Medico-Biowealth of India

Volume 20



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MESSAGE

It gives me immense pleasure to note the publication of **Medico-Biowealth of India, Volume 20,** a continuation of an inspiring and scientifically valuable series that documents the plant diversity and its medicinal potential of India. This volume, with its well-curated chapters, reflects the dedicated efforts of scientists and scholars who have explored the therapeutic, ecological, and economic values of various plant species across the country. Their work not only strengthens our understanding of medicinal flora but also highlights the importance of conserving these biological treasures for future generations. I congratulate the editors and all contributing authors for their commitment to advancing interdisciplinary research that bridges ethnobotany, phytochemistry, and pharmacology. This book stands as a testament to the collective endeavor of Indian scientists to transform traditional wisdom into scientific evidence, supporting both academic progress and practical applications in natural medicine. I am confident that **Medico-Biowealth of India, Volume 20** will serve as a valuable reference for researchers, students, and policymakers alike, fostering deeper appreciation and responsible utilization of India's vast medico-biowealth.

Padma Mahanti

(Padma Mahanti, IFS)

PREFACE

India, renowned for its vast and diverse biodiversity, holds a remarkable repository of medicinally valuable flora that continues to support traditional healthcare systems and inspire modern scientific inquiry. **Medico-Biowealth of India, Volume 20** is a humble effort to document and highlight this unique botanical heritage, focusing on plants with ethnomedicinal, pharmacological, and ecological significance. This volume aims to serve as a comprehensive reference for researchers, academicians, and students engaged in the exploration of natural wealth of India and its role in health and sustainable development. The present volume brings together ten chapters contributed by experts across India, encompassing diverse topics such as antidiabetic medicinal plants, horticulturally important tuberous species, ornamental and economically important trees, and phytochemical investigations of select orchids. The volume also emphasizes the pharmacological potential of plants like *Solanum sisymbriifolium*, *Scoparia dulcis* and *Heliotropium indicum*, which have been traditionally employed in indigenous medicine. Further, studies on the cytotoxicity and bioactivity of orchids such as *Vanda tessellata* and *Zeuxine strateumatica* demonstrate the integration of traditional knowledge with modern laboratory-based evaluations. This compilation is envisioned to strengthen the bridge between ethnobotany, phytochemistry and pharmacology, fostering interdisciplinary collaboration in medicinal plant research. It is our sincere hope that *Medico-Biowealth of India, Volume 20* will not only enrich academic and research literature but also inspire conservation, innovation, and sustainable utilization of India's botanical wealth for the well-being of future generations.

Editors

BACKGROUND

The idea of compiling **Medico-Biowealth of India, Volume 20** emerged from a growing need to integrate traditional ethnobotanical knowledge with modern scientific validation of medicinal plants. Cultural and ecological diversity of India has endowed it with an immense wealth of plant-based remedies that form the backbone of Ayurvedic, Siddha, Unani and various indigenous healing systems. However, with the rapid pace of modernization, habitat loss and declining traditional practices, much of this invaluable knowledge is at risk of being lost. Recognizing this urgency, the editors and contributors of this volume aimed to bring together a scientifically enriched compilation that documents, analyses and preserves information on medicinally important plant taxa from different regions of India. The focus is not only on cataloguing traditional uses but also on presenting phytochemical and pharmacological evidence that underscores their therapeutic potential. This book stands as a collaborative effort involving botanists, pharmacologists, ethnobotanists, and biotechnologists, each contributing unique perspectives that reflect India's multidisciplinary approach to medicinal plant research. The inclusion of studies on orchids, tuberous plants and ethnomedicinal herbs reflects the editors' vision to present a broad botanical spectrum ranging from field-based ethnobotanical documentation to laboratory-based bioactivity analyses. Several chapters also highlight recent discoveries and cytotoxicity assessments, thereby linking traditional healing practices with modern biomedical research. This integrative approach strengthens the scientific foundation of traditional medicine and promotes the rational use of natural resources for developing safer and more effective therapeutic agents. The edited volume will serve as a valuable reference for researchers, academicians, students, and policymakers working in the fields of botany,

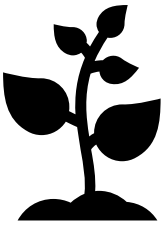
pharmacognosy, ethnopharmacology and conservation biology. By presenting both traditional knowledge and scientific evidence in a single platform, it bridges the gap between folk wisdom and modern science. The book is also expected to be useful in promoting sustainable utilization and conservation of medicinal plants by highlighting their ecological, economic, and therapeutic importance. Ultimately, **Medico-Biowealth of India, Volume 20** aims to inspire future studies in medicinal plant research and encourage interdisciplinary collaboration for the discovery of novel bioactive compounds that can contribute to global health and well-being.



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Chapter 1

Antidiabetic medicinal plants of India

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Abstract: The present study documented the ethnomedicinal plants useful in the management of diabetes in the different states of India. Field surveys were carried out in the selected states (Odisha, Haryana, Himachal Pradesh, and Maharashtra) from the year 2022 to 2025. The information was collected through interviews with the local communities using semi-structured questionnaires. A total of 40 plant species belonging to 39 genera and 28 families were enumerated, having anti-diabetic uses. Among these, some of the most used species are *Andrographis paniculata*, *Azadirachta indica*, *Momordica charantia* and *Phyllanthus emblica*. The present study highlights the importance of local plants in the management of diabetes and draws attention towards their sustainable utilisation and conservation.

Keywords: Ethnomedicinal, diabetes management, global health problem

Introduction

The prevalence of diabetes has nearly doubled from the 20th century to the 21st century, with lifestyle changes being a significant contributing factor (Hossain et al., 2024). Globally, other key factors include obesity, population

growth, poor dietary practices, socioeconomic inequalities, and genetic predisposition (Hu, 2011). Diabetes poses serious health consequences, including a high risk of cardiovascular disease, blindness, kidney failure, and limb amputation (Nazar et al., 2024; Khajuria et al., 2025; Uti et al., 2025), as well as a substantial economic burden. Approximately 537 million adults worldwide live with diabetes, representing 10.5 % of the global population (Uti et al., 2025). The situation is particularly dire in low- and middle-income countries like India, where diabetes affects a significant portion of the working-age population. While prevention and management are feasible, they require sustainable lifestyle changes and a shift towards natural and organic products. India has a rich tradition of using natural remedies for diabetes management, highlighting the need for documentation and validation of such knowledge (Debbarma et al., 2017). The present study aims to enumerate common plant species in India used to manage diabetes and draw attention to the therapeutic potential of medicinal plants and natural products.

Methodology

A field survey was conducted from 2022 to 2025 in selected states of India (Odisha, Haryana, Himachal Pradesh, and Maharashtra). Local communities were engaged through interviews and discussions, during which a total of 40 plant species were documented, along with their used parts. The collected data were cross-verified with previously reported ethnobotanical studies on antidiabetic plants to authenticate their medicinal potential (Aradhana et al., 2022; Kumar, 2025; Pradhan et al., 2025). The study adhered to standard methods of ethnobotanical survey, ensuring a rigorous and reliable documentation of traditional knowledge (Jena et al., 2025).

Results and discussion

The present survey documented 40 plant species from diverse botanical families, showcasing the rich ethnobotanical heritage of Indian traditional medicine (Table 1; Figures 1-10). The Fabaceae, Malvaceae, Amaranthaceae, and Cucurbitaceae families were predominantly represented. Various plant parts were utilised for their therapeutic properties, with leaves, barks, and roots being the most frequently used, followed by fruits, flowers, and whole plant preparations. Notably, specific plants like *Azadirachta indica* and *Aegle marmelos* are recognised for their hypoglycemic properties, primarily utilising their leaves, whereas species like *Pterocarpus marsupium* and *Santalum album* are valued for their medicinal bark.

Table 1: Ethnomedicinal plants used to treat diabetes

Plant Name	Family	Common Name	Parts used
Abrus precatorius L.	Fabaceae	Rosary pea	Leaf
Achyranthes aspera L.	Amaranthaceae	Devil's horsewhip	Root
Aegle marmelos (L.) Corrêa	Rutaceae	Bael	Leaf
Aerva lanata (L.) Juss. ex Schult.	Amaranthaceae	Mountain knotgrass	Whole plant
Ailanthus excelsa Roxb. (Figure 1)	Simaroubaceae	Tree of heaven	Bark
Alangium salviifolium (L.f.) Wangerin (Figure 2)	Cornaceae	Sage-leaved alangium	Leaf
Andrographis paniculata (Burm.f.) Wall. ex Nees	Acanthaceae	Green chiretta	Leaf
Azadirachta indica A.Juss.	Meliaceae	Neem	Leaf
Bacopa monnieri (L.) Wettst.	Plantaginaceae	Brahmi	Leaf

Barleria cristata L.	Acanthaceae	Bluebell barleria	Root
Cajanus cajan (L.) Huth	Fabaceae	Pigeon pea	Leaf
Calotropis gigantea (L.) W.T. Aiton	Apocynaceae	Crown flower	Flower
Cassia fistula L. (Figure 3)	Fabaceae	Golden shower	Root
Cinnamomum verum J.Presl	Lauraceae	Cinnamon	Inner bark and root
Coccinia grandis (L.) Voigt	Cucurbitaceae	Ivy gourd	Flower and young fruit
Curcuma longa L.	Zingiberaceae	Turmeric	Rhizome
Cynodon dactylon (L.) Pers.	Poaceae	Bermuda grass	Whole plant and rhizome
Dioscorea alata L.	Dioscoreaceae	Greater yam	Tuber
Ficus religiosa L.	Moraceae	Peepal	Unripe fruit
Gmelina arborea Roxb. ex Sm.	Lamiaceae	Gamhar	Young leaf
Grewia tiliifolia Vahl	Tiliaceae	Dhaman	Bark
Helicteres isora L. (Figure 4)	Malvaceae	East-Indian screw tree	Root/bark
Hemidesmus indicus (L.) R.Br.	Apocynaceae	Indian sarsaparilla	Root
Hibiscus × *rosa-sinensis* L.	Malvaceae	Chinese hibiscus	Petal
Afrohybanthus enneaspermus (L.) Flicker	Violaceae	Spade flower	Whole plant
Madhuca longifolia (L.) J.F. Macbr.	Sapotaceae	Indian butter tree	Bark
Momordica charantia L. (Figure 8)	Cucurbitaceae	Bitter gourd	Fruit
Oxalis corniculata L. (Figure 7)	Oxalidaceae	Creeping wood-sorrel	Leaf
Phyllanthus emblica L.	Phyllanthaceae	Indian gooseberry	Fruit
Phyllanthus niruri L.	Phyllanthaceae	Gale of the wind	Whole plant
Plumbago indica L.	Plumbaginaceae	Scarlet leadwort	Root

Pterocarpus marsupium Roxb.	Fabaceae	Indian kino tree	Bark
Punica granatum L.	Punicaceae	Pomegranate	Root, bark and fruit
Santalum album L.	Santalaceae	Indian sandalwood	Bark
Saraca asoca (Roxb.) W.J.de Wilde	Caesalpiniaceae	Sita Ashok	Flower
Scindapsus officinalis (Roxb.) Schott (Figure 5)	Araceae	Gajapippali	Inflorescence
Semecarpus anacardium L.f.	Anacardiaceae	Marking nut tree	Fruit
Sida cordifolia L.	Malvaceae	Country mallow	Root
Spondias pinnata (L.f.) Kurz (Figure 6)	Anacardiaceae	Wild mango	Bark of young branch
Tamarindus indica L.	Caesalpiniaceae	Tamarind	Seed



Figure 1: Leaves and flowers of *Ailanthus excelsa*



Figure 2: Flowers of *Alangium salviifolium*



Figure 3: Flowers and fruits of *Cassia fistula*



Figure 4: Flowers of *Helicteres isora*



Figure 5: Fruit of *Scindapsus officinalis*

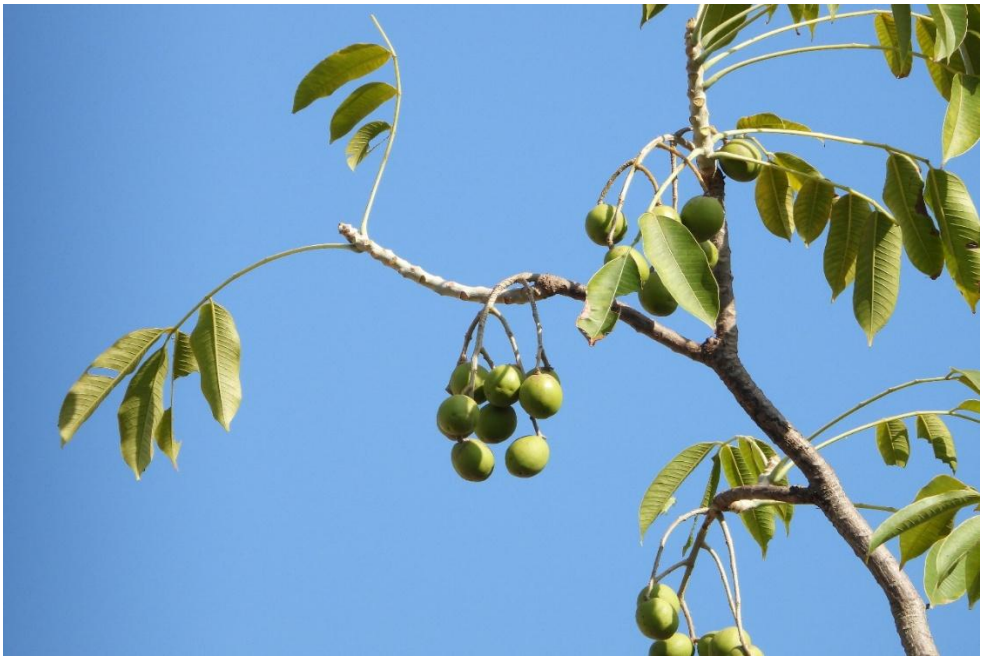


Figure 6: Leaves and fruit of *Spondias pinnata*



Figure 7: Leaves of *Oxalis corniculata*



Figure 8: Fruit and seeds of *Momordica charantia*

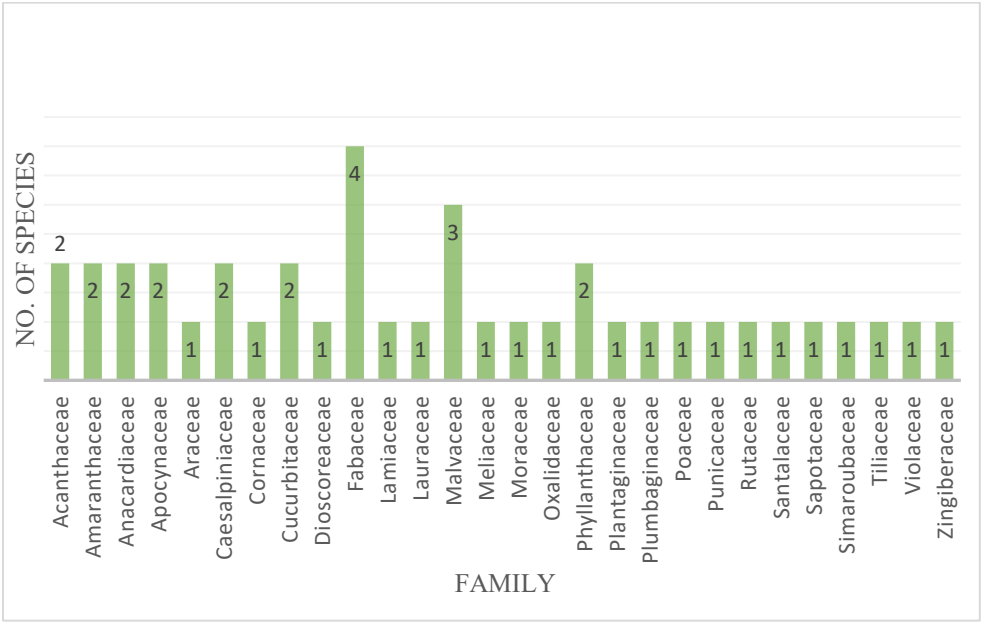


Figure 9: Diversity of antidiabetic medicinal plants in 28 families

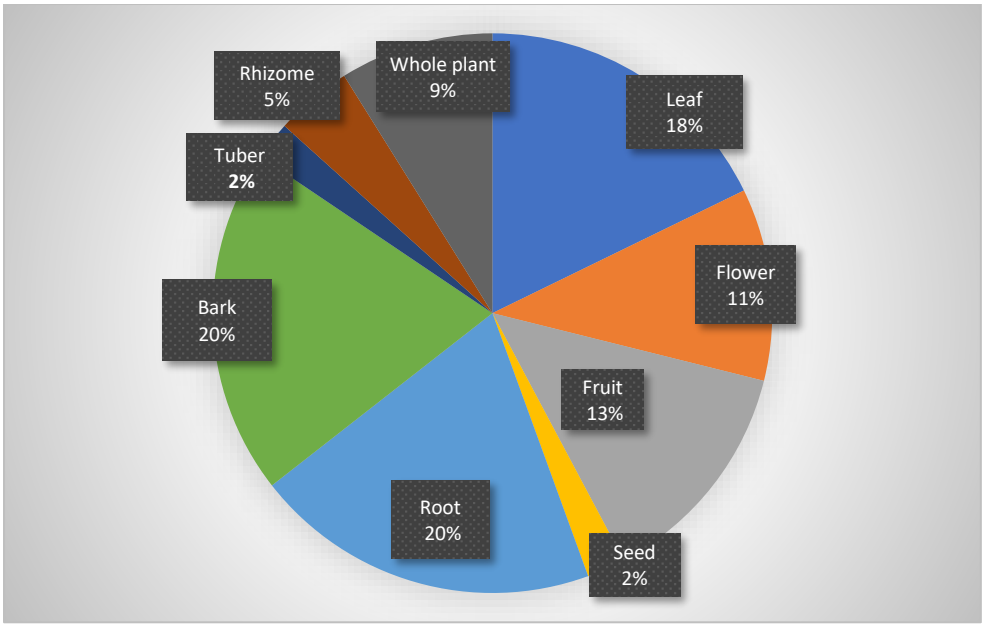


Figure 10: Percentage of parts used for diabetes management

Moreover, some plants, such as *Momordica charantia* (Bitter gourd), *Phyllanthus emblica* (Indian gooseberry), and *Coccinia grandis* (Ivy gourd), are well recognised in both folk medicine and scientific studies for their strong antidiabetic properties (Figure 11). The use of multiple parts in some species, such as *Punica granatum* (Pomegranate), where the root, bark, and fruit are all utilised, reflects the complex phytochemical composition and therapeutic adaptability of these plants. The survey results not only provided a brief understanding of the biodiversity of India's medicinal flora but also highlighted the importance of preserving and validating traditional knowledge to support the development of effective plant-based antidiabetic therapies. Over the last three to five years, several peer-reviewed studies have validated the antidiabetic potential of traditional Indian medicinal plants, showing diverse mechanisms and therapeutic benefits (Sharma et al., 2023).

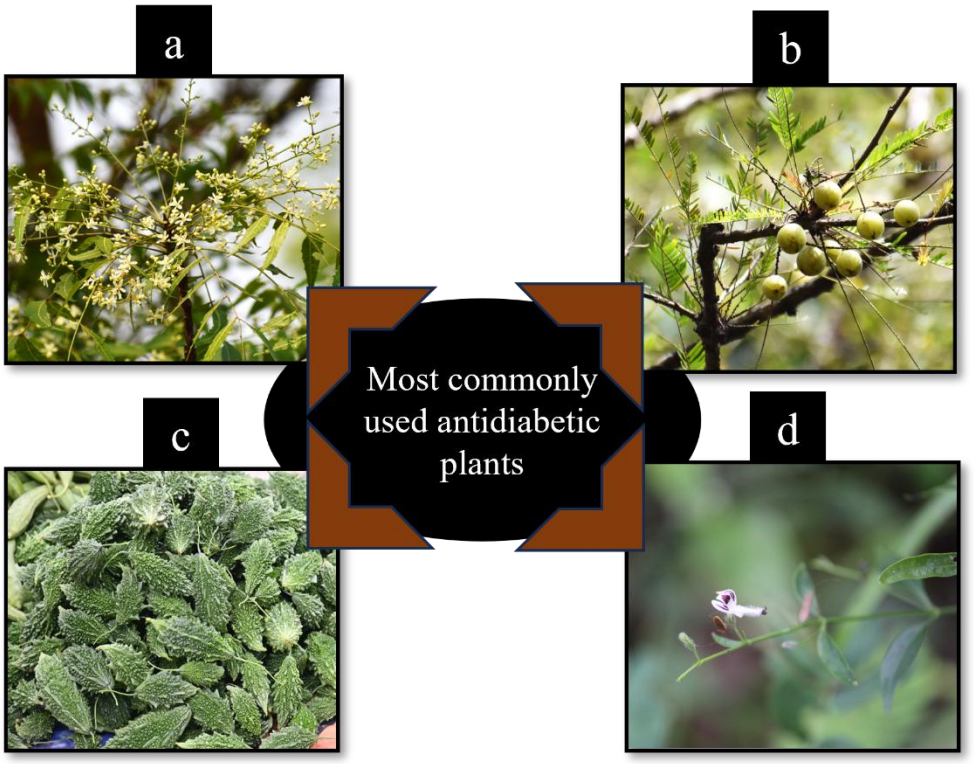


Figure 11: Most common plants used in diabetes; a) *Azadirachta indica*, b) *Phyllanthus emblica*, c) *Momordica charantia*, and d) *Andrographis paniculata*

In 2025, Yusuf and his co-workers studied about 47 plant species that have antidiabetic properties. Uti et al., (2025) reviewed about 15 antidiabetic plants with their major bioactive compounds. *Sesuvium portulacastrum* was evaluated in the *Journal of Pharmacy and Bioallied Sciences*, showing significant in vitro α-amylase and α-glucosidase inhibition, along with in silico evidence suggesting a multitarget interaction with diabetic pathways, often outperforming acarbose in assays (Mukundh et al., 2024). Additionally, a landmark in vitro and in silico study published in the *Indian Journal of Biochemistry and Biophysics* evaluated *Withania somnifera* root extract, demonstrating potent inhibition of key glucose-regulating enzymes (Narayanaswamy et al., 2025).

Conclusion

Diabetes is a global health problem. It creates a lot of problems, and its management is of high priority. A lot of allopathic medicines are available with side effects. In this aspect, the present study draws attention towards the use of 40 local plants in the management of diabetes. The present study provides baseline data for advanced experimental works using the enumerated plants.

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Chapter 2

Horticulturally important tuberous plants of India

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Abstract: The diversity of tuberous plants in India represents a significant component of the country's horticultural wealth, contributing to food security, traditional medicine, and rural livelihoods. The present study highlighted several horticulturally important tuberous plants across various genera, including *Amorphophallus* sp. (Elephant foot yam group), *Curcuma* sp. (Turmeric group), *Ipomoea* sp. (Sweet potato group), and *Dioscorea* sp. (Yams). These plants are not only vital as staple or supplementary food sources rich in starch, fibre, vitamins, and minerals but also serve important medicinal roles in indigenous and Ayurvedic systems. The integration of these tuberous plants into sustainable agriculture and health systems holds promise for enhancing nutrition, promoting traditional medicine, and preserving agro-biodiversity in India. The chapter highlighted the importance of 15 horticulturally important tuberous plants of India along with their significance. The paper will be helpful to select the species for cultivation and research & development in the aspects of economic food crops.

Keywords: Agro-biodiversity, food security, rural livelihood, sustainable agriculture

Introduction

Most nutraceuticals are obtained from the soil. Tuber, root, rhizome and corm are the plant parts that grow inside the soil and have food and medicinal properties (Siddiqui et al., 2022; Chovatiya et al., 2025). They also have different types of minerals, primary metabolites and particularly fibre, which make them a suitable food for human beings (Chandrasekara and Kumar, 2016; Kaviraj et al., 2022). Due to these properties, they have been cultivated as horticultural plants since the primitive era (Nanbol and Namo, 2019). Our ancestors have developed indigenous knowledge to use them and added in our day-to-day food practices (Kumar et al., 2012; Kumar et al., 2013; Sharma and Ramawat, 2014; Kumar et al., 2017; Kom et al., 2024). Such practices are also reflected in many cultural and ritual activities, like "Dasamularishta" is used in Jagannath culture. During the course of time, modern humans adopted the fashionable lifestyle and started consuming different types of junk food, leading to global health issues like obesity, diabetes, high blood pressure, cardiovascular problems and many more (Tabish, 2017; Fuhrman, 2018; Clemente-Suarez et al., 2023; Rapinski et al., 2023; Jiajie et al., 2024). In this scenario, researchers have a prime duty to address the importance of tuberous plants, which have been cultivated and have horticultural importance. A proper address and value additions will give our rich food practices on the plate of an urban dining table. It will not only reduce the health problems but helpful for economic growth, sustainable food consumption and the development of a family to a nation. Therefore, an attempt has been made to document some cultivated tuberous plant species in India that have horticultural importance. The present study also draws attention towards the natural food products having medicinal values and their therapeutic applications to combat contemporary health problems.

Methodology

A field survey was conducted from 2024 to 2025 in selected states of India (Odisha, Chhattisgarh, Jharkhand and Maharashtra) during different floristic works. Local communities were engaged through interviews and discussions, during which a total of 15 tuberous plant species were documented along with their food and medicinal values. The collected data were cross-verified with previously reported ethnobotanical studies of tuberous plants to authenticate their medicinal potential (Kumar, 2025). The present study adhered to standard methods of ethnobotanical survey, ensuring a rigorous and reliable documentation of traditional knowledge (Jena et al., 2025).

Results and discussion

In the present survey, 15 commonly available horticulturally important tuberous plants of India were enumerated belonging to12 genera and 9 families, primarily Zingiberaceae, Dioscoreaceae, Araceae, and Fabaceae (Table 1; Figure 1). These enumerated plants exhibited significant variation in their uses, nutritional values, and medicinal properties. Edible tubers such as *Curcuma longa* (Turmeric) (Figure 4), *Ipomoea batatas* (Sweet potato) (Figure 5), *Dioscorea alata* (Greater yam), and *Manihot esculenta* (Cassava) are widely cultivated across different agro-climatic zones and are rich in starch, dietary fibre, and micronutrients (Arutselven et al., 2023). Their consumption contributes substantially to the dietary energy of rural and tribal populations. Additionally, several plants like *Maranta arundinacea* (Arrowroot) and *Cyperus esculentus* (Tiger nut) offer gluten-free and nutritionally rich alternatives to common cereals (Herawati et al., 2022). Medicinally, many tuberous species demonstrate therapeutic potential, supporting their traditional use in ethnomedicine. *Curcuma longa* (Turmeric)

and *Zingiber officinale* (Ginger) are extensively utilised for their antimicrobial and hepatoprotective properties (Sheikh et al., 2023), while *Pueraria tuberosa* and *Curcuma caesia* show promise in regulating blood sugar and managing pain (Grover et al., 2019). Species like *Maerua oblongifolia* are employed in treating urinary disorders, indicating the wide scope of pharmacological uses of tuberous plants (Singh and Singh, 2024). Overall, the present study findings confirmed that these underutilised and often neglected tuber crops have significant potential in enhancing food security, promoting health, and preserving traditional knowledge systems in India.

Table 1: Horticulturally important tuberous plants

Plant name	Family	Common name	Medicinal uses	Food values
Amorphophallus paeoniifolius (Denn st.) Nicolson (Figure 2)	Araceae	Elephant foot yam	Anti-inflammatory properties.	Tubers are edible and nutrient-rich.
Colocasia esculenta (L.) Schott	Araceae	Taro	Traditionally used for the treatment of rheumatic pain.	Leaves are a rich source of micronutrients.
Curcuma angustifolia Roxb. (Figure 3)	Zingiberaceae	East Indian arrowroot	Rhizomes have anti-diabetic properties.	Rhizomes are edible, a source of starch.
Curcuma longa L.	Zingiberaceae	Turmeric	It has significant anti-microbial activity.	It is a curry spice, flavouring enhancer and food preservative.
Curcuma caesia Roxb.	Zingiberaceae	Black turmeric	It has anti-depressant and analgesic properties.	NIL
Cyperus esculentus L.	Cyperaceae	Tiger nut		Tubers are edible and

				contain significant amounts of starch, fat, protein and dietary fibre.
Dioscorea alata L.	Dioscoreaceae	Greater yam	Tubers are extensively used in the treatment of dysentery, piles and chronic liver pain disease.	The tuber is a staple food for many rural and tribal groups.
Dioscorea esculenta (Lour.) Burkill	Dioscoreaceae	Asiatic yam	Traditionally used for treating inflammatory and metabolic disorders.	Starchy root and tuber crops are the global sources of carbohydrates.
Ipomoea batatas (L.) Lam.	Convolvulaceae	Sweet potato	The leaves are rich in antioxidants.	Tubers are used as a delicious vegetable, possessing high nutritional value.
Maerua oblongifolia (Forssk.) A. Rich.	Capparaceae	Desert caper	Traditionally used to treat urinary calculi (kidney stones).	Thick rootstock is consumed with sugar and has a taste like coconut pulp.
Manihot esculenta Crantz	Euphorbiaceae	Cassava	The leaves and roots are used to treat hypertension and fever.	The starchy root vegetable serves as a staple food for many, particularly in tropical regions.
Maranta arundinacea L.	Marantaceae	Arrowroot	It is useful in diabetes.	Arrowroot is used to make flour, which can be used in various recipes as a thickening agent or as a gluten-free

				alternative to wheat flour.
Pachyrhizus erosus (L.) Urb.	Fabaceae	Yam bean	Good for indigestion.	It is a root vegetable with high fibre content.
Pueraria tuberosa (Roxb. ex Willd.) DC.	Fabaceae	Indian kudzu	Useful for weak health.	The raw tubers, flour and their juice are edible.
Zingiber officinale Roscoe	Zingiberaceae	Ginger	Useful for cough and cold.	The rhizome is a popular spice.

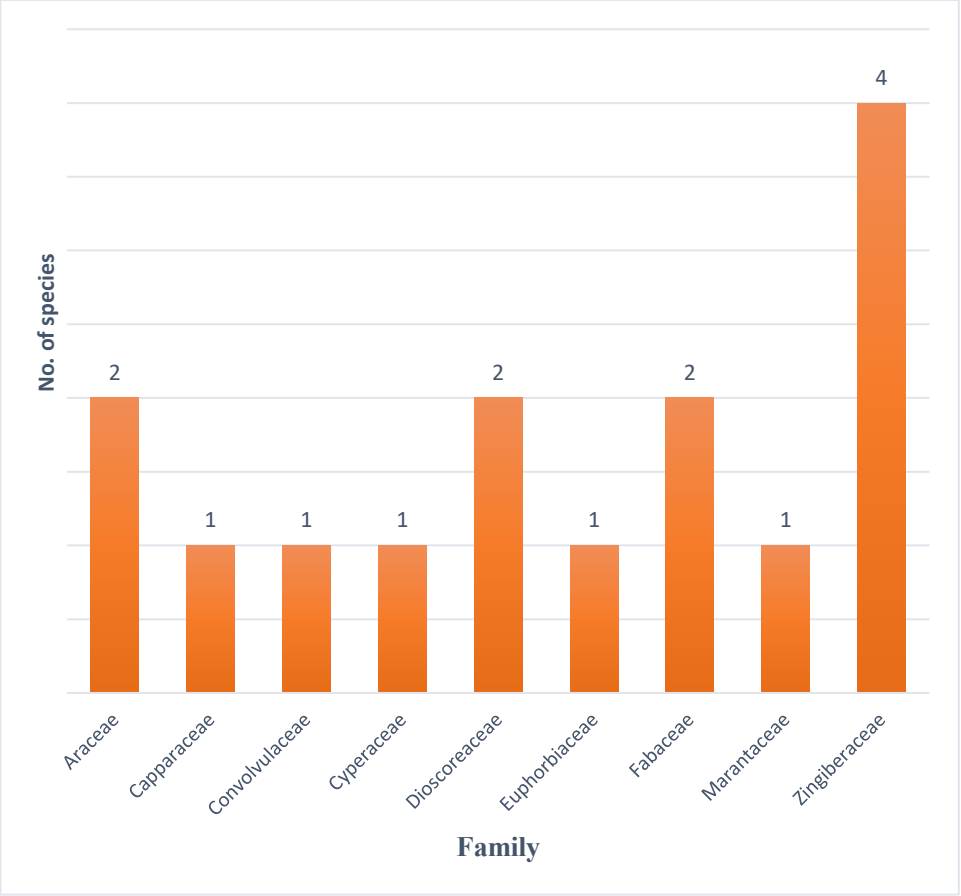


Figure 1: Diversity of tuberous medicinal plants in 9 families



Figure 2: Whole plant of *Amorphophallus paeoniifolius*



Figure 3: Flower of *Curcuma angustifolia*



Figure 4: Whole plant of *Curcuma longa*



Figure 5: Flower of *Ipomoea batatas*

Globally, medicinal tuberous plants have been a unique source of medicines. India is one of the 12 mega biodiversity centres having over 45,000 plant species (Aggarwal, 2014). There are 5 major areas of distribution of root and tuber crops in India. These include, South-western hilly and coastal region, the southern peninsular region, the eastern coastal region, the northeastern region and the north-western region (Nayar et al., 2009). Among them, the two hot spots (the north-eastern Himalayas and the Western Ghats) are particularly rich in wild relatives of tropical root and tuber crops (Sharma and Ramawat, 2014). In 2014, Ramanathan and his colleagues reported about 30 tuberous plants used by rural folklore people in the Kolli hills of Tamil Nadu observed during their ethnobotanical survey (Ramanathan et al., 2014). In terms of research progression, India has witnessed substantial scholarly and institutional activity around these tuberous species. A bibliometric analysis of global sweet potato (*Ipomoea batatas*) research alone recorded an

accelerating body of work over the past 30 years, including detailed phytochemical and functional assessments such as anthocyanin profiling in purple-fleshed varieties (Bilali et al., 2025). The All India Coordinated Research Project on Tuber Crops maintains over 4,100 accessions across 25 species in field gene banks, reflecting both preservation and breeding efforts (Mithra et al., 2014). Ethnobotanical surveys in Odisha documented 56 tuberous species used by tribal communities (Padhan and Panda, 2016). Taken together, the research ecosystem encompasses a wide array of disciplines from agronomy and genetics to phytochemistry and ethnomedicine, suggesting both growing interest and ample opportunities for further multidisciplinary studies.

Conclusion

Tuberous plants play a vital role in India's horticulture by serving as nutritious food sources and traditional medicinal resources. Their rich diversity and multifunctional uses highlight their importance in improving health, supporting rural economies, and preserving indigenous knowledge. Promoting the cultivation of the enumerated 15 horticulturally important tuberous plants and their conservation can contribute to sustainable agriculture and food security.

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Chapter 3

Ornamental Trees of India and Their Medicinal and Economic Aspects

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Abstract: The present exploratory study documented the medicinal and economic values of ornamental trees in India, highlighting their potential uses and benefits. A total of 21 tree species belonging to 13 families were found to have diverse medicinal properties through a field survey. The trees also had significant economic value, with uses in construction, furniture making, perfume production, and other industries. The study highlights the significance of preserving and promoting these trees not only for their aesthetic appeal but also for their medicinal and economic advantages. It serves as a foundation for sustainable management and conservation practices.

Keywords: Aesthetic value, conservation, sustainability

Introduction

Ornamental trees are an integral part of urban and rural landscapes, providing aesthetic value, shade, and beauty to the environment (Das et al., 2025).

Beyond their visual appeal, many ornamental trees have been found to possess medicinal properties, making them valuable resources for therapeutic uses (Grygier et al., 2023). In India, where traditional medicine systems like Ayurveda and Unani are some of the most widely practised, ornamental trees play a significant role in providing natural remedies for various ailments (Chandrashekar et al., 2025). The medicinal properties of ornamental trees have been recognised for centuries, with many species being used in traditional medicine to treat a range of health issues (Dwevedi et al., 2015). In addition to their medicinal value, ornamental trees also have economic importance, providing timber, fuelwood, and other products that support rural economies. With the increasing demand for sustainable and eco-friendly products, ornamental trees have the potential to contribute significantly to local and national economies. The present study aims to document the medicinal and economic values of ornamental trees in India, highlighting their potential uses and benefits. Through exploring the properties and uses of these trees, the study seeks to promote their sustainable utilisation and conservation, while also supporting the development of rural economies and communities. The findings of the present study will contribute to a better understanding of the importance of ornamental trees and their potential to support human well-being and sustainable development.

Methodology

A field survey was conducted from 2023 to 2025 in selected states of India (Odisha, Bihar, Himachal Pradesh, and Andaman & Nicobar Islands). Local communities were engaged through interviews and discussions, during which a total of 21 tree species were documented, along with their used parts. The collected data were cross-verified with previously reported ethnobotanical

studies on wild ornamental plants to authenticate their medicinal potential (Aradhana et al., 2022; Kumar, 2025; Pradhan et al., 2025). The study adhered to standard methods of ethnobotanical survey, ensuring a rigorous and reliable documentation of traditional knowledge (Jena et al., 2025).

Results and discussion

The study documented the medicinal and economic values of 21 ornamental tree species in India, belonging to 13 families. The trees were found to have diverse medicinal properties, including anti-inflammatory, antimicrobial, antifungal, and anticancer activities. Some trees, such as *Cassia fistula* and *Terminalia catappa*, were found to have multiple medicinal uses, highlighting their potential as valuable resources for traditional medicine. The economic values of the trees were also significant, with many species having uses in construction, furniture making, and perfume production. Trees like *Santalum album* and *Magnolia champaca* were found to have high-value essential oils, while others like *Gliricidia sepium* and *Lagerstroemia speciosa* had potential uses in agriculture and environmental conservation. The study highlights the importance of these ornamental trees beyond their aesthetic value, emphasising their potential to support rural economies and contribute to sustainable development. The findings of this study have implications for the conservation and sustainable utilisation of these ornamental tree species. By documenting their medicinal and economic values, the study provides a foundation for developing effective conservation strategies and promoting sustainable livelihoods for local communities. The present study also highlights the need for further research on the ecological and economic benefits of these trees, as well as their potential for sustainable management and conservation.

Table 1: Medicinal and economic values of ornamental trees of India

Botanical name	Family	Medicinal Uses	Economic value
Ailanthus excelsa Roxb.	Simaroubaceae	The bark extracts are useful in bacterial infections.	The wood is used for fuelwood, timber, including construction and making packing cases.
Bauhinia racemosa Lam.	Fabaceae	Leaves are useful in cancer treatment.	The matured leaves are used for making beedi (Indian cigarettes).
Bauhinia variegata L.	Fabaceae	Leaves are useful in cancer treatment.	The wood is used for agricultural implements. The tree supports rural economies by providing raw materials for herbal medicine and culinary products.
Bombax ceiba L. (Figure 1)	Malvaceae	The bark decoction is taken orally to treat fever and stomach ache.	The seed oil can be used for soap making and as a potential feedstock for biodiesel.
Butea monosperma (Lam.) Kuntze (Figure 2)	Fabaceae	The root powder mixed with water is drunk as an antidote for scorpion bite.	The flowers are a source of nectar, making them beneficial for honey production.
Cassia fistula L. (Figure 3)	Fabaceae	The leaves are used to cure skin irritation.	It's utilised in local markets for various purposes, including traditional medicine, fuel, and as a source of tannins and dyes.

Cassia javanica L.	Fabaceae	Leaves are useful in skin infections.	The wood is very hard and highly durable.
Delonix regia (Bojer ex Hook.) Raf.	Fabaceae	Flowers are used to improve poor appetite.	It has several economic values, including a source of oil, fodder, and firewood.
Gliricidia sepium (Jacq.) Kunth (Figure 4)	Fabaceae	Leaf paste is used to reduce inflammation.	Prunings can be incorporated into the soil as green manure, improving soil fertility and reducing the need for synthetic fertilisers.
Grevillea robusta A.Cunn. ex R.Br. (Figure 5)	Proteaceae	Bark paste with camphor is used to reduce headaches.	The tree is increasingly recognised for its carbon sequestration potential, making it valuable for environmental service payment schemes.
Jacaranda mimosifolia D.Don	Bignoniaceae	Flowers are used to improve immunity.	The durable wood is used in furniture and other items. Its vibrant purple flowers make it popular for landscaping.
Lagerstroemia speciosa (L.) Martyn (Figure 6)	Lythraceae	Unripe fruits are used to treat diabetes.	The wood is used in construction, boat building and various crafts.
Magnolia champaca (L.) Baill. Ex Pierre	Magnoliaceae	Seeds paste is used to heal cracked feet.	The fragrant flowers are extracted to create essential oil, to create high-end fragrances in the

			perfume industry.
Melaleuca citrina (Curtis) Dum.Cours.	Myrtaceae	Oil extracted from leaves is used to cure fungal infections.	The flowers are a good source of nectar for honey production, and it has potential uses in agriculture as a source of natural herbicides.
Ochna obtusata DC. (Figure 7)	Ochnaceae	Bark is used to cure malaria.	It has ornamental values, and samplings are demanded for plantation in the garden.
Peltophorum pterocarpum (DC.) Backer ex K. Heyne	Fabaceae	Bark infusion is used to reduce postpartum pain.	The wood is durable and suitable for cabinet-making, construction and boat building.
Santalum album L.	Santalaceae	Wood paste has a cooling agent.	The wood is converted into chips and steam-distilled to produce oil. The sapwood, also called "white wood", is used for producing "agarbattis".
Spathodea campanulata P.Beauv.	Bignoniaceae	Leaves are used for kidney problems.	The wood is suitable for light construction, carving, joinery and used for making charcoal. The flowers contain a natural dye that can be used as a substitute for synthetic dyes in textiles.

Sterculia foetida L.	Malvaceae	The leaves and bark are used as diuretic agents.	The seed shells can be processed into activated carbon, which has various industrial applications.
Terminalia catappa L.	Combretaceae	The leaves are used for treating diabetes and high blood pressure.	The timber is used in buildings, floors, boxes, and bridges. The yellow and black dye obtained is used in leather preparation and as a base for inks.
Wrightia tinctoria (Roxb.) R.Br. (Figure 8)	Apocynaceae	Bark is used to treat diarrhoea.	The tree is locally harvested, used as a medicine and source of a dye and wood.



Figure 1: Flowers of *Bombax ceiba*



Figure 2: Flowers of *Butea monosperma*



Figure 3: Flowers of *Cassia fistula*



Figure 4: Flowers of *Gliricidia sepium*



Figure 5: Flowers of *Grevillea robusta*



Figure 6: Flowers of *Lagerstroemia speciosa*



Figure 7: Flowers of *Ochna obtusata*



Figure 8: Flowers of *Wrightia tinctoria*

Conclusion

The present study highlighted the significant medicinal and economic values of ornamental trees in India, showcasing their potential to support human well-being and sustainable development. Documentation of the properties and uses of these trees serves as a valuable resource for promoting their sustainable utilisation and conservation, while also aiding the development of rural economies and communities. The findings of this study emphasise the importance of preserving and promoting the use of ornamental trees, not only for their aesthetic value but also for their medicinal and economic benefits. By recognising the value of these trees, we can work towards sustainable management and conservation practices that benefit both local

communities and the environment, ultimately contributing to a more sustainable and equitable future.

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Chapter 4

Ethnobotanical, phytochemical profiling and cytotoxicity analysis of *Zeuxine strateumatica* (L.) Schltr.: A terrestrial orchid of India

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Abstract: *Zeuxine strateumatica* (L.) Schltr is a terrestrial orchid native to India. An ethnobotanical survey of this species was conducted among the Munda tribe of Odisha in 2023. The plant was studied for its phytochemical constituents and cytotoxic potential. Qualitative phytochemical screening of different whole-plant extracts revealed the presence of alkaloids, saponins, and reducing sugars. Cytotoxicity was evaluated using the Brine shrimp assay indicated good inhibitory effects. The findings suggest that the whole plant of *Z. strateumatica* possesses promising bioactive compounds with potential applications in cancer therapeutics and natural drug development, which need more advanced experimental work for this primary pharmacological claim.

Keywords: Cancer therapeutics, cytotoxic potential, inhibitory effects, natural drug development

Introduction

Orchids, one of the largest and most diverse families of flowering plants, are known not only for their ornamental beauty but also for their medicinal

potential (Kumar and Kumar, 2020; Kumar, 2022; Mety et al., 2022). Among them, terrestrial orchids are increasingly gaining attention due to their diverse phytochemical constituents and associated biological activities (Kumar and Thorat, 2018; Bazzicalupo et al., 2023). *Zeuxine strateumatica* (L.) Schltr., commonly known as soldier's orchid or lawn orchid (Figure 1-2), is a small terrestrial orchid widely distributed across tropical and subtropical regions (up to 1000 m elevation), including India, United Arab Emirates, Brazil (Aspinall, 2006; Neto et al., 2011; Verma et al., 2014; Martin et al., 2024; Betageri and Kotresha, 2025). Botanically, it is distinguished by its grass-like foliage and a short cluster of small white to pale green flowers, typically occurring in open grasslands, lawns, and damp fields (Saxena and Brahmam, 1995). The flowering and fruiting period is January to April. Although regarded as a weed in certain regions, this species has been traditionally utilised in folk medicine across parts of Asia, indicating the potential presence of bioactive compounds (Sreelakshmi et al., 2024; Verma et al., 2014). Phytochemicals such as alkaloids, saponins, tannins, flavonoids and reducing sugars are secondary metabolites that play significant roles in plant defence and have been linked to various pharmacological activities, including antimicrobial, antioxidant, and anticancer effects (Bhatti et al., 2021). While many orchid species have been extensively studied for these compounds, *Z. strateumatica* remains largely unexplored. It is a terrestrial, rhizomatous herb. The rhizome is short, while the stem is either erect or ascending, pale brown in colour, and bears several to many leaves. The stem is glabrous and can range from stout to slender, typically measuring 5-25 cm in length and approximately 2 mm in thickness. The roots are fleshy and about 1.5 mm thick. The plant has 3 to 6 sessile, erect leaves that are linear and acuminate, measuring 2-7 cm in length and 0.4-0.6 cm in width.



Figure 1: Habitat of *Z. strateumatica*



Figure 2: Inflorescence of *Z. strateumatica*

The leaves feature a stout midrib and recurved margins. The inflorescence consists of terminal racemes, 1.5-6 cm long, bearing many flowers that are

arranged either loosely or densely. The floral bracts are ovate-lanceolate, acuminate, and measure 10-14 mm in length and 3-4 mm in width. These bracts are longer than the ovary. The flowers are greenish-white with a yellow lip and measure approximately 10 mm in length. The sepals are unequal, ranging from 5 to 7 mm in length and 2 to 3 mm in width. The dorsal sepal is ovate and concave, while the lateral sepals are obliquely lanceolate, obtuse, and connivent. The petals are obliquely oblong and obtuse, about 6 × 2 mm in size, and form a hood with the dorsal sepal. The lip is yellow and equal in length to the sepals. It is cymbiform and saccate at the base, with two inward-pointing teeth and two narrow lamellae inside the sac that unite at the midrib. The terminal lobe of the lip is short, subquadrate, and either entire or bifid. The column is very short and has two wings at its apex that cover the anther. The plant has two clavate pollinia, with a hyaline, thin, and slender stipe and an oblong-ovate viscidium. The fruit is an ellipsoid capsule, strongly ribbed, and measures 10-12 mm in length and 4-5 mm in width (Neto et al., 2011; Verma et al., 2014).

Given the increasing demand for plant-based therapeutics and the ongoing search for novel anticancer agents, investigating the phytochemical composition and biological activity of underutilised species like *Z. strateumatica* is both timely and valuable. The present study aims to carry out an ethnobotanical survey, preliminary phytochemical screening of *Z. strateumatica* whole plant extracts using solvents of varying polarity (n-hexane, ethanol, and aqueous) to identify key bioactive groups. In addition, the present study evaluated the cytotoxic potential of these extracts using the Brine shrimp assay. By correlating the presence of specific phytochemicals with observed cytotoxic effects, this research seeks to provide information

on the medicinal relevance of this terrestrial orchid and lay the groundwork for further pharmacological investigations.

Methodology

Ethnobotanical Survey: An ethnobotanical survey on the orchid *Z. strateumatica* was conducted among the Munda tribe in the Rourkela Forest Division of Odisha in 2023 by the authors using a questionnaire (Jena et al., 2025).

Plant Sample, Extraction and Phytochemical Screening: The whole plant of *Z. strateumatica* was collected from the nearby Mahanadi River area of Cuttack, Odisha, India (Figure 3). The plant species was identified by the authors. The Maceration extraction method was adopted using three solvents (n-hexane, ethanol and aqueous) for phytochemical analysis. Detection of nine secondary metabolites was conducted using standard methods (Jena et al., 2025). Details of phytochemical analysis are given below.

Test for tannin: 1 ml of whole plant extract was taken in a test tube, and 3-5 drops of 10% lead acetate solution were added to it. The gelatinous precipitate formation confirmed the presence of tannin.

Test for saponin: About 1 ml of distilled water was added to 1 ml of the whole plant extract and shaken well. The formation of persistent froth was observed, confirming the presence of saponin.

Test for flavonoids: About 1 ml of the whole plant extract was taken, and 2 ml of NaOH solution and 3-5 drops of dilute HCl were added to it. The colour initially turned to an intense yellow colour with NaOH solution and later became colourless, which confirmed the presence of flavonoids.



Figure 3: Collected plant sample of *Z. strateumatica*

Test for terpenoids: To 1 ml of the whole plant extract, 5-6 drops of chloroform were added. Then, 4-6 drops of concentrated sulphuric acid were added to it. The reddish-brown interface confirmed the presence of terpenoids.

Test for phenols: About 1 ml of the whole plant extract was taken. A few drops of 5% ferric chloride solution were added. The dark bluish-black appearance confirmed the presence of phenolic compounds.

Test for reducing sugars: About 1 ml of the whole plant extract was taken. 2 drops of Fehling's solution A followed by an equal volume of Fehling's solution B were added and kept in the water bath for a few minutes. The presence of red-orange precipitate confirmed the presence of reducing sugars.

Test for steroids: To 1 ml of the whole plant extract, 1 ml of chloroform, followed by 1 ml of concentrated sulphuric acid, was added. The appearance of upper red and lower yellow with green fluorescence indicated the presence of steroids.

Test for alkaloids: About 1 ml of the whole plant extract was taken, and 3-4 drops of Dragendroff's reagent were added to it. The formation of a reddish-brown precipitate confirmed the presence of alkaloids.

Test for carbonyl compounds: About 1 ml of whole plant extract was taken, and 3-4 drops of 2,4-Dinitrophenylhydrazine (DNPH) reagent were added. The formation of yellow crystals confirmed the presence of carbonyl compounds.

Toxicity analysis: For toxicity analysis, hatching of brine cysts is the initial process. Standardisation of the optimum is done at 2.0, 3.5 and 5.0% saline concentration to check the optimum salinity for proper hatching of brine shrimp (*Artemia salina*) cysts. The brine shrimp cysts are then incubated in 3.5% saline water with proper aeration, at room temperature or between 28-35^{o}C and light for 48 hours. Proper hatching can be observed within 24-48 hours, depending upon the quality of cysts, proper aeration and light provided. Different concentrations of the sample extract are taken, and 3.5% saline water is used to make the volume 2 ml in each test tube. 1% DMSO is used to dissolve the crude extracts. Ten nauplii were selected and introduced

to five test tubes of the extracts. Positive and negative controls were prepared using vincristine sulphate (5 mg/ml) or potassium dichromate and 3.5% saline water, respectively, with a volume of 2 ml. The live larva is highly mobile and thus differentiates from the unhatched cysts. The survivor nauplii were counted, and the death % was analysed (Jena et al., 2025).

Results and discussion

From the field survey, it was noted that leaves are consumed as a vegetable, while its roots are used to treat weakness and are believed to have antioxidant properties. Phytochemical screening of the whole plant extracts of *Z. strateumatica* was carried out using three different solvents to identify the presence of various bioactive compounds. The results showed that reducing sugars were the only compounds present in all three extracts (Table 1). Notably, saponins and alkaloids were detected in both ethanol and aqueous extracts but were absent in the n-hexane extract. Other phytochemicals such as tannins, flavonoids, phenolic compounds, steroids, and carbonyl compounds were not detected in any of the extracts. The absence of flavonoids and phenolic compounds, which are commonly reported in many orchid species, suggested a unique chemical profile for *Z. strateumatica*, possibly linked to specific ecological or environmental factors influencing secondary metabolite production.

Table 1: Qualitative screening of secondary metabolites of *Z. strateumatica* whole Plant

Bioactive compounds	Extracts		
	n-hexane	Ethanol	Aqueous
Tannin	Absent	Absent	Absent
Saponin	Absent	Present	Present
Flavonoids	Absent	Absent	Absent

Phenolic compounds	Absent	Absent	Absent
Reducing sugar	Present	Present	Present
Steroid	Absent	Absent	Absent
Alkaloid	Absent	Present	Present
Carbonyl compounds	Absent	Absent	Absent

Toxicity analysis of whole-plant extracts of *Z. strateumatica* against brine shrimp nauplii revealed a concentration-dependent increase in mortality. The ethanol extract exhibited the highest toxicity with 80-100% mortality, followed by n-hexane extract with 84-100% mortality, and aqueous extract with 61-100% mortality. The positive control, Vincristine sulphate, showed 100% mortality, while the negative control, 3.5% Saline, showed no mortality. These findings suggest that *Z. strateumatica* extracts possess cytotoxic properties (Table 2), which may have implications for their potential medicinal or other applications.

Table 2: Toxicity analysis of *Z. strateumatica* whole plant using Brine shrimp nauplii (*Artemia salina*)

Extracts	Concentration ($mgml^{-1}$)	Initial number of nauplii	Number of deaths of nauplii (after hours)			Death rates (%) after 2 hours
			1	2	3	
n-hexane	41.65	13	8	11	13	84
	62.475	11	8	10	11	90
	83.3	10	9	9	10	90
	104.12	11	10	10	11	90
	166.6	10	10	10	10	100
	3.5% Saline	10	0	0	0	0
	Vincristine sulphate	10	10	10	10	100

Ethanol	41.65	10	7	8	9	80
	62.475	11	9	10	11	90
	83.3	10	10	10	10	100
	104.12	13	11	13	13	100
	166.6	12	12	12	12	100
	3.5% Saline	10	0	0	0	0
	Vincristine sulphate	10	10	10	10	100
Aqueous	41.65	13	5	8	8	61
	62.475	10	5	7	9	70
	83.3	9	5	7	9	77.7
	104.12	11	10	10	11	90.9
	166.6	10	9	10	10	100
	3.5% Saline	10	0	0	0	0
	Vincristine sulphate	10	10	10	10	100

Conclusion

Traditionally, the plant's leaves are eaten as a vegetable, and its roots are used to treat weakness and for their antioxidant properties. The present study revealed the presence of important bioactive compounds, indicating that *Z. strateumatica* could be a promising source of naturally derived therapeutics. Future research should focus on comprehensive phytochemical isolation and structural elucidation of the active constituents using advanced chromatographic and spectroscopic methods. Furthermore, extensive in vivo investigations are essential to confirm the cytotoxic potential, elucidate the underlying mechanisms of action, and assess the safety profile of these extracts.

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Chapter 5

Ethnomedicinal and pharmacological uses of *Solanum sisymbriifolium* Lam. (Solanaceae)

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Abstract: *Solanum sisymbriifolium* Lam., commonly known as the Sticky Nightshade or wild tomato, is a shrub with substantial ethnomedicinal and pharmacological potential. The present chapter provides an inclusive overview of its traditional uses and scientific validation. Ethnomedicinally, various parts of the plant are used to treat a range of ailments. Pharmacological studies have corroborated many of these traditional uses, revealing the presence of bioactive compounds such as alkaloids, flavonoids, and steroidal saponins. Research has demonstrated the plant's diverse properties, including antimicrobial, anti-inflammatory, antioxidant, and cytotoxic activities. This chapter synthesises current knowledge on the plant's phytochemistry, ethnomedicinal uses and biological activities, highlighting its potential as a source of novel therapeutic agents.

Keywords: Bioactive compounds, medicinal plants, pharmacology

Introduction

Solanaceae is an important family that comprises both economic as well as medicinal uses, such as potatoes, tomatoes, eggplants, and peppers are the most important crops that belong to this family. *Solanum* is a large family that comprises 102 genera and over more than 2500 species of trees, shrubs

and herbs belonging to the family Solanaceae (Chidambaram et al., 2022). Mostly, *Solanum* species are preferred for food as well as medicinal aspects. Due to the availability of such rich traditional uses, it also contains varied phytochemical compounds such as alkaloids, flavonoids, and tannins (Kaunda and Zhang, 2019; Dahiya et al., 2025). *Solanum sisymbriifolium* Lam., a species belonging to the large and diverse family Solanaceae, is a perennial herb characterised by its deeply lobed, spiny leaves and striking white or pale violet flowers (Chauhan et al., 2011). Commonly known as sticky nightshade, litchi tomato, or dense-thorned nightshade, this plant is native to South America but has become naturalised in various parts of the world, often growing as a weed in disturbed areas. In India, Andhra Pradesh, Assam, Bihar, Kerala, Karnataka, Maharashtra, Manipur, Odisha, Punjab, Sikkim, Tripura, Uttar Pradesh and West Bengal (Panda et al., 2023). Among *Solanum* species*, Solanum sisymbriifolium* is proven to the abundant medicinal value, which could aid in curing different ailments. Compound classes include steroidal saponin, spirostane saponins, glycol-alkaloids, steroidal alkaloids, pyrrolidine alkaloids, sterols, steroid glycosides and lignans from different parts (More, 2017). Steroidal saponin Isonuati-genin-3-O-β-solatriose, spirostane saponin, nuatigenosido, a rare natural steroidal sapogenin and nuatigenin-3-O-β-chacotriose in the roots. Two steroidal alkaloids, solamargine and β-solamarine, were isolated from a methanol extract of *S. sisymbriifolium* fruit. Neolignan and sisymbrifolin were isolated from the berries (More, 2017; Momen et al., 2020). Despite its weedy nature, *S. sisymbriifolium* holds significant value in traditional medicine systems across different cultures (Biswas et al., 2023). Its ethnobotanical history is rich, with indigenous communities utilising various parts of the plant, including the roots, leaves, and fruits, to treat a wide array of ailments. The

therapeutic applications are vast, ranging from fever reduction and pain relief to addressing more complex conditions like inflammatory diseases and snakebites. The traditional uses of *S. sisymbriifolium* are a testament to its perceived medicinal properties (Biswas et al., 2023). In various folk medicine traditions, decoctions prepared from the roots and leaves are consumed orally to manage gastrointestinal issues, such as stomach aches and dysentery. The plant's antipyretic properties have been exploited for centuries to alleviate fevers, while its analgesic effects have made it a popular remedy for body aches and rheumatism. Furthermore, poultices made from crushed leaves are topically applied to wounds, cuts, and skin infections, leveraging the plant's antiseptic and wound-healing potential (More et al., 2017). The fruit, often resembling a small, spiny tomato, is also consumed in some regions, though its edibility and medicinal use are debated and vary depending on local traditions and the specific chemotype of the plant (Biswas et al., 2023).

Modern pharmacological research has begun to validate and shed light on the scientific basis of these traditional uses. A key focus of this research has been the phytochemical analysis of *S. sisymbriifolium*, which has revealed a rich profile of bioactive compounds. The plant is particularly known for its high content of steroidal alkaloids, such as solasodine, which have been linked to a variety of pharmacological activities (Chauhan et al., 2011). Other significant compounds include flavonoids, saponins, and phenolic acids, all of which contribute to the plant's therapeutic potential. These secondary metabolites are responsible for the plant's documented pharmacological effects, including anti-inflammatory, antioxidant, antimicrobial, and cytotoxic properties. The diverse pharmacological activities of *S. sisymbriifolium* have opened new avenues for its potential in drug discovery (Momen et al., 2020). Studies have shown that extracts from the plant exhibit

potent anti-inflammatory effects, which could be beneficial in managing chronic inflammatory conditions. Its antioxidant capacity helps in neutralising free radicals, thereby protecting cells from oxidative stress and potentially mitigating the risk of various diseases. Furthermore, the plant's antimicrobial properties have been demonstrated against a range of pathogens, suggesting its potential in developing new antibacterial and antifungal agents (Vaghela et al., 2009). Perhaps one of the most promising areas of research is the investigation of the cytotoxic effects of its steroidal alkaloids on cancer cells, with some studies indicating their potential as chemotherapeutic agents. Henceforth, *S. sisymbriifolium* represents a fascinating plant for both ethnobotanical study and modern pharmacological investigation, bridging the gap between traditional wisdom and scientific validation. Its rich history of use and diverse phytochemical profile underscore its potential as a valuable source for new therapeutic compounds.



Figure 1: Habit of *S. sisymbriifolium*



Figure 2: Flower of *S. sisymbriifolium*



Figure 3: Leaves and ripe fruit of *S. sisymbriifolium*

Morphology: It is an erect annual or perennial undershrub up to 3m high, much-branched, woody at base, glandular stem with dense prickles, simple and stellate hairs. Leaves are simple or sometimes pinnate, pinnately lobed or parted, lobes pinnately lobed or dentate, apex acute. Inflorescences axillary. Corolla white, stellate. Fruiting calyx enlarged, densely prickly, and enveloping most berries. Seeds reniform. (Sahu et al., 2017: Figure 1-3).

Methodology

Through tentative literature and field survey, it revealed a wide array of ethnomedicinal uses and through literature survey, it revealed its pharmacological values. Literature data were gathered from Scopus, Web of Science, Springer, PubMed, Google Scholar, using search terms "*S. sisymbriifolium*, "phytochemistry", "Pharmacology"," ethnomedicinal uses", MDPI, Science Direct, SciFinder, Scirus, and Scientific Electronic Library Online (SciELO) from 2020-2025 (Jena et al., 2025; Kumar, 2025).

Results and discussion

The study reveals the various plant parts used to treat different ailments, showcasing the versatility of the plant in traditional knowledge. The root is used as a decoction for its diuretic and contraceptive properties, while the aerial parts are utilised to treat diarrhoea, respiratory, and urinary tract issues. The flowers are used as an analgesic, and the leaves are employed to treat fever, cough, and as a diuretic. Notably, the leaves and fruits are also used as contraceptives, highlighting the plant's potential in reproductive health. Table 1 suggests that the plant's diverse phytochemical composition may be responsible for its broad range of medicinal properties. Mostly, the most common uses are obtained as decoction, infusion, and paste. The use of different plant parts for various ailments indicates a sophisticated

understanding of the plant's properties and potential applications. The literature review supports the plant's significance in traditional medicine and warrants further investigation into its pharmacological potential and phytochemical constituents.

Table 1: Ethnomedicinal uses of different parts of *S. sisymbriifolium*

Plant parts	Mode of consumption	Different ailment	Sources
Aerial part	Decoction	Diarrhoea, respiratory and urinary tracts	Prajapati et al., (2013)
Flowers	Decoction	Analgesic	Vaghela et al., (2009); Prajapati et al., (2013);
Fruits	Decoction	Contraceptive	Vaghela et al., (2009); More, (2017)
Leaves	Decoction	Febrifuge	Prajapati et al., (2013)
Leaves	Decoction	Diuretic	Vaghela et al., (2009); More, (2017)
Leaves	Decoction	Cough	Tumpa et al., (2014)
Leaves	Infusion	Stomach pains	Nayak and Kumar, (2023)
Root	Decoction	Diuretic, contraceptive	Prajapati et al., (2013)
Root	Decoction	Epilepsy	Kumar et al., (2022); Nayak and Kumar, (2023)
Roots	Paste	Cuts and wounds	Nayak and Kumar, (2023)

The *S. sisbriifolium* exhibits a wide range of pharmacological activities across its various parts. The root shows promise in treating syphilis and hypertension, while the aerial parts demonstrate antioxidant and antimicrobial properties, which could be valuable in preventing chronic diseases and infections. The leaves have been found to possess antibacterial, analgesic, and antidiarrheal properties, making them a potential natural remedy for pain management and gastrointestinal issues. The fruits exhibit

insecticidal and anticonvulsant properties, suggesting possible applications in pest control and the treatment of neurological disorders. Interestingly, the aerial parts, unripe fruits, and ripe fruits have been studied for toxicity, with some plants showing low toxicity profiles. In Table 2, *S. sisbriifolium* shows diverse pharmacological activities, making it a valuable resource for developing new therapeutic agents. Further research could fully explore its potential and ensure safe usage (Figure 4).

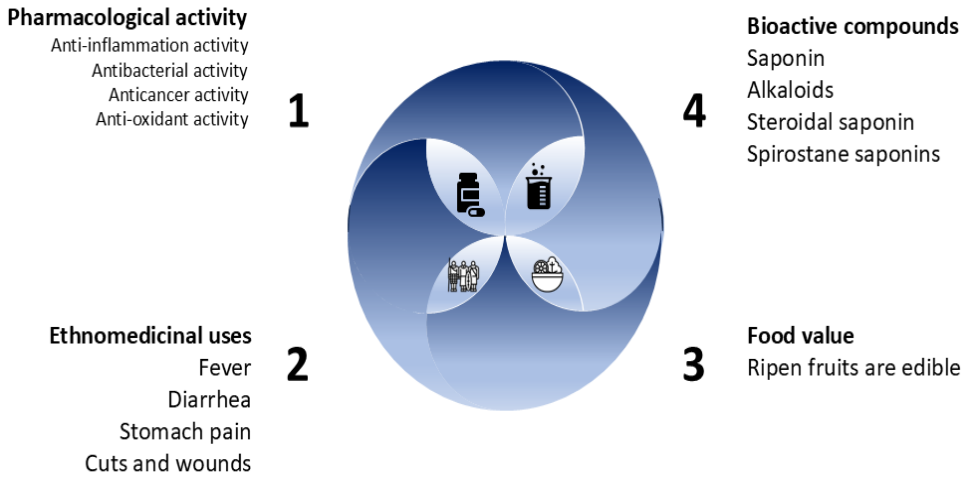


Figure 4: Illustration exploring its application for further future aspects of *S. sisymbriifolium*

Table 2: Pharmacological values of different parts of *S. sisymbrifolium*

Plants parts	Pharmacological activities	Sources
Aerial part	Antioxidant and anti-microbial activity	More, (2017); Momen et al., (2020)
Aerial part, unripe fruit and ripe fruit	Toxicity activity	More, (2017); Momen et al., (2020)
Fruit	Insecticidal activity	More, (2017)
Fruit	Anti-convulsant activity	More, (2017)
Leaves	Antibacterial activity	Gebrewbet and Hndeya, (2023)
Leaves	Analgesic activity	More, (2017)

Leaves	Anti-diarrhoeal activity	More, (2017); Biswas et al., (2023)
Leaves and stem	Anti-fungal activity	Vaghela et al., (2009); More, (2017)
Root	Anti-syphilitic activity	More, (2017); Biswas et al., (2023)
Root	Anti-hypertensive activity	More, (2017); Arrua et al., (2024)

Conclusion

Solanum sisymbriifolium Lam. is a valuable plant species with a rich antiquity of ethnomedicinal uses and scientifically validated pharmacological properties. Its diverse range of bioactive compounds and therapeutic effects make it a promising source for developing new medicines. Further research and development are needed to fully harness its potential and explore its applications in modern medicine.

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Chapter 6

Ethnomedicinal and ethnopharmacological values of *Scoparia dulcis* L.

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Abstract: *Scoparia dulcis* L., a perennial herb widely distributed in tropical and subtropical regions, holds noteworthy ethnomedicinal and ethnopharmacological importance. Traditionally, various parts of the plant, including leaves, roots, and stems, have been used in folk traditional medicine to treat a wide range of ailments such as diabetes, hypertension, fever, cough, and gastrointestinal disorders. Scientific studies have validated many of these traditional uses, revealing a rich phytochemical profile that includes flavonoids, terpenoids, alkaloids, and phenolic compounds. These bioactive constituents are responsible for the plant's diverse pharmacological activities, including antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and hepatoprotective effects. The chapter mostly encompasses on ethnomedicinal and ethnopharmacological aspects of different plant parts of *S. dulcis*. Therefore, in future, further research into the mechanisms of action and potential drug development from *S. dulcis* is warranted to harness its full therapeutic potential and contribute to the development of new, natural-based medicines.

Keywords: Ethnomedicinal, traditional knowledge, phytochemical, pharmacological

Introduction

The use of plants for medicinal purposes is an ancient practice that forms the bridge of traditional healthcare systems worldwide. Ethnobotany, the study

of the relationship between people and plants, highlights the profound knowledge of indigenous and local communities regarding the therapeutic properties of flora (Petrovska, 2012). This traditional knowledge, passed down through generations, has provided a rich source of inspiration for modern drug discovery (Lal et al., 2024). According to the literature review, Plantaginaceae consists of 107 genera and about 1,900 species. All genera of Plantaginaceae were formerly included in Scrophulariaceae. In the family Plantaginaceae in the genus *Scoparia* has 11 accepted species (POWO, 2025). One such plant, *Scoparia dulcis*, has garnered significant attention for its widespread use in folk medicine and its promising pharmacological profile. *Scoparia dulcis* L., commonly known as "sweet broom weed," is a perennial herb belonging to the family Plantaginaceae. Native to tropical and subtropical regions of the Americas, it has since become naturalised in various parts of the world, including India, Brazil, Myanmar, and the West Indies (Phan and Nguyen, 2014). It is mostly found in roadside and wasteland areas. The flowering and fruiting are mostly throughout the year. In these regions, the plant is a common weed but is highly valued for its medicinal properties. The plant's name, "sweet broom," refers to its sweet taste and the traditional use of its stems as temporary brooms. Its versatile application in traditional medicine makes it a prime subject for ethnopharmacological investigation. Phytochemical screening of the plant has revealed a complex array of bioactive compounds, including alkaloids, reducing sugar, steroids, flavonoids, saponins, flavones, terpenes and steroids, phenols, tannins, saponins, amino acids, coumarins and carbohydrates. The main chemicals include scopadulcic acids A and B, scopadiol, scopadulciol, scopadulin, scoparic acids A – C, tannin and betulinic acid. Other chemical constituents are acacetin, amyrin, apigenin, benzoxazin, benzoxazolin, benzoxazolinone,

cirsimarin, cirsitakaoside, coixol, coumaric acid, cynaroside, daucosterol, dulcinol, dulcioic acid, gentisic acid, glutinol, hymenoxin, linarin, luteolin, mannitol, scoparinol, scutellarein, scutellarin, sitosterol, stigmasterol, taraxerol, vicenin, and vitexin (Saikia et al., 2013; Phan and Nguyen, 2014; Paul et al., 2017; Aysha et al., 2020). Ethnomedicinally, *S. dulcis* has been utilised to treat a remarkable diversity of ailments. Across different cultures, various parts of the plant, including the whole plant, leaves, roots, and stems, have been prepared as decoctions, infusions, or poultices. Traditional uses include managing conditions such as diabetes, hypertension, fever, cough, bronchitis, and gastrointestinal issues like diarrhoea and stomach ache. It is also used for skin disorders, haemorrhoids, diuretic and analgesic (Murtl et al., 2012; Aysha et al., 2020; Sarkar et al., 2020). The historical and ongoing use of this plant by traditional healers and communities accentuates its perceived efficacy and cultural significance as a panacea for various health problems. Scientific studies have begun to validate the traditional claims, providing a strong basis for the ethnopharmacological values of *S. dulcis*. These compounds are believed to be responsible for the plant's wide range of documented pharmacological activities, which include antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and hepatoprotective effects (Agrawal et al., 2014). Apart from medicinal value, it also has a significant role in other aspects, such as bushy stems are used for brooms in some countries (Aysha et al., 2020). This chapter will explore the traditional uses of *S. dulcis* and the scientific evidence supporting its therapeutic potential, bridging the gap between ancient wisdom and modern scientific understanding. It is an erect much much-branched, glabrous herb or undershrub, up to 60 cm; stems 4-6 angled or lined.



Figure 1: Habit and habitat of *S. dulcis*



Figure 2: Flowers of *S. dulcis*

Leaves are petiolate, 3-nately whorled, upper often opposite, rhomboid, elliptic, ovate or lanceolate, serrate, acute, glandular, base tapering; petiole scarcely separable from the tapering leaf-base. Flowers 3-6 from each whorl; pedicels long. Sepals are 3-nerved, slightly shorter than the capsule. Corolla white, 5 mm across, divided nearly to the base. Stamens are as long as the corolla. Style stout. Capsule subglobose, valves ultimately 2-fid (Saxena and Brahmam, 1995; Figure 1-2).

Methodology

Through field and literature survey, it concluded that it possesses a wide array of ethnomedicinal uses, and through literature survey, it revealed its pharmacological values. Literature data was gathered from Scopus, Web of Science, Springer, PubMed, Google Scholar, using search terms "*S. dulcis*, "phytochemistry", "Pharmacology"," ethnomedicinal uses", "other uses"

MDPI, Science Direct, SciFinder, Scirus, and Scientific Electronic Library Online (SciELO) from 2022-2025 (Jena et al., 2025; Kumar, 2025).

Results and discussion

The plant exhibits a range of traditional medicinal uses, with various parts to treat different ailments. Through a literature survey, it was revealed that the leaves are used to treat malaria, cough, and cuts/wounds, while the leaves and twigs are used for jaundice and as an emetic. The stem and leaves are used to treat diabetes, and the whole plant is used for fever, kidney stones, nephritis, snake bites, and diabetes (Table 1). These findings highlight the plant's versatility in traditional medicine and its potential for further pharmacological investigation. The use of different plant parts for various ailments suggests a sophisticated understanding of the plant's properties and potential applications.

Table 1: Ethnomedicinal uses of different parts of *Scoparia dulcis*

Plant parts	Mode of use	Diseases	Sources
Leaves	Infusion	Malaria	Aysha et al., (2020)
Leaves	Decoction	Cough	Gogoi et al., (2019)
Leaves	Paste	Cuts and wounds	Mishra et al., (2016)
Leaves and twigs	Decoction	Jaundice	Das and Choudhury (2012)
Leaves and twigs	Infusion	Emetic	Das and Choudhury (2012)
Root	Decoction	Digestive problems	Kumar et al., (2022)
Stem and leaves	Decoction	Diabetes	Aysha et al., (2020)

Whole plant	Infusion	Fever and kidney stones	Sarkar et al., (2020)
Whole plant	Decoction	Nephritis	Sarkar et al., (2020)
Whole plant	Decoction	Snake bite	Sarkar et al., (2020)
Whole plant	Decoction	Diabetes	Deb and Sharma. (2021)

Table 2: Pharmacological activities of *Scoparia dulcis*

Plant parts	Pharmacological activities	Sources
Leaves	Anti-diabetic activity	Pamunuwa et al., (2016); Aysha et al., (2020)
Leaves	Analgesic and anti-inflammatory activity	Okanlawon et al., (2022); Thykkaden et al., (2025)
Leaves	Antimicrobial activity	Sarkar et al., (2020)
Leaves	Anti-sickling activity	Abere et al., (2015);
Leaves	Anti-hyperlipidemic activity	Sarkar et al., (2020)
Leaves	Anti-ulcer activity	Sarkar et al., (2020)
Leaves	Nephroprotective activity	Aysha et al., (2020)
Whole plant	Anti-malarial activity	Sarkar et al., (2020)
Whole plant	Antioxidant activity	Sarkar et al., (2020); Arulandhu et al., (2025)

The plant's ability to treat a range of conditions, including diabetes, fever, and snake bites, makes it a valuable resource for traditional medicine. Further studies are needed to validate the efficacy and safety of these traditional uses and to explore the plant's potential for modern medicinal applications. The results of this chapter support the importance of documenting and preserving

traditional knowledge of medicinal plants. By understanding the traditional uses of plants like this one, researchers can identify potential leads for new medicines and work to conserve and sustainably use these valuable resources. According to the literature survey, it concluded that it possesses many pharmacological activities such as hypoglycaemic, antitumor, antiviral, hyperlipidaemia, antioxidant, and analgesic activity (Saikia et al., 2013). The leaves have demonstrated anti-diabetic, analgesic, anti-inflammatory, antimicrobial, anti-sickling, anti-hyperlipidaemic, anti-ulcer, and nephroprotective activities.

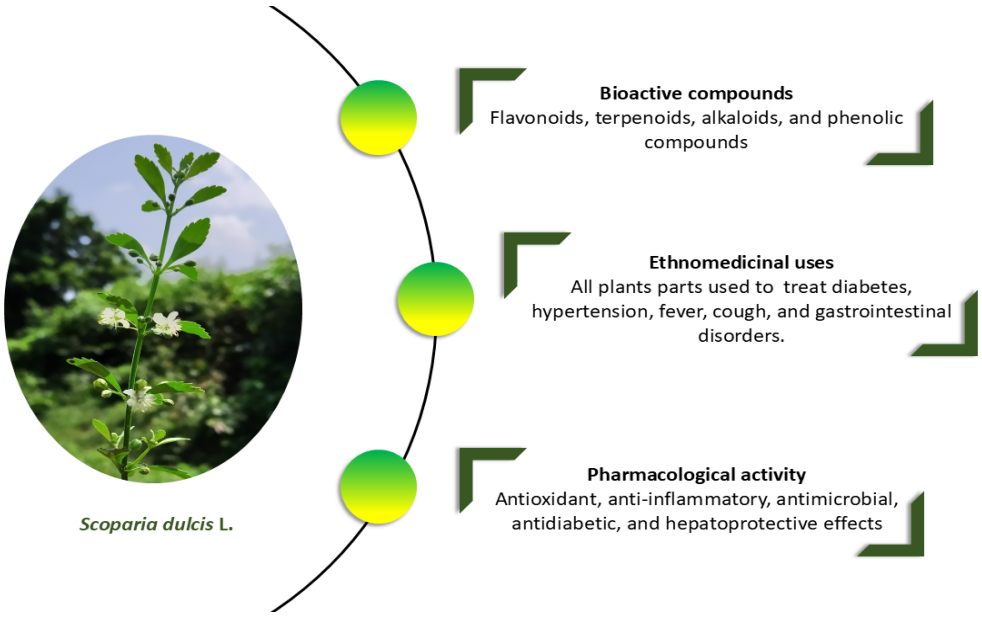


Figure 3: Illustration to justify *S. dulcis* for various important factors

This literature suggests that the plant's leaves may be a valuable resource for developing new treatments for a range of diseases. The whole plant has also shown significant pharmacological activity, with anti-malarial and antioxidant properties observed. The anti-malarial activity is particularly noteworthy, given the ongoing need for effective treatments against this

disease. The antioxidant activity suggests that the plant may have potential in preventing or treating conditions associated with oxidative stress (Table 2). Overall, the plant's diverse range of pharmacological activities makes it a promising candidate for further research and development. Its potential uses in traditional medicine are supported; further studies are warranted to fully explore its therapeutic potential and ensure safe usage (Figure 3).

Conclusion

Scoparia dulcis represents a compelling example of a traditional medicinal plant that has widespread ethnomedicinal uses and has been extensively validated by modern ethnopharmacological research. The traditional use of this "sweet broom weed" as a panacea for conditions ranging from diabetes and gastrointestinal ailments to fevers, skin disorders, and hypertension is supported by the identification of a rich array of bioactive compounds, including diterpenoids, flavonoids, and triterpenoids. Scientific studies have confirmed its notable antidiabetic, antioxidant, anti-inflammatory, antimicrobial, and even anti-cancer properties. This synthesis of traditional knowledge and scientific evidence not only justifies the plant's long-standing use in various cultures but also highlights its significant potential as a source for developing new therapeutic agents.

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Chapter 7

Ethnobotanical, ethnopharmacological and ecological significant uses of *Heliotropium indicum* L.

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Abstract: *Heliotropium indicum*, commonly known as Indian heliotrope, holds a valuable role in ethnobotanical, ethnopharmacological, and ecological domains. Ethnobotanically, it is revered in traditional medicine systems worldwide for its diverse applications, including the treatment of fevers, inflammation, wounds, and skin infections. Its ethnopharmacological importance is from its rich phytochemical profile, which includes alkaloids, flavonoids, and terpenoids. These compounds are responsible for their scientifically validated properties, such as antimicrobial, anti-inflammatory, antioxidant, and wound-healing effects. Ecologically, *H. indicum* plays a vital role as a pioneer species in disturbed habitats, contributing to soil stabilisation and nutrient cycling. Furthermore, it serves as a significant resource for pollinators, particularly bees and butterflies, which are attracted to its nectar-rich flowers. Its ability to tolerate harsh conditions makes it a key species in ecological restoration efforts, and its interactions with various insects can also provide insights into co-evolutionary relationships. This chapter will delve into these various uses, highlighting the plant's importance from a human cultural and medicinal perspective, as well as its crucial role in maintaining ecosystem health.

Keywords: Bioactive compounds, ethnopharmacology, weeds

Introduction

Boraginaceae includes 154 accepted genera worldwide (POWO, 2025). The Boraginaceae family encompasses a diverse range of herbs, shrubs, lianas (occasionally) and trees that are distributed globally. Boraginaceae is distinct in possessing alternate leaves, round stems, unique secondary metabolites, regular flower structures, an equal number of stamens and petals, and flower clusters that often exhibit a coiled formation reminiscent of a scorpion's tail (Shinde and Gupta, 2022). The plants of this family are widely dispersed in tropical and temperate regions, especially the Mediterranean. *Cordia, Echium, and Anchusa* are cultivated. *Heliotropium, Cordia, Arnebia, Martensia, and Trichodesma* are the main genera of the Boraginaceae family (Ghori et al., 2016; Gupta et al., 2024). According to POWO, *Heliotropium* Tourn. ex L., includes 255 accepted species worldwide (POWO, 2025). It is one of the largest genera of the family Boraginaceae. Mostly herbs, climbers, shrubs and trees. The name “heliotrope” originates from the ancient ideas that these plants turned their leaves towards the sun. ‘Helios’ meaning in Greek languages is ‘sun,’ and the ‘tropium’ word comes from another Greek word ‘tropein’, and the meaning of this word is ‘to turn’ (Fayed, 2021). They are simply identified by their partial inflorescences of scorpioid cymes and by the morphology of the greatly modified stigmatic head in the flower (Fayed et al., 2022). *Heliotropium indicum* L., a common annual herb belonging to the Boraginaceae family, is a plant with remarkable significance in Unani, Ayurveda and Siddha. Known by various names such as Indian heliotrope and Indian turnsole, this species is widely distributed across tropical and temperate regions, often found as a ruderal weed in disturbed areas, fields, and along roadsides (Kalam et al., 2023). Despite its common weed status, it holds a profound place in indigenous traditional medicine systems and local

cultures across the globe, particularly in Asia, Africa, and the Americas. The plant's historical use as a folk remedy for a wide array of ailments has led to a growing body of scientific research aimed at understanding its pharmacological properties and ecological role. The ethnobotanical uses of *H. indicum* are a testament to its long history as a medicinal plant. Traditional healers and indigenous communities have utilised different parts of the plant, including the leaves, stems, roots, and flowers, to prepare decoctions, poultices, and juices. These preparations have been employed to treat a diverse range of health conditions, from minor skin afflictions like wounds, ulcers, and boils to more serious internal disorders. Its traditional applications extend to treating fevers, inflammation, rheumatic pain, menstrual abnormalities, and even as an antidote for bites and stings from venomous animals (Lal et al., 2023). This rich tapestry of traditional knowledge underscores its value as a natural resource for human health and well-being. The ethnopharmacological investigation of *H. indicum* has provided scientific validation for many of its traditional uses. Researchers have identified a variety of bioactive compounds in different plant parts, including pyrrolizidine alkaloids, sterols, amines, flavonoids, and terpenoids, which are responsible for the plant's therapeutic effects. Alkaloids reported so far are indicine, heliotrine, indicidin, indicine N-oxide, lasiocarpine, acetyl indicine, cinoglosine, helleurin, eurypine N-oxide, heliotridine N-oxide and heliotrine N-oxide (Ovalle et al., 2022). Studies have shown that extracts from the plant possess significant cytotoxic, antimicrobial, anti-inflammatory, antioxidant, and wound-healing properties (Chunthorng-Orn et al., 2016; Ghosh et al., 2018). These findings support its use in treating infections, reducing swelling, and promoting tissue regeneration. While some of the alkaloids present in the plant, such as indicine N-oxide, have shown potential anti-

cancer properties, their cumulative toxicity is also a subject of concern, highlighting the need for careful research into their safety and dosage. insecticidal and toxicological effects from the leaf extracts of *H. indicum* for controlling insect pests of stored grains (Adeniyi et al., 2025). Beyond its medicinal applications, *H. indicum* plays a crucial ecological role. As a pioneer species, it is often one of the first plants to colonise and thrive in nutrient-poor and disturbed habitats. Its ability to grow in challenging environments contributes to soil stabilisation and helps facilitate the succession of other plant species. It also serves as an important resource for various insects, acting as a host plant for certain butterfly species and a significant source of nectar for pollinators, including bees and moths. These ecological functions highlight its contribution to local biodiversity and ecosystem health, making it an ecologically significant species in its native and naturalised ranges.

Methodology

Through field and literature surveys, concluded that *H. indicum* possesses a wide array of ecological significance, and through a literature survey, it revealed its ethnomedicinal uses and pharmacological values were revealed. Literature data was gathered from Scopus, Web of Science, Springer, PubMed, Chem Spider, Elsevier, BioMed Central, Google Scholar, MDPI, ScienceDirect, SciFinder, Scirus, and Scientific Electronic Library Online (SciELO) using search terms "*H. indicum*, "phytochemistry", "pharmacology", and "ethnomedicinal uses", from 2022-2025 (Jena et al., 2025; Kumar, 2025).

Morphology

It is an erect with hirsute, branched, about 20-60 cm tall and coarse foetid herb. Branched, hirsute with hairs in the stem and the root is a tap root.

Leaves are opposite or sub-opposite, alternate or straight forward or sub-alternate, ovate to obovate, hairy, acute. Leaf margins undulate, nerves on either side, serrulate or cordate, or veins are conspicuous beneath the leaves. Petiole is about 3-11 cm long. Flowers are white or whitish violet and approximately 5.1 mm in diameter. Flowers develop apically within the cymose; at maturity, nutlets are present at the base of the inflorescence. Flowers are regular, sessile, and axillary. Sepals 5-3 mm long, diffused with hairs on the outside, deep green, linear to lanceolate and uneven or unequal. Fruits are dry, 2-4 lobed, with or without united nutlets, 3 to 6 mm long (Saxena and Brahmam, 1995; Figure 1-2).

Results and discussion

Various parts of *H. indicum* have been traditionally used to treat a wide range of ailments, showcasing its versatility in folk medicine. Through various literature aspects, it concludes that the leaves are used to treat insect stings, skin ulcers, conjunctivitis, ophthalmic disorders, warts, fever, and rheumatoid arthritis, while also being explored for potential use in treating leukaemia. The roots are used for joint pain and as an astringent, and the seeds are used to treat malaria. The whole plant is used to address inflammatory conditions in postpartum women, cold and cough, stomach infections, and ringworm infections. Among different plant parts, the most dominant are leaves and the whole plant, followed by the root and the seed. Averagely, the modes of use are decoction, maceration, infusion, juice, and paste (Table 1). These findings highlight the plant's potential as a valuable resource for traditional medicine, with its various parts offering a range of therapeutic benefits. Further research is needed to validate the efficacy and safety of these traditional uses, explore the plant's bioactive compounds, and investigate its potential for modern medicinal applications.



Figure 1: Habit and habitat of *H. indicum*



Figure 2: Inflorescence of *H. indicum*

By studying the plant's properties and uses, scientists can identify new leads for drug development and work towards preserving traditional knowledge while promoting sustainable use of this valuable resource.

Table 1: Ethnomedicinal uses of *H. indicum*

Plants parts	Mode of use(s)	Diseases	Sources
Leaves	Decoction	Insect stings	Chunthorng-Orn et al., (2016)
Leaves	Juice	Skin ulcers	Kalam et al., (2023); Gupta et al., (2024); Sanchez-Mendoza et al., (2024)
Leaves	Decoction	Conjunctivitis	Gupta et al., (2024)
Leaves	Decoction	Ophthalmic disorder	Poojari and Bhalerao, (2018)
Leaves	Paste	Warts	Kalam et al., (2023)
Leaves	Decoction	Fever	Kalam et al., (2023); Kainge et al., (2024)
Leaves	Maceration	Rheumatoid arthritis	Kalam et al., (2023)
Leaves	Decoction	Leukaemia	Kalam et al., (2023)
Leaves	Paste	Lice	Kumar et al., (2022)
Root	Maceration	Joint pain	Sarkar et al., (2021); Kalam et al., (2023)
Roots	Decoction	Astringent	Poojari and Bhalerao, (2018)
Seed	Decoction	Malaria	Poojari and Bhalerao, (2018)
Whole plant	Decoction	Inflammatory condition in postpartum women	Gupta et al., (2024)
Whole plant	Infusion	Cold and cough	Sarkar et al., (2021); Kalam et al., (2023)
Whole plant	Infusion	Stomach infections	Kalam et al., (2023)
Whole plant	Paste	Ringworm infection	Kalam et al., (2023)

Pharmacological activity

Many researchers have documented on pharmacological activities of *H. indicum*. According to the literature survey, it concluded that many researchers reported on pharmacological activities as it is a promising herb (Chunthorng-Orn et al., 2016; Ghosh et al., 2018; Lal et al., 2023). The flower has demonstrated antiulcer activity, while the leaf and stem have shown anticancer properties. The leaf, stem, and root have antioxidant activity, which can help protect against oxidative stress. Additionally, the leaves have wound healing activity, and the whole plant has analgesic and anti-inflammatory properties. Table 2 suggests that *H. indicum* has potential as a source of new medicines, with its various parts offering a range of therapeutic benefits. The presence of antioxidant, anti-inflammatory, and analgesic activities in the whole plant suggests that it may be beneficial in treating various conditions, including pain and inflammation (Table 2). Further research is needed to fully explore the plant's pharmacological potential, identify the bioactive compounds responsible for these activities, and examine its safety and efficacy in humans.

Table 2: Pharmacological activities of *H. indicum*

Plants parts	Pharmacological activity	Sources
Flower	Antiulcer activity	Kalam et al., (2023)
Leaf and stem	Anticancer activity	Aswini et al., (2017)
Leaf, stem and root	Antioxidant activity	Lal et al., (2023)
Leaves	Wound healing activity	Kalam et al., (2023)
Whole plant	Analgesic activity	Lal et al., (2023)
Whole plant	Anti-inflammation activity	Chunthorng-Orn et al., (2016); Shoily et al., (2025)



Figure 3: *Utetheisa pulchella* (Crimson Speckled) pollinates on *H. indicum*



Figure 4: *Danaus genutia* (Striped tiger butterfly) pollinates on *H. indicum*

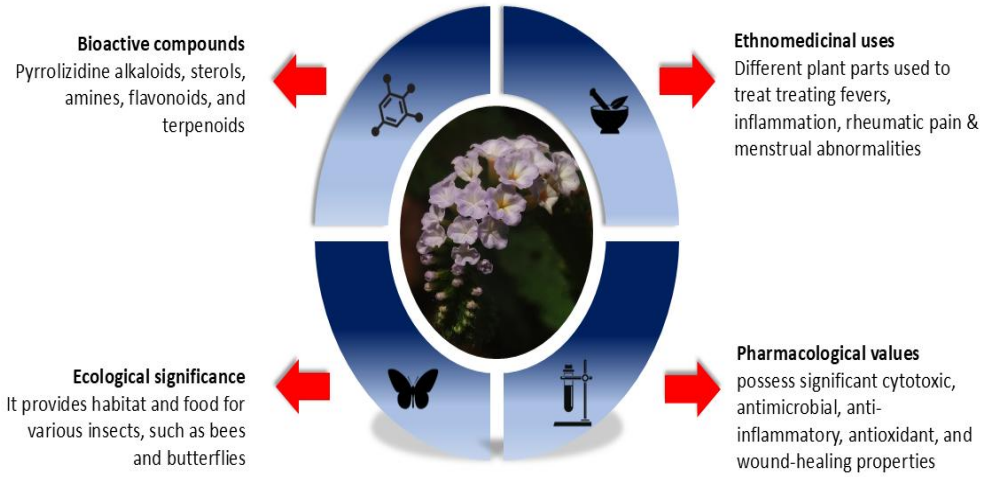


Figure 5: Illustration to justify *H. indicum* for various important factors

Ecological significance

The present field and literature study indicates that *H. indicum* is exclusively pollinated by butterflies and moths. It provides habitat and food for various insects, such as bees and butterflies, which are attracted to its flowers. As per the literature survey, it revealed that it is a nectar plant for *Euploea core* (Common crow butterfly*), Danaus genutia* (Striped tiger butterfly)*, Danaus chrysippus* (Plain tiger butterfly)*, Tirumala limniace* (Blue tiger butterfly) and *Parantica aglea* (Glassy tiger butterfly) (Solomon Raju and Suvarna Raju, 2020). The field survey revealed that many pollinators are present on H. indicum due to its attractiveness for pollination purposes. Some pollinators like *Utetheisa pulchella* (Crimson Speckled) (Figure 3) and *Danaus genutia* (Striped tiger butterfly) (Figure 4). Henceforth, *H. indicum*'s ability to thrive in a range of environments makes it a valuable species for ecological restoration and conservation efforts (Figure 5). Its presence can also indicate soil health and fertility, highlighting its importance in ecosystem functioning and biodiversity.

Conclusion

Heliotropium indicum, a pantropical weed, holds significant ethnobotanical, ethnopharmacological, and ecological value. Ethnobotanically and ethnopharmacologically, its diverse uses in traditional medicine systems worldwide are notable, particularly for treating ailments like skin diseases, wounds, inflammation, fever, and respiratory issues. These traditional uses are supported by modern research, which has identified various bioactive compounds with antioxidant, anti-inflammatory, antimicrobial, and cytotoxic properties. Ecologically, *H. indicum* plays a role as a pioneer species in disturbed habitats, contributing to soil stabilisation and providing a food source for some insect species. However, its potential to become an invasive weed in certain environments and its hepatotoxic pyrrolizidine alkaloids warrant caution. Therefore, a balanced approach is necessary to harness its therapeutic potential while managing its ecological impact, ensuring sustainable use and conservation of this versatile plant.

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Chapter 8

Phytochemical profiling and cytotoxicity analysis of *Vanda tessellata* root: an epiphytic orchid of India

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Abstract: The search for novel therapeutic agents from natural sources has intensified due to the limitations of conventional drugs and the rise of drug resistance. In this study, the roots of *Vanda tessellata*, an epiphytic orchid of India with ethnomedicinal relevance, were subjected to solvent-based extraction and evaluated for their phytochemical profile and cytotoxic potential. Phytochemical screening revealed the presence of tannins, alkaloids, reducing sugars, and carbonyl compounds exclusively in the hydroethanolic extract, while n-hexane and petroleum ether extracts showed no detectable metabolites. Cytotoxicity analysis using the brine shrimp lethality assay demonstrated 100% mortality at all tested concentrations for n-hexane and petroleum ether extracts, suggesting potent cytotoxic effects. In contrast, the hydroethanolic extract exhibited mild toxicity at lower concentrations and no lethality at higher doses. These findings highlight the solvent-dependent bioactivity of *V. tessellata* roots, indicating their potential as a source of novel bioactive compounds for therapeutic exploration.

Keywords: Bioactive compounds, ethnopharmacology, orchids

Introduction

The increasing incidence of drug resistance and the emergence of new diseases have created a global demand for novel therapeutic agents (Devi et al., 2023). Conventional drugs often face limitations such as toxicity, high cost, and reduced efficacy, which necessitate the discovery of alternative bioactive compounds from natural sources (Dzobo, 2022). Medicinal plants remain a rich reservoir of diverse secondary metabolites that can serve as templates for the development of safer and more effective pharmaceuticals (Pradhan et al., 2025). In this context, systematic phytochemical screening is a key step in identifying plants with promising biological properties. Among the vast diversity of plant groups, orchids (family Orchidaceae) are comparatively underexplored despite being one of the largest families of angiosperms (Droissart et al., 2023). Traditionally, orchids have been used in various indigenous systems of medicine for treating different health problems (Kumar et al., 2021; Kumar, 2022), yet their scientific validation remains limited. The structural diversity of orchid metabolites and their ecological adaptations (Sharma et al., 2024) suggest a high potential for yielding compounds of pharmacological significance. Exploring these plants through modern screening approaches may therefore open avenues for discovering novel leads in drug development. *Vanda tessellata*, an epiphytic orchid widely distributed in India, represents a species of ethnomedicinal relevance (Kumar and Kumar, 2020) but with limited phytochemical and pharmacological studies. Its roots are traditionally used in treating ailments, indicating the possible presence of bioactive molecules. However, scientific evaluation of its phytochemical constituents and cytotoxic potential is scarce. Thus, the present study aims to investigate the phytochemical profile of *V. tessellata* (Figure 1-2) root extracts and assess their cytotoxic activity,

thereby contributing to the growing search for new therapeutic agents from unexplored orchid species.

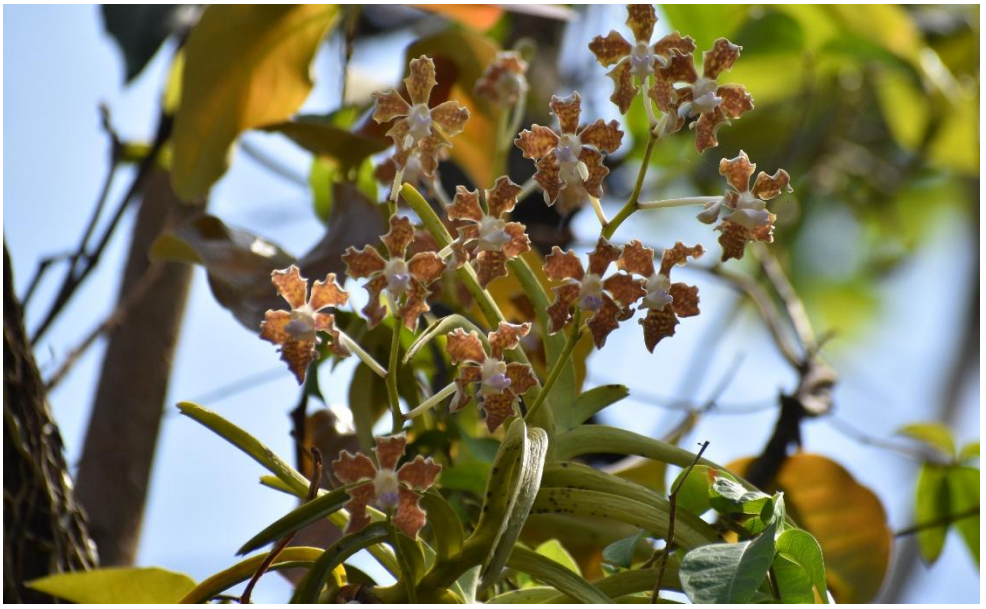


Figure 1: Habit and habitat of *V. tessellata*



Figure 2: Root and leaves of *V. tessellata*

Methodology

Plant Sample, Extraction and Phytochemical Screening: The root of *Vanda tessellata* was collected from the nearby Mahanadi River area of Cuttack, Odisha, India (Figure 3). The plant species was identified by the authors. The Maceration extraction method was adopted using three solvents (n-hexane, petroleum ether and hydroethanolic extract) for phytochemical analysis. Detection of nine secondary metabolites was conducted using standard methods (Jena et al., 2025). Details of phytochemical analysis are given below.



Figure 3: Collected roots for experimental works

Test for tannin: 1 ml of root extract was taken in a test tube, and 3-5drops of 10% lead acetate solution were added to it. The gelatinous precipitate formation confirmed the presence of tannin.

Test for saponin: About 1 ml of distilled water was added to 1 ml of the root extract and shaken well. The formation of persistent froth was observed, confirming the presence of saponin.

Test for flavonoids: About 1 ml of the root extract was taken, and 2ml of NaOH solution and 3-5 drops of dilute HCl were added to it. The colour initially turned to an intense yellow colour with NaOH solution and later became colourless, which confirmed the presence of flavonoids.

Test for terpenoids: To 1 ml of the root extract, 5-6 drops of chloroform were added. Then, 4-6 drops of concentrated sulphuric acid were added to it. The reddish-brown interface confirmed the presence of terpenoids.

Test for phenols: About 1 ml of the root extract was taken. A few drops of 5% ferric chloride solution were added. The dark bluish-black appearance confirmed the presence of phenolic compounds.

Test for reducing sugars: About 1 ml of the root extract was taken. Two drops of Fehling's solution A followed by an equal volume of Fehling's solution B were added and kept in the water bath for a few minutes. The presence of red-orange precipitate confirmed the presence of reducing sugars.

Test for steroids: To 1 ml of the root extract, 1 ml of chloroform, followed by 1 ml of concentrated sulphuric acid, was added. The appearance of upper red and lower yellow with green fluorescence indicated the presence of steroids.

Test for alkaloids: About 1 ml of the root extract was taken, and 3-4 drops of Dragendroff's reagent were added to it. The formation of a reddish-brown precipitate confirmed the presence of alkaloids.

Test for carbonyl compounds: About 1 ml of root extract was taken, and 3-4 drops of 2,4-Dinitrophenylhydrazine (DNPH) reagent were added. The formation of yellow crystals confirmed the presence of carbonyl compounds.

Toxicity analysis: For toxicity analysis, hatching of brine cysts is the initial process. Standardisation of the optimum is done at 2.0, 3.5 and 5.0% saline concentration to check the optimum salinity for proper hatching of brine shrimp (*Artemia salina*) cysts. The brine shrimp cysts are then incubated in 3.5% saline water with proper aeration, at room temperature or between 28-35^{o}C and light for 48 hours. Proper hatching can be observed within 24-48 hours, depending upon the quality of cysts, proper aeration and light provided. Different concentrations of the sample extract are taken, and 3.5% saline water is used to make the volume 2 ml in each test tube. 1% DMSO is used to dissolve the crude extracts. Ten nauplii were selected and introduced to five test tubes of the extracts. Positive and negative controls were prepared using vincristine sulphate (5 mg/ml) or potassium dichromate and 3.5% saline water, respectively, with a volume of 2 ml. The live larva is highly mobile and thus differentiates from the unhatched cysts. The survivor nauplii were counted, and the death % was analysed (Jena et al., 2025).

Results and discussion

Phytochemical screening of the root extracts of *V. tessellata* was carried out using three different solvents to identify the presence of various bioactive compounds (Table 1). The phytochemical analysis of the root of *V. tessellata* reveals the presence of various bioactive compounds in the hydroethanolic extract, including tannins, reducing sugars, alkaloids, and carbonyl compounds. In contrast, the n-hexane and petroleum ether extracts do not show the presence of these compounds, which suggests that the hydroethanolic extract is rich in polar bioactive compounds. The absence of flavonoids, terpenoids, phenols, and steroids in all three extracts may indicate that these compounds are present in very low quantities. The presence of

tannins, alkaloids, and carbonyl compounds in the hydroethanolic extract suggests potential medicinal properties, such as antioxidant, antimicrobial, and anti-inflammatory activities (Fraga-Corral et al., 2021).

Table 1: Phytochemical analysis of *Vanda tessellata* root

Bioactive compounds	n-Hexane extract	Petroleum ether extract	Hydro-ethanolic extract
Tannin	-	-	+
Saponin	-	-	-
Flavonoids	-	-	-
Terpenoids	-	-	-
Phenols	-	-	-
Reducing sugars	-	-	+
Steroid	-	-	-
Alkaloid	-	-	+
Carbonyl compound	-	-	+

(-ve- negative; +ve – positive)

Table 2: Toxicity analysis of *Vanda tessellata* root using Brine shrimp nauplii (*Artemia salina*)

Extracts	Concentration	Initial number of nauplii	Number of deaths of nauplii (after hours)				Death rates (%) after 2 hours
			1	2	3	4	
n-Hexane	15.62	10	10	10	10	10	100
	31.25	10	10	10	10	10	100
	62.5	10	10	10	10	10	100
	125	10	10	10	10	10	100
	250	10	10	10	10	10	100
	3.5% saline	10	0	0	0	0	0
	Vincristine sulphate	10	10	10	10	10	10
Petroleum ether	15.62	10	10	10	10	10	100
	31.25	10	10	10	10	10	100
	62.5	10	10	10	10	10	100
	125	10	10	10	10	10	100
	250	10	10	10	10	10	100
	3.5% saline	10	0	0	0	0	0
	Vincristine sulphate	10	10	10	10	10	10
Hydro-ethanolic	15.62	10	3	3	3	3	30
	31.25	10	0	2	2	2	20

	62.5	10	0	0	0	0	0
	125	10	0	0	0	0	0
	250	10	0	0	0	0	0
	3.5% saline	10	0	0	0	0	0
	Vincristine sulphate	10	10	10	10	10	100

The brine shrimp lethality assay results indicate that the n-hexane and petroleum ether extracts exhibited a 100% mortality rate at all tested concentrations, like the positive control vincristine sulphate (Table 2). In contrast, the hydroethanolic extract showed concentration-dependent toxicity, with higher concentrations (62.5-250 µg/mL) resulting in 0% mortality rate, while lower concentrations (15.62 and 31.25 µg/mL) showed 30% and 20% mortality rates, respectively. The negative control (3.5% saline) showed no toxicity. The results revealed that the n-hexane and petroleum ether extracts possess potent cytotoxic activity, while the hydroethanolic extract shows varying toxicity depending on concentration.

Conclusion

The present study demonstrated that the root extracts of *Vanda tessellata* possess solvent-dependent phytochemical and cytotoxic properties. While hydroethanolic extracts revealed the presence of bioactive compounds such as tannins, alkaloids, reducing sugars, and carbonyl groups with comparatively low toxicity, the n-hexane and petroleum ether extracts exhibited strong cytotoxicity at all concentrations, suggesting the presence of potent lipophilic metabolites. These findings validate the ethnomedicinal importance of *V. tessellata* and emphasise its potential as a promising source of novel therapeutic agents. Further bioassay-guided fractionation and molecular characterisation are required to isolate active principles and explore their pharmacological applications.

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Chapter 9

Unlocking Nature's Pharmacy: Anticancer Potential of Medicinal Plants from India

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Abstract: Cancer remains a major global health challenge and one of the leading causes of mortality worldwide. The limitations of conventional therapies such as chemotherapy and radiation, including high toxicity, drug resistance, and adverse effects, have increased interest in alternative and complementary treatment approaches, particularly those derived from natural sources. India, with its rich biodiversity and long-standing tradition of healing systems such as Ayurveda, offers a vast reservoir of medicinal plants with significant anticancer potential. This chapter presents a comprehensive overview of selected Indian medicinal plants that have shown promising anticancer activity in both traditional usage and modern pharmacological research. The therapeutic effects of these plants are largely attributed to a wide variety of bioactive phytochemicals, including alkaloids, flavonoids, terpenoids, and phenolic compounds. These compounds exert anticancer effects through multiple mechanisms such as inducing apoptosis, inhibiting cell proliferation, suppressing

angiogenesis, modulating immune responses, and enhancing antioxidant defences. Key medicinal plants discussed include *Withania somnifera* (Ashwagandha), *Tinospora cordifolia* (Guduchi), and *Curcuma longa* (Turmeric), with a focus on their traditional uses and scientific validation. By connecting traditional knowledge with current biomedical research, this chapter highlights the role of Indian medicinal plants in cancer prevention and treatment. It also emphasises their potential as sources for the development of safer and more effective anticancer agents, contributing to the progress of integrative oncology and future drug discovery. This chapter primarily draws upon existing literature to summarise widely used anticancer plants in India.

Keywords: Anticancer medicinal plants, anti-tumour, Ayurveda, bioactive compounds, Indian ethnomedicine

Introduction

India's rich and diverse flora has long served as a valuable source of medicinal plants, many of which possess significant anticancer properties. Rooted in the ancient traditions of Ayurveda and various indigenous healing systems, these plants have been used for centuries in traditional medicine. Today, modern scientific research is increasingly validating its therapeutic potential. Spanning from the Himalayan foothills to the tropical rainforests of the Western Ghats, India's varied ecosystems are home to a wide range of plant species, several of which have demonstrated promising anticancer activity. Cancer is one of the leading causes of death worldwide. According to the World Health Organisation (WHO), cancer is responsible for millions of deaths globally each year. The disease can affect anyone, regardless of age, gender, or geographical location (https://www.who.int/). The exploration of anticancer medicinal plants in India is a multidisciplinary field that combines traditional knowledge with modern scientific research. Researchers are investigating the bioactive compounds present in these plants, their mechanisms of action, and their potential applications in cancer treatment (Srinivasan, 2018; Singh et al., 2021). This research has the potential to lead

to the development of novel anticancer therapies that are effective, safe, and accessible. Many Indian medicinal plants have been studied for their anticancer properties, including *Withania somnifera*, *Tinospora cordifolia*, *Ocimum sanctum*, *Azadirachta indica*, and *Curcuma longa* (Sirsat et al., 2019; Morris et al., 2023). These plants have shown promising potential in targeting a variety of cancer types, including breast, lung, colon, and prostate cancers. The bioactive compounds they contain have been found to inhibit the growth of cancer cells, induce apoptosis (programmed cell death), and suppress tumour progression. Using medicinal plants in cancer treatment offers several benefits, such as lower toxicity and fewer side effects compared to conventional chemotherapy. Moreover, many of these plants are widely available and affordable, making them more accessible to a broader population (Greenwell and Rahman, 2015). However, further research is needed to fully harness the anticancer potential of these plants and to ensure their safe and effective use. The Indian government has recognised the potential of medicinal plants in healthcare and has initiated several programs to promote their cultivation, conservation, and utilisation. The National Medicinal Plants Board, for example, works to promote the development of the medicinal plant sector, including research, cultivation, and trade (https://nmpb.nic.in). India's anticancer medicinal plants offer a promising avenue for cancer treatment and research. By combining traditional knowledge with modern scientific research, we can unlock the potential of these plants and develop novel therapies that can improve the lives of cancer patients. The future of cancer treatment in India may well lie in the country's rich botanical heritage, and further research is needed to explore the vast potential of these medicinal plants. Through traditional and indigenous

knowledge, we can develop new, effective, and sustainable treatments for cancer that are tailored to the needs of the Indian population.

Methodology

Through field and literature surveys, it was concluded that the plant possesses a wide array of ethnomedicinal uses. Additionally, the literature survey revealed its significant pharmacological values. Data were gathered from various databases, including Scopus, Web of Science, Springer, PubMed, Google Scholar, MDPI, Science Direct, SciFinder, Scirus, and the Scientific Electronic Library Online (SciELO). The search terms used included "plants used for anticancer activity," "phytochemistry," "pharmacology," "active compounds," and "other uses." The literature reviewed spans the period from 2022 to 2025 (Jena et al., 2025; Kumar, 2025).

Results and discussion

The compilation of bioactive compounds from various plant species highlights the vast potential of natural products in cancer treatment. Table 1 lists 48 plant species along with their active compounds (Figure 1). These plants, belonging to diverse families, exhibit a range of anticancer properties attributed to different classes of compounds, including flavonoids, terpenes, alkaloids, and phenolic compounds. For example, curcumin from *Curcuma longa*, vincristine and vinblastine from *Catharanthus roseus*, and paclitaxel from *Taxus chinensis* are well-established potent anticancer agents. The mechanisms of action of these compounds are varied and include antioxidant activity, inhibition of cancer cell growth, induction of apoptosis, and disruption of signalling pathways involved in cancer progression. Compounds such as epigallocatechin from *Camellia sinensis* and quercetin from various plants have shown promise in inhibiting cancer cell

proliferation and promoting apoptosis. The diversity of bioactive compounds and their mechanisms underscore the significant potential for discovering new candidates for cancer therapy. Continued research is essential to fully explore their therapeutic value, improve their efficacy, and assess their safety profiles. By integrating traditional knowledge with modern scientific methodologies, the development of innovative anticancer treatments can be accelerated, offering promising new options for enhanced patient care.

Table 1: Some anticancer medicinal plants with their active compounds from India

Botanical name	Common name	Active compound (s)	Family	Sources
Aegle marmelos (L.) Corrêa	Golden apple	Lupeol (triterpene)	Rutaceae	Sirsat et al., (2019); Chandra et al., (2023)
Allium sativum L.	Garlic	Allicin, diallyl disulfide, S-allylmercapto-L-cysteine and S-allylcysteine	Amaryllidaceae	Umadevi et al., (2013); Nouroz et al., (2015); Keshav et al., (2025)
Andrographis paniculata (Burm.f.) Wall. ex Nees	Green chiretta	Andrographolide	Acanthaceae	Desai et al., (2008); Sirsat et al., (2019)
Azadirachta indica A.Juss.	Neem	Azadirachti A, nimbin, nimbolide, gedunin	Meliaceae	Keshav et al., (2025)
Bauhinia variegata L.	Mountain ebony	Lupeol, kaempferol, quercetin, quercitrin, kaempferol-3-glucoside	Fabaceae	Singh et al., (2021); Sharma et al., (2020)
Berberis vulgaris L.	Common barberry	Berberine	Berberidaceae	Khushali et al., (2020)

Betula pubescens Ehrh.	Downy birch	Betulinic acid	Betulaceae	Saranya et al., (2019); Srinivasan, (2018)
Boerhavia diffusa L.	Punarnava	Boeravinones	Nyctaginaceae	Keshav et al., (2025)
Boswellia serrata Roxb.	Indian frankincense	Boswellic acids	Burseraceae	Srinivasan, (2018); Khushali et al., (2020); Trivedi et al., (2023)
Butea monosperma (Lam.) Kuntze	Flame-of-the-forest	Isocoreopsin, butrin and isobutrin	Fabaceae	Subramaniyan et al., (2016); Singh et al., (2021); Gupta et al., (2015)
Camellia sinensis (L.) Kuntze	Tea plant	EGCG (Epigallocatechin)	Theaceae	Saranya et al., (2019)
Carica papaya L.	Papaya	Papain, carpaine, isothiocyanate	Caricaceae	Morris et al., (2023)
Catharanthus roseus (L.) G.Don	Cape periwinkle	Vincristine, vinblastine	Apocynaceae	Umadevi et al., (2013); Keshav et al., (2025)
Citrus × limon (L.) Osbeck	Lemon	Citral and limonene	Rutaceae	Morris et al., (2023)
Cullen corylifolium (L.) Medik.	Scurfy pea	Flavonoids	Fabaceae	Khushali et al., (2020); Lee et al., (2024)
Curcuma longa L.	Turmeric	Curcumin	Zingiberaceae	Srinivasan, (2018); Keshav et al., (2025)
Cyperus rotundus L.	Nut grass	Sesquiterpenes, cyperotundone,	Cyperaceae	Khushali et al., (2020);

		caryophyllene oxide, α-Cyperone, α-Pinene		Nidugala et al., (2023); Bezerra et al., (2025)
Dregea volubilis (L.f.) Benth. ex Hook.f.	Jukti	Taraxerone	Apocynaceae	Hossain et al., (2012)
Elephantopus scaber L.	Elephant foot	Deoxyelephantopin and isodeoxyelephantopin	Asteraceae	Khushali et al., (2020); Roy et al., (2015)
Ferula narthex Boiss.	Asa foetida	Asafoetida are alpha-pinene, alpha terpineol,	Apiaceae	Khushali et al., (2020)
Ficus racemosa L.	Cluster fig	Galic acid, chloragenic acid, syringic acid, catechin, epicatechin and rutin.	Moraceae	Khushali et al., (2020); Sivakumar et al., (2019)
Glycine max (L.) Merr.	Soybean	Genistein	Fabaceae	Sirsat et al., (2019); Saranya et al., (2019)
Glycyrrhiza glabra L.	Liquorice	Glycyrrhizinic acid	Fabaceae	Saranya et al., (2019)
Hemidesmus indicus (L.) R.Br.	Indian sarsaparilla	Rutin, withanolides, glycosides, flavonoids, tannins and sterols	Apocynaceae	Sai et al., (2024)
Jatropha curcas L.	Physic nut	Jatrophalactone, jatrophalone, jatrophadiketone, pyrogallol	Euphorbiaceae	Oskoueian et al., (2011); Liu et al., (2012); Saleh et al., (2023)
Mimosa pudica L.	Touch -me-not	Amino acid Mimosine.	Fabaceae	Parmar et al., (2015)
Moringa oleifera Lam.	Drumstick tree	Isothiocyanat, thiocarbamate	Moringaceae	Morris et al., (2023)
Morus alba L.	White mulberry	Quercetin	Moraceae	Saranya et al., (2019)

Nigella sativa L.	Black caraway	Thymoquinone	Ranunculaceae	Saranya et al., (2019)
Ocimum tenuiflorum L.	Holy basil	Eugenol, cirsilineol, isothymusin, apigenin	Lamiaceae	Morris et al., (2023)
Persicaria acuminata (Kunth) M.Gómez	Knotweeds	Resveratrol	Polygonaceae	Saranya et al., (2019)
Phyllanthus emblica L.	Indian gooseberry	Ellagic acid, gallic acid, quercetin, emblicannins A and B	Euphorbiaceae	Sirsat et al., (2019)
Podophyllum hexandrum Royle	Ban kakri	Podophyllotoxin, podophyllotoxin 4-O-glucoside	Berberidaceae	Anand et al., (2022)
Pulicaria wightiana (DC.) C.B.Clarke	False fleabane	Flavonoids, terpenes, clerodane	Asteraceae	Khushali et al., (2020); Bhanu and Thyagaraju, (2017)
Raphanus sativus L.	Radish	Roscovitine	Brassicaceae	Greenwell and Rahman, (2015)
Reseda luteola L.	Dyer's rocket	Luteolin	Resedaceae	Saranya et al., (2019)
Rubia cordifolia L.	Indian madder	Rubidianin, rubiadin, rosemary acids, purpurin, alizarin, xanthopurpurin	Rubiaceae	Sirsat et al., (2019)
Senegalia catechu (L.f.) P.J.H.Hurter & Mabb.	Black Cutch Tree	Polyphenolic and flavonoid compounds	Fabaceae	Khushali et al., (2020)
Senna alexandrina Mill.	Egyptian senna	Sennosides, which are anthraquinone glycosides	Fabaceae	Singh et al., (2021); Khatoon et al., (2025)

Senna auriculata (L.) Roxb.	Tanner's cassia	4-(4-chlorobenzyl)-2,3,4,5,6,7-hexahydro-7-(2-ethoxyphenyl) benzo[h][1,4,7]triazecin-8(1H)-one	Fabaceae	Esakkirajan et al., (2014); Singh et al., (2021)
Tanacetum parthenium (L.) Sch.Bip.	Feverfew	Parthenolide	Asteraceae	Saranya et al., (2019)
Taxus chinensis (Pilg.) Rehder	Chinese yew	Paclitaxel (taxol)	Taxaceae	Saranya et al., (2019)
Tecomella undulata (Sm.) Seem.	Roheda	Quercetin	Bignoniaceae	Khushali et al., (2020)
Terminalia arjuna (Roxb. ex DC.) Wight & Arn.	Arjuna	Arjunine, arjunetin, lactone, reducing/non reducing sugar, essential oil	Combretaceae	Singh et al., (2021); Singh et al., (2017)
Tinospora cordifolia (Willd.) Hook.f. & Thomson	Heart-leaved moonseed	Palmatine, magnoflorin, jatrorrhizine, tinocordiside	Menispermaceae	Morris et al., (2023)
Trigonella foenum-graecum L.	Methi	Diosgenin	Fabaceae	Raju et al., (2004)
Withania somnifera (L.) Dunal	Ashwagandha	Withaferin A, withanolides	Solanaceae	Srinivasan, (2018); Keshav et al., (2025)
Ziziphus mauritiana Lam.	Indian jujube	Betulinic acid, ursonic acid	Rhamnaceae	Khurshid et al., (2021); Khushali et al., (2020); Kumari et al., (2025)

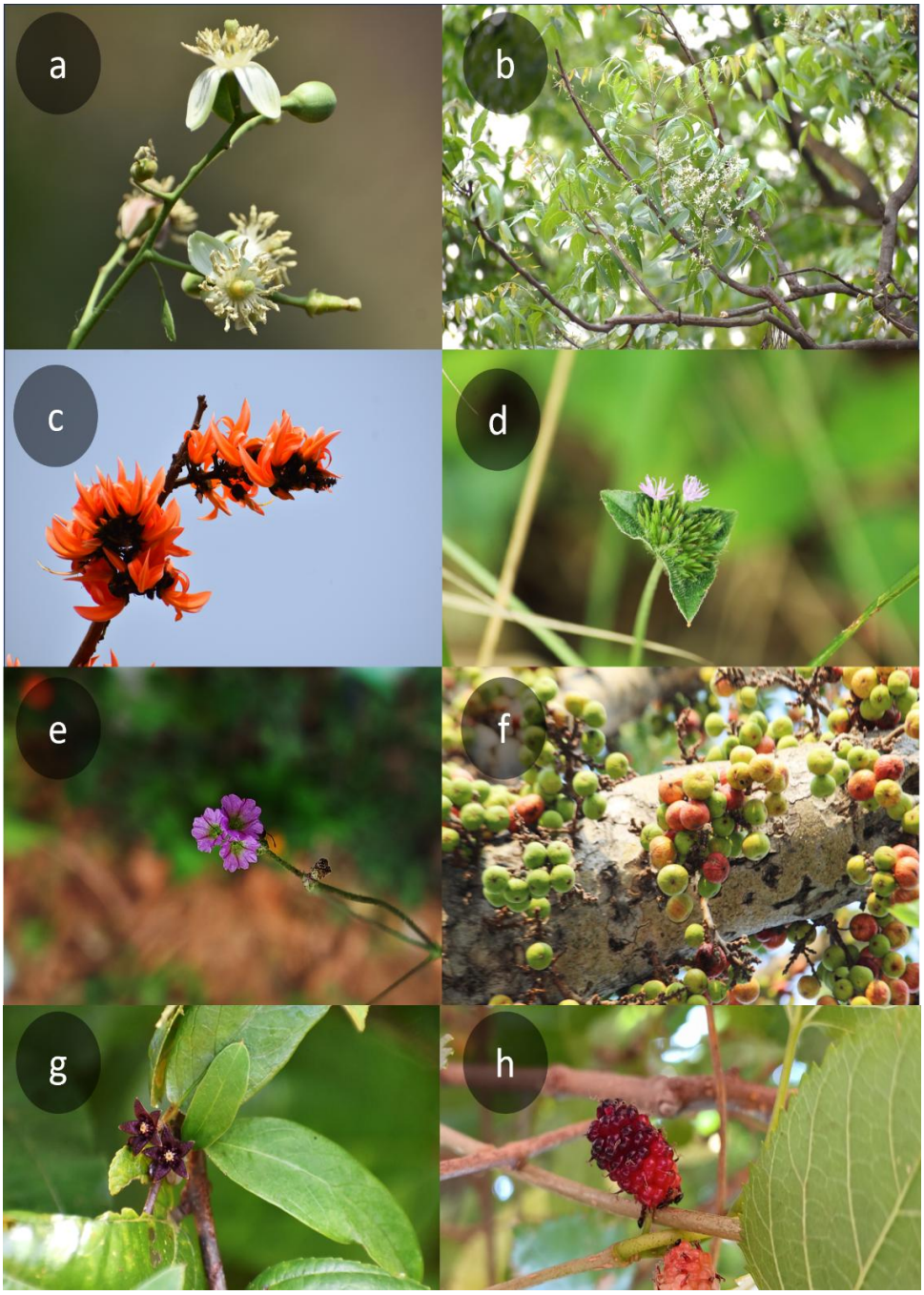


Figure 1: Some anticancer medicinal plants in India a) *Aegle marmelos,* b) *Azadirachta indica,* c) *Butea monosperma,* d) *Elephantopus scaber,* e) *Boerhavia diffusa,* f) *Ficus racemosa,* g) *Hemidesmus indicus,* and h) *Morus alba*

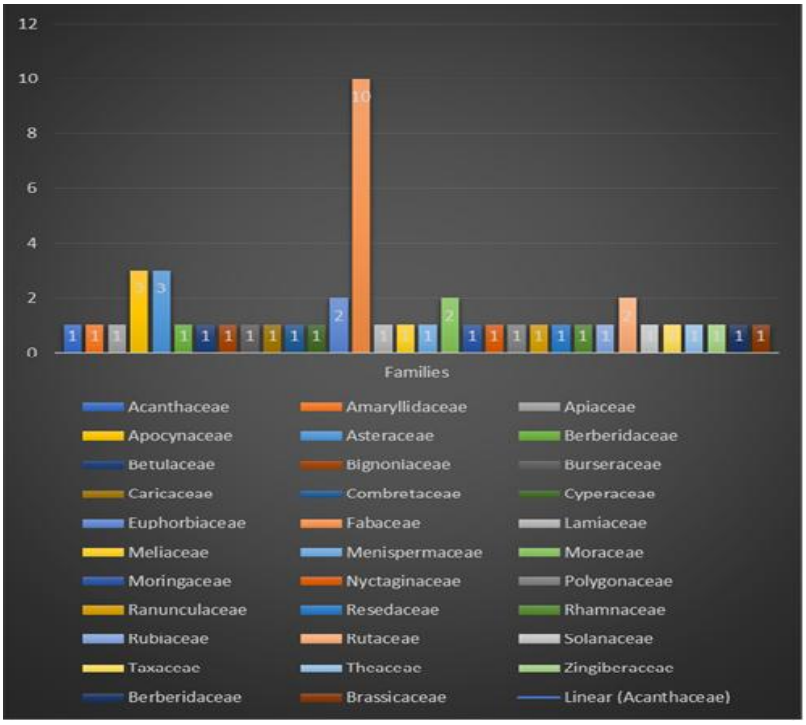


Figure 2: Graphical presentation of some anticancer medicinal plant families

According to Figure 2, it concluded that the list of various plant families, the most dominant species are Fabaceae consist of 10 plant species, Asteraceae, and Apocynaceae consist of 3 species, followed by Rutaceae, Apocynaceae, Moraceae, Euphorbiaceae, followed by the rest of the families.

Conclusion

Cancer remains one of the most widespread and deadly diseases worldwide, posing significant challenges to global healthcare. Although conventional treatments such as chemotherapy, radiation, and targeted therapies have advanced, their limitations, including severe side effects, variable efficacy, and drug resistance, highlight the critical need for safer and more effective alternatives. India, with its rich biodiversity and longstanding traditions in herbal medicine, holds a vast and largely untapped reservoir of medicinal

plants with promising anticancer potential. Ancient healing systems such as Ayurveda, Siddha, and Unani have long valued these plants, and modern scientific research increasingly supports their therapeutic efficacy through pharmacological and biochemical studies. This chapter has provided a comprehensive overview of select Indian medicinal plants, emphasising their traditional applications, botanical characteristics, and bioactive compounds. By integrating ethnomedicinal knowledge with contemporary scientific evidence, it demonstrates the significant promise these plants hold for developing novel plant-based anticancer therapies. Ultimately, bridging traditional wisdom with modern science not only deepens our understanding of these natural resources but also paves the way for innovative, safe and sustainable cancer treatment strategies.

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Chapter 10

Discoveries of New Taxa of Orchidaceae from India in the Last Decade

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Abstract: India, recognised as one of the world's major biodiversity hotspots, has shown a substantial increase in orchid discoveries over the past decade (2015-2025). This study compiles, reviews and analyses 51 newly described taxa of the family Orchidaceae from diverse regions across the country, emphasising their taxonomic significance, distinctive morphological characteristics and expanded geographical distributions. The results highlight the pivotal role of regional floristic explorations and institutional initiatives, particularly those led by the Botanical Survey of India (BSI), in enhancing our understanding of the nation's orchid diversity. This synthesis further underscores the urgent need for targeted conservation strategies, habitat protection and timely dissemination of taxonomic findings to ensure the preservation of India's rich orchid flora.

Keywords: Expansion of geographical range, new discoveries, new distributional record, orchid, plant taxa

Introduction

The family Orchidaceae Juss., one of the largest and most diverse families of flowering plants, comprises an estimated one million species distributed across nearly all biogeographic regions of the world. Although many orchid species have been well documented, a substantial number remain poorly studied or have become locally extinct due to environmental degradation and anthropogenic pressures. According to Plants of the World Online (POWO, 2025), Orchidaceae currently includes 693 accepted genera globally. In India, the past decade has witnessed a notable rise in the discovery of new plant taxa, particularly within Orchidaceae. A recent example is *Gastrodia indica*, a fully cleistogamous orchid species discovered in Sikkim, representing the first record of its kind from India (Khanal et al., 2024). This taxon exhibits distinct floral morphological traits that clearly separate it from its congeners. The Western Ghats and the northeast region of India have emerged as significant biodiversity centres, contributing approximately 14% of the nation's total new plant discoveries. In 2023 alone, 339 new taxa were added to India's plant database, including 326 species and 13 infraspecific taxa. Of these, 171 were newly described to science, while 168 represented new distribution records (Kuriakose and Sebastian, 2016; Deepu et al., 2023). Notable examples include *Curcuma kakchingensis*, a newly described turmeric species from Manipur and *Asystasia venui*, a flowering plant from West Bengal. These discoveries substantially enrich the nation's floristic inventory and underscore the importance of continued botanical research and conservation.

The Botanical Survey of India (BSI) plays a central role in documenting, assessing and conserving the country's plant diversity through systematic field explorations and taxonomic studies. Since 2015, BSI-led initiatives have reported 51 new orchid taxa, reflecting both the ongoing expansion of India's documented orchid diversity and the need for targeted conservation of these newly identified species and their habitats. Nevertheless, several regions, particularly in northeast India, remain inadequately explored, resulting in significant knowledge gaps in orchid distribution and taxonomy. Comprehensive documentation, coupled with the timely publication of new discoveries in peer-reviewed scientific journals, is crucial for the formal recognition of new species and for strengthening evidence-based conservation planning.

Methodology

A comprehensive literature review was conducted to document newly described orchid species reported from India between 2015 and 2025. The review involved the systematic collection, evaluation and synthesis of published research from both scholarly and institutional sources. Primary data were obtained from reputable online databases and peer-reviewed scientific journals, with an emphasis on verified taxonomic records. Key databases consulted included IPNI, POWO, Scopus, Web of Science, Springer, PubMed and Google Scholar. Searches were performed using combinations of keywords such as "new to India from Orchidaceae," "new discoveries," "orchids", and restricted to the period 2015–2025. Additional academic and specialised databases, including MDPI, ScienceDirect, SciFinder, Scirus and the Scientific Electronic Library Online (SciELO), were also reviewed. Institutional publications, particularly those produced by the Botanical Survey of India (BSI), were examined to incorporate

authoritative and up-to-date taxonomic information. The literature survey culminated in the compilation of a comprehensive list of newly described orchid taxa from India. Each record was assessed for taxonomic classification, distributional range and distinctive morphological or ecological features. All collected data were critically verified for accuracy, relevance and completeness in accordance with established standards for systematic botanical documentation (Kumar, 2025).

Results and discussion

The results reveal that the majority of newly described orchid taxa in India during the period 2015-2025 were reported from the northeast India, particularly Arunachal Pradesh, Assam, Manipur, Mizoram, Nagaland, Sikkim and Tripura. This pattern reaffirms the region's status as a major centre of orchid diversity within the country. The Western Ghats also contributed several significant discoveries, notably among terrestrial taxa such as *Habenaria agasthyamalaiana* and *Pecteilis korigadensis*. In addition, new records from the Andaman Islands and Odisha emphasise the importance of smaller and geographically isolated regions, which remain comparatively underexplored. Taxa that were later synonymised with previously valid species were excluded from this study (Table 1).

Several newly described species, including *Gastrodia indica*, *Phalaenopsis quadridentata* and *Zeuxine seetharamii*, provide valuable insights into ecological and evolutionary processes such as mycoheterotrophy, pollination biology and micro-endemism. The steady rate of orchid discoveries across India indicates that a considerable number of species likely remain undocumented, underscoring the need for sustained

field exploration, long-term ecological monitoring and the protection of natural habitats.

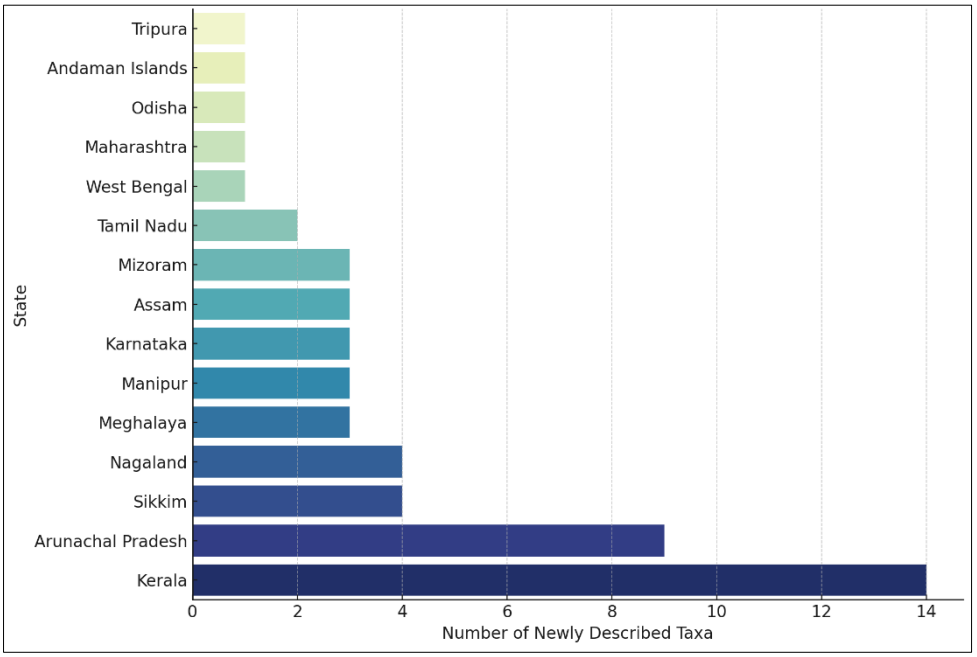


Figure 1: Regional Richness of Newly Described Orchid Taxa in India (2015-2025)

The analysis of newly described orchid taxa from India between 2015 and 2025 revealed that Kerala, with 14 taxa, stands out as the primary hotspot for orchid exploration and description, reflecting the exceptional diversity and continued research activity in the Western Ghats. Arunachal Pradesh, accounting for nine taxa, follows as the most significant centre of orchid richness in northeastern India. A moderate number of discoveries were recorded from Nagaland, Sikkim, Assam, Mizoram, Karnataka, and Meghalaya, each contributing between three and four taxa, highlighting their importance as emerging regions for floristic studies. In contrast, the Andaman Islands, Odisha, Maharashtra, Tripura, and West Bengal reported only a few new records, indicating the need for intensified field surveys and

taxonomic investigations in these comparatively underexplored areas (Figure 1). The integration of molecular barcoding with traditional morphological approaches holds significant promise for enhancing taxonomic resolution, particularly in distinguishing cryptic or morphologically similar species. This integrative framework is critical for accurate species identification, comprehensive biodiversity assessment and the formulation of evidence-based conservation strategies.

Table 1: Newly described taxa of the family Orchidaceae in India (2015–2025)

Botanical name	Year	Place	Reference
Aerides agasthiyamalaiana Karupp. & P.S.S.Rich.	2022	Tamil Nadu	Karuppusamy et al., (2022)
Bulbophyllum gopalianum Sawmliana, K.Gogoi & Kumar	2024	Mizoram	Sawmliana et al., (2024)
Bulbophyllum karbianglongensis K.Gogoi & Hondiqui	2021	Assam	Gogoi and Hondiqui, (2021)
Chamaegastrodia reiekensis Tlanhlui, S.D.Khomdram & S.D.Yumkham	2025	Mizoram	Tlanhlui et al., (2025)
Chiloschista confusa M.J.Mathew, J.Mathew, P.M.Salim & Szlach.	2021	Kerala and Karnataka	Mathew et al., (2021)
Cleisostomopsis salimii (J.Mathew, Hrideek, V.B.Sreek. & K.Madhus.) A.N.Rao ≡ *Seidenfadeniella salimii* J.Mathew, Hrideek, V.B.Sreek. & K.Madhus.	2016	Kerala	Rao, (2020)

Coelogyne fimbriata Lindl. var *burmanensis* Sanjeet Kumar	2019	Manipur	Devi et al., (2019)
Coelogyne tripurensis Adit	2024	Tripura	Adit and Kumar, (2024)
Crepidium assamicum K.Gogoi & Jintu Sarma	2024	Assam	Gogoi and Sarma, (2024)
Crepidium manikathilum (J.Mathew, P.M.Salim & Szlach.) R.Kr.Singh & Sanjeet Kumar ≡ *Seidenfia manikathila* J.Mathew, P.M.Salim & Szlach.	2022	Kerala	Singh and Kumar, (2024)
Crepidium meghalayensis Murug., Sushil K.Singh & A.A.Mao	2016	Meghalaya	Singh et al., (2016)
Cymbidium hengbungense A.N.Rao, Chowlu, H.B.Sharma, K.S.Thithila & D.S.Thokchom	2016	Manipur	Rao et al., (2016)
Cymbidium viride Sanjeet Kumar	2020	Manipur	Devi et al., (2020)
Dendrobium anilii P.M.Salim, J.Mathew & Szlach.	2016	Kerala	Salim et al., (2016)
Dendrobium gopalanii M.Sulaiman & Murugan	2021	Kerala	Sulaiman and Murugan, (2021)
Dendrobium tuensangense Odyuo & C.Deori	2017	Nagaland	Odyuo et al., (2017)
Gastrochilus pseudocalceolaris S.Dey, L.Phom, Av.Bhattacharjee, Moaakum & K.Eshuo	2022	Nagaland	Dey et al., (2022)

Gastrodia indica M.Khanal	2024	Sikkim	Khanal et al., (2024b)
Gastrodia sikkimensis M.Khanal & S.Sarkar	2024	Sikkim	Khanal et al., (2024a)
Habenaria agasthyamalaiana Jalal, Jayanthi & P.Suresh Kumar	2019	Kerala	Jalal et al., (2019)
Habenaria bonaccordensis (K.Prasad, Jalal & Agrawala) R.Kr.Singh, Ch.S.Reddy & Sanjeet Kumar ≡ *Odisha bonaccordensis* K.Prasad, Jalal & Agrawala	2021	Kerala	Singh et al., (2023)
Habenaria keralensis K.Prasad	2019	Kerala	Prasad, (2019)
Habenaria sahyadrica K.M.P.Kumar, Nirmesh, V.B.Sreek. & Kumar	2016	Kerala	Kumar et al., (2016)
Hemipilia pathakiana (Av.Bhattacharjee) R.Kr.Singh & Sanjeet Kumar ≡ *Amitostigma pathakianum* Av.Bhattacharjee	2015	Arunachal Pradesh	Singh & Kumar, (2024)
Liparis sanamalabarica P.M.Salim	2017	Kerala	Salim, (2017)
Liparis tortilis P.M.Salim & J.Mathew	2019	Kerala	Salim et al., (2019)
Luisia diglipurensis Sanjay Mishra & Jalal	2020	Andaman Islands	Mishra et al., (2020)
Luisia megamalaiana Karupp. & V.Ravich.	2019	Tamil Nadu	Karuppusamy and Ravichandran, (2019)
Oberonia bopannae Chowlu & Kumar	2017	Arunachal Pradesh	Chowlu et al., (2017)

Oberonia jhae Chowlu & K.S.Rab	2017	Arunachal Pradesh	Chowlu and Rab, (2017)
Oberonia marnkuliensis Shreyas & Kotresha	2024	Karnataka	Shreyas and Kotresha, (2024)
Oberonia muthikulamensis K.Prasad, K.M.P.Kumar & P.Sudheshna	2018	Kerala	Prasad et al., (2018)
Oberonia similipalensis S.Misra	2021	Odisha	Misra, (2021)
Pecteilis korigadensis Jalal & Jayanthi	2019	Maharashtra	Jalal and Jayanthi, (2019)
Pennilabium labanyaeanum C.Deori, Odyuo & A.A.Mao	2015	Meghalaya	Deori et al., (2015)
Phalaenopsis quadridentata M.Khanal & Kumar	2025	Arunachal Pradesh	Khanal et al., (2025)
Platanthera dambungensis K.Prasad	2023	Sikkim	Prasad, (2023)
Platanthera lachungensis K.Prasad	2023	Sikkim	Prasad, (2023)
Pleione arunachalensis Hareesh, Kumar & M.Sabu	2017	Arunachal Pradesh	Hareesh et al., (2017)
Rhomboda monensis Odyuo, D.K.Roy, Av.Bhattacharjee & Ormerod	2019	Nagaland	Odyuo et al., (2019)
Rhynchostylis cymifera Yohannan, J.Mathew & Szlach.	2018	Kerala	Yohannan et al., (2018)
Schoenorchis mishmensis K.Gogoi, Mega & Chowlu	2022	Arunachal Pradesh	Gogoi et al., (2022)
Spathoglottis arunachalensis Tsering & K.Prasad	2020	Arunachal Pradesh	Tsering and Prasad, (2020)

Stereochilus arunachalensis Chowlu & A.N.Rao	2020	Arunachal Pradesh	Chowlu and Rao, (2020)
Tainia epiphytica S.Sarkar, Agrawala, S.Chakr., D.Maity & Odyuo	2023	Mizoram and Nagaland	Sarkar et al., (2023)
Thrixspermum changlangensis K.Gogoi	2019	Arunachal Pradesh	Gogoi, (2019)
Thrixspermum indicum Vik.Kumar, D.Verma & A.N.Rao	2017	Meghalaya	Kumar et al., (2017)
Thrixspermum patkaiense K.Gogoi	2022	Assam	Gogoi, (2022)
Vanda sathishii Motes	2022	Kerala	Motes, (2022)
Zeuxine seetharamii Betageri & Katrah.	2025	Karnataka	Betageri and Kotresha, (2025)
Zeuxine yonzoneana R.Yonzone	2025	West Bengal	Yonzone, (2025)

Conclusion

India has witnessed a notable surge in orchid discoveries between 2015 and 2025, with over 51 newly described taxa and many new distribution records contributing significantly to the country's floristic diversity. These findings underscore the importance of continuous field exploration, cross-institutional collaboration, and the application of integrative taxonomic approaches. Looking ahead, future research should emphasise biogeographic modelling, ex situ conservation efforts, and public engagement to address the growing threats of habitat loss. Establishing a national orchid database with real-time updates would be an invaluable tool for researchers, conservationists, and

policymakers, supporting more informed decision-making and long-term biodiversity planning.

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but in the green wealth of her healing plants".

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