*

Keywords: Anti-microbial resistance, medicinal plants, plant extracts, nano-particles

Introduction: Global temperature and climate changes are observed everywhere. These are the results of anthropogenic activities. Population of the world misusing our biological resources and providing a base for the development of pathogenic microbes. On the other hand, we are losing our standard and traditional food leads to poor immunity. These two above factors demand antimicrobial drugs but unfortunately, we are also facing anti-microbial resistance where due to malpractices of drug handling or natural mutation, the available drugs are not able to kill or inhibit the pathogenic bacteria. The above-all burning issues are the rationale behind global screening activities of antimicrobial drugs by researchers from plant resources. Modern techniques are discovered to enhance the potential of plant extracts against pathogenic bacteria for rapid and fruitful results. There are numbers of modern techniques are available to enhance the potential of plant extracts. Among them, the nanoparticles technique is common, effective, and easy in handling. Hence, keeping the importance of rapid screening of plant-based microbial agents and enhancing their activities an attempt has been done to understand the role of nanoparticles of plant extract against microbial pathogens from literature. The chapter

highlights the modern techniques against antimicrobial agents (Bao et al. 2021; Adeyemi et al. 2022).

Methods for development of nanoparticles

Synthesis of nanoparticles is based on two approaches namely, top-down approach and bottom-up (Baig et al. 2021).

Top-down approach: The top-down approach uses initial macroscopic structures. The methods begin with larger particles which are reduced to being synthesized as antimicrobial agents **(**Patil et al. 2021**;** Ahmed et al. 2021**)**. Methods in top-down approach are:

1. Physical vapour deposition
2. Chemical vapour deposition
3. Ion implantation
4. Electron beam lithography
5. X-ray lithography

Bottom-up approach: Bottom-up approaches to the production of nanomaterials comprise the miniaturization of materials constituents to the atomic level with the additional procedure leading to the development of nanostructures. Throughout the further progression, the physical forces working at the nanoscale combined simple units into larger stable structures. The methodology is principally based on the principle of molecular recognition (self-assembly). Many of these techniques are still under development or are just beginning to be used for the commercial production of nanoparticles (Patil et al. 2021; Ahmed et al. 2021).

Methods in a bottom-up approach:

1. Sol-gel synthesis
2. Colloidal precipitation
3. Hydrothermal synthesis
4. Organometallic chemical route
5. Electrodeposition

Types of nanoparticles

Silver: Silver nanoparticles have proved to be most effective because of their good antimicrobial efficacy against bacteria, viruses, and other eukaryotic micro-organisms. They are undoubtedly the most widely used nanomaterials among all, thereby being used as antimicrobial agents, in textile industries, for water treatment, sunscreen lotions etc. Studies have already reported the successful biosynthesis of silver nanoparticles by plants such as *Azadirachta indica*, *Capsicum annuum*, and *Carica papaya* (Hasan 2015; Ealias & Saravanakumar 2017; Khan et al. 2019).

Gold: Gold nanoparticles (AuNPs) are used in immunochemical studies for the identification of protein interactions. They are used as lab tracers in DNA fingerprinting to detect the presence of DNA in a sample. They are also used for the detection of aminoglycoside antibiotics like streptomycin, gentamycin, and neomycin. Gold nanorods are being used to detect cancer stem cells, beneficial for cancer diagnosis and for identification of different classes of bacteria (Hasan 2015; Ealias & Saravanakumar 2017; Khan et al. 2019).

Alloy: Alloy nanoparticles exhibit structural properties that are different from their bulk samples. Since Ag has the highest electrical conductivity among metal fillers and, unlike many other metals, their oxides have relatively better conductivity, Ag flakes are most widely used. Bimetallic alloy nanoparticle's properties are influenced by both metals and show more advantages over ordinary metallic NPs (Hasan 2015; Ealias & Saravanakumar 2017; Khan et al. 2019).

Magnetic: Magnetic nanoparticles like Fe_3O_4 (magnetite) and Fe_2O_3 (maghemite) are known to be biocompatible. They have been actively investigated for targeted cancer treatment (magnetic hyperthermia), stem cell sorting and manipulation, guided drug delivery, gene therapy, DNA analysis, and magnetic resonance imaging (MRI) (Hasan 2015; Ealias & Saravanakumar 2017; Khan et al. 2019).

Synthesis of Ag nanoparticles utilizing plant extracts: Metal nanoparticles have attained a lot of interest due to their high surface area, high conductivity, better chemical nature, and distinct properties. Ag nanoparticles have captivated the researchers' attention due to their unique properties, such as thermal and large electrical conductivity, Raman scattering, high catalytical activity, chemical stability, and their promising antimicrobial activities. Ag nanoparticles have significant importance as antimicrobial agents compared to other noble metals. These exceptional properties of Ag nanoparticles make them unique for microbial infections with minimal systematic toxicity. At present, various researchers are working on nanoparticle-based therapeutics targeting anticancer activities. Their works are mainly focused on the practical synthesis of the Ag nanoparticles using plant extracts (Gowhar et al. 2021; Ahmed et al. 2016).

Synthesis of ZnO nanoparticles utilizing plant extracts: ZnO nanoparticles due to their exceptional semiconducting properties and biocompatible nature are explicitly used in ceramic resistors, catalysts, gas sensors, photonic devices, energy harvesting and biomedical applications. Additionally, the US FDA has registered ZnO nanoparticles as GRAS (usually established as benign) metal oxide. ZnO nanoparticles have been employed in the area of the drug transport system and exhibit antibacterial properties (Gowhar et al. 2021).

Synthesis of Fe_3O_4 nanoparticles utilizing plant extracts: Numerous methods of fabrication of Fe3O4-NPs can be employed, such as the sol-gel method, solid-state synthesis, and flame spray synthesis. In contrast to the time-consuming chemical and physical methods which involve complicated procedures, the green method is much easier and safer to use, and plant-mediated synthesis of nanoparticles is still a new scheme and the outcome is yet to be studied. There are a couple of successful studies in synthesizing Fe3O4-NPs by using plant extract. However, there are only finite studies on the synthesis of Fe3O4-NPs from marine plants (Yew et al. 2016).

Synthesis of SnO_2 nanoparticles utilizing plant extracts: SnO_2 nanoparticles also have many applications such as their antifungal, antibacterial, photocatalysis, and antioxidant activities, and are also used in the development of sensors. The plant parts are mostly utilized for SnO_2 nanoparticles' production as buds, leaves, flowers, fruits, bark, and seeds. Steps involved in the development of SnO_2 nanoparticles include the collection of plants, separation of required parts, cleaning and drying, grinding, dispersion followed by heating them in distilled water. This is then filtered off to remove fiber, giving a clear extract. Various precursors are added

into plant extract to produce SnO_2, which is calcinated at a temperature 600–800 °C (Pal et al. 2011; Gowhar et al. 2021).

Earlier reports with nanoparticles: In 2017, Jain and Meheta reported that green chemistry was employed for the synthesis of silver nanoparticles (AgNPs) using leaf extracts of *Ocimum Sanctum* (Tulsi) and its derivative quercetin (flavonoid present in Tulsi) separately as precursors to investigate the role of biomolecules present in Tulsi in the formation of AgNPs from cationic silver under different physicochemical conditions such as pH, temperature, reaction time and reactants concentration. The size, shape, morphology, and stability of resultant AgNPs were investigated by optical spectroscopy (absorption, photoluminescence (PL), PL-lifetime and Fourier transform infrared), X-ray diffraction (XRD) analysis, and transmission electron microscopy (TEM). The enhanced antibacterial activity of AgNPs against E-Coli gram-negative bacterial strains was analyzed based on the zone of inhibition and minimal inhibitory concentration (MIC) indices. The results of different characterization techniques showed that AgNPs synthesized using both leaf extract and neat quercetin separately followed the same optical, morphological, and antibacterial characteristics, demonstrating that biomolecules (quercetin) present in Tulsi are mainly responsible for the reduction of metal ions to metal nanoparticles.

In the year 2018, Loo et al. reported that silver nanoparticles (AgNPs) using pu-erh tea leaves extract with particle size of 4.06 nm. The MIC and MBC of AgNPs against *Escherichia coli*, *Klebsiella pneumoniae*, *Salmonella typhimurium*, and *Salmonella* Enteritidis were 7.8, 3.9, 3.9, 3.9 and 7.8, 3.9, 7.8, 3.9 µg/mL, respectively. Time-kill curves were used to evaluate the concentration between MIC and bactericidal activity of AgNPs at concentrations ranging from 0×MIC to 8×MIC. The killing activity of AgNPs was fast-acting against all the Gram-negative bacteria tested; the reduction in the number of CFU mL^{-1} was >3 Log_{10} units (99.9%) in 1–2 h.

Jeevanandan et al. (2018) noted that NMs from anthropogenic activities and engineered NMs in consumer products are able to cause toxic effects in living creatures. Additionally, emerging NPs, such as viral NPs and nanozymes, should be subjected to rigorous cytotoxicity tests to establish benign mechanisms of application and dosage levels. In order to minimize or avoid the potential hazards of engineered NMs in consumer products, regulations and laws have been implemented in many countries. Extensive research in the field of nanotoxicology and strict laws by government agencies are essential to identify and avoid toxic NPs.

In 2019, Masum et al. reported Biogenic synthesis of silver nanoparticles (AgNPs) using plants. In this study, they reported low-cost, green synthesis of AgNPs using fresh fruit extract of *Phyllanthus emblica*. The biosynthesized AgNPs were confirmed and characterized by analysis of the spectroscopy profile of the UV-visible and Energy dispersive spectrophotometer, Fourier transforms infrared, X-ray diffraction pattern, and electron microscopy images examination. UV-visible spectra showed a surface resonance peak of 430 nm corresponding to the formation of AgNPs, and FTIR spectra confirmed the involvement of biological molecules in AgNPs synthesis. In spherical AgNPs, the particle size ranged from 19.8 to 92.8 nm and the average diameter was 39 nm. Synthesized nanoparticles at 20 µg/ml showed remarkable antimicrobial activity in vitro against the pathogen *Acidovorax oryzae* strain RS-2 of rice bacterial brown stripe, while 62.41% reduction in OD600 value was observed compared to the control. Moreover, the inhibitory efficiency of AgNPs increased with

the increase of incubation time. Furthermore, AgNPs not only disturbed biofilm formation and swarming ability but also increased the secretion of effector Hcp in strain RS-2, resulting from damage to the cell membrane, which was substantiated by TEM images and lives/dead cell staining results. Overall, this study suggested that AgNPs can be an attractive and eco-friendly candidate to control rice bacterial disease.

In 2020, Castillo-Henríquez et al. reported that green chemistry is an innovative and growing resource in the search for more environmentally friendly processes. Using plant extracts for the synthesis of metal NPs is a recently growing area of interest due to its benefit in comparison to the traditional physicochemical methods. AuNPs and AgNPs generated by green synthesis have potential applications in agriculture and agroindustry, especially as antimicrobial agents of certain microorganisms for which their efficacy has been scientifically proven. Although recent studies suggest that environmental concentrations of AuNPs and AgNPs affect microbial biomass with a low impact on their diversity.

In the year 2021, Mussin et al. reported Combining traditional medicine with nanotechnology for treating skin and soft tissue infections (SSTIs) and also contributing to the fight against the rise of antimicrobial resistance. Spherical and stable silver nanoparticles (AgNPs) of 14 ± 2 nm were synthesized from the aqueous extract of *A. australe* and silver nitrate. The antimicrobial activity against main species causing SSTIs and cytotoxicity on peripheral blood mononuclear cells of AgNP solution and its synthesis components were evaluated. Compared to its synthesis components, AgNP solution showed greater antimicrobial activity and lower cytotoxicity.

Future aspects: There is an increasing interest to improve drug delivery for the resolution of diseases caused by pathogenic microbes. This interest thus represents a unique opportunity for candidates in biogenic metal-based nanoparticles with improved biodistribution and pharmacokinetics. Nature-inspired metallic nanoparticles represent a new generation of innovative nanomedicines designed to act against microbial infections. These materials have been found to have the potential against microbial infections. The contribution of nanotechnology to the precise treatment of microbial infections, which are often with lesser life-threatening side effects, can potentially contribute to the positive movement in clinical practices for life-saving approaches. Besides the problems related to the scaling-up, government regulations and the overall cost-effectiveness in comparison to the currently available chemotherapies are other important limitations in the success of nanomedicines. Their reproducibility has been identified as one of the greatest challenges as a slight modification of the size, the shape, and/or the nanoparticle surface chemistry may dramatically influence the stability. Thus, reliable, and standardized methodologies to obtain reproducible nanoparticles are required. Additionally, plant extracts contain some unique compounds that help to improve the synthesis efficiency and increase the stability of NPs. This discovery could lead to novel, drug-free therapeutics that can slow and/or stop microbial infections.

Conclusion: In summary, this review discussed the recent progress on the synthesis of nanoparticles using plant extracts, focusing on the synthesis of several commonly used NPs such as nanogold, silver etc. The booming development of nanotechnology has promoted the exploitation of methods for synthesizing nanomaterials via plants and microorganisms. The synthesis of NPs has recently received much attention in sustainable chemistry. The plant-extract-mediated method for the preparation of NPs has the advantages of low cost, nontoxicity,

easy scale-up, and environmental friendliness, which are highly conducive to sustainable nanoscience development. Particularly, the as-synthesized NPs have a wide range of applications in the fields of catalysis, medicine, water treatment, antibacterial, anticancer, bioengineering, sensors, and medical imaging. Importantly, the synthesis reaction does not involve any toxic chemical reagents and the resulting NPs are not contaminated with toxic substances, thus being of special value in biomedical applications where nontoxicity is strictly required. In addition, plant extracts contain some unique compounds that help to improve the synthesis efficiency and increase the stability of NPs.

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Chapter 8
Can *Dioscorea* species reduce oxidative stress?

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Abstract*: Oxidative stress created lot of health problems including cardiovascular, diabetic, neoplastic, cognitive disorders etc. These health problems are burning issues throughout the world might be due to lack of dietry items with antioxidants & modern life style. Therefore, need the consumption of food having high concentration of antioxidants from nature or food products. In this aspect, tubers and bulbils of Dioscorea species could be the prime choice as they are the source of high concentration of starch along with diverse secondary metabolites and historical evidences of consumtion by the many communities globally. Therefore, keeping this in view the chapter is designed to bring attention towards their bio-chemical components as a source of the bioagents that could be able to manage the oxidative stress to fight against many leathal health problems. The literature, field and experimental results revelaed that the plant parts of Dioscorea could be an important food and medicines in reducing the oxidative stress in cellular level in our body.*

Key words: Tuberous, bioactive compounds, medicinal values, antioxidant, nutraceutical

Introduction: Oxidative stress observed when reactive oxygen species (ROS) level suppresses the defence mechanisma of cell. ROS are continuously formed by mitochondrion in the body during metabolic reactions. When ROS level surpasses the defense mechanisms, a cell experiences "oxidative stress". Several environmental stresses play central role in the excessive production of ROS, thereby causing progressive oxidative damage and can lead to cell death. The reactive oxygen species (ROS) form under normal physiological conditions and may have both beneficial and harmful role. Reactive oxygen species (ROS) are chemically unstable oxygen-containing molecules such as superoxide anions and hydroxyl radicals that are able to readily react with and inflict damage to cellular constituents. ROS are extremely harmful to organisms at high concentrations and very low ROS levels are required to sustain normal physiological functions. The balance between reactive oxygen species (ROS) production, and their scavenging depends on whether it will serve as a signaling molecules or will cause cause oxidative stress. The balanced antioxidant system of tissues includes several nonenzymatic as well as enzymatic antioxidants that play a key role in effective scavenging of ROS produced during environmental stresses (Juan et al. 2021). ROS are also produced due to pollutants and misuse of drugs. ROS species excessive build up due stress factors leads to oxidative stress, cell & tissue injury, cell death, and is probably at the basis of several ailments such as heart conditions, Alzheimer's disease, cancer, as well as premature aging and cerebrovascular accidents. In order to diminish the potential damage by ROS, the body activates it innate antioxidant system which includes enzymatic antioxidant systems and non-

enzymatic systems. In addition to these innate defense systems, exogenous antioxidants provided through the diet and/or nutritional supplements may help protect the body from oxidative stress. Thus, the consumption such antioxidant rich compounds may decrease the risk of developing the above-mentioned diseases. An important class of plant-derived antioxidants is represented by phenolic compounds. The species belongs to the family *Dioscoreaceae* are rich with phenolic compounds and other natural antioxidants (Kumar et al. 2017a; Kumar et al. 2017b). Therefore, keeping the above-mentioned health problems & importance of *Dioscorea* species in mitigating them, an attempt has been made to validate the perception – "Can *Dioscorea* species reduce the oxidative stress" through the literature and field survey.

Figure 1: Fruits, flowers and bulbil of *Dioscorea bulbifera*

***Dioscorea* species:** The *Dioscorea* species are taken to consideration to be the foremost earliest of the Angiosperm used by human beings. They mainly occurs within the regions of Southern Asia, Africa and South America. In early as 50000 BC during the Palaeolithic era, domestication of yam started in many geographical areas. As per archaeologist, the actual cultivation of yam started in 3000BC. *D. rotundata*, *D. cayenensis*, and *D. dumetorum* are the preliminary cultivated *Dioscorea* in West and Central Africa, while in southeast Asia *D. alata* was first cultivated then quit 2000 years ago it had been shifted to India and Pacific Ocean. The word "YAM" only relate to the genus *Dioscorea* belongs to family Dioscoreaceae, order Discoreales and classified under monocotyledons. It is a perennial monocot belongs to family *Dioscoreaceae*. The vine is also known for its heart shaped leaves. It can mature up to 18 meters and reproduce vegetative through tuber or bulbils which are potato like structure and grows at the axils of the leaves. Tubers are various in shape and size. (Ummalyma et al. 2018; Swain et al. 2020; Mohanty et al. 2021). They have nutraceutical properties and can be a very important food. Tubers are the source of protein, fats and vitamins. Wild variety of yams are used for food purpose in time of deficiency or drought. The Asiatic species i.e. *Dioscorea hispida* closely related to *D. dumetorum*, used as food during the shortage in the many parts of India. A few varieties of yam may be eaten without cooking and some requires to cook or boil for detoxification before eating. Toxicity of the tuber or bulbils depends on the variety and renewed annually. The toxicity of the roots of *Dioscorea bulbifera* are considered to be poisonous and have been used as medicine as a remedy for sore throat and for stroma (Kumar et al. 2012; Kumar et al.

2013a; Kumar et al. 2013b; Kumar et al. 2013b; Kumar and Jena 2014). The detail uses are gathered through field surveys in Odisha state of some common *Dioscorea* species are listed in the Table 1.

Phytochemical constituents: In many regions of the world, *Dioscorea* serves as important saccharide food stuff. The phytochemical study of *Dioscorea* have been disclosed a number of secondary metabolites like saponins, stilbenes, diterpenes, purine derivatives etc. Many studies reprted that yam consists of many phytochemical constituents like polysaccharides, amino acid, proteins, vitamins and mineral components. Organic acid like succinic acid, citric acid, oxalic acid and maleic acid are found in large amount in yam. Antidiosbulbin A and B, norclerodne diterpenes, 8-epidiosbulins E and G are present in *Dioscorea*. It is a supplier of proteins, fats, phenolics, vitamins, glycosides, sterols, alkaloid poly phenols, tannin and saponins (Kumar et al. 2015; Kumar 2015; Kumar and Jena 2017; Kumar 2017).

Browning activaties in *Dioscorea* species: Browning activities of *Dioscorea* species is observed due to the presence of natural phenols and oxidation which is catalysed by the polyphenol oxidase (PPO). Several polyphenols like (+)-catechin that may be a substrate of O-diphenol oxidase, anthocyanins, catecholamine, a leucoanthocyanidin and cinnamic compounds are known in several yam species (Kumar and Jena 2017; Kumar et al. 2017a; Kumar et al. 2017b).

Toxicity of *Dioscorea* species: During the collection of ethnomedicinal values (2009-2022, location-Odisha) of Dioscorea species, it was noticed that the tubers of some wild Dioscorea species are not consumed directly due to the presence of toxic compounds & anti-nutrational factors. Specially, wild yam is harmful and inedible, taste unpleasant and may cause vomiting and diarrhoea once an oversized quantity is eaten while not correct process or eaten uncooked. In some yam species dioscorine has been considered as harmful principle which is a harmful alkaloid. Dioscorine triggers the fatal paralysis of the nervous system. Histamine is also reported as the principal allergen that causes gentle irritation and discomfort. The unpleasantness and poisonousness of many yam species may be also caused by high level of saponins (Kumar and Jena 2017; Kumar et al. 2017a; Kumar et al. 2017b).

Table 1: Food and medicinal values of some common *Dioscorea* species

Species	Parts used	Uses
Dioscorea alata	Tuber & bulbils	Tuber and bulbils are edible Bulbil paste is used to cure piles and gonorrhoea.
Dioscorea bulbifera (Figure 1)	Tuber & bulbils	Tuber can be consumed after boiling. The powder of the tuber is used to cure dysentery.
Dioscorea deltoidea	Tuber	Juice of root tuber is taken in the treatment of roundworm.
Dioscorea dumetorum	Tuber	Juice of boiled tuber is used as cooling agent during summer.
Dioscorea esculenta	Tuber	Tubers are kept overnight in water and cooked as a vegetable.
Dioscorea glabra	Tuber	Tuber paste is used in wound healing.
Dioscorea oppositifolia (Figure 2)	Tuber	Tubers are edible.

Dioscorea pentaphylla	Tuber & bulbils	Tuber is consumed after successive boiling and bulbil paste is used to cure skin infections.
Dioscorea pubera	Tuber	Boiled tuber is consumed as a snack.
Dioscorea spinosa	Tuber	Tubers are edible.
Dioscorea villosa	Tuber	Tuber juice is used as birth control agent.
Dioscorea wallichii	Tuber	Tubers are consumed in stomach pain.

Figure 2: Fruits and leaves of *Dioscorea oppositifolia* in wild

Validation: The comprehensive works on the nutraceutical potential of yam through literature & field works validate that the species of genus *Dioscorea* has antioxidant potential and rich with phenolic compounds. Therefore, these species could be able to reduce the oxidative stress and associated helath problems.

Recommendations: The recommendations are:

1. There are a need of more exploration works on taxonomy of *Dioscorea* species.
2. There is a need of documentation on food & medicinal values of them.
3. Futhure, advance works on food chemistry and pharmacological values of *Dioscorea* species available in India.

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