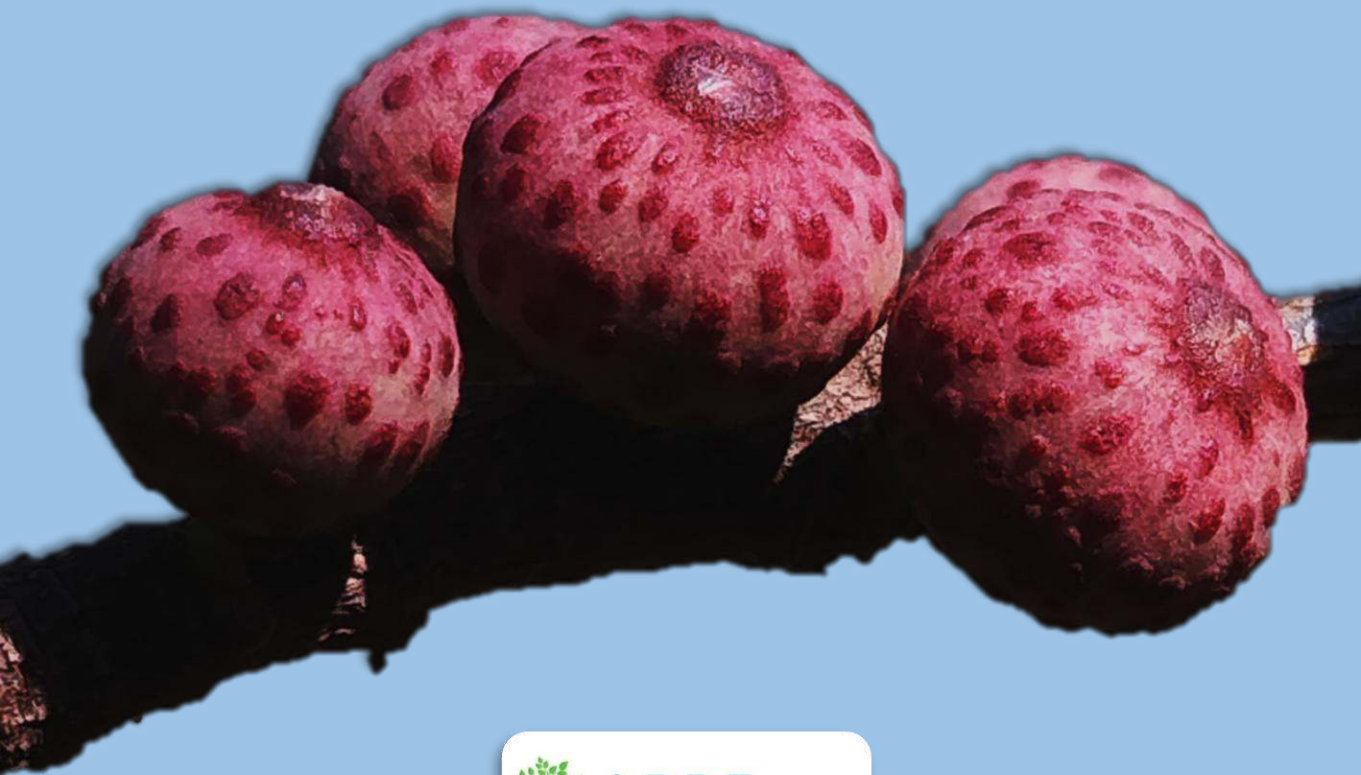


# **BANYAN FAMILY - MEDICINAL, PHARMACOLOGICAL AND ECONOMICAL ASPECTS**

Emdad Hossain  
Sugimani Marndi  
Rahul Kumar  
Sanjeet Kumar





# MEDICINALLY IMPORTANT MORACEAE FAMILY OF INDIA

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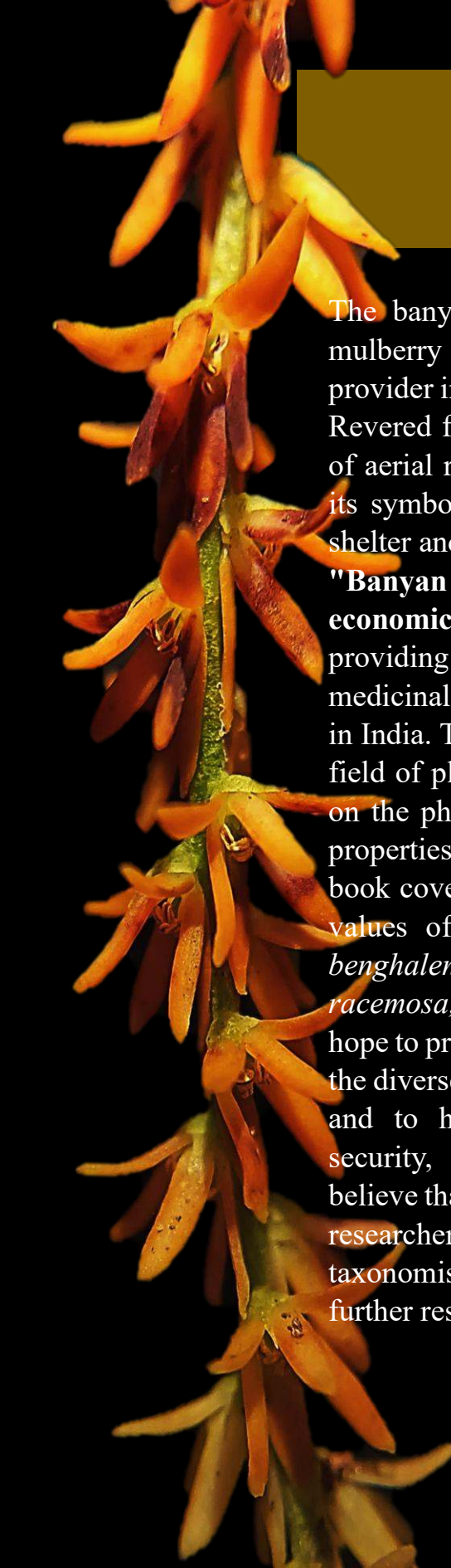
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# PREFACE

The banyan tree, a majestic and iconic member of the mulberry family (Moraceae), is far more than just a shade provider in the tropical and subtropical landscapes it graces. Revered for its expansive canopy, supported by a network of aerial roots that develop into secondary trunks. Beyond its symbolic importance and ecological role in providing shelter and sustenance to various faunal species. This book, **"Banyan family – medicinal, pharmacological and economical aspects"**, aims to bridge this knowledge gap by providing a comprehensive overview of the food and medicinal values of various aspects of banyan family found in India. This volume brings together leading experts in the field of plant botanists to share their research and insights on the phytochemical, pharmacological, and nutraceutical properties of select Rubiaceae family. The chapters in this book cover a range of topics, from the food and medicinal values of wild species like the *Strebulus asper*, *Ficus benghalensis*, *Ficus hispida*, *Ficus concinna*, *Ficus racemosa*, *Ficus benjamina*, etc. Through this book, we hope to promote a greater understanding and appreciation of the diverse range of Moraceae family species found in India and to highlight their potential contributions to food security, healthcare, and sustainable development. We believe that this volume will serve as a valuable resource for researchers, students, and practitioners in the fields of taxonomists, food science, and medicine, and will inspire further research and innovation in the years to come.

(Editors)

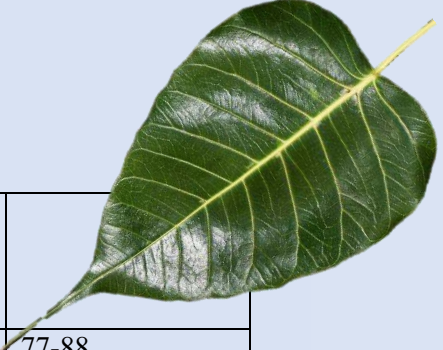
# INTRODUCTION

The Banyan family, comprising various species of *Ficus*, has been an integral part of traditional medicine and cultural practices for centuries. These plants have been revered for their medicinal properties, ecological significance, and economic importance. **"Banyan Family - Medicinal, Pharmacological, and Economical Aspects"** is a comprehensive book that explores the multi-layered world of *Ficus* species, delving into their ethnobotanical relevance, pharmacological potential, and ecological impacts. The book provides 10 chapters with their respective phytochemical, pharmacological and ecological values. The book brings together cutting-edge research and traditional knowledge to shed light on the phytochemical and pharmacological properties of these plants. The chapters cover a range of topics, from the comprehensive analysis of *Streblus asper* to the phytochemical analysis of various *Ficus* species, including *F. benghalensis*, *F. hispida*, *F. racemosa*, and *F. religiosa*. Each chapter provides an in-depth investigation of the bioactive compounds, therapeutic potential, and ecological importance of these plants. *Ficus* species have been used in traditional medicine for various purposes, including wound healing, treating digestive issues, and managing chronic diseases. The pharmacological properties of these plants have been extensively studied, revealing their potential as antioxidant, anti-inflammatory, antimicrobial, and antidiabetic agents. The phytochemical investigation of these plants has identified a range of bioactive compounds, including flavonoids, terpenoids, and phenolic acids, which contribute to their medicinal properties. The ecological significance of *Ficus* species cannot be overstated. These plants play a vital role in maintaining ecosystem balance, providing food and shelter for various animal species, and supporting biodiversity. This book aims to provide a detailed understanding of the Banyan family's potential in modern medicine and agriculture aspects. By exploring the proliferation of traditional knowledge and modern science, this book offers insights into the potential applications of these plants in improving human health and well-being. The book will be a valuable resource for researchers, practitioners, and students in the fields of pharmacology, botany, and traditional medicine. The contributors to this book are experts in their respective fields, and their research has shed new light on the medicinal, pharmacological, and ecological aspects of *Ficus* species. The book's comprehensive approach and in-depth analysis make it an essential resource for anyone interested in the potential of these plants. The book's scope extends beyond the scientific community, as it also explores the cultural significance and traditional uses of *Ficus* species. By documenting the traditional knowledge and practices surrounding these plants, the book aims to preserve the cultural heritage associated with the Banyan family. Overall, **"Banyan Family - Medicinal, Pharmacological, and Economical Aspects"** is a groundbreaking book that highlights the importance of *Ficus* species in modern times. Its comprehensive approach, in-depth analysis, and expert contributions make it an invaluable resource for anyone interested in the potential of these plants to improve human health, support ecosystem balance, and promote sustainable development.

# CONTENT



| Chapters  | Title                                                                                                                                     | Authors                                                                                  | Page Numbers |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|--------------|
| Chapter 1 | Comprehensive analysis of <i>Streblus asper</i> Lour. - ethnobotanical relevance, pharmacological potential, and bark phytochemistry      | Surender Kumar, Sanjeet Kumar and Sugimani Marndi                                        | 1-14         |
| Chapter 2 | <i>Ficus benghalensis</i> L: an ethnobotanical, pharmacological, and ecological analysis with phytochemical investigation of its bark     | Akash Vilas Galande, Sugimani Marndi, Sanjeet Kumar and Surender Kumar                   | 15-29        |
| Chapter 3 | Investigating the bioactive compounds and the therapeutic potential of <i>Ficus hispida</i> L.f.                                          | Bhagwati Prashad Sharma, Sanjeet Kumar, Sugimani Marndi and Ranjana Singh                | 30-44        |
| Chapter 4 | Phytochemical & pharmacological profiling of <i>Ficus racemosa</i> bark: an integrated study of its ethnobotany and ecological importance | Emdad Hossain, Mithlesh Kumar Sinha, Gireesh Tripathi, Sanjeet Kumar and Sugimani Marndi | 45-62        |
| Chapter 5 | <i>Ficus benjamina</i> L. (Moraceae): comprehensive analysis of phytochemical, pharmacological                                            | J Jeline Rani, Swati Celia Topno, Sanjeet Kumar, Murugan Muthukumar,                     | 63-76        |



|            |                                                                                                                                               |                                                                                                       |         |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|---------|
|            | activities and ecological impacts                                                                                                             | Sachin Somalal Choudhari and Sugimani Marndi                                                          |         |
| Chapter 6  | Exploring pharmacological properties of bark of <i>Ficus drupacea</i> Thunb.: - a phytochemical investigation                                 | Saraswati Majhi, Prasanta Kumar Samantray, Sanjeet Kumar and Sugimani Marndi                          | 77-88   |
| Chapter 7  | Bark of <i>Ficus amplissima</i> Sm.: - identification of novel bioactive compounds and their therapeutic implications                         | Gireesh Tripathi, Namrata Sharma, Shikha Thakur, Bidhan ChandraRoy, Sanjeet Kumar and Sugimani Marndi | 89-102  |
| Chapter 8  | The medicinal and ecological value of <i>Ficus concinna</i> : - a comprehensive analysis of its ethnobotany, pharmacology, and phytochemistry | Emdad Hossain, Sanjeet Kumar, Sugimani Marndi and Akshay Gajanan Thakare                              | 103-118 |
| Chapter 9  | Exploring the pharmacological properties of <i>Ficus religiosa</i> : a phytochemical investigation                                            | Anjali Arya, Sanjeet Kumar and Sugimani Marndi                                                        | 119-134 |
| Chapter 10 | <i>Ficus tinctoria</i> : analysis of bioactive compounds and their pharmacological potential with smattering of ecological factors            | A. Maajitha Begam, Agamani Pattanayak, Sanjeet Kumar, and Sugimani Marndi                             | 135-150 |



# CHAPTER 1

## Comprehensive Analysis of *Streblus asper* Lour.- Ethnobotanical Relevance, Pharmacological Potential, and Bark Phytochemistry

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**Abstract:** *Streblus asper* Lour., commonly known as the “Sand paper tree” or “Siamese rough-brush tree”, holds significant ethnobotanical, pharmacological, and ecological importance. Ayurvedic and local medicinal practices, traditionally utilize it for dental hygiene, skin ailments, and gastrointestinal disorders. The plant exhibits diverse pharmacological activities. Phytochemical investigation reveals the presence of cardiac glycosides, flavonoids, tannins, and saponins in the bark, contributing to its antimicrobial, anti-inflammatory, antioxidant, anticancer, and antidiabetic properties. Present chapter summarizes the current understanding of *S. asper*, particularly emphasizing the bark’s chemical constituents and their therapeutic potential. This chapter aims to provide a phytochemical analysis of the bark of *S. asper*, which is a crucial source of bioactive compounds.

**Keywords:** Ethnomedicinal, ecological, pharmacological, bioactive compounds

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## INTRODUCTION

According to POWO (Plants of the World Online), about 880 accepted *Ficus* species were recorded (**POWO, 2025**). *Ficus* was originally split into several genera in the mid-1800s, providing the basis for a subgeneric classification when reunited into one genus in 1867. Corner (**1965**) reorganized the genus based on the breeding system, uniting four dioecious subgenera into a single dioecious subgenus, *Ficus*. Monoecious figs were classified within the subgenera *Urostigma*, *Pharmacosycea* and *Sycomorus*. (**Corner, 1965; Weiblen, 2000**). The first systematic account of the Indian *Ficus*, composed of 113 species and 47 infraspecific taxa across British India. Of these, only 75 species and 16 infraspecific taxa were reported from India. More recently, based on morphological features and distributional patterns, the genus has been reclassified into six genera, 19 sections, and 27 subsections (**Lepcha and Sharma, 2021**). The genus *Streblus*, a captivating member of the 'Fig' family (Moraceae), encompasses approximately 25 species distributed primarily throughout tropical and subtropical Asia (**Singh et al., 2012**). In China, the genus is represented by seven species, viz., *S. taxoides* (Roth) Kurz, *S. tonkinensis* (Dubard & Eberhardt) Corner, *S. asper* Lour., *S. indicus* (Bureau) Corner, *S. zeylanicus* (Thwaites) Kurz, *S. ilicifolius* (S. Vidal) Corner and *S. macrophyllus* Blume (**Singh et al., 2012**). In India, the genus is represented by five species (**Roy et al., 2013**). *S. asper* Lour., *S. ilicifolius* (S. Vidal) Corner, *S. indicus* (Bureau) Corner, *S. taxoides* (Roth) Kurz, and *S. zeylanicus* (Thwaites) Kurz. Some literature reviews indicate that four *Streblus* species have been recorded from Northeast India; *S. asper*, which is distributed throughout the regions; *S. ilicifolius*, found in Mizoram; *S. indicus*, occurring in Assam and Meghalaya; and *S. zeylanicus*, reported from Assam (**Roy et al., 2013**). *Streblus asper* Lour., a member of the Moraceae family, stands as a plant of significant historical and contemporary relevance, particularly within the traditional medicinal systems of South and Southeast Asia. Commonly known as the “Sand paper tree or Siamese rough -brush tree”, this species has been employed for centuries in ethnobotanical practices, addressing a diverse spectrum of ailments. Flowering occurs January to March, and fruiting April to May (**Figure 1**). It is distributed in several countries throughout India, Sri Lanka, Thailand, China, Malaysia, Philippines and Vietnam. In India, it is found in Assam, Andaman Islands, Maharashtra, Odisha, Tamil Nadu, and Uttar Pradesh (**Sen and Behera, 2024**). It is small to medium-sized evergreen tree. It typically grows to a



height of 6 to 10 meters (**Figure 2**). Its widespread use in traditional medicine has spurred scientific interest in its pharmacological potential, leading to investigations into its chemical constituents. Among the various parts of the plant, the bark has emerged as a particularly valuable source of bioactive compounds. Apart from the medicinal value, it possesses cultural values, as it is recognized as ‘Sthalavriksha’ or sacred plant in Tamil Nadu (**Sen and Behera, 2024**).

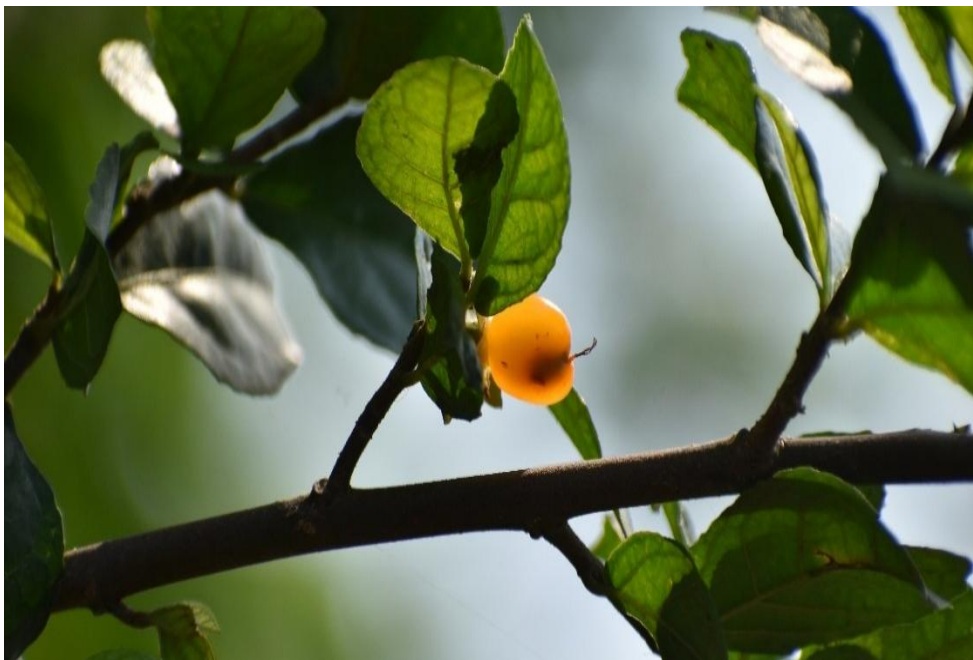


**Figure 1:** Flowers of *S. asper* in natural habitat

The root and bark of *S. asper* possess rich compounds such as cardiac glycosides, kamloside, asperoside, strebloside, indroside, canno-dimemoside, strophalloside, strophanolloside, 16-O-acetyl-glucogitomethoside, glucogitodimethoside, glucokamloside, sarmethoside and glucostrebloside. Many researchers reported the presence of phytoconstituents in roots like  $\beta$ -sitosterol 3-O-  $\beta$ -D-arabinofuranosyl-O- $\alpha$ -L-rhamnopyranosyl-O- $\beta$ -D-glucopyranoside, lupanol-3-O- $\beta$ -D-glucopyranosyl- [1 $\rightarrow$ 5]-O- $\beta$ -D-xylofuranoside and vijaloside, i.e., periplogenin 3-O- $\beta$ -D-xylopyranosyl-(1 $\rightarrow$ 5)- $\beta$ -D-glucopyranoside. The roots also contain lupeololeate, sterblusteryl palmitate, lupeollinoleate, cerotic acid, stigmasterol palmitate, and octacosanoic acid (**Aeri et al., 2015**).



**Figure 2:** Habit and leaves of *S. asper*



**Figure 3:** Fruit of *S. asper*

This chapter focuses on comprehensive exploration of the ethnomedicinal, pharmacological and ecological significance of *S. asper*, with a focused investigation of the phytochemical profile of its bark. Present study highlights the therapeutic potential of the bark's constituents and their contributions to the plant's overall medicinal efficacy, while also acknowledging the ecological role of this important plant.

### **MORPHOLOGY**

It is a rigid, much branched shrub or small tree having rough, stringy, and light grey bark. Leaves are very shortly petiolated, obovate or rhombic-elliptic, obscurely toothed, acute, subacute or acuminate, stiff, scabrid on both sides, secondary nerves 7-9, nervules raised beneath. Petiole length is 2-3mm. Stipules are 2.5 mm long. Male heads are 5.9-7.3 mm in diameter. Bracts are very small, ovate, under 1.2 mm long and outer bracts are involucrate. Flower peduncles are 7.5-10 mm in length. Tepals are free but closely wrapping round the ovary. Length of style 1.8 mm, excluding the 7.5 mm long arms. Fruits are yellow, succulent, globose, 3.7 mm in diameter. (Saxena and Brahmam, 1995; Figures 3).



BIOCHEMICAL ASPECTS

Mostly, the frugivorous avifaunal species consume the tender flowers and ripen fruits. Since all parts of *S. asper* shows medicinal values including its bark. Tannin, phenol, reducing sugars and alkaloids are present in hydro-ethanolic extracts of the bark of *S. asper* (**Table 1; Figures 4-5; Jena et al., 2025**).

**Table 1:** Phytochemical screening using different extracts of *S. asper* bark

| Bioactive compounds | Hydro-ethanolic extract |
|---------------------|-------------------------|
| Tannin              | +                       |
| Saponin             | -                       |
| Flavonoid           | -                       |
| Terpenoids          | -                       |
| Phenols             | +                       |
| Reducing sugars     | +                       |
| Steroids            | -                       |
| Alkaloids           | +                       |

(+ve – Positive; -ve – Negative)

The people of tribal communities of south-eastern states like Odisha and Andhra Pradesh use the plant parts of *S. asper* for medicinal purposes, as the leaves are used to treat injuries and wounds. For some avifaunal species, it is also one of the sources of food. There are many biologically active constituents in *S. asper*. Structural details of some constituents are given ahead (**Figure 6**). The presence of tannin may be responsible for astringent effects, anti-inflammation activity, antidiarrheal activity, hemostatic activity, antioxidant activity, antimicrobial activity, and anti-ageing (**Makkar et al., 1987; Cosme et al., 2025; Lin et al., 2001; Czerkas et al., 2024**). Phenols can exhibit antioxidant, anti-inflammatory, antimicrobial, antidiabetic, anticancer activity and neuroprotective effects (**Platzer et al., 2022; Kauffmann and Castro, 2023; Chimento et al., 2023; Williamson and Sheedy, 2020**).



**Figure 4:** Bark of *S. asper* for phytochemical analysis



**Figure 5:** Screening of secondary metabolites using hydro-ethanolic extract

Alkaloids may be responsible for analgesic, antibacterial, antimalarial, and anticancer effects (Heinrich et al., 2021; Dey et al., 2020). Other researchers have also reported the medicinal uses of this plant. Bark, leaves and roots are considered for treating different diseases such as toothache, diabetes, dysentery, piles, ulcers, and fever. Decoction, infusion, paste, and powder is



made available utilizing different plant parts like bark of stem, seeds, leaves, roots etc. (**Table 2**).

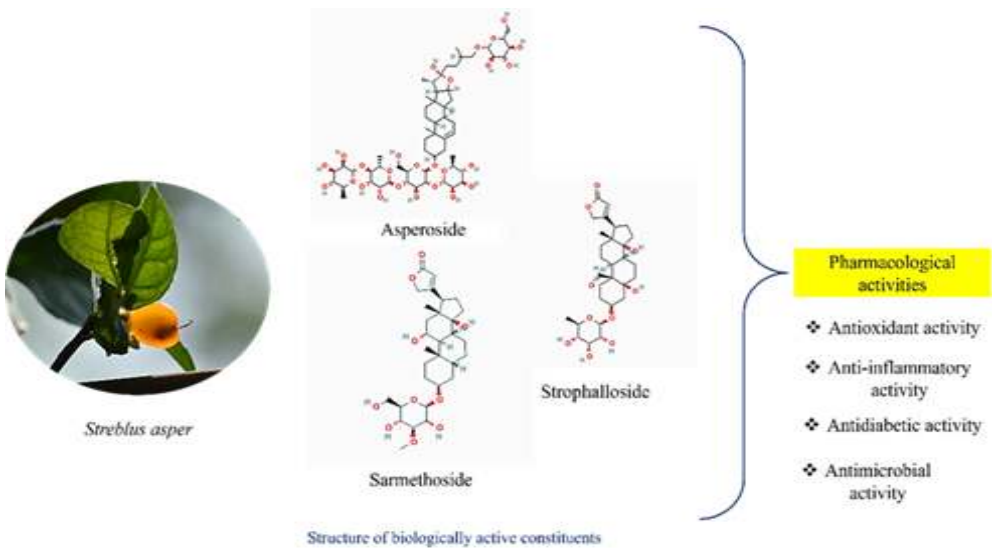
**Table 2:** Ethnomedicinal uses of *S. asper*

| Plant parts   | Mode of uses | Diseases                   | Sources                                                 |
|---------------|--------------|----------------------------|---------------------------------------------------------|
| Bark and stem | Powder       | Toothache                  | Pandey and Rastogi, (2022); Aeri et al., (2015)         |
| Bark          | Infusion     | Digestive system disorders | Pandey and Rastogi, (2022)                              |
| Bark          | Paste        | Acne                       | Sen and Behera, (2024)                                  |
| Leaves        | Decoction    | Diabetes                   | Pandey and Rastogi, (2022); Rahman et al., (2021)       |
| Leaves        | Juice        | Dysentery                  | Pandey and Rastogi, (2022); Kumar and Saravanan, (2022) |
| Leaves        | Decoction    | Piles                      | Sen and Behera, (2024)                                  |
| Root          | Juice        | Ulcers                     | Rastogi et al., (2006)                                  |
| Root          | Juice        | Fever                      | Pandey and Rastogi, (2022)                              |
| Root          | Paste        | Menorrhoea                 | Sen and Behera, (2024); Neekhra et al., (2017)          |
| Seed          | Powder       | Ringworm                   | Sen and Behera, (2024)                                  |



|      |           |              |                        |
|------|-----------|--------------|------------------------|
| Stem | Decoction | Constipation | Sen and Behera, (2024) |
|------|-----------|--------------|------------------------|

Traditional uses are being investigated by modern science, with studies showing potential for antimicrobial, anti-inflammatory, antioxidant, anticancer and other pharmacological activities. Literature data, concludes that photochemical constituents of leaves, bark, and stems possess various pharmacological activities (**Table 3**).



**Figure 6:** Structure of biologically active constituents in *S. asper*

**Table 3:** Pharmacological values of *S. asper*

| Plants parts | Pharmacological values     | Sources                                            |
|--------------|----------------------------|----------------------------------------------------|
| Leaves       | Antioxidant activity       | Pandey and Rastogi, (2022)                         |
| Leaves       | Anti-inflammation activity | Pandey and Rastogi, (2022)                         |
| Leaves       | Antimicrobial activity     | Pandey and Rastogi, (2022); Rastogi et al., (2006) |



|                             |                       |                                                 |
|-----------------------------|-----------------------|-------------------------------------------------|
| Leaves, stem, bark and root | Antidiabetic activity | Pandey and Rastogi, (2022)                      |
| Root bark                   | Cardiotonic activity  | Neekhra et al., (2017); Madhavan et al., (2009) |
| Stem bark                   | Anticancer activity   | Rastogi et al., (2006)                          |
| Stem bark                   | Antifilarial activity | Neekhra et al., (2017)                          |



**Figure 7:** Ecological services of *S. asper* many bird's species consume the flowers and fruits

### ECOLOGICAL FACTORS

*S. asper* plays an important role in the form of biotic factor for ecological balance (**Figure 7**). At the time of the flowering and fruiting period, in the months of January to March and April to May, many frugivorous birds remain active. The fruits are consumed by various birds (e.g., Bulbuls, Mynas) which



act as important agencies of seed dispersal for this plant species. Apart from birds, other small animals also consume fruits and seeds and help in seeds dispersal (**Aruna and Balasubramanian, 2014**).

## CONCLUSION

*Streblus asper*, a wild edible fruiting plant, has been found to possess significant medicinal, pharmacological, and ecological importance. Present chapter highlights the bioactive compounds especially present in its bark. Various aspects of *S. asper* provide valuable insights into its food, medicinal, and ecological uses, emphasizing the need for advanced research and conservation efforts to harness its potential.

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## CHAPTER 2

### ***Ficus benghalensis* L: an ethnobotanical, pharmacological, and ecological analysis with phytochemical investigation of its bark**

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**Abstract:** *Ficus benghalensis* Linn., popularly known as the banyan tree, is a prominent species belonging to the Moraceae family, deeply rooted in the ethnomedicinal practices of various cultures worldwide. The present chapter comprehensively covers the traditional uses, pharmacological properties, and ecological significance of *F. benghalensis*, with a particular focus on the phytochemical analysis of its bark. Whole plant parts possess a wide array of ethnomedicinal uses, including diabetes, inflammation, diarrhea, dysentery, skin diseases and hemorrhoids. The chapter aims to provide a phytochemical perspective of the bark besides other parts of *F. benghalensis*, which is a vital source of bioactive compounds.

**Keywords:** Bark, bio-active compounds, traditional, pharmacological



## INTRODUCTION

The natural world has long served as an invaluable reservoir of therapeutic agents, with traditional medicine arrangements offering profound insights into the curative potential of various flora. *Ficus* is one of the largest genera in the plant kingdom that belongs to the Moraceae family. *Ficus* is a genus of about 1,400 species of woody trees, shrubs, vines, epiphytes and hemi epiphytes in the family Moraceae (Weiblen, 2000; Singh et al., 2023; POWO, 2025). They are popularly known as fig trees or figs. *Ficus* species are among the most popular houseplants in the form of bonsai (Mewar et al., 2020). *Ficus carica* is believed to be one of the first plants cultivated by humans. Several fossils were discovered that date back to 9400 BC (Barolo et al., 2014).

Many species of *Ficus* serve in diverse forms for various purposes to mankind and ecosystem. Some are valued as ornamental plants, such as the fiddle-leaf fig (*Ficus lyrata*). Others are cultivated for their edible fruits, like the edible fig (*Ficus carica*). There are many prominent species within the genus which include banyan fig (*Ficus benghalensis*); Roxburgh fig (*Ficus auriculata*); sacred fig (*Ficus religiosa*); rubber fig (*Ficus elastica*); weeping fig (*Ficus benjamina*) (Patel and Gautam, 2014; Singh et al., 2023). Among these, *Ficus benghalensis* Linn, commonly known as the Banyan tree which belongs to the Moraceae family, stands as an iconic species, not only for its immense ecological significance and cultural reverence across the Indian subcontinent, but also for its extensive history of medicinal use (Patel and Gautam, 2014). *Ficus benghalensis* (syn. *Urostigma benghalense*) also holds an important role in the cultural significance of India and other parts of south and southeast Asia (POWO, 2025). Its sprawling growth, longevity, and unique aerial roots have fostered a rich tapestry of symbolism, religious beliefs, traditional practices, and community life. The tree is deeply revered in Hinduism, often regarded as the "Tree of Life" or "Kalpavriksha," meaning the "wish-fulfilling tree." It is believed to be the abode of the Hindu trinity. It depicts Lord Vishnu, Brahma, and the Shiva. Vishnu is believed to have the bark, Brahma, the roots and Shiva the branches (Gopukumar and Praseetha, 2015).

Revered in ancient Ayurvedic, Siddha, and Unani traditions for millennia, virtually every part of the Banyan tree – from its bark and leaves to its aerial roots, fruits, and latex has been active in treating a remarkably diverse array



of human ailments, including diabetes, inflammatory diseases, diarrhea, skin disorders, dysentery, fever, ulcers, and various infectious diseases (Murugesu et al., 2021; Singh et al., 2023). Despite this rich ethnomedicinal heritage and compelling anecdotal evidence, a comprehensive scientific understanding of its underlying therapeutic mechanisms and bioactive constituents remains an area of ongoing investigation.

For many years, many researchers have worked on its aspects to find bioactive compounds. Stem bark consists of anthocyanidin derivatives (methyl ethers of leucodelphinidin-3-O-L-rhamnoside, leucopelargonidin-3-O-L-rhamnoside, Lecocyanidin-3-O-D-galactosylcellobioside) and aliphatic long chain ketones (pentatriacontan-5-one, tetratriacont-20-en-2-one, heptatriacont-6-en-10-one), besides beta-sitosterol glucoside and mesoinositol. Bark consists of Leucodelphinidin derivative and bengalenoside such as Aglucoside, Leucopelargonin derivative, leucocynidin derivative, glycoside of leucopelargonid. Leaves contain quercetin-3-galactoside, rutin, friedelin, taraxosterol, lupeol,  $\beta$ -amyrin along with psoralen, bergapten and  $\beta$ -sisterol (Chaudhary et al., 2015; Gopukumar and Praseetha, 2015; Gopukumar et al., 2016; Singh et al., 2023).

This chapter aims to provide a comprehensive analysis of *F. benghalensis*, integrating its deeply rooted ethnomedicinal claims with modern pharmacological validations, its critical ecological role, and a detailed phytochemical investigation of its bark, ultimately highlighting its potential as a source for novel phyto-therapeutics and emphasizing the imperative for its sustainability and conservation.

## MORPHOLOGY

Banyan tree (*F. benghalensis* L.) is a large, long lived, having height up to 20-30 meters. This species is some time epiphytic when young. It has a broad foliage crown of horizontal branches covering up to 100 meters area. The trunk is massive, fluted and branched. Branches bear aerial roots which move downward and transform into prop roots or accessory trunks for mechanical support. Young bark is grey, softly puberulous and old bark is dark brown, sometime having rhytidomes. Leaves are large, broad and stoutly petiolated. Lamina is ovate to elliptic, 10-17x 7-12 cm, coriaceous, 3-5 nerved, secondary nerves 5-9 above the basal ones, looping close to margin and united by numerous close tertiaries and reticulate nervules which are not



raised. Lamina is glabrous on the upper surface and finely pubescent beneath. Petiole is 1.8-4.3 cm long, glandular or mostly with a large, flat, smooth gland beneath near the confluence of the main nerves. Stipules are 1.8-2.5 cm long. Syconia are sessile, in pairs, globose or sub-globose, 1.2-1.8 cm in diameter, scarlet in colour when ripened, puberulous, with 2-4 obtuse bracts at the base. Most important thing is cross pollination by insects in special way (**Saxenna and Brahmam, 1995; Figure 1-3**).



**Figure 1:** Leaves of *F. benghalensis*



**Figure 2:** Syconium (fruits) of *F. benghalensis*



### PHYTOCONSTITUENTS

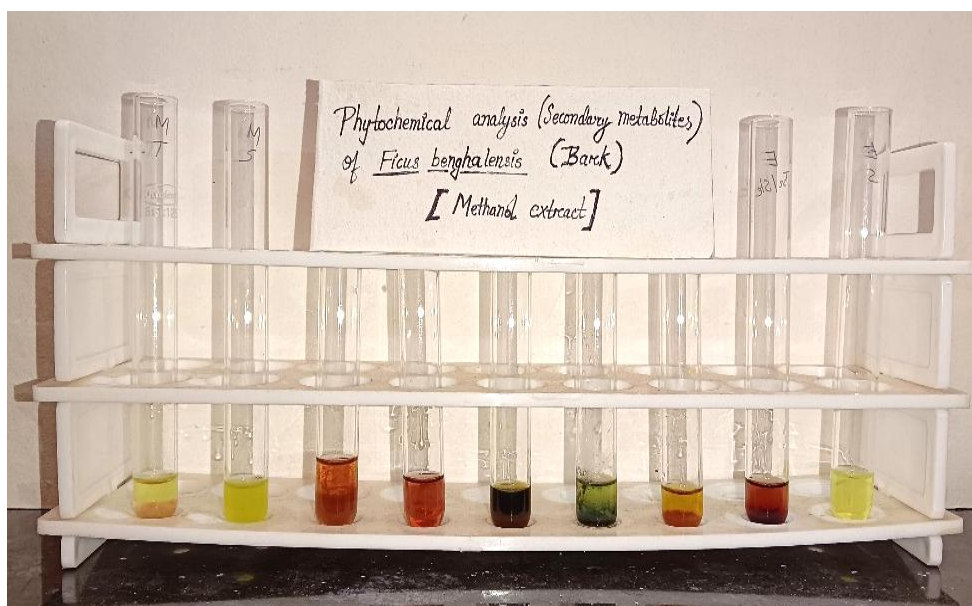
In many states, tribal communities consume the ripened fruits. According to published literature, it can be concluded that all parts of *F. benghalensis* have medicinal properties and bio active compounds (Table 1; Figure 4-6). Many studies conclude that some bioactive compounds are also present in bark, including reducing sugars, tannin, terpenoids, and phenolic compounds. Many avifaunal species relish ripened fruits as these fruits are also one of the sources of food for these avifaunal species.

**Table 1:** Phytochemical screening using different extracts of *F. benghalensis* bark

| Bioactive compounds | N- hexane | Ethanol | Methanol |
|---------------------|-----------|---------|----------|
| Tannin              | -         | +       | +        |
| Saponin             | -         | -       | -        |
| Flavonoid           | -         | -       | -        |
| Terpenoids          | +         | -       | -        |
| Phenolic compounds  | -         | +       | +        |
| Reducing sugars     | +         | +       | +        |
| Steroids            | -         | -       | -        |
| Alkaloids           | -         | +       | +        |
| Carbonyl compounds  | -         | -       | -        |



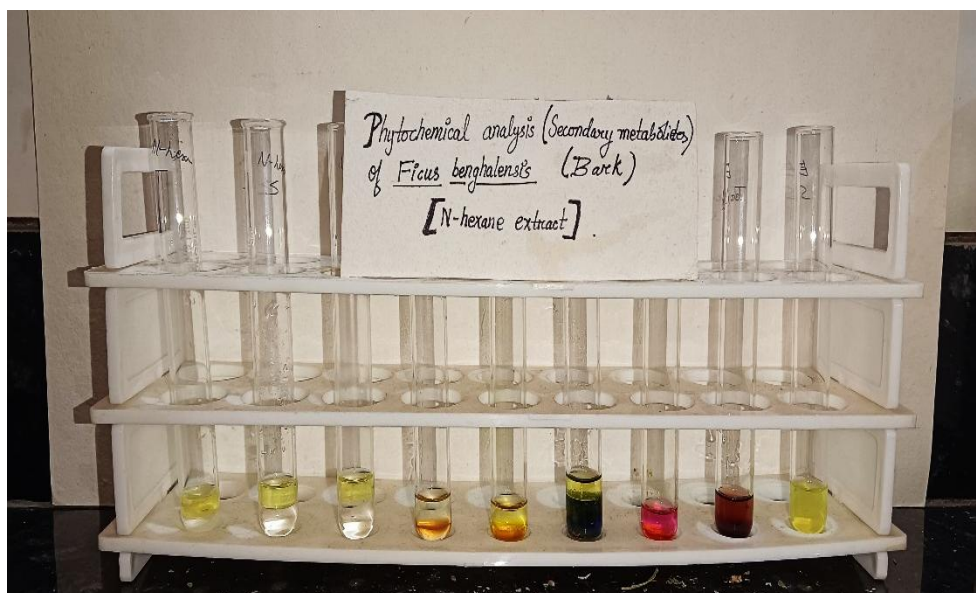
**Figure 3:** Bark of *F. benghalensis*



**Figure 4:** Phytochemical analysis (Secondary metabolites) of *F. benghalensis* (Bark) of ethanol extract



**Figure 5:** Phytochemical analysis (Secondary metabolites) of *F. benghalensis* (Bark) of ethanol extract



**Figure 6:** Phytochemical analysis (Secondary metabolites) of *F. benghalensis* (Bark) of n- hexane extract



## ETHNOMEDICINAL USES

*F. benghalensis* has remarkable medicinal properties for treatment of multiple diseases. The ripened fruits of *F. benghalensis* are consumed in raw form by local people as a source of tonic (Figure 7). It is believed that latex is used for wound healing. Further, most of the plant parts such as leaves, bark, aerial roots, fruits and latex are used to treat piles, fever, rheumatism, inflammation, and wound healing (Table 2).

**Table 2:** Ethnomedicinal uses of *F. benghalensis*

| Parts used           | Mode of uses | Diseases              | Source                                             |
|----------------------|--------------|-----------------------|----------------------------------------------------|
| Aerial root          | Decoction    | Bleeding piles        | Chaudhary et al., (2015)                           |
| Aerial root          | Decoction    | Jaundice              | Singh et al., (2023)                               |
| Aerial root and leaf | Decoction    | Fever                 | Chaudhary et al., (2015)                           |
| Bark                 | Decoction    | Dysentery             | Chaudhary et al., (2015); Patel and Gautam, (2014) |
| Buds and fruits      | Decoction    | Biliary complications | Singh et al., (2023)                               |
| Latex                | Decoction    | Rheumatism            | Chaudhary et al., (2015)                           |
| Latex                | Paste        | Ulcer                 | Khaliq, (2017)                                     |
| Latex                | Decoction    | Urogenital disorders  | Murugesu et al., (2021)                            |
| Leaves               | Paste        | Wound healing         | Chaudhary et al., (2015)                           |
| Leaves               | Decoction    | Leucorrhoea           | Murugesu et al., (2021)                            |
| Milky sap            | Paste        | Joint pain            | Singh et al., (2023)                               |
| Ripen fruit          | Raw          | Immunity              | Present study                                      |
| Root                 | Decoction    | Vomiting              | Chaudhary et al., (2015)                           |
| Stem bark            | Infusion     | Diarrhoea             | Singh et al., (2023)                               |
| Young stem           | Raw          | Toothache             | Khaliq, (2017)                                     |



**Figure 7:** Tribal lady eating ripens fruit of *F. benghalensis*



### PHARMACOLOGICAL ASPECTS

Pharmacological studies have corroborated many of these traditional claims, demonstrating its antidiabetic, anti-inflammatory, antioxidant, antimicrobial, anticancer, and wound healing activities. Various parts of *F. benghalensis* (including roots, bark, leaves and fruits) seem to possess varied pharmacological activities, such as anti-diarrheal, anti-tumour, anti-allergic, anti-fungal, anti-pyretic, and antioxidant activities (**Table 3**).

**Table 3:** Pharmacological activities of *F. benghalensis*

| Parts used  | Pharmacological values                          | Sources                                           |
|-------------|-------------------------------------------------|---------------------------------------------------|
| Roots       | Antidiarrheal activity                          | Tripathi and Sharma, (2016)                       |
| Stem bark   | Antidiabetic activity                           | Khaliq, (2017); Dhungana et al., (2012)           |
| Fruit       | Anti-tumour activity                            | Tahir et al., (2023)                              |
| Bark        | Anti-allergic activity and anti-stress activity | Chaudhary et al., (2015)                          |
| Aerial root | Anti- fungal activity                           | Gopukumar and Praseetha, (2015)                   |
| Root        | Antipyretic activity                            | Dhungana et al., (2012)                           |
| Latex       | Antioxidant activity                            | Yadav et al., (2011)                              |
| Aerial root | Immunomodulatory activity                       | Tripathi et al., (2015); Chaudhary et al., (2015) |
| Latex       | Anti-inflammatory activity                      | Tripathi et al., (2015)                           |
| Bark        | Antiatherogenic activity                        | Tripathi et al., (2015)                           |



|                      |                            |                                                      |
|----------------------|----------------------------|------------------------------------------------------|
| Aerial part and root | Anti-angiogenesis activity | Tahir et al., (2023)                                 |
| Stem bark            | Analgesic activity         | Tripathi and Sharma, (2016); Dhungana et al., (2012) |
| Fruit                | Antibacterial activity     | Dhungana et al., (2012)                              |
| Bark                 | Antinociceptive            | Rajdev et al., (2018)                                |

## ECOLOGICAL FACTORS

Beyond its profound cultural significance and recognized medicinal properties, *F. benghalensis*, the venerable Banyan tree, holds a pivotal role within diverse ecosystems across its native range. As a keystone species in many tropical and subtropical forests, its ecological contributions extend far beyond its imposing canopy, influencing biodiversity, nutrient cycling, and community structure. Ecologically, *F. benghalensis* plays a crucial role as a bedrock species, supporting diverse faunal communities and contributing significantly to biodiversity stability. Various parts of this plant are consumed by monkeys and many species of birds (**Gopukumar and Praseetha, 2015**). For many avifaunal species, it is a shelter (**Figure 8**). The unique growth habit as a hemi-epiphyte, its critical function as a prolific producer of figs that serve as a year-round food source for a wide array of frugivores, its complex obligate mutualism with fig wasps for pollination, and its role in providing habitat and support for numerous plant and animal species, makes this plant an ecologically important keystone species (**Noort, 2003; Kjellberg et al., 2022**). Understanding the intricate ecological dynamics orchestrated by *F. benghalensis* is important in natural landscapes but also for informing conservation strategies that acknowledge its vital contribution to ecosystem health and resilience, especially in the face of ongoing environmental changes.



**Figure 8:** *F. benghalensis* is a home for many avifaunal species

## CONCLUSION

*Ficus benghalensis* has a rich ethnomedicinal legacy, deeply embedded in ancient traditional knowledge, is increasingly validated by modern pharmacological investigations demonstrating a wide spectrum of bioactivities, including significant antioxidant, anti-inflammatory, antidiabetic, antimicrobial, and anticancer properties. These therapeutic potentials are strongly correlated with the diverse array of phytochemicals, particularly within its bark, such as reducing sugars, phenolic compounds, and tannins. Beyond its direct utility to human health, the Banyan tree plays a critical ecological role as a keystone species, supporting biodiversity through its unique growth habits, providing essential sustenance for frugivores, and engaging in intricate mutualistic relationships. The confluence of its established traditional efficacy, scientifically supported pharmacological actions, identified bioactive compounds, and vital ecological contributions firmly positions *Ficus benghalensis* as a valuable species for further research and sustainable utilization. Future work should focus on isolating specific lead compounds, elucidating precise mechanisms of action, conducting rigorous clinical trials, and developing conservation



strategies to ensure this remarkable species continues to benefit both human well-being and the ecosystem.

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## CHAPTER 3

### Investigating the bioactive compounds and the therapeutic potential of *Ficus hispida* L.f.

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**Abstract:** *Ficus hispida*, a species of fig tree group, is widely utilized in traditional medicine for its diverse therapeutic applications. This chapter summarizes investigations into its bioactive compounds and their associated therapeutic potential. Phytochemical analyses revealed that *F. hispida* is rich with diverse secondary metabolites. These compounds collectively contribute to a broad spectrum of pharmacological activities. Literature studies have also reported its significant hepatoprotective, antioxidant, and anti-inflammatory properties, validating its traditional uses for liver ailments and inflammatory conditions. The chapter aims to provide an ethnomedicinal, pharmacological and phytochemical analysis of the bark of *F. hispida*. The wealth of bioactive compounds underscores its considerable therapeutic potential, warranting further research to elucidate specific mechanisms and develop evidence-based phytomedicines.

**Keywords:** Active compounds, ecosystem, pharmacological, indigenous



## INTRODUCTION

The escalating global demand for natural product-derived pharmaceuticals has invigorated research into traditional medicinal plants, which serve as invaluable reservoir of novel bioactive compounds. Among these, *Ficus hispida* L.f., commonly known as the "Hairy Fig", belong to family Moraceae. Name *F. hispida* is derived from the Latin word Fik-us for "Fig" and Hiss-pih- duh for "with bristly hairs". It is commonly known as devil fig, hairy fig. In India, it is recognised by different names in Odia and "Dimri or baidimri", hindi as "gobla, kagsha, kala umbar belonging to the Moraceae family, stands out as a prominent species with a rich history of ethnomedicinal use (Ali and Chaudhary, 2010). *Ficus hispida* linn. Synonymed as *Covellia hispida* (L.f.) Miq., *Gonosuke hispida* (L.f) Raf., *Ficus glomerata* Roxb. (POWO, 2025). Distributed across tropical and subtropical regions of Asia, including India, China, and Australia, this moderate-sized tree is deeply embedded in various traditional healthcare practices, notably Ayurveda, Siddha, and Unani medicine. Its fruiting period is November to July. It is found commonly in waste lands near roadsides areas. Historically, different parts of *F. hispida*, including its leaves, fruits, bark, and roots, have been employed by indigenous communities and traditional practitioners to treat a wide array of ailments. These traditional applications span conditions such as inflammatory disorders, liver dysfunctions (e.g., jaundice, hepatitis), gastrointestinal complaints (e.g., diarrhea, dysentery, ulcers), skin diseases (e.g., psoriasis, vitiligo), anemia, diabetes, and even as an anti-hemorrhagic and lactagogue. According to some literature fruits of *F. hispida* are considered as emetic, demulcent, laxative, purgative and lactagogue properties and is used for jaundice, oedema, anaemia, leucoderma, antihemorrhagic and vitiligo. (Ramasamy et al., 2011; Shrikumar et al., 2024).

The widespread and diverse therapeutic claims associated with *F. hispida* strongly suggest the presence of a complex array of biologically active chemical constituents. In recent decades, scientific scrutiny has increasingly focused on *F. hispida* to validate its traditional uses and to explore its therapeutic potential through modern pharmacological approaches. Comprehensive phytochemical investigations have revealed a rich profile of secondary metabolites, including alkaloids, terpenoids, flavonoids, phenols, and sterols. Leaves and root contains leanolic acid, bergapten,  $\beta$ -sitosterol,  $\beta$ -



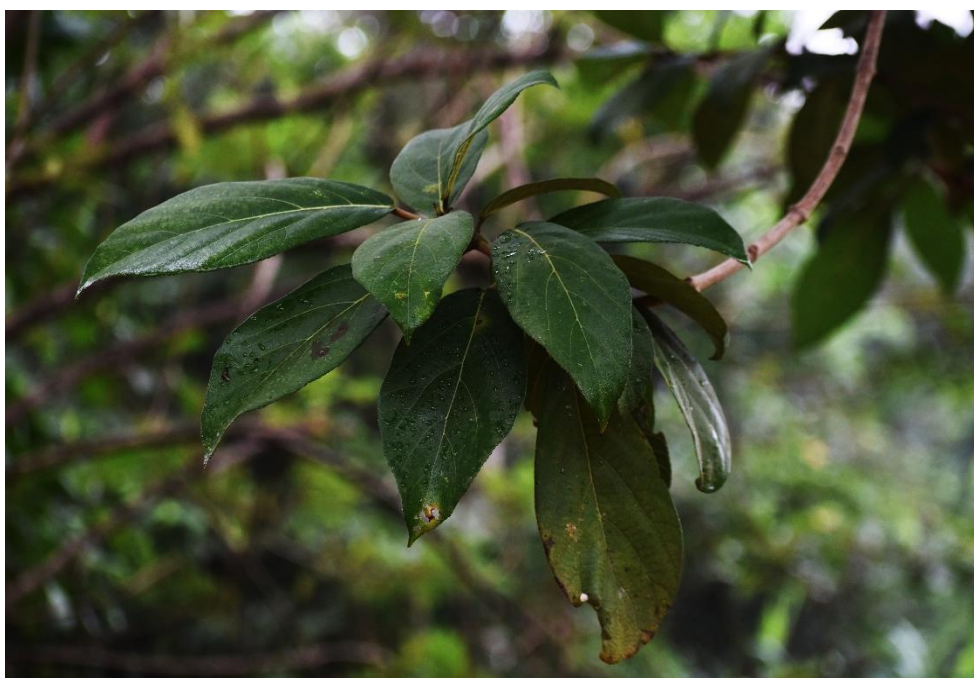
amyrine, hispidin. In another study, a new norisoprenoid, ficustriol, phenanthroindolizidine alkaloid O methyltylophorinidine<sup>7</sup>, palmitic oil, 9,12-octadecadienoic acid, hexadecanoic acid ethyl ester, linalool, 1-hydroxylinalool, 1 hydroxylinalool and benzyl alcohol have been reported (**Ravichandra and Paarakh, 2011**). The bark was stated in imitation to contain 10-ketotetracosylarachidate,  $\beta$ -amyrine acetate,  $\beta$ -sitosterol lupeol acetate,  $\beta$ -amyrin and triacontanolacetate. The availability on a number of volatiles have been reported from the fruit, which include linalool, linalool oxide, terpineol, and 2,6-dimethyl-1,7- octadiene-3,6-diol. Plant additionally includes ficus hispimines A and B, ficus hispidine, hispiloscine, N-triacontanyl acetate, ficusin A. Two enormous phenanthroindolizidine alkaloids, 6-Omethyltylophorinidine and 2-demethoxytylophorine and a novel biphenyl hexahydroindolizine hispidine have been reported from stem and leaves (**Markate et al., 2024**). Amphetamine, piperidine, pyrrolidine, and isoquinoline alkaloids have been reported from this plant previously Amine alkaloids with a rhamnosyl group or with N-oxide moiety were discovered for the first time from the genus *Ficus*. In 2020, Jia et al., reported Four new alkaloids, ficuhismines A-D (1-4), together with three known ones, were isolated from *F. hispida*. Two new pyrrolidine alkaloids, ficushismines A and B, a new  $\omega$ -(dimethylamino)caprophenone alkaloid, ficushisimine C, and a new indolizidine alkaloid, ficushispidine were also reported. In stem, bark and leaves it contains hispidacine, an 8,4'-oxyneolignan featuring incorporation of an unusual 2-hydroxyethylamine moiety at C-7, and hispiloscine, a phenanthroindolizidine alkaloid, (**Sanchez et al., 2002; Yap et al., 2015; Shi et al., 2016; Jia et al., 2020; Choudhury et al., 2021; Shrikumar et al., 2024**). These compounds are believed to be responsible for the plant's documented pharmacological activities, such as antioxidant, anti-inflammatory, hepatoprotective, antidiabetic, antimicrobial, and significant anticancer properties (**Zhang et al., 2017; Jia et al., 2020; Anvitha et al., 2022**).

This chapter aims to provide a comprehensive overview of the current scientific understanding of *Ficus hispida*, with a particular focus on its key bioactive compounds and a critical evaluation of their therapeutic potential. By systematically reviewing the existing literature, this study seeks to consolidate the evidence supporting its traditional uses and to highlight for future pharmacological research and potential drug development.



## MORPHOLOGY

It is a small tree; branches hispid with hollow or sometimes solid internodes. Leaves mostly opposite, obovate, obovate-oblong or ovate-oblong, 11-36 x 6-23 cm, toothed, rarely entire, obtuse or obtusely acuminate, scabrous above, hispid, especially on the nerves beneath, base obtuse, rounded or cordate, mostly 5 – nerved, secondary nerves 6-8, strong and raised beneath, looping close to the margin; petiole 1.3-7 cm. Figs numerous, fascicled on both the trunk and branches, often on leafless drooping branches, also sometimes axillary, globose, 2-2.6 cm diam., yellowish when ripe, tomentose or closely shortly hairy, umbo prominent, base narrowed to a slender or very short stalk with scattered bracts. Style hispid; stigma tubular. Male flowers very few. There are usually four oval, spear shaped bumps and they appear on leafless fruit trees. The inflorescence is of the syconium type, clustered in tubules on the main stem, older branches and sometimes on pendulous leafless branches (Saxena and Brahmam, 1995; Figure 1-4).



**Figure 1:** Leaves of *F. hispida*



**Figure 2:** Bark of *F. hispida*



**Figure 3:** Fruit of *F. hispida*



**Figure 4:** Syconium of *F. hispida*

## METHODOLOGY

The bark of *F. hispida* was collected from the nearby Mahanadi River area of Cuttack district of Odisha, India. The plant species was identified by the authors (**Figure 5; Nayak and Kumar, 2023**). The Soxhlet extraction method was adopted using three extracts n-hexane, methanol and ethanolic extract for phytochemical analysis (**Marndi et al., 2024**). Detection of nine secondary metabolites was conducted using standard methods (**Kumar et al., 2013; Marndi et al., 2024**).

### Qualitative phytochemical analysis (**Marndi et al., 2024**)

**Test for tannin:** About 1 ml of the bark extract was taken. Three to five drops of 10% lead acetate solution were added. The gelatinous precipitate formation confirmed the presence of tannin.

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

**Test for flavonoids:** About 1 ml of the bark extract was taken. Two ml of 2% NaOH solution and 3 to 4 drops of dilute HCl were added. The colour initially



turned to an intense yellow colour with NaOH solution and later became colourless. This colour changes in appearance confirmed the presence of flavonoids.

**Test for terpenoids:** About 1 ml of the bark extract was added with 5-6 drops of chloroform and placed in the water bath for a few minutes. Then 5-6 drops of concentrated sulphuric acid were added. The reddish-brown interface confirmed the presence of terpenoids.

**Test for phenolic groups:** About 1 ml of the bark 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 bark extract was taken and 2 drops of Fehling's solution A followed by Fehling's solution B were added and kept in the water bath for some time. The presence of red-orange precipitate confirmed the presence of reducing sugar.

**Test for steroids:** About 1 ml of the bark extract was taken. 1 ml of chloroform and 1 ml of concentrated sulphuric acid was added to it. The appearance of upper red and lower yellow color with green fluorescence provided the presence of steroids.

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

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

## RESULTS AND DISCUSSION

The phytochemical analysis concerning a variety of section over plant *F. hispida* revealed the availability of tannins, saponin, terpenoids, reducing sugars (**Figure 6-8**), alkaloids and many more bioactive compounds through literature aspects, which act as a palliative of pain, inflammation, fever, diarrhoeal, neuro-pharmacological disorders, antioxidants and diabetes etc. Tannin and saponin are present in ethanol and methanol extract. Terpenoid is



present in n-hexane extract. Alkaloids are present in ethanol extract. Reducing sugars is present in all three extracts (**Table 1**).

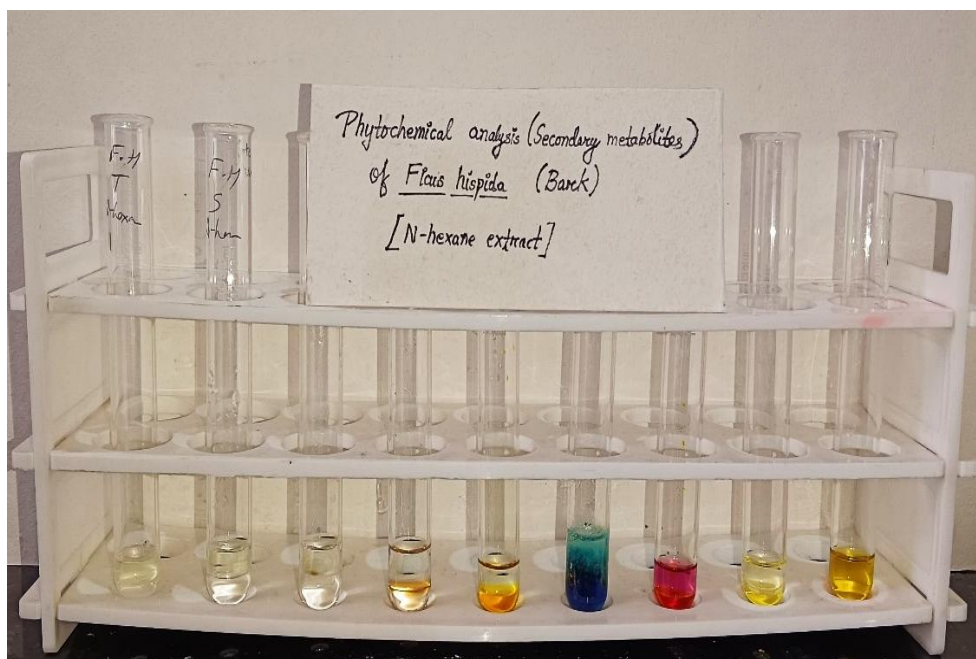
**Table 1:** Phytochemical analysis of bark of *F. hispida*

| Bioactive compounds | N- Hexane extract | Ethanol extract | Methanol extract |
|---------------------|-------------------|-----------------|------------------|
| Tannin              | -                 | +               | +                |
| Saponin             | -                 | +               | +                |
| Flavonoid           | -                 | -               | -                |
| Terpenoids          | +                 | -               | -                |
| Phenolic compounds  | -                 | -               | -                |
| Reducing sugars     | +                 | +               | +                |
| Steroids            | -                 | -               | -                |
| Alkaloids           | -                 | +               | -                |
| Carbonyl compound   | -                 | -               | -                |

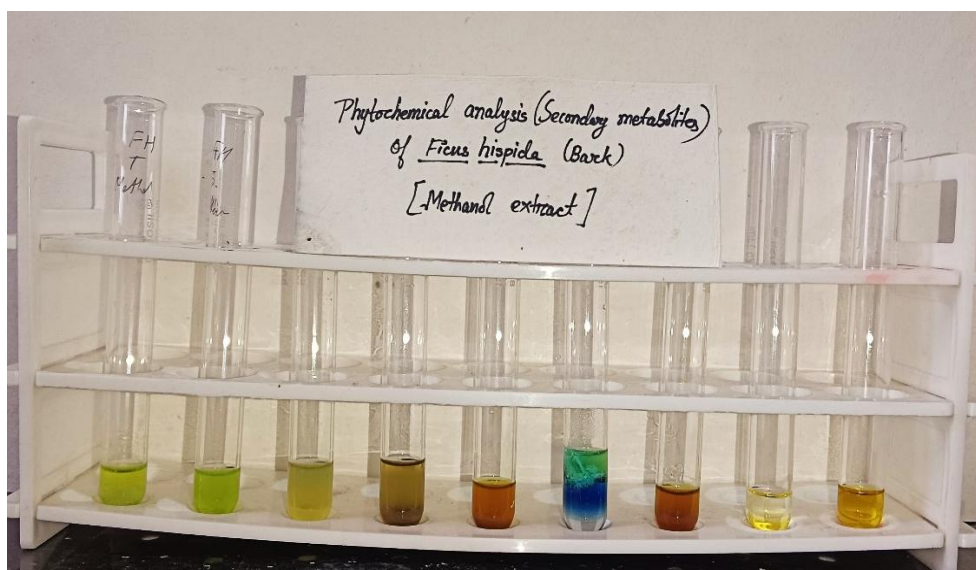
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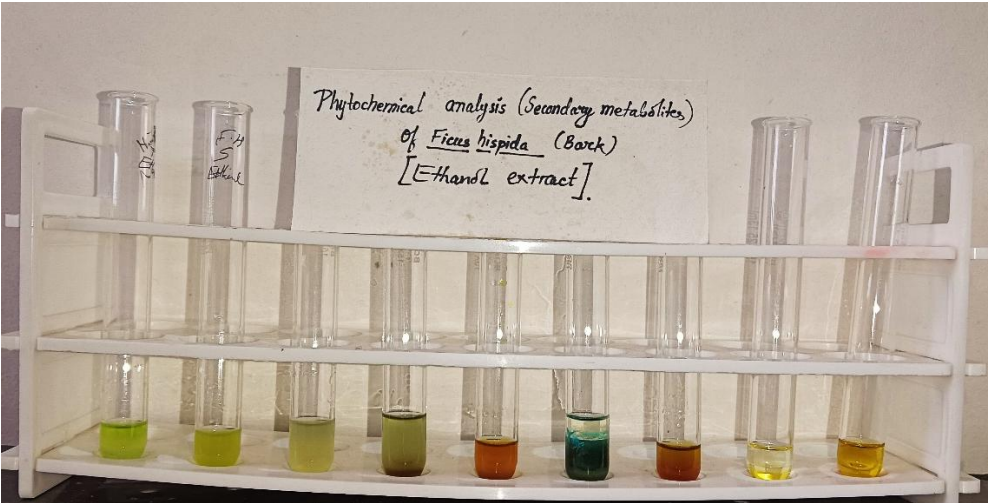
**Figure 5:** Bark sample for photochemical analysis



**Figure 6:** Phytochemical analysis (Secondary metabolites) of *F. hispida* (Bark) of n-hexane extract



**Figure 7:** Phytochemical analysis (Secondary metabolites) of *F. hispida* (Bark) of methanolic extract



**Figure 8:** Phytochemical analysis (Secondary metabolites) of *F. hispida* (Bark) of ethanolic extract

Historically, *F. hispida* has been used for back in dates to the times of Charaka. The tribals of Meghalaya use the unripe fruit for preparation of curry. In village of Khatra, Bankura, West Bengal in India, people chew the leaves is used to treat diarrhea (Ali and Chaudhary, 2010). From table 2, it is concluded that mostly the leaves and fruits are used to treat various ailments such as coolant agent, diarrhea, hemorrhage, dysentery, ringworm, earache and purgative.

**Table 2:** Ethnomedicinal uses of *F. hispida*

| Plant parts | Mode of uses | Diseases       | Sources                                         |
|-------------|--------------|----------------|-------------------------------------------------|
| Fig         | Juice        | Mild purgative | Chatterjee et al., (2015)                       |
| Fig         | Juice        | Hemorrhage     | Chatterjee et al., (2015); Salvi et al., (2013) |
| Fruit       | Juice        | Tonic          | Choudhury et al., (2021)                        |
| Latex       | Paste        | Ringworm       | Salvi et al., (2013)                            |
| Leaves      | Raw          | Diarrhea       | Shrikumar et al., (2024)                        |



|                 |           |                         |                      |
|-----------------|-----------|-------------------------|----------------------|
| Leaves          | Decoction | Cough                   | Salvi et al., (2013) |
| Leaves          | Juice     | Ear-ache                | Salvi et al., (2013) |
| Leaves and bark | Decoction | Dysentery and diarrhoea | Li, (2021)           |
| Ripe fruit      | Paste     | Goitre                  | Salvi et al., (2013) |
| Root            | Decoction | Leukoderma              | Salvi et al., (2013) |
| Root and bark   | Decoction | Blood purifier          | Salvi et al., (2013) |

Literature survey revealed that various plant parts of *F. hispida* contain various pharmacological activities. In Table 3, it concluded that leaves, root, bark and fruit have various pharmacological activities such as antihemorrhagic, anti-diarrheal, anti-inflammatory, antitumor, antioxidant, nociception, antioxidant, and hypoglycemic activity.

**Table 3:** Pharmacological activities of *F. hispida*

| Part used | Pharmacological activities | Sources                                            |
|-----------|----------------------------|----------------------------------------------------|
| Bark      | Hypoglycemic activity      | Shrikumar et al., (2024)                           |
| Bark      | Nociception                | Choudhury et al., (2021)                           |
| Fig       | Anti-obesity               | Sharma et al., (2024)                              |
| Fruit     | Anti-hemorrhagic activity  | Choudhury et al., (2021)                           |
| Fruits    | Anticancer                 | Zhang et al., (2018)                               |
| Leaves    | Anti-diarrheal activity    | Choudhury et al., (2021); Shrikumar et al., (2024) |
| Leaves    | Anti-inflammatory activity | Choudhury et al., (2021); Ali and                  |



|        |                               |                                                              |
|--------|-------------------------------|--------------------------------------------------------------|
|        |                               | Chaudhary, (2010); Jia et al., (2020); Smruti et al., (2022) |
| Leaves | Antioxidant activity          | Shrikumar et al., (2024); Chatterjee et al., (2015)          |
| Leaves | Neuropharmacological activity | Shrikumar et al., (2024)                                     |
| Leaves | Antimicrobial activity        | Chatterjee et al., (2015)                                    |
| Leaves | Cardioprotective effect       | Ali and Chaudhary, (2010)                                    |
| Leaves | Anticonvulsant effect         | Ali and Chaudhary, (2010)                                    |
| Root   | Antiulcerogenic effect        | Ali and Chaudhary, (2010)                                    |
| Roots  | Wound healing                 | Choudhury et al., (2021)                                     |
| Stem   | Antitumor activity            | Shrikumar et al., (2024)                                     |

## ECOLOGICAL SIGNIFICANCES

The selected plant of present study has ecological values. Figs are consumed by bats and palm civets (**Shrikumar et al., 2024**). *F. hispida* engages in an obligate, species-specific mutualism with pollinating fig wasps (e.g., *Ceratosolen solmsi*). The fig syconium serves as a nursery for the fig wasp larvae, in return, the female wasps pollinate the enclosed flowers (**Pereira et al., 2000; Rong et al., 2002**). The ripe figs are a vital food source for a diverse range of frugivorous animals, including birds, bats and various mammals (**Borges et al., 2008; Dev et al., 2010**).

## CONCLUSION

*Ficus hispida*, is a medicinally significant tree with a rich ethnomedicinal history, particularly in Asian traditional practices. Scientific investigations have largely validated its traditional uses, revealing a diverse phytochemical



profile responsible for its broad therapeutic potential for pharmacological factors. Present chapter highlights the bioactive compounds especially present in its bark through phytochemical screening. The finding provide valuable insights into its food, medicinal, ecological uses and rigorous clinical trials is essential to translate its traditional wisdom into evidence-based modern therapeutics.

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## CHAPTER 4

### Phytochemical & pharmacological profiling of *Ficus racemosa* bark: an integrated study of its ethnobotany and ecological importance

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**Abstract:** *Ficus racemosa* Linn. bark is a cornerstone of traditional knowledge and a key ecological component. This study integrates its ethnobotanical uses, phytochemical composition, pharmacological activities, and ecological significance. Traditionally, the bark treats diverse ailments like dysentery, diabetes, skin diseases, and inflammation. Phytochemically, it is rich in flavonoids, phenolic acids, steroids, saponins, and triterpenoids. Pharmacologically, it exhibits significant antidiabetic, anti-inflammatory, antioxidant, antimicrobial, and hepatoprotective effects. Ecologically, *F. racemosa* is a basis species, providing vital food for frugivores (e.g., birds, mammals, bats) and contributing to soil stability. This integrated analysis highlights its therapeutic potential and critical role in ecosystem health, advocating for its sustainable utilization.

**Keywords:** Ecological, ethnopharmacological, medicinal, phytochemical



## INTRODUCTION

Medicinal plants have long been the foundation of conventional healthcare systems because they are a rich source of bioactive compounds with therapeutic potential. This long-standing endorsement of nature-based healing highlights the significance of scientific validation of traditional methods and the exploration of novel phytomedicines. The genus *Ficus* is classified into six different subgenera: *Urostigma*, *Pharmacosycea*, *Ficus*, *Sycidium*, *Sycomorus*, and *Synoechia*. The *Ficus* originated from the tropics, extended into warm temperate zones and displays interspecific morphological variations and adaptiveness to diversified environments. The secretion of sticky latex, a pair of stipules or a stipule sheath to protect the young branches, and a "tri-veined" shape where the basal lateral veins of the leaves exhibit an oblique orientation and form acute angles with the central vein, are the main traits of the majority of *Ficus* trees (Yuan et al., 2024).

*Ficus* species, such as *Ficus racemosa* Linn., belonging to the family Moraceae, are widely valued for their medicinal and nutritional properties. *Ficus racemosa* Linn., syn *Ficus glomerata* Roxb., it is commonly known as the Cluster Fig, Gular, or Indian Fig tree, and stands out as a particularly significant species due to its profound ethnobotanical importance and diverse pharmacological activities. Belonging to the Moraceae family, *F. racemosa* is widely distributed in India (Himalayan ranges from Punjab, Khasia mountains, Maharashtra, Bihar, Orissa, West Bengal, Rajasthan, Deccan and South India) and the world (Australia, Malaysia, Burma, China, Indonesia) (Ahmed and Urooj, 2010; Chaware et al., 2020). Stem and bark are utilized as tea (Ahmed et al., 2010). In Africa, the traditional liquor is obtained from the fruit of *F. racemosa* (Bhalerao et al., 2014). *F. racemosa* is considered a sacred tree in Hinduism. It is often associated with divine significance, symbolizing abundance and prosperity. Ancient Vedic texts, such as the Atharvaveda, mention the Udumbara tree as a source of wood for rituals and amulets. Almost every part of the plant, from the leaves and fruits to the roots and bark, is used medicinally in India's many traditional medical systems, such as Ayurveda, Unani, and Siddha. The bark, in particular, holds a prominent position in traditional pharmacopoeias, recognized for its efficacy in treating a wide spectrum of ailments. Traditional practitioners have historically employed *F. racemosa* bark as an astringent for gum diseases, a decoction for managing dysentery, menorrhagia, and diabetes, and skin



conditions such as boils, inflammation, and ulcers (**Ahmed and Urooj, 2010**). A thorough empirical grasp of its medicinal characteristics is further demonstrated by the fact that its traditional uses include the treatment of fever, leprosy, vomiting, liver diseases, heart disease, hyperlipidemia, and cough, pneumonia, and pertussis. The remarkable array of traditional uses suggests a complex interplay of bioactive compounds within the bark. Modern scientific investigations have begun to unravel this complexity, revealing a rich phytochemical analysis that includes flavonoids, phenolic acids, steroids, saponins, coumarins, tannins, and triterpenoids. Bark contains different compounds such as  $\beta$ -sitosterol,  $\beta$ -sitosterol-D-glucoside, dextran acetate, leucopelargonidin-3-O- $\alpha$ -L rhamnopyranoside,  $\beta$  leucopelargonidin-3-O-beta-D-glucopyranoside, leucocyanidin-3-O-  $\beta$  -D-glucopyranoside, ceryl behenate,  $\alpha$ -coumarin acetate,  $\beta$ , leucocyanidins, kaempferol, coumarin, ellagic acid,  $\alpha$ -coumarin, stigmasterol, bergen. ellagic acid,  $\alpha$ -coumarin,  $\beta$ -amyrin, stigmasterol, bergenin. Leaves contain campesterol, arabinose, bergamot, psoralen, eicosanol, n-octasanol acetate, racemic acid, quercetin-3-glucoside, rutin and leucocyanidin methyl ester. Tetracyclic triterpene, glauanol acetate-characterized as 13 $\alpha$ , 14 $\beta$ , 17 $\beta$ H, 20 $\alpha$ H-lanosta-8, 22-diene-3 $\beta$ -acetate along with racemosic acid, was isolated from the leaves (**Paarakh, 2009; Ahmed and Urooj, 2010; Bhalerao et al., 2014; Shabab et al., 2021;**). Phenolic substances like gallic and ellagic acids are found in fruit. Hentriacontane,  $\beta$ -sitosterol, glauanol, glauanol acetate, tiglic acid, lupeol acetate, friedelin, esters of taraxasterol, higher hydrocarbons, and other phytosterols were discovered from fruit. Latex contains euphorbinol, isoeuphorbol, cycloartenol, cycloeuphordenol, 4-deoxyphorbol euphol, palmitic acid,  $\alpha$ -amyrin, and  $\beta$  -sitosterol, taraxerol, trimethyl ellagic acid, tinyatoxin (**Bhalerao et al., 2014; Bhogaonkar et al., 2014; Chaware et al., 2020; Pahari et al., 2022; Kale et al., 2023**). An acute toxicity study in rats demonstrated that the aqueous extract of the bark is safe at doses up to 2000 mg/kg of body weight. No significant abnormalities were observed in histopathological examinations or biochemical markers, indicating a favorable safety profile (**Solanki and Bhavsar, 2014**).

These diverse classes of compounds are believed to be responsible for the many pharmacological activities. Preliminary studies have already validated several traditional claims, demonstrating the bark's significant antidiabetic, anti-inflammatory, antioxidant, antimicrobial, and hepatoprotective properties. For instance, research has shown its capacity to significantly



reduce blood glucose levels, alleviate inflammatory responses, neutralize harmful free radicals, and protect liver cells from damage. In addition to its therapeutic uses, *F. racemosa* is an important ecological plant. It is essential to preserving biodiversity since it is a keystone species in many habitats, especially riparian zones. Its distinctive syconia, or figs, are an essential food source for many different kinds of frugivorous creatures, including as bats, birds, and other mammals, which helps spread seeds and promote forest regeneration. Moreover, its extensive root system helps in soil stabilization, preventing erosion and promoting ecological balance. This integrated study aims to provide a comprehensive phytochemical and pharmacological profiling of *F. racemosa* bark, bringing together its rich ethnobotanical history with modern scientific validation and acknowledging its critical ecological importance. By bridging traditional knowledge with contemporary research, this study seeks to further elucidate the therapeutic potential of *F. racemosa* bark and promote its sustainable utilization for both human health and ecosystem well-being (Mandal et al., 2000; Deep et al., 2013; Sharma et al., 2023).

## MORPHOLOGY

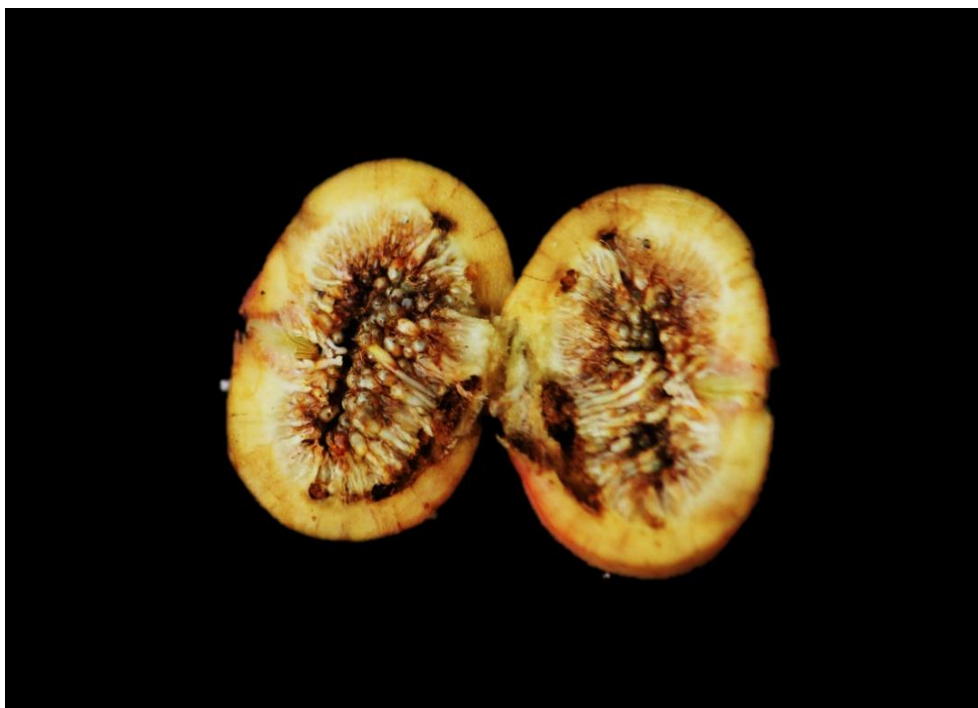
It is a large moderate sized tree with few short aerial roots, bark grey to rusty. Leaves ovate, ovate – lanceolate or elliptic, 7-20 x 3.5 – 9 cm, entire, obtuse, acute or subacute, dark green above, paler beneath, glabrous above, glabrous or pubescent on the nerves beneath, base obtuse or rounded, rarely acute, 3-nerved, secondary nerves 4-8; petiole 1.6- 6 cm long; stipules ovate – lanceolate, 1.2- 2.5 cm long. Figs on short or sometimes up to 60 cm long leafless, scariously bracteolate, tubercle and warted branchlets from the main trunk or larger branches, figs occasionally axillary, globose to pyriform, 2.6 – 6 cm diam., red when ripe, pubescent or tomentose; peduncle up to 1.8 cm long. Male, female and gall flowers in the same fig. Male flowers near the mouth; tepals 3-4; inflated. Perianth of gall and female flowers toothed. Stigma clavate. Achene granulates (Saxena and Brahmam, 1995; Figure 1-3).



**Figure 1:** Leaves of *F. racemosa*



**Figure 2:** Fruits of *F. racemosa*



**Figure 3:** Syconium of fruit of *F. racemosa*

## METHODOLOGY

The bark of *F. racemosa* was collected from the nearby Mahanadi River area of Cuttack district of Odisha, India. The plant species was identified by the authors (**Figure 4; Nayak and Kumar, 2023**). The Soxhlet extraction method was adopted using three extracts for phytochemical analysis (**Marndi et al., 2024**). Detection of nine secondary metabolites was conducted using standard methods (**Kumar et al., 2013; Marndi et al., 2024**).

**Qualitative phytochemical analysis** (**Marndi et al., 2024; Jena et al., 2025**)

**Test for tannin:** About 1 ml of the bark extract was taken. Three to five drops of 10% lead acetate solution were added. The gelatinous precipitate formation confirmed the presence of tannin.



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

**Test for flavonoids:** About 1 ml of the bark extract was taken. Two ml of 2% NaOH solution and 3 to 4 drops of dilute HCl were added. The colour initially turned to an intense yellow colour with NaOH solution and later became colourless. This colour changes in appearance confirmed the presence of flavonoids.

**Test for terpenoids:** About 1 ml of the bark extract was added with 5-6 drops of chloroform and placed in the water bath for a few minutes. Then 5-6 drops of concentrated sulphuric acid were added. The reddish-brown interface confirmed the presence of terpenoids.

**Test for phenolic groups:** About 1 ml of the bark 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 bark extract was taken and 2 drops of Fehling's solution A followed by equal amount of Fehling's solution B were added and kept in the water bath for some time. The presence of red-orange precipitate confirmed the presence of reducing sugar.

**Test for steroids:** About 1 ml of the bark extract was taken. 1 ml of chloroform and 1 ml of concentrated sulphuric acid was added to it. The appearance of a red color in the upper layer and a yellow color with green fluorescence in the lower layer indicated the presence of steroids.

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

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

## RESULTS AND DISCUSSION

During the present study focusses on bark in three extract such as N- hexane, methanol, and ethanol extract. It was observed the bark contain tannin, saponin, terpenoids, reducing sugars and alkaloids. Tannin, phenolic



compounds, alkaloids and saponin are present in ethanol and methanol extract. Reducing sugars is present in three extracts. Terpenoid is present in ethanolic extract (**Table 1; Figure 5-7**). Tannin may be responsible for astringent effects. Phenolic compounds may be responsible for antioxidant activity. Saponin may be responsible for anti-inflammatory activity. Terpenoids may be responsible for antimicrobial and analgesic activity. Reducing sugars may be responsible for antioxidant activity (**Table 1**). Tannin, saponin, phenolic compounds and alkaloids are not found in the non-polar solvent extracts of *F. racemosa* barks but found in moderate polar solvents are expected for the biological activities.

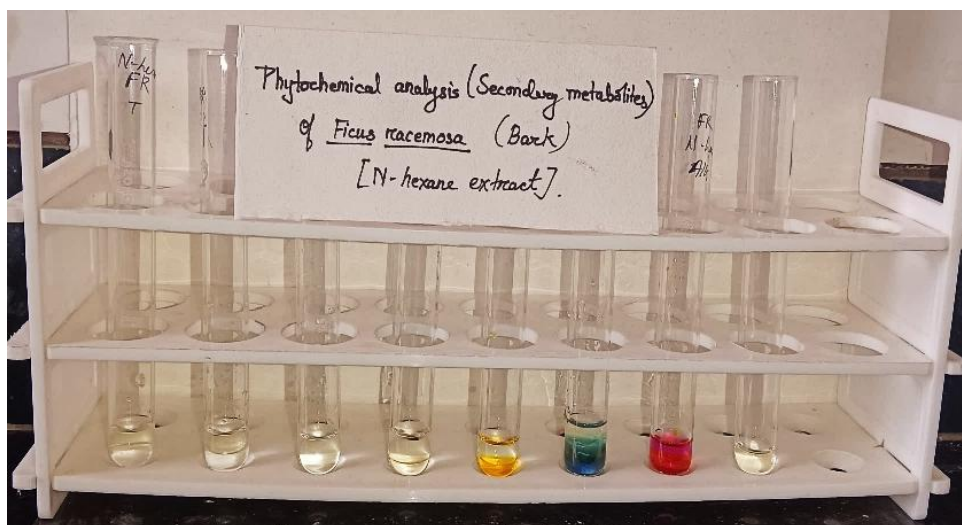
**Table 1:** Phytochemical screening of *F. racemosa* bark

| Bioactive compounds | N- Hexane extract | Ethanol extract | Methanol extract |
|---------------------|-------------------|-----------------|------------------|
| Tannin              | -                 | +               | +                |
| Saponin             | -                 | +               | +                |
| Flavonoid           | -                 | -               | -                |
| Terpenoids          | -                 | +               | -                |
| Phenolic compounds  | -                 | +               | +                |
| Reducing sugars     | +                 | +               | +                |
| Steroids            | -                 | -               | -                |
| Alkaloids           | -                 | +               | +                |
| Carbonyl compounds  | -                 | -               | -                |

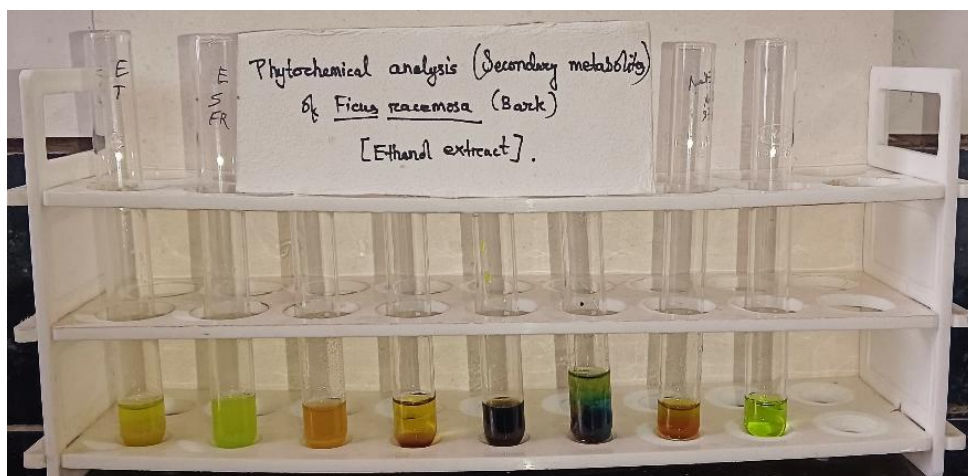
(+ve – Positive; -ve – Negative)



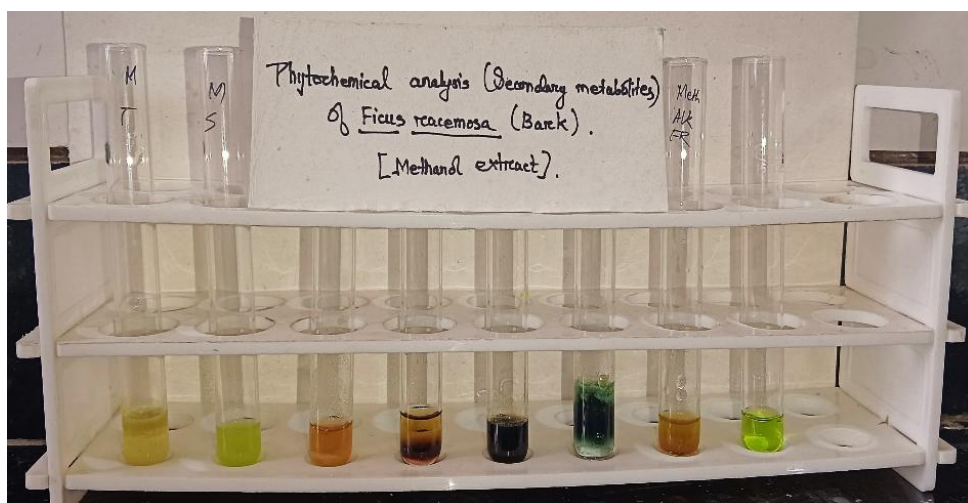
**Figure 4:** Bark of *F. racemosa*



**Figure 5:** Phytochemical analysis (Secondary metabolites) of *F. racemosa* (Bark) of n- hexane extract



**Figure 6:** Phytochemical analysis (Secondary metabolites) of *F. racemosa* (Bark) of ethanol extract



**Figure 7:** Phytochemical analysis (Secondary metabolites) of *F. racemosa* (Bark) of methanol extract

During the theoretical survey it was revealed that ripen fruit is consumed to treat diabetes and bark paste is applied to treat wound. In Table 2, it clinched that mostly root, bark, fruits, latex and leaves are used to treat various ailments. The specific modes of use include decoction, infusion, juice, paste, and consumption in raw form.



**Table 2:** Ethnomedicinal uses of *F. racemosa*

| Plants parts   | Mode of uses | Diseases                 | Sources                                                                    |
|----------------|--------------|--------------------------|----------------------------------------------------------------------------|
| Bark           | Infusion     | Gum problem              | Awasthi and Dixit, (2023)                                                  |
| Bark           | Infusion     | Dysentery                | Kale et al., (2023)                                                        |
| Bark           | Decoction    | Hemorrhoids              | Kale et al., (2023)                                                        |
| Bark           | Decoction    | Piles                    | Deep et al., (2013)                                                        |
| Fruit and bark | Infusion     | Leprosy                  | Ahmed and Urooj; (2010); Kale et al., (2023)                               |
| Fruits         | Decoction    | Visceral obstruction     | Ahmed et al., (2010)                                                       |
| Fruits         | Decoction    | Constipation             | Ahmed et al., (2010); Ahmed and Urooj, (2010)                              |
| Latex          | Decoction    | Boils                    | Awasthi and Dixit, (2023)                                                  |
| Latex          | Paste        | Fractures                | Kale et al., (2023)                                                        |
| Leaves         | Decoction    | Biliary tract infections | Ahmed and Urooj, (2010); Kale et al., (2023); Kohale et al., (2024)        |
| Leaves         | Decoction    | Dysmenorrhea             | Kale et al., (2023)                                                        |
| Leaves         | Paste        | Blisters                 | Kunwar and Bussmann, (2006); Ahmed and Urooj, (2010); Kale et al., (2023); |



|             |           |              |                             |
|-------------|-----------|--------------|-----------------------------|
| Leaves      | Infusion  | Menorrhoea   | Kunwar and Bussmann, (2006) |
| Ripen fruit | Raw       | Diabetes     | Kale et al., (2023)         |
| Root        | Decoction | Tonsillitis  | Ramakrishna et al., (2023)  |
| Roots       | Paste     | Wounds       | Murti and Kumar, (2012)     |
| Sap         | Decoction | Gonorrhea    | Ramakrishna et al., (2023)  |
| Stem        | Juice     | Stomach ache | Kunwar and Bussmann, (2006) |

In Table 3, mostly bark and leaves possess antidiabetic, antioxidant, antidiarrheal, antipyretic, antitussive, analgesic activity. In this table, it summarizes the different plants parts possess pharmacological effects.

**Table 3:** Pharmacological activities of *F. racemosa*

| Parts used      | Pharmacological activities | Sources                                                                    |
|-----------------|----------------------------|----------------------------------------------------------------------------|
| Bark and leaves | Antidiabetic activity      | Ahmed and Urooj, (2010); Amin et al., (2015); Awasthi and Dixit, (2023);   |
| Bark            | Antioxidant activity       | Awasthi and Dixit, (2023); Sharma et al., (2023)                           |
| Bark            | Antidiarrheal activity     | Ahmed and Urooj, (2010); Awasthi and Dixit, (2023)                         |
| Bark            | Antipyretic activity       | Ahmed and Urooj, (2010); Awasthi and Dixit, (2023); Sharma et al., (2023); |
| Bark            | Antitussive activity       | Kale et al., (2023); Sharma et al., (2023)                                 |



|                         |                            |                                                                           |
|-------------------------|----------------------------|---------------------------------------------------------------------------|
| Bark and leaves         | Analgesic activity         | Awasthi and Dixit, (2023)                                                 |
| Bark, fruits and leaves | Gastroprotective activity  | Ahmed and Urooj, (2010); Awasthi and Dixit, (2023); Kale et al., (2023)   |
| Fruits                  | Anti-filarial activity     | Awasthi and Dixit, (2023)                                                 |
| Leaf bark               | Larvicidal                 | Bhalerao et al., (2014)                                                   |
| Leaves                  | Hepatoprotective activity  | Mandal et al., (1999); Awasthi and Dixit, (2023); Kale et al., (2023)     |
| Leaves                  | Hypotensive activity       | Ahmed and Urooj, (2010)                                                   |
| Leaves                  | Anti-inflammatory activity | Mandal et al., (2000); Awasthi and Dixit, (2023); Sharma et al., (2023)   |
| Stem, bark and root     | Antibacterial activity     | Pingale et al., (2019); Awasthi and Dixit, (2023); Chaware et al., (2020) |
| Stem bark               | Antifungal activity        | Pingale et al., (2019); Awasthi and Dixit, (2023)                         |
| Stem bark               | Hypoglycemic activity      | Kale et al., (2023)                                                       |
| Stem bark               | Wound healing              | Bhalerao et al., (2014)                                                   |

## ECOLOGICAL FACTORS

Figs are a critical food source for a wide range of animals, making it a keystone species in many tropical ecosystems (Pothasin et al., 2014). It serves as a food plant for the caterpillars of the butterfly the two – brand crow (*Euploea Sylvester*) of northern Australia (Bhalerao et al., 2014). Asian elephant feeding on ripe fruit, bark and leaves particularly along riverbanks



(Kunwar and Bussmann, 2006; Mohapatra et al., 2012; Koirala et al., 2016). Bats are crucial seed dispersers their ingestion often enhances seed germination (Tang et al., 2007). Indian giant flying squirrel also consumed the leaves and ripen fruits (Nandini and Parthasarathy, 2008). Fig wasps (*Ceratosolen fusciceps*) are highly specialized, obligate pollinators. They don't consume it like other animals, but it provides the essential environment and resources for developing wasp larvae inside the syconium (Ramakrishna et al., 2023).

## CONCLUSION

Present study highlights the profound significance of *Ficus racemosa* bark, not only as a repository of diverse phytochemicals with validated pharmacological activities but also as a plant deeply embedded in traditional medicine and critical for ecological balance. Flavonoids, tannins, and phenolic acid were among the many bioactive substances found in the bark, according to the phytochemical profiling. The phytochemical profiling revealed the presence of a rich array of bioactive compounds in the bark including flavonoids, tannins, phenolic acid. These compounds collectively underpin the bark's extensive therapeutic potential. Keeping this mind, an attempt has been made to summarize the phytochemical, ethnomedicinal, pharmacological activities and ecological importance. Systematic research, including clinical validation and drug development, can pave the way for its integration into evidence-based medicine.

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## CHAPTER 5

### ***Ficus benjamina* L. (Moraceae): Comprehensive analysis of phytochemical, pharmacological activities and ecological impacts**

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**Abstract:** *Ficus benjamina* (Weeping Fig) is a widely recognized Indian rubber plant with emerging therapeutic relevance and complex ecological roles. Phytochemical analysis revealed a rich composition of secondary metabolites, including tannins, saponins and reducing sugars, contributing to its diverse pharmacological activities. Through literature survey the research indicates potent antioxidant, anti-inflammatory, antimicrobial, anticancer, hepatoprotective, and antidiabetic properties, validating traditional uses and suggesting novel applications. This comprehensive analysis highlights the bioactive compounds in the bark of *F. benjamina*. Present chapter summarizes the current understanding of *F. benjamina*, particularly emphasizing the bark's chemical constituents and their therapeutic potential.

**Keywords:** Ethnomedicinal, ecological, pharmacological, phytochemical



## INTRODUCTION

The genus *Ficus* (Moraceae), comprising over 1,400 species, is renowned for its ecological significance and its traditional medicinal and economic value (Singh et al., 2023). Among these, *Ficus benjamina* L., commonly known as the weeping Fig, Indian rubber tree, Benjamin Fig, or Ficus tree, stands as one of the most ubiquitous and widely cultivated ornamental plants globally (Jain et al., 2022). *Ficus benjamina* L., has several synonyms reflecting historical classification changes and regional variations in naming. Some synonyms are *Urostigma benjaminum* (L.) Miq., *Ficus nitida* Thunb., *Ficus retusa* var. *nitida* (Thunb.) Miq. (POWO, 2025). *Ficus* species are widely distributed across various regions of the world. In India, they are found in several states, including Andhra Pradesh, the Andaman and Nicobar Islands, Assam, Bihar, Delhi, Kerala, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Tamil Nadu, and Tripura. Beyond India, *Ficus* species are also distributed throughout Southern China and many parts of Asia, including Bhutan, Cambodia, Malaysia, Laos, Myanmar, Nepal, Papua New Guinea, the Philippines, Thailand, and Vietnam. In addition, they are present on the Oceanic Islands, such as the Solomon Islands, and in parts of Australasia, including Northern Australia and the islands of the South Pacific (Imran et al., 2014; Kaur et al., 2023). *F. benjamina* prefer slightly acidic to slightly alkaline and neutral to highly alkaline soils respectively (Solis et al., 2016). *F. benjamina* is distinguished by its graceful, drooping branches and glossy, elliptical leaves, making it a popular choice for indoor decor, landscaping, and urban greening. Beyond its aesthetic appeal, emerging scientific interest in *F. benjamina* has increasingly focused on its less-explored therapeutic potential. The leaves, bark and fruits contain various bioactive constituents like cinnamic acid, lactose, naringenin, quercetin, caffeic acid and stigmasterol. Some reported phytoconstituents, e.g., triterpenes, cinnamic acid, lactose, quercetin, caffeic acid, stigmasterol, lutein, sitosterol, phytol, fatty alcohols, triglycerides, fatty acids, essential oils, flavone glycosides, isoflavonoids, and chlorogenic, p-coumaric, and ferulic acids. Other phytoconstituents isolated from roots, fruits, leaves and bark are cinnamic acid, lactose, naringenin, quercetin, caffeic acid, stigmasterol. The leaves contain Quercetin 3-O-rutinoside, kaempferol 3-O-robinobioside, kaempferol 3-O-rutinoside, cyclopropyl methylcarbino, 2-propanol-1,1 dimethoxy acetate, acetic acid, 1- methyl-ethyl ester, gluoctic acid lactone (Imran et al., 2014; Mahomoodally et al., 2019; Smruti et al., 2021; Dahan et al., 2025).



Traditional knowledge systems in its native range have historically attributed various medicinal properties to different parts of the plant, suggesting the presence of bioactive compounds. This growing body of pharmacological research aims to validate these traditional uses and identify the specific phytochemicals responsible for its observed health benefits, which include antioxidant, anti-inflammatory, antimicrobial, cytotoxic, antidiabetic, antiulcer, anticonvulsant and potentially anticancer activities (**Bora and Pant, 2021; Salehi et al., 2021; Dahan et al., 2025**). Leaves were considered as important ingredient in the different events of the Hindu religion. Heartwood was used as timber. Twigs of the plant are utilized as an insect repellant by keeping these beneath the beds. Leaf juice is effectively used as flea and bug repellant (**Safinska et al., 2021; Kaur et al., 2023**).

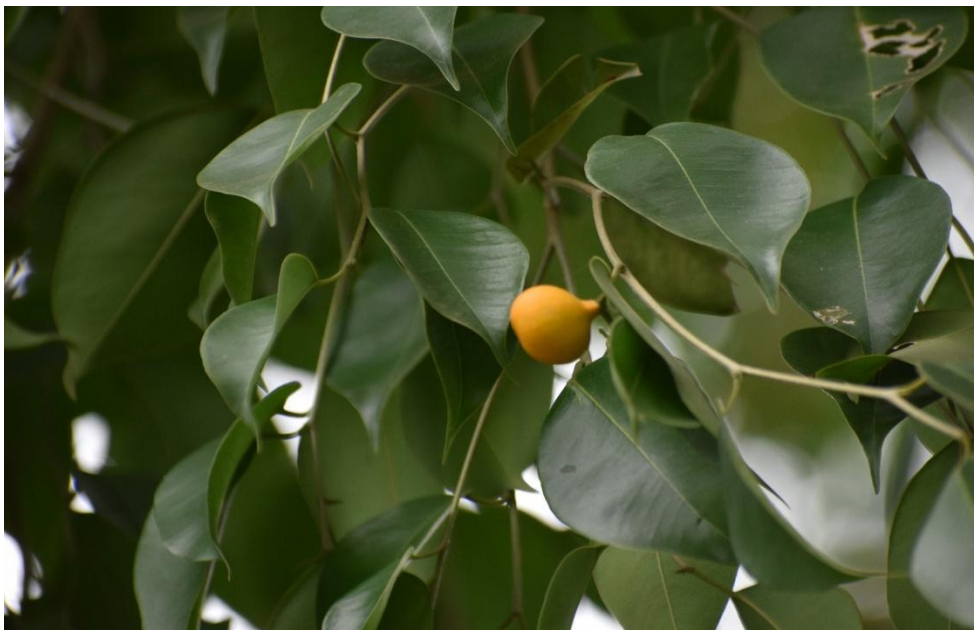
However, the widespread cultivation of *F. benjamina* outside its native habitat have also brought forth significant ecological considerations. While playing a vital role in its natural ecosystem as a keystone species providing food and habitat for various fauna, its invasive tendencies in certain non-native environments pose considerable challenges. By synthesizing current scientific knowledge, this chapter seeks to provide a holistic understanding of *F. benjamina*, fostering informed perspectives on its utilization in therapeutic uses, pharmacological values.

## MORPHOLOGY

It is a large, glabrous tree with the slender drooping branches. Leaves elliptic-oblong, ovate- oblong, broadly elliptic or ovate, 3.6 -10.6 x 1.5-5.6 cm, abruptly acuminate or shortly caudate, glabrous, base rounded or very obtuse, scarcely 3-nerved, the two lateral basal nerves being hardly stronger than the very numerous close spreading secondary parallel nerves, the secondaries and their scarcely finer intermediates meeting the intramarginal nerve close to the thickened margin; petiole slender, 1.3-2.5 cm, grooved; stipules linear – oblong, 1-1.3 cm long, acuminate. Figs mostly terminating or towards the ends of the branchlets, geminate, axillary (but the leaf often suppressed or deciduous), sessile, globose or suddenly contracted into the base, 1.6-3 cm across and upto 2.4 cm long when contracted at base, glabrous, yellow when ripe; one basal bract not sunk in the base, two others almost concealed by the base and often inconspicuous and concolorous with the figs (**Saxena and Brahmam, 1995; Figure 1-4**).



**Figure 1:** Leaves of *F. benjamina*



**Figure 2:** Fruit of *F. benjamina*



**Figure 3:** Syconium of *F. benjamina*



**Figure 4:** Bark of *F. benjamina*



## METHODOLOGY

The bark of *F. benjamina* was collected from the State Botanical Garden, district of Odisha, India. The plant species was identified by the authors (Nayak and Kumar, 2023). The Soxhlet extraction method was adopted using three solvents for phytochemical analysis (Kumar et al., 2013; Marndi et al., 2025). Detection of nine secondary metabolites was conducted using standard methods (Devi et al., 2023; Jena et al., 2024; Marndi et al., 2024; Figure 5-8).

### Qualitative phytochemical analysis (Marndi et al., 2024)

**Test for tannin:** About 1 ml of the bark extract was taken. Three to five drops of 10% lead acetate solution were added. The gelatinous precipitate formation confirmed the presence of tannin.

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

**Test for flavonoids:** About 1 ml of the bark extract was taken. Two ml of 2% NaOH solution and 3 to 4 drops of diluted HCl were added. The colour initially turned to an intense yellow colour with NaOH solution and later became colourless. This colour change in appearance confirmed the presence of flavonoids.

**Test for terpenoids:** About 1 ml of the bark extract was added with 5-6 drops of chloroform and placed in the water bath for a few minutes. Then 5-6 drops of concentrated sulphuric acid were added. The reddish-brown interface confirmed the presence of terpenoids.

**Test for phenolic groups:** About 1 ml of the bark 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 bark extract was taken and 2 drops of Fehling's solution A followed by Fehling's solution B were added and kept in the water bath for some time. The presence of red-orange precipitate confirmed the presence of reducing sugar.

**Test for steroids:** About 1 ml of the bark extract was taken. 1 ml of chloroform and 1 ml of concentrated sulphuric acid was added to it. The



appearance of upper red and lower yellow colors with green fluorescence provided the presence of steroids.

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

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



**Figure 5:** Bark sample for phytochemical analysis

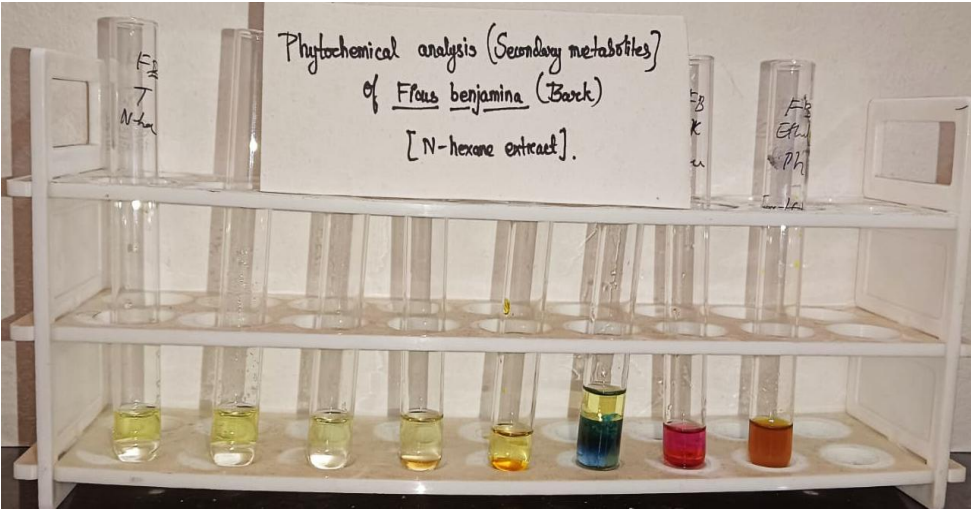
## RESULTS AND DISCUSSION

The phytochemical analysis concludes that bark of *F. benjamina* revealed the availability of tannins, saponin, reducing sugars, and alkaloids and many more bioactive compounds through literature survey, which act as a palliative of pain, inflammation, fever, diarrhea. Tannin, alkaloids and saponin are present in ethanolic and methanolic extract. Reducing sugars are present in all three extracts (**Table 1**).

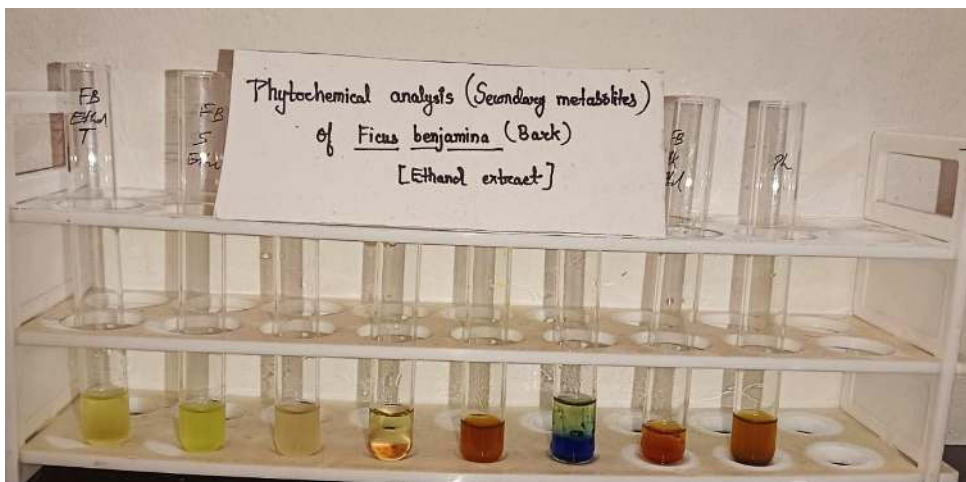


**Table 1:** Phytochemical screening of *F. benjamina* bark

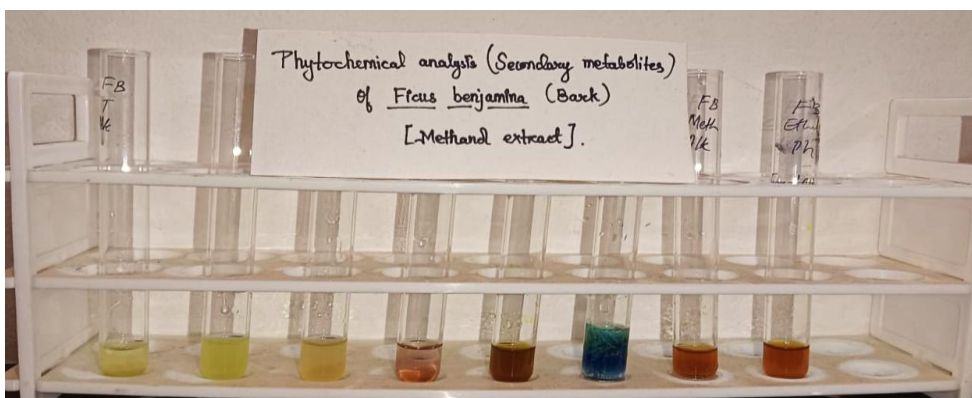
| Bioactive compounds | N- hexane | Ethanol | Methanol |
|---------------------|-----------|---------|----------|
| Tannin              | -         | +       | +        |
| Saponin             | -         | +       | +        |
| Flavonoid           | -         | -       | -        |
| Terpenoids          | -         | -       | -        |
| Phenolic compounds  | -         | -       | -        |
| Reducing sugars     | +         | +       | +        |
| Steroids            | -         | -       | -        |
| Alkaloids           | -         | +       | +        |
| Carbonyl compounds  | -         | -       | -        |



**Figure 6:** Phytochemical analysis (Secondary metabolites) of *F. benjamina* (Bark) of n-hexane extract



**Figure 7:** Phytochemical analysis (Secondary metabolites) of *F. benjamina* (Bark) of ethanolic extract



**Figure 8:** Phytochemical analysis (Secondary metabolites) of *F. benjamina* (Bark) of methanolic extract

According to literature survey it concluded that while many *Ficus* species, *Ficus hispida* or *Ficus religiosa* have deeply gained and well- documented in ethnomedicinal uses across various cultures. However, *F. benjamina* appear to be less extensively documented or as prominent in historical record. In 2023, Kaur et al., reported some ethnomedicinal uses of various parts of *F. benjamina*. In table 2, it concluded that leaves, fruit, latex shows various therapeutic uses such as rheumatism, piles, leprosy, skin diseases, fever, stomachache, blood purifier in the mode of uses in the form of decoction and paste.

**Table 2:** Ethnomedicinal uses of *F. benjamina*

| Plant parts      | Mode of uses | Diseases              | Sources             |
|------------------|--------------|-----------------------|---------------------|
| Bark             | Decoction    | Rheumatism            | Kaur et al., (2023) |
| Latex from fruit | Paste        | Piles                 | Devi et al., (2022) |
| Leaves           | Paste        | Leprosy               | Kaur et al., (2023) |
| Leaves           | Paste        | Skin diseases         | Jain et al., (2013) |
| Leaves           | Decoction    | Respiratory disorders | Jain et al., (2013) |
| Roots            | Paste        | Fever                 | Kaur et al., (2023) |
| Whole plant      | Decoction    | Blood purifier        | Kaur et al., (2023) |
| Whole plant      | Decoction    | Stomachache           | Kaur et al., (2023) |

In table 3, it concluded that plant parts of *F. benjamina* shows various pharmacological activities such as anti-inflammatory, anti-ageing, antioxidant, antimicrobial, anticancer, anti-plasmodium and anti-convulsant.

**Table 3:** Pharmacological uses of *F. benjamina*

| Plant parts           | Pharmacological activities | Sources                                       |
|-----------------------|----------------------------|-----------------------------------------------|
| Fruit                 | Anti-ageing                | Smruti et al., (2021)                         |
| Leaves                | Antioxidant activity       | Jain et al., (2013)                           |
| Root                  | Antioxidant activity       | Imran et al., (2014)                          |
| Stem, root and leaves | Antimicrobial activity     | Imran et al., (2014);<br>Dahan et al., (2025) |



|                        |                                  |                                                                       |
|------------------------|----------------------------------|-----------------------------------------------------------------------|
| Stem, roots and leaves | Anticancer and anti-inflammatory | Khan et al., (2024);<br>Smruti et al., (2021);<br>Jain et al., (2022) |
| Whole plant            | Anti-Plasmodium                  | Marie et al., (2018)                                                  |
| Fig                    | Anti-convulsant activity         | Singh et al., (2023)                                                  |
| Leaves                 | Anticancer activity              | Obafemi and Ottah, (2023)                                             |

### ECOLOGICAL VALUES

According to literature survey it concluded that less documentation available of *F. benjamina* due to its highly ornamental values. Wild animals like to eat this plant as a food source and it contains many medicinally potent substances such as flavonoids, sugars, phenols, enzymes and vitamins A, C, K (Zerega, 2006). Fruits are edible by birds (Kumar et al., 2022). In 2020, Mahajan and Das reported some avian species consumed fruit of *F. benjamina* *Columba livia domestica* (Domestic Pigeon), *Sturnus vulgaris* (Common starling), *Turdus merula* (Common black bird), *Psittacula krameri* (Rose ringed parakeet), and *Cuculus canorus* (Common Cukoo) are reported.

### CONCLUSION

*Ficus benjamina* is globally famous for its ornamental appeal, a comprehensive analysis reveals its multifaceted nature, extending into significant phytochemical, pharmacological, and ecological aspects. Phytochemical investigations have confirmed the presence of a diverse array of bioactive compounds, including tannins, saponins, and reducing sugars. These constituents underpin a range of promising pharmacological activities, with literature survey through scientific studies validating its traditional uses and indicating potent antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, and antidiabetic effects, alongside emerging anticancer potential. However, less work carried out on the basis of ethnomedicinal uses and ecological aspects. Therefore, future work should focus on isolating specific bioactive compounds responsible for various therapeutic uses.



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## CHAPTER 6

### Exploring pharmacological properties of bark of *Ficus drupacea* Thunb.: - a phytochemical investigation

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**Abstract:** *Ficus drupacea* (Moraceae) is widely recognized for its medicinal value in some ethnomedicinal aspects. Despite its traditional uses, a comprehensive understanding of the pharmacological potential of its bark and the underlying phytochemical constituents remains largely underexplored. Present study aims to conduct a systematic phytochemical analysis of *Ficus drupacea* bark to identify and characterize its secondary metabolites, thereby laying the groundwork for future pharmacological evaluations. The results from this phytochemical analysis are likely to show a variety of active compounds that may explain the traditional medicinal uses of *F. drupacea* bark. This chapter highlights the need for phytochemical profiling, which will serve as a foundational step towards understanding the bark's pharmacological properties and identifying lead compounds for drug discovery and development.

**Keywords:** Indigenous, healers, pharmacological, active compound



## INTRODUCTION

The *Ficus* species is well known for its large tree species, mostly the climbers, shrubs, creepers, and trees. The *Ficus* species is one of the oldest tree species in human history. It holds a significant value in highly religious value for both Hindus and Buddhists and is deemed sacred. In many temples, many *Ficus* species are planted, which makes it a way to reach deforestation. Due to its huge forage character, it has mostly lived for thousands of years. Various plant parts of *Ficus* species, such as leaves, bark, roots, branches, and fruits serve as a component in traditional value for local and tribals communities. The fig trees have enormous uses based on its traditional values. It is retained as a single, large genus because it is well defined by its unique reproductive systems involving syconia – figs and specialized pollinator wasps (Yuan et al., 2024). Fruits of *Ficus* species are termed as nourishing, energizing, and healthy and have ethnomedicinal benefits. Some *Ficus* species are also host plants for orchids (Darshani et al., 2023).

Among the genus *Ficus drupacea*, thumb has been selected as a subject of interest for the current chapter according to its phytochemical and pharmacological analysis. *Ficus drupacea* belongs to the family Moraceae, which holds enormous value in various fields. It is distributed throughout Southeast Asia and Northeast Australia. *F. drupaceae*, also known as the brown- woolly fig or Mysore fig. *Ficus drupacea* has several synonyms, including *Ficus aurantiicarpa*, *Ficus chrysochlamys*, *Ficus chrysocoma*, *Ficus citrifolia*, *Ficus gonia*, *Ficus mysorensis*, *Ficus payapa*, *Ficus pilosa*, *Ficus subrepanda*, *Ficus vidaliana*, *Urostigma dasycarpum* & *Urostigma mysorensis*. Additionally, various varieties and forms like *Ficus drupacea* var. *glabrata*, *Ficus drupacea* var. *pedicellate*, *Ficus drupacea* var. *pubescens*, *Ficus drupacea* var. *subrepanda*, *Ficus mysorensis* var. *dasycarpa*, *Ficus mysorensis* var. *parvifolia* & *Ficus mysorensis* var. *subrepanda* are also considered synonyms (POWO, 2025). Some researchers reported the stem and bark identified several phytochemicals, including  $\beta$ -amyrin,  $\beta$ -sitosterol-3-O- $\beta$ -D-glucopyranoside, 5-O-methylatifolin, oleanolic acid, epifriedelanol, friedelin, and epilupeol acetate. Latex possesses a cysteine protease called Drupin, which exhibited hemostatic characteristics. Isolation, structural elucidation, and evaluation of  $\alpha$ -glucosidase inhibitory activity of one new megastigmane, 4'-dihydrophaseate sodium, one new benzene diol glucoside, 1,4-di-O- $\beta$ -glucopyranosyl-2-(1,1-dimethyl-propenyl) benzene,



along with nine known compounds from the leaves (Kiem et al., 2013; Yessoufou et al., 2015; Murthy et al., 2024). In 2024, Bakry et al. reported 90 metabolites were annotated, including phenolic acids, flavonoids, furanocoumarins, fatty acids and terpenoids. It also reported that 66 structures of chemical constituents, 47 of them are tentatively recognized compounds and 19 were identified as isolated metabolites. Flavonoids-C-glycosides, flavonoids-O-glycosides and isoflavonoids were present in leaves. Fruit contains significant proportions of essential fatty acids such as linoleic acid, oleic acid, palmitic acid, etc (Kansal et al., 2024). *Ficus drupacea* is an ornamental medicinal tree distributed in temperate areas and used for the treatment of paragonimiasis, malaria, anasarca, naso sinusitis and sinusitis, but also in the pharmaceutical industry as a source of  $\alpha$ -glucosidase inhibitors (Kiam et al., 2013).

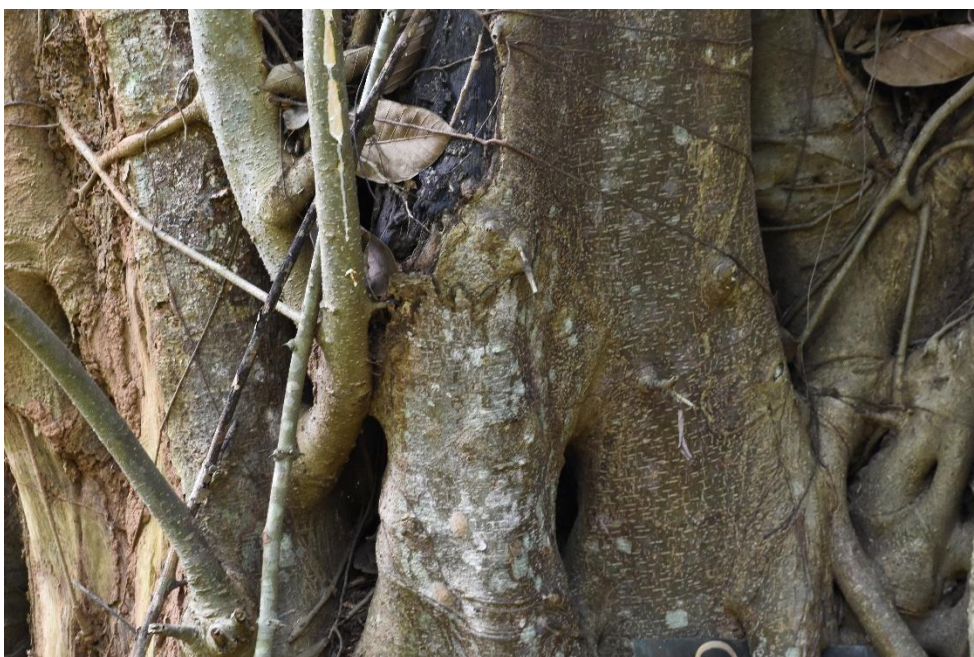
As per research done by other researchers, it revealed that a small number of *Ficus* species are used as traditional medicines, and their pharmacological activities, most of which are about some species, have not undergone any pharmacological activity. Some *Ficus* species remain underexplored compared to other medicinal plants. This chapter gives a baseline or a preliminary stage of bark.

## MORPHOLOGY

It is a large tree with few aerial roots; occasionally epiphytic; strangling fig. Lenticels tend to be in horizontal lines. A hard brown horny layer normally visible in the outer blaze. Exudate rapid and copious. Leaves ovate to ovate-elliptic, 11-22.5 x 7-16.8 cm, shortly acuminate, glabrescent, glandless, 3-6-ribbed, primary nerves 10-13, very prominent below, regular, parallel, base rounded or cordate. Both surfaces of young leaf blades densely clothed in rusty hairs. Oil dots sometimes visible on the underside of the blade with the aid of a lens. Tepals glabrous. Male flowers scattered at random among the fruitlets in the ripe fig. Bracts at the base of the fig. No lateral bracts on the outside of the fig body. Figs sessile, in axillary pairs, oblong to obovate, ca. 3cm long, nearly glabrous, orange- red when ripe (Saxena and Brahmam, 1995; Figure 1-2).



**Figure 1:** Leaves of *F. drupacea*



**Figure 2:** Bark of *F. drupacea*



## METHODOLOGY

The bark of *F. drupacea* was collected from the State Botanical Garden, Odisha, India. The plant species was identified by the authors. The Soxhlet extraction method was adopted using N- hexane, ethanolic, and methanolic extracts for phytochemical analysis (Marndi et al., 2024; Figure 3-5). Detection of nine secondary metabolites was conducted using standard methods (Kumar et al., 2013; Marndi et al., 2024).

Qualitative phytochemical analysis (Marndi et al., 2024)

**Test for tannin:** About 1 ml of the bark extract was taken. Three to five drops of 10% lead acetate solution were added. The gelatinous precipitate formation confirmed the presence of tannin.

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

**Test for flavonoids:** About 1 ml of the bark extract was taken. Two ml of 2% NaOH solution and 3 to 4 drops of dilute HCl were added. The colour initially turned to an intense yellow colour with NaOH solution and later became colourless. This colour changes in appearance confirmed the presence of flavonoids.

**Test for terpenoids:** About 1 ml of the bark extract was added with 5-6 drops of chloroform and placed in the water bath for a few minutes. Then 5-6 drops of concentrated sulphuric acid were added. The reddish-brown interface confirmed the presence of terpenoids.

**Test for phenolic groups:** About 1 ml of the bark 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 bark extract was taken and 2 drops of Fehling's solution A followed by Fehling's solution B were added and kept in the water bath for some time. The presence of red-orange precipitate confirmed the presence of reducing sugar.

**Test for steroids:** About 1 ml of the bark extract was taken. 1 ml of chloroform and 1 ml of concentrated sulphuric acid was added to it. The



appearance of upper red and lower yellow color with green fluorescence provided the presence of steroids.

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

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

## RESULTS AND DISCUSSION

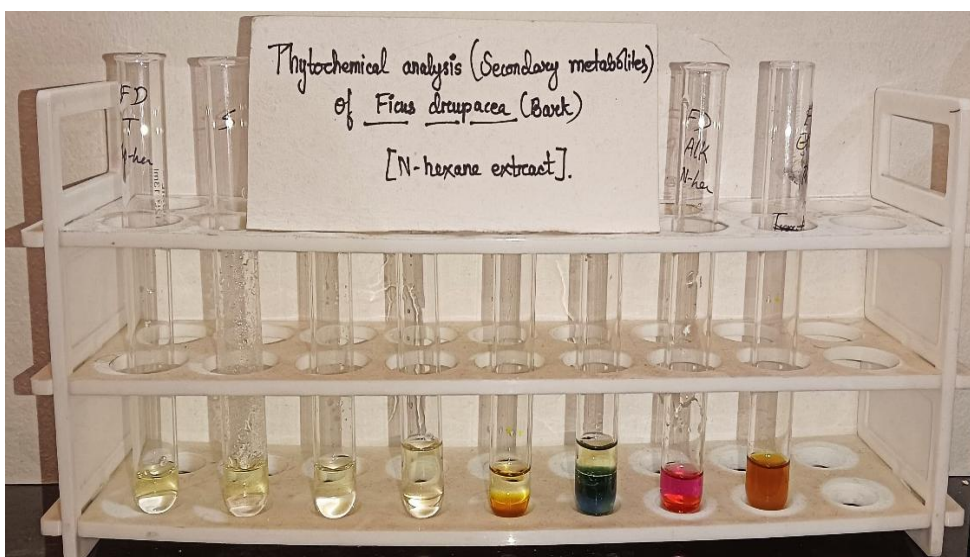
The phytochemical analysis concludes that bark of *F. drupacea* revealed the availability of tannins, saponin, reducing sugars, and alkaloids and many other compounds through literature aspects. According to table 1, it revealed that tannins, saponin, and alkaloids are present in ethanolic and methanolic extract. Reducing sugars are present in all three extracts. According to researchers, it revealed that leaves often used to treat malaria, skin infection, paragonimiasis, nasosinusitis, sinusitis and anasarca (Kiem et al., 2013). While specific documentation through literature survey it reveals that bark of *F. drupacea* has less documentation as compared to others plants parts. Many researchers have worked on *Ficus* species, but the ethnomedicinal and pharmacological values are still not documented in a proper way. Therefore, through this the phytochemical screening it will aid in for more exploratory cum laboratory work in future works.

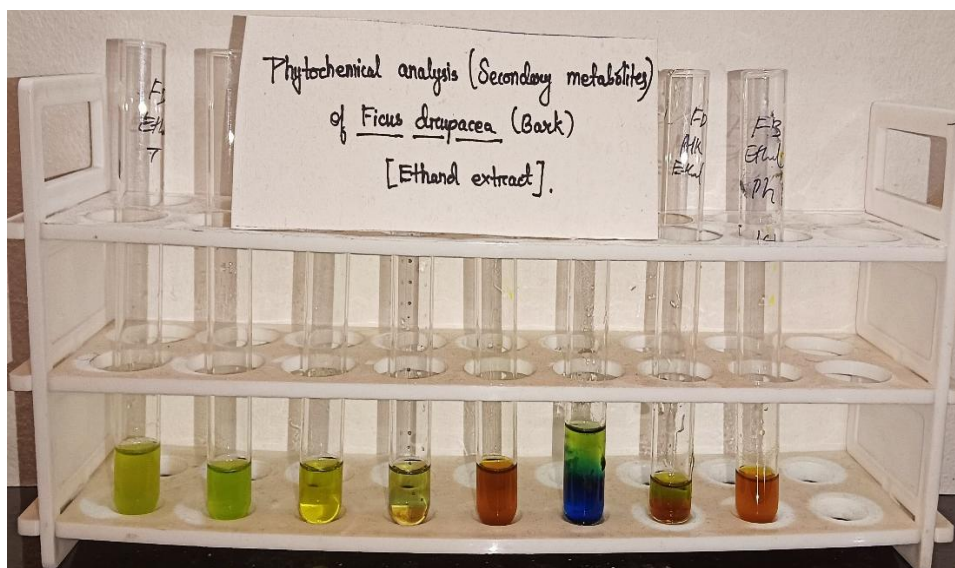


**Figure 3:** Bark sample for phytochemical analysis of *F. drupacea*

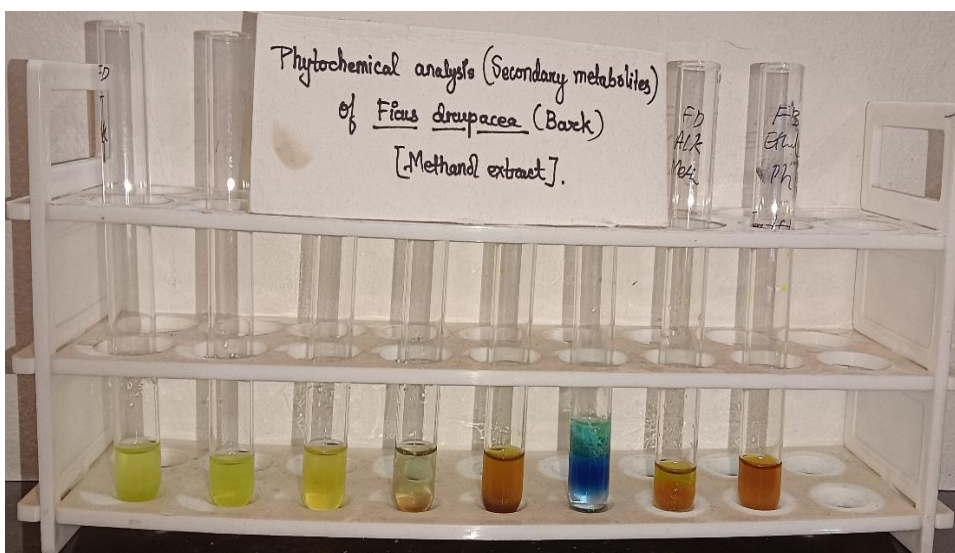
**Table 1:** Phytochemical screening of *F. drupacea* bark

| Bioactive compounds | N-hexane | Ethanol | Methanol |
|---------------------|----------|---------|----------|
| Tannin              | -        | +       | +        |
| Saponin             | -        | +       | +        |
| Flavonoid           | -        | -       | -        |
| Terpenoids          | -        | -       | -        |
| Phenolic compounds  | -        | -       | -        |
| Reducing sugars     | +        | +       | +        |
| Steroids            | -        | -       | -        |
| Alkaloids           | -        | +       | +        |
| Carbonyl compounds  | -        | -       | -        |

**Figure 3:** Phytochemical analysis (Secondary metabolites) of *F. drupacea* (Bark) of n- hexane extract



**Figure 4:** Phytochemical analysis (Secondary metabolites) of *F. drupacea* (Bark) of ethanol extract



**Figure 5:** Phytochemical analysis (Secondary metabolites) of *F. drupacea* (Bark) of methanol extract

### ETHNOMEDICINAL USES

Various parts of the plant, including roots, leaves, fruits and bark are employed to treat a range of ailments. According to table 2, it concludes that



plants parts such as leaves, latex and root treat various ailments. Mostly leaves are used for ethnomedicinal uses to cure certain diseases malaria, diabetes, gastric ulcers and parasitic lung infection. Copiously, mode of uses mostly decoction and paste of intake plants parts. Apparently, through various literature survey it concludes that less work carried out in aspects of ethnomedicinal values of *F. drupacea*.

**Table 2:** Ethnomedicinal uses of *F. drupacea*

| Plants parts | Mode of uses | Medicinal uses           | Sources                                                              |
|--------------|--------------|--------------------------|----------------------------------------------------------------------|
| Latex        | Paste        | Wounds                   | Kansal and Shukla, (2025)                                            |
| Leaves       | Decoction    | Malaria                  | Andalil et al., (2023)                                               |
| Leaves       | Decoction    | Diabetes                 | Kansal and Shukla, (2025); Kiam et al., (2013)                       |
| Leaves       | Decoction    | Gastric ulcers           | Bakry et al., (2023)                                                 |
| Leaves       | Decoction    | Parasitic lung infection | Shukla and Kansal, (2024); Kiam et al., (2013); Bakry et al., (2023) |
| Root         | Paste        | Skin infections          | Shukla and Kansal, (2024)                                            |

### PHARMACOLOGICAL ASPECTS

According to Table 3, it concludes that stem bark and leaves and fruits possess antifungal, antibacterial, anticancer, antidiabetic, anti-inflammatory,



antioxidant, antiulcerogenic, wound healing, and anti-hyperlipidemic properties.

**Table 3:** Pharmacological aspects of *F. drupacea*

| Plants parts | Pharmacological activities               | Sources                   |
|--------------|------------------------------------------|---------------------------|
| Fruits       | Antioxidant                              | Murthy et al., (2024)     |
| Leaves       | Antidiabetic                             | Kansal and Shukla, (2025) |
| Leaves       | Anti-inflammatory                        | Kansal and Shukla, (2025) |
| Leaves       | Antiulcerogenic                          | Bakry et al., (2024)      |
| Leaves       | Wound healing                            | Bakry et al., (2024)      |
| Leaves       | Anti-hyperlipidemic                      | Bakry et al., (2024)      |
| Stem bark    | Antifungal, antibacterial and anticancer | Yessoufou et al., (2015)  |

### CONCLUSION

As per a survey conducted through literature, survey there is comparatively less detailed documentation specifically on the ethnomedicinal uses of the bark of *Ficus drupacea* when compared to its leaves, roots and latex. However, some information regarding the general references to *Ficus* species often mentions the bark as having medicinal properties, and *F. drupacea* is part of that genus; specific and detailed traditional applications of its bark are



less frequently documented as available in literature. Keeping this in mind, an attempt has been made to summarize the phytochemical, ethnomedicinal, pharmacological activities.

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## CHAPTER 7

### Bark of *Ficus amplissima* Sm.: - identification of novel bioactive compounds and their therapeutic implications

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**Abstract:** This chapter focuses on identifying therapeutic compounds from *Ficus amplissima* bark. The tree has a long history in traditional medicine for treating various health problems. However, the full range of its bioactive compounds, especially novel ones, remains largely unexplored. Present chapter aims to fill this gap by evaluating the bioactive compounds, especially in the bark of *F. amplissima*. Therefore, the chapter will analyze its bioactive compounds, which could lead to innovative natural product-based treatments for chronic diseases.

**Keywords:** Traditional, medicinal, pharmacological, phytochemical



## INTRODUCTION

The enduring legacy of natural products in drug discovery since ancient times, natural products derived from plants, and microorganisms, have served as the keystone of medicine and continue to be an indispensable source for the discovery and development of novel therapeutic agents. Traditional medicine classifications, such as Ayurveda, Siddha, Unani, and traditional Chinese medicine, have accumulated vast empirical knowledge over millennia regarding the medicinal properties of various plant species. This rich ethnopharmacological heritage provides a powerful roadmap for modern scientific inquiry, directing researchers towards promising natural sources that warrant rigorous study for their bioactive constituents. The past few decades have witnessed a resurgence of interest in natural product plant-based for drug discovery, driven by the escalating challenges of drug resistance, the emergence of new diseases, and the growing demand for safe and effective therapies.

The genus *Ficus*, belonging to the Moraceae family, comprises over 880 species of trees, shrubs, and climbers widely distributed across tropical and subtropical regions. Many *Ficus* species are renowned for their traditional medicinal uses, often attributed to their rich phytochemical constituents (Smruti et al., 2022; Sasidharan et al., 2023; Chandra et al., 2023; POWO, 2025). *Ficus amplissima* Smith, commonly known as "Indian Bat Fig" or "Piparee" in various regional languages. It is a large, spreading tree found extensively in India, Sri Lanka, and parts of Southeast Asia and Northern Australia. In India, it is distributed in the Himalaya, Assam, Sikkim, Kerala, Tamil Nadu, Andhra Pradesh, and Maharashtra (Arunachalam et al., 2013). Figs in the months of September to February. *F. amplissima* bark holds significant therapeutic prominence. It is traditionally used for a diverse range of ailments, including diabetes, inflammatory conditions, and various skin disorders (Arunachalam et al., 2014). The bark's decoction is often employed as an antidiabetic remedy, believed to help regulate blood glucose levels (Salehi et al., 2019). Furthermore, its anti-inflammatory and antioxidant properties have been recognized, leading to its traditional application in wound healing and the management of inflammatory conditions. Other uses, such as leaves and branches, are used for fodder food for cows, goats and sheep. In rural areas, it is used for fuelwood and used as timber. Ripened fruit are used to make pickles (Reddy et al., 2024). Apart



from its medicinal and food value, it also has ecological significance. Mostly the avian species consume the fig of *F. amplissima*, such as the Asian green bee-eater (*Merops orientalis*), rufous treepie (*Dendrocitta vagabunda*), blue-winged parakeet (*Psittacula columboides*), eurasian golden oriole (*Oriolus oriolus*), and common myna (*Acridotheres tristis*). Some faunal species also consumed the figs, such as the lesser short-nosed fruit bat (*Cynopterus brachyotis*), greater short-nosed fruit bat (*Cynopterus sphinx*), leopard (*Panthera pardus*), and Indian moorhen (*Gallinula chloropus*) (Vanitharani et al., 2009; Mahajan and Das, 2020; Devi et al., 2022).

Previous investigations by many researchers on various parts of *Ficus amplissima* and other *Ficus* species have revealed the presence of a wide array of secondary metabolites. These include flavonoids, phenolic acids, tannins, triterpenoids (such as lupeol, lupenyl acetate,  $\beta$ -amyrin, and  $\alpha$ -amyrin), steroids (like  $\beta$ -sitosterol, and ergost-5-en-3-ol), fatty acids (e.g., myristic acid, stearic acid, and linoleic acid), coumarins, alkaloids, and glycosides (Smruti et al., 2022). These compounds are largely responsible for the pharmacological activities of *Ficus* species. Pharmacological studies on *Ficus amplissima* bark extracts have indeed validated several of its traditional uses. Despite the existing knowledge, the full chemical repertoire of *Ficus amplissima* bark, particularly regarding novel or previously uncharacterized compounds, remains largely unexplored. Many traditional remedies are complex mixtures, and the synergistic effects of multiple compounds may contribute to their overall efficacy. The identification of novel compounds can lead to the discovery of new pharmacophores, providing fresh insights into molecular mechanisms of action and offering unique opportunities for drug development. Aerial roots of *F. amplissima* are used for natural fiber-reinforced polymer composites. In 2029, Kumbhar et al. reported the dyeing of cotton with brown natural dye extracted from the leaves of *F. amplissima* (Kumbhar et al., 2019; Rameshkannan et al., 2025). The current scenario of natural product research increasingly emphasizes the use of advanced analytical techniques to precisely identify and characterize even low-abundance compounds that might possess significant bioactivity. Traditional approaches often focused on known compound classes, potentially overlooking unique chemical entities. Therefore, a systematic and targeted approach is crucial to unlock the complete therapeutic potential of *F. amplissima* bark.



## MORPHOLOGY

It is a large spreading tree, often epiphytic when young, usually without aerial roots; bark smooth, white or greenish. Leaves elliptic, oblong, narrowly ovate or ovate, 8-14 x 4-7 cm, apex very bluntly acuminate or acute to obtuse, glabrous (puberulous or pubescent), coriaceous, secondary nerves, 7-13 above the basal ones and not much stronger than the intermediate, basal nerves usually 3 and 2 weaker ones, punctulate, dots translucent when fresh, showing as minute tubercles when dry, base rounded, subtruncate (or cuneate or oblique); petiole 3-5 cm or nearly as long as the blade. Figs globose or globose-pyriform from a broad base, 1-1.5 cm diam., not wrinkled when dry, 1-2 axillary and from the leaf – scars, white or sometimes purplish, often with large not raised dots, sometimes pubescent or puberulous; basal bracts very broadly ovate, 1.2-2.7 mm, unequal, more or less connate, covering only the broad base of the figs (**Saxena and Brahmam, 1995; Figure 1-3**).



**Figure 1:** Leaves of *F. amplissima*



**Figure 2:** Fruit of *F. amplissima*



**Figure 3:** Syconium of *F. amplissima*



## METHODOLOGY

The bark of *F. amplissima* was collected from the State Botanical Garden, Odisha, India (**Figure 4**). The plant species was identified by the authors. The Soxhlet extraction method was adopted using three solvents for phytochemical analysis (**Marndi et al., 2024; Figure 5-7**). Detection of nine secondary metabolites was conducted using standard methods (**Kumar et al., 2013**).

### Qualitative phytochemical analysis (**Marndi et al., 2024**)

**Test for tannin:** About 1 ml of the bark extract was taken. Three to five drops of 10% lead acetate solution were added. The gelatinous precipitate formation confirmed the presence of tannin.

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

**Test for flavonoids:** About 1 ml of the bark extract was taken. Two ml of 2% NaOH solution and 3 to 4 drops of dilute HCl were added. The colour initially turned to an intense yellow colour with NaOH solution and later became colourless. This colour change in appearance confirmed the presence of flavonoids.

**Test for terpenoids:** About 1 ml of the bark extract was added with 5-6 drops of chloroform and placed in the water bath for a few minutes. Then 5-6 drops of concentrated sulphuric acid were added. The reddish-brown interface confirmed the presence of terpenoids.

**Test for phenolic groups:** About 1 ml of the bark 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 bark extract was taken and 2 drops of Fehling's solution A followed by Fehling's solution B were added and kept in the water bath for some time. The presence of red-orange precipitate confirmed the presence of reducing sugar.

**Test for steroids:** About 1 ml of the bark extract was taken. 1 ml of chloroform and 1 ml of concentrated sulphuric acid was added to it. The



appearance of upper red and lower yellow color with green fluorescence provided the presence of steroids.

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

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

## RESULTS AND DISCUSSION

During the literature survey it was revealed that the use of fruit, leaves and latex is used to cure various ailments. The preliminary phytochemical screening of the three extracts (N-hexane, methanol and ethanol) revealed the presence of tannin, saponin, reducing sugars and alkaloids (**Table 1; Figure 5-7**). Tannin, saponin, and alkaloids are present in methanolic and ethanolic extracts. Reducing sugars are present in all three extracts.

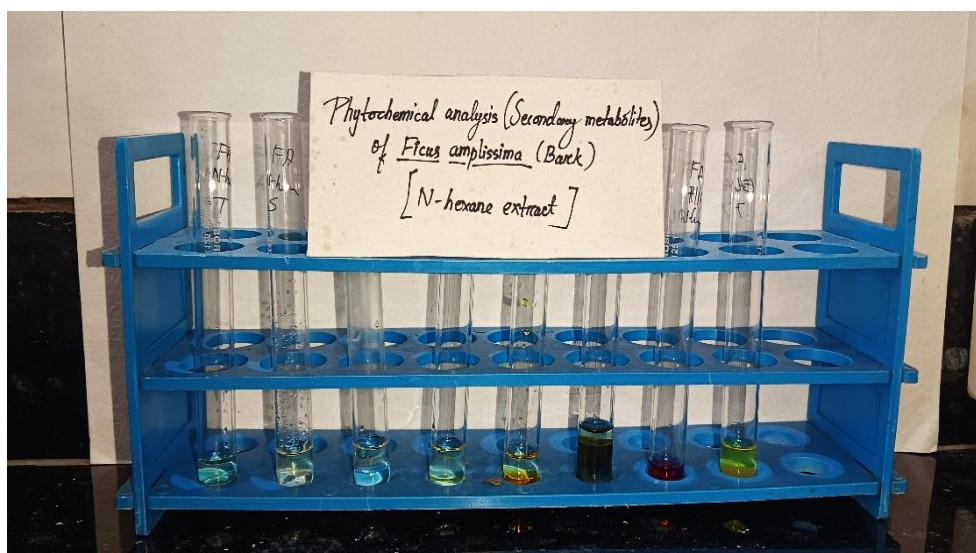
**Table 1:** Phytochemical screening using different extracts of *F. amplissima*

| Bioactive Compounds | N- Hexane extract | Methanolic extract | Ethanolic extract |
|---------------------|-------------------|--------------------|-------------------|
| Tannin              | -                 | +                  | +                 |
| Saponin             | -                 | +                  | +                 |
| Flavonoid           | -                 | -                  | -                 |
| Terpenoids          | -                 | -                  | -                 |
| Phenolic compound   | -                 | -                  | -                 |
| Reducing sugars     | +                 | +                  | +                 |
| Steroids            | -                 | -                  | -                 |
| Alkaloids           | -                 | +                  | +                 |
| Carbonyl Compound   | -                 | -                  | -                 |

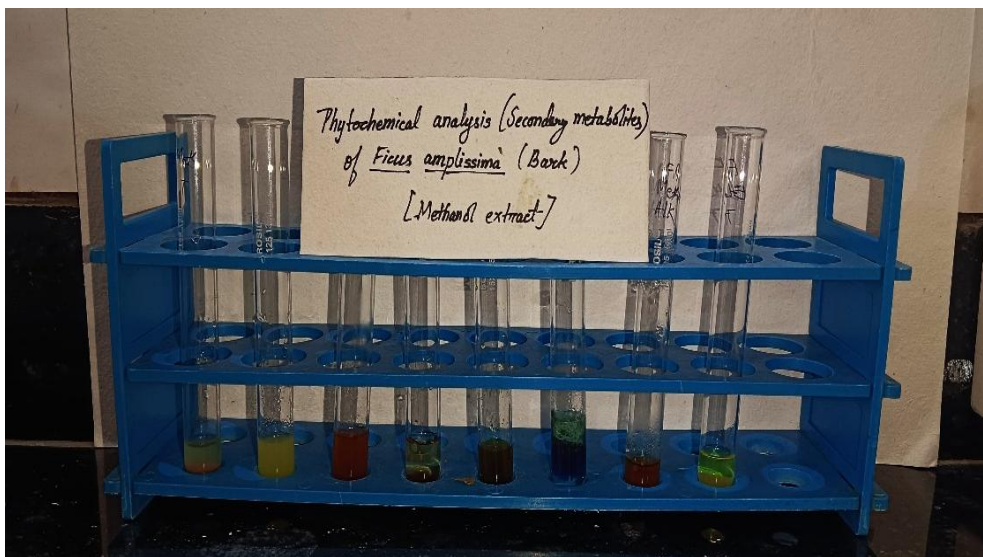
(+ve – Positive; -ve – Negative)



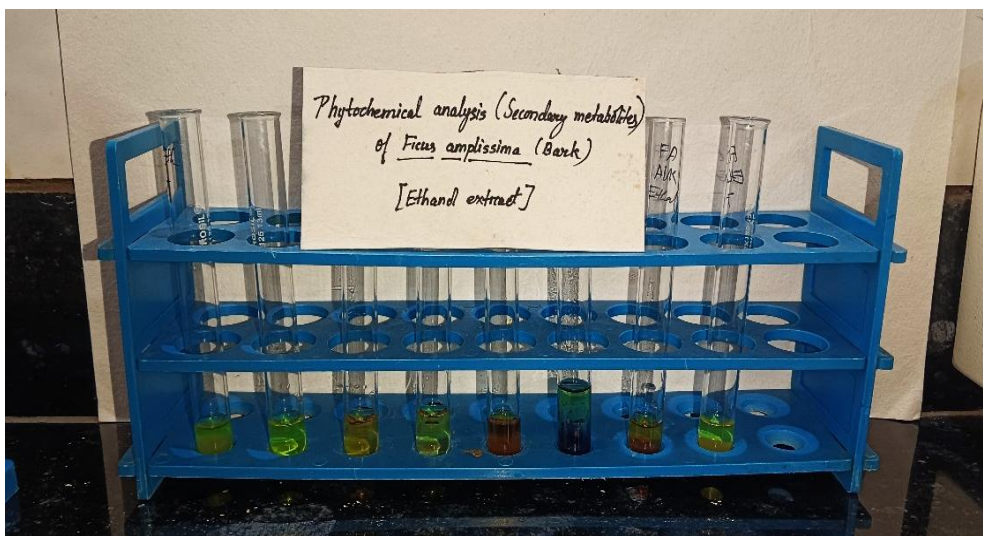
**Figure 4:** Bark sample for phytochemical screening



**Figure 5:** Phytochemical analysis (Secondary metabolites) of *F. amplissima* (Bark) of n- hexane extract



**Figure 6:** Phytochemical analysis (Secondary metabolites) of *F. amplissima* (Bark) of methanolic extract



**Figure 7:** Phytochemical analysis (Secondary metabolites) of *F. amplissima* (Bark) of ethanolic extract

According to Table 2, through tentative literature survey it concluded that bark, figs, fruit, latex and leaves are used to treat diabetes, mouth ulcers, mentally deranged, and wound healing in the form of decoction, raw and paste.



**Table 2:** Ethnomedicinal uses of *F. amplissima*

| Plants parts | Mode of uses | Diseases          | Sources                                          |
|--------------|--------------|-------------------|--------------------------------------------------|
| Bark         | Decoction    | Diabetes          | Reddy et al., (2024); Arunachalam et al., (2013) |
| Figs         | Raw          | Mouth ulcers      | Reddy et al., (2024)                             |
| Fruit        | Raw          | Mentally deranged | Arunachalam et al., (2014)                       |
| Latex        | paste        | Wound             | Reddy et al., (2024)                             |
| leaves       | Paste        | Wound healing     | Reddy et al., (2024)                             |

Research has demonstrated its significant antidiabetic activity, with studies showing a dose-dependent reduction in fasting blood glucose levels in diabetic models. The mechanisms proposed for its antidiabetic effects include improved insulin sensitivity, inhibition of glucose absorption, and regulation of enzyme activities involved in glucose metabolism (Salehi et al., 2019). Moreover, the bark extracts have exhibited notable anti-inflammatory and antioxidant properties in various in vitro and in vivo assays (Smruti et al., 2022). These activities are often attributed to the presence of phenolic compounds and flavonoids, which are known free radical scavengers and modulators of inflammatory pathways. According to Table 3, it concluded that the plant parts such as bark, leaves and fruit possess antidiabetic, antioxidant, anti-inflammatory, anti-hyperglycemic, wound-healing and antibacterial activity. Bark possesses antidiabetic, antioxidant, anti-hyperglycemic and anti-inflammatory properties. Leaves possess anti-inflammatory, wound-healing, and antibacterial activity. Fruit possesses antioxidant activity.



**Table 3:** Pharmacological aspects of *F. amplissima*

| Plant parts | Pharmacological values         | Sources                                                      |
|-------------|--------------------------------|--------------------------------------------------------------|
| Bark        | Antidiabetic and antioxidant   | Reddy et al., (2024); Arunachalam and Parimelazhagan, (2013) |
| Bark        | Antioxidant, anti-inflammatory | Murugan et al., (2012)                                       |
| Bark        | Anti-hyperglycemic             | Sindhe et al., (2016)                                        |
| Fruit       | Antioxidant                    | Thangaraj, (2013)                                            |
| Leaves      | Anti-inflammatory              | Reddy et al., (2024)                                         |
| Leaves      | Wound healing                  | Arunachalam and Parimelazhagan, (2013)                       |
| Leaves      | Antibacterial                  | Prabu and Johnson, (2015)                                    |

**CONCLUSION**

These widespread traditional applications strongly suggest the presence of potent bioactive compounds within the bark of *Ficus amplissima*. Apparently, the literature survey concluded that there was less documentation of the ethnomedicinal and pharmacological activity of *Ficus amplissima* compared to some other well-studied medicinal plants. The perception is that the sheer diversity within the *Ficus* genus means that research efforts might be fragmented across many species, rather than concentrated on a few, potentially leading to less in-depth documentation for any single lesser-known species. Therefore, keeping this in view, an attempt has been made to put a limelight on the ethnomedicinal and pharmacological activities of



bark *F. amplissima*, which could aid in the development of natural product-derived drugs for chronic disease.

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## CHAPTER 8

### The medicinal and ecological value of *Ficus concinna*: - a comprehensive analysis of its ethnobotany, pharmacology, and phytochemistry

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**Abstract:** *Ficus concinna*, a graceful fig species native to various regions of Asia, possesses notable yet largely underexplored nutritional, medicinal, and ecological value. This comprehensive chapter brings together current knowledge on its ethnobotanical applications, pharmacological activities, and phytochemical composition, aiming to underscore its potential and guide future research efforts. Traditional medicinal systems have used *F. concinna* to address a range of health issues. Although pharmacological studies remain limited. Preliminary phytochemical analyses indicate the presence of bioactive compounds present in bark, including saponin, tannin, terpenoids, and alkaloides, which are likely responsible for its observed therapeutic potential. This chapter underscores the need for further systematic research to fully elucidate the therapeutic mechanisms and isolate novel bioactive compounds of *F. concinna* bark, thereby unlocking its full potential for both human well-being and ecological conservation.

**Keywords:** Ecological, medicinal plant, pharmacological, phytochemical



## INTRODUCTION

The plant kingdom has long served as an invaluable source of both ecological stability and medicinal compounds, offering solutions to a myriad of environmental challenges and human health concerns. Within this vast kingdom, the genus *Ficus* (family Moraceae) stands as a particularly remarkable and diverse group, comprising over 880 species distributed predominantly across tropical and subtropical regions worldwide (Chaudhary et al., 2012; Sasidharan et al., 2023; Hossain et al., 2025). Figs hold both cultural significance and critical ecological importance. They are often regarded as "keystone species" because their asynchronous fruiting provides a reliable year-round food source for a diverse range of frugivores, thereby supporting and maintaining biodiversity within their ecosystems. Their complex mutualistic relationship with fig wasps for pollination further underscores their distinctive evolutionary and ecological significance (Mackay et al., 2018).

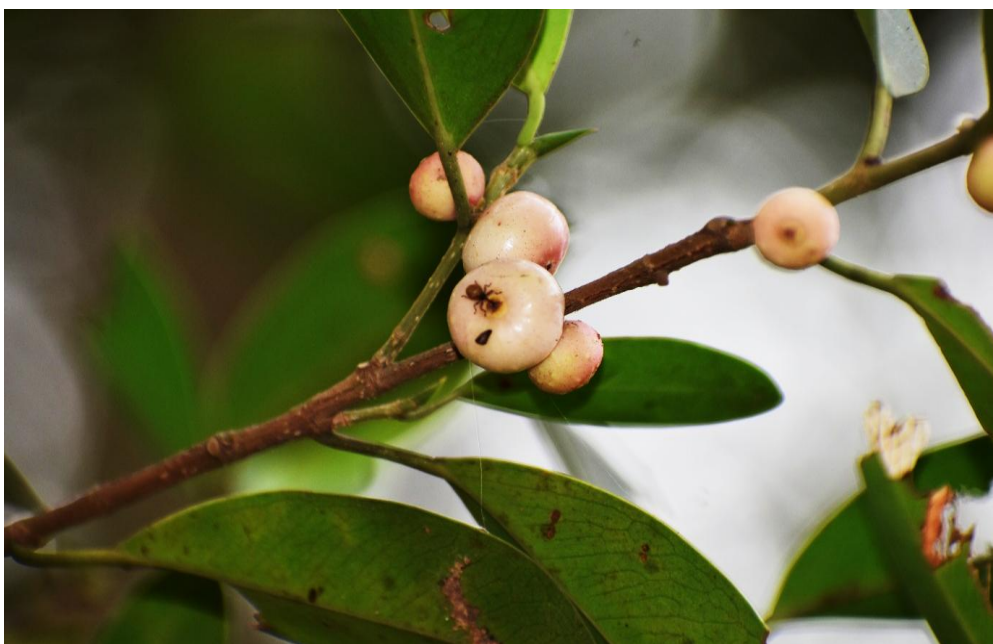
Among the many species within this ecologically important genus, *Ficus concinna* (Miq.) Miq. which is commonly known as the Red Leaf Fig or Drooping Fig, stands out as a notable tree native to a wide geographical area, extending from India and Bangladesh to southern China, Myanmar, Thailand, Vietnam, and Borneo. In India, *F. concinna* is found across several regions, including the Andaman Islands, Assam, Bihar, Jharkhand, Madhya Pradesh, Meghalaya, Odisha, Sikkim, and West Bengal (Karthigeyan and Jayanthi, 2016). *F. concinna* has synonyms *Ficus glabella* var. *concinna* (Miq.) King and *Urostigma concinnum* Miq. (POWO, 2025). In India, it is distributed across various states, with significant diversity found in the North-East and Peninsular regions (Chaudhary et al., 2012). *F. concinna* is characterized by its distinctive aerial roots and often cultivated as an ornamental tree in urban landscapes, demonstrating its adaptability to various environmental conditions, including those influenced by climate change and urbanization (Hayat et al., 2022). It is predominantly found in semi-evergreen forests, particularly along stream banks. Its capacity to sustain high transpiration rates even under relatively dry conditions highlights its potential in mitigating urban heat island effects. In addition to its ecological value, *F. concinna* has been traditionally used in folk medicine by various indigenous communities throughout its native range, albeit to a lesser extent than some other species. Ethnobotanical records document the use of different parts of



the plant including the leaves, bark, roots, and stems for treating a wide range of ailments. These include inflammatory conditions, gastrointestinal issues such as diarrhea and dysentery, skin infections, and its use as a general health tonic. It has also been employed in the traditional management of diabetes, arthritis, and urinary tract infections (**Dapar et al., 2020**). In the Philippines, the Manobo tribe traditionally uses decoctions made from the leaves, bark, and roots of *F. concinna* as potential anticancer remedies (**Cabanlit et al., 2025**). As per the literature, it revealed that less documentation was carried out on medicinal values. Despite its widespread traditional use, the scientific validation of these claims and a comprehensive understanding of the underlying pharmacological mechanisms remain relatively underexplored for *F. concinna* specifically. Preliminary phytochemical screenings of *Ficus* species, in general, suggest the presence of a wide array of bioactive compounds, including flavonoids, terpenoids, phenolic acids, alkaloids, saponins, and steroids (**Murugesu et al., 2021; Chandra et al., 2023**). In some parts of the world the tender leaves serve as a source of edible vegetables (**Mon et al., 2020; Zhang and Hou, 2022**). These secondary metabolites are often associated with the observed medicinal properties in plants. The wood of *F. concinna* is used as fuelwood (**Lepcha and Sharma, 2021**). However, comprehensive phytochemical profiling of *F. concinna* and the identification of specific compounds or extracts linked to particular pharmacological effects remains in its early stages. Considering the species' important ecological role and its widespread, yet scientifically underexplored, use in traditional medicine, a thorough review of its ethnobotanical applications, pharmacological properties, and phytochemical composition is essential. Such a review would not only integrate the currently scattered body of knowledge but also identify critical research gaps, thereby guiding future scientific inquiry. This chapter aims to provide a holistic analysis of *F. concinna*, emphasizing its multifaceted value and underscoring its potential as a source of novel therapeutic agents and as a species vital for ecosystem health and biodiversity conservation. Ultimately, this comprehensive synthesis seeks to stimulate further scientific inquiry into *F. concinna*, contributing to its sustainable utilization and conservation in the face of ongoing environmental and health challenges.



**Figure 1:** Leaves of *F. concinna*



**Figure 2:** Figs of *F. concinna*



**Figure 3:** Bark of *F. concinna*



**Figure 4:** Bark sample for phytochemical analysis



## MORPHOLOGY

It is a tall tree upto 25-30 m high. The branchlets are terete, smooth, and hairless (glabrous), with sparse lenticels. The leaves are simple and arranged alternately. They are narrowly elliptic to oblong-elliptic or ovate in shape, with bases that range from rounded to wedge-shaped (cuneate). The leaf margins are entire (smooth, without teeth), dark green and glossy on the upper surface, and pale on the underside. Both surfaces are glabrous and coriaceous. There are 9-10 pairs of lateral veins, and the midrib is canaliculate on the upper side. The petiole is glabrous and measures 1-2.1 cm in length and 2.1-2.4 mm in width. The stipules are ovate, 7-9 mm long and 3-5 mm wide, tapering to a long point (long acuminate), hairless, and fall off early (caducous). The hypanthodium is sessile, occurring singly or in pairs, sub-globose in shape, and dark orange, turning scarlet red upon maturity, with a few pale yellowish spots. It is glabrous throughout. The basal bracts are persistent, ovate, and glabrous. The ostioles are prominent, located at the ostiolar region, and are minutely ovate in shape. The interfloral bracts are lanceolate and glabrous. Male flowers are few in number, located near the ostiole, and are minutely pedicellate. They have three united tepals, and the anthers are broadly ovoid in shape. Gall flowers are pedicellate. Female flowers are also pedicellate, measuring 2.6-3 mm in length. They have three glabrous tepals, each 1-1.4 mm long. The ovary is ovoid or nearly spherical (sub-globose), with a style 1-1.5 mm long and a bifid stigma (Karthigeyan and Jayanthi, 2016; Figure 1-4).

## METHODOLOGY

The bark of *F. concinna* was collected from the State Botanical Garden, Odisha, India. The plant species was identified by the authors. The Soxhlet extraction method was adopted using three solvents (N-hexane, ethanolic, and methanolic) for phytochemical analysis. Detection of nine secondary metabolites was conducted using standard methods (Kumar et al., 2013; Marndi et al., 2024).

### Qualitative phytochemical analysis (Marndi et al., 2024)

**Test for tannin:** About 1 ml of the bark extract was taken. Three to five drops of 10% lead acetate solution were added. The gelatinous precipitate formation confirmed the presence of tannin.



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

**Test for flavonoids:** About 1 ml of the bark extract was taken. Two ml of 2% NaOH solution and 3 to 4 drops of dilute HCl were added. The colour initially turned to an intense yellow colour with NaOH solution and later became colourless. This colour changes in appearance confirmed the presence of flavonoids.

**Test for terpenoids:** About 1 ml of the bark extract was added with 5-6 drops of chloroform and placed in the water bath for a few minutes. Then 5-6 drops of concentrated sulphuric acid were added. The reddish-brown interface confirmed the presence of terpenoids.

**Test for phenolic groups:** About 1 ml of the bark 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 bark extract was taken and 2 drops of Fehling's solution A followed by Fehling's solution B were added and kept in the water bath for some time. The presence of red-orange precipitate confirmed the presence of reducing sugar.

**Test for steroids:** About 1 ml of the bark extract was taken. 1 ml of chloroform and 1 ml of concentrated sulphuric acid was added to it. The appearance of upper red and lower yellow color with green fluorescence provided the presence of steroids.

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

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

## RESULTS AND DISCUSSION

A thorough scrutiny of the literature survey revealed that some plant parts of *F. concinna* have less documentation on medicinal properties. Researchers often prioritize documentation on the species with a long history of

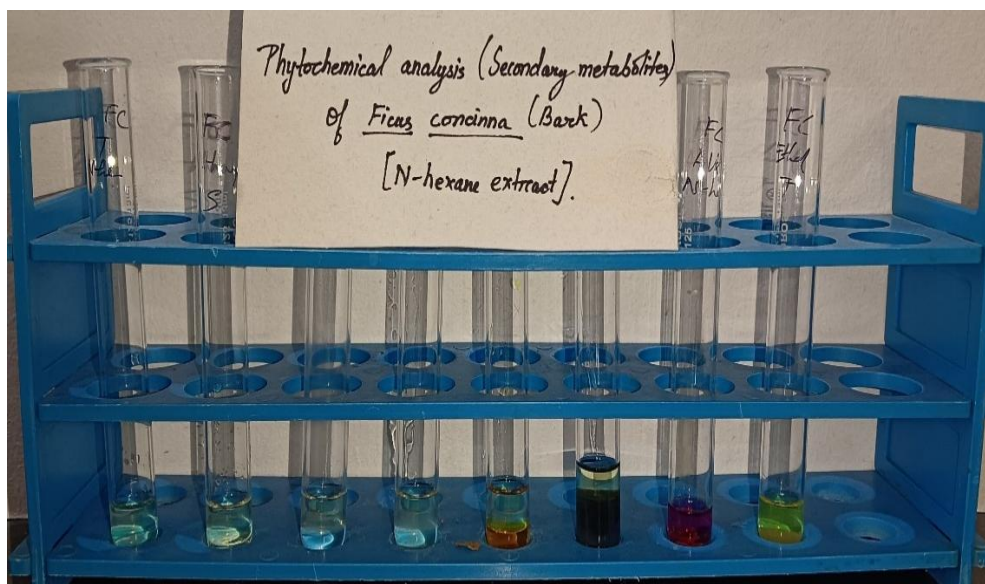


widespread traditional uses, leading to more accumulated data for the species of *F. concinna*. Preliminary phytochemical analysis revealed that tannin and alkaloids are present in methanolic and ethanolic extracts. Saponin and terpenoids are present in the methanolic extract. Reducing sugars are present in all the extract (**Table 1; Figure 5-7**).

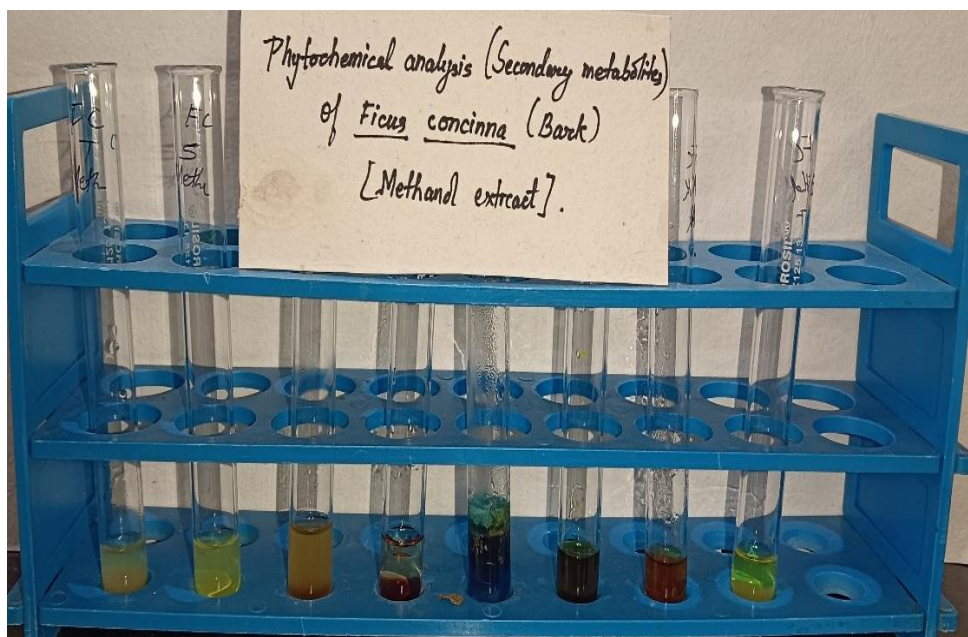
**Table 1:** Phytochemical analysis using different extracts of *F. concinna*

| Bioactive compounds | N-hexane extract | Ethanolic extract | Methanolic extract |
|---------------------|------------------|-------------------|--------------------|
| Tannin              | -                | +                 | +                  |
| Saponin             | -                | -                 | +                  |
| Flavonoids          | -                | -                 | -                  |
| Terpenoids          | -                | -                 | +                  |
| Phenolic compounds  | -                | -                 | -                  |
| Reducing sugars     | +                | +                 | +                  |
| Steroids            | -                | -                 | -                  |
| Alkaloids           | -                | +                 | +                  |
| Carbonyl compounds  | -                | -                 | -                  |

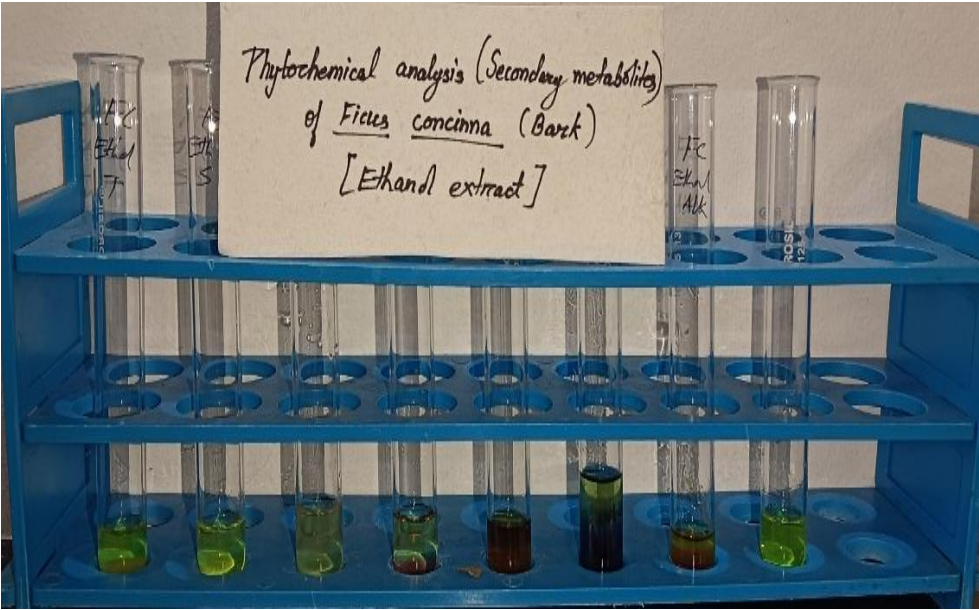
(‘+’ve – Positive; ‘-’ ve – Negative)



**Figure 5:** Phytochemical analysis (Secondary metabolites) of *F. concinna* (Bark) of n-hexane extract



**Figure 6:** Phytochemical analysis (Secondary metabolites) of *F. concinna* (Bark) of methanolic extract



**Figure 7:** Phytochemical analysis (Secondary metabolites) of *F. concinna* (Bark) of ethanolic extract

There might be a lack of comprehensive ethnomedicinal surveys focusing specifically on *F. concinna* in all regions where it grows. This could lead to traditional knowledge not being systematically recorded and therefore have less scientific literature available. According to Table 2, only a few researchers have recorded the use of leaves and stems, primarily for treating cancer, cuts, and wounds, while little to no research has been conducted on the bark, roots, and fruits. This gap presents an opportunity for future researchers to explore and contribute to this under-studied area.

**Table 2:** Ethnomedicinal uses of all parts of *F. concinna*

| Plant parts             | Mode of uses | Diseases        | Sources                 |
|-------------------------|--------------|-----------------|-------------------------|
| Leaves                  | Paste        | Cuts and wounds | Dapar et al., (2020)    |
| Leaves, bark, and roots | Decoction    | Cancer          | Cabanlit et al., (2025) |
| Stem                    | Raw          | Toothache       | Devi et al., (2022)     |



The *Ficus* genus is known for its diverse array of phytochemicals associated with ethnomedicinal values, except some of the *Ficus* species are unexplored or might be overlooked. Less work is carried out on pharmacological values because maybe the particular species isn't seen as having immediate high potential or widespread traditional values; it might receive less attention and resources for in-depth studies. According to the present phytochemical analysis carried out in Table 1, on that basis their probable utilization is listed in **Table 3**.

**Table 3:** Some bioactive compounds from the *F. concinna* (bark) and their probable utilization

| Bioactive compounds | Pharmacological values                                                                                               | Sources                            |
|---------------------|----------------------------------------------------------------------------------------------------------------------|------------------------------------|
| Alkaloids           | They are well known for their analgesic and anti-inflammatory                                                        | Jiang et al., (2022)               |
| Flavonoids          | Anti-cancer                                                                                                          | Cabanlit et al., (2025)            |
| Saponin             | It contributes significantly to anti-inflammatory and antioxidant activity                                           | Jang et al., (2013)                |
| Tannin              | It possesses astringent properties which are beneficial for wound healing, treating skin infections, anti-diarrhoeal | Dufourc, (2021); Xu et al., (2023) |
| Terpenoids          | Anti-cancer, anti-inflammatory, antimicrobial activity                                                               | Thoppil and Bishayee (2011)        |

### ECOLOGICAL SIGNIFICANCE

Many *Ficus* species are well known for their ecological significance. As a keystone species in many ecosystems, it provides essential resources for a



wide range of fauna, contributing significantly to biodiversity. Its ability to thrive in various environments and its role in ecological succession further emphasize its importance in maintaining ecosystem health and resilience. Ecologically, *Ficus concinna* functions as a keystone species, contributing significantly to biodiversity and ecosystem health through its role as a food source for various fauna and its adaptability to diverse environmental conditions (**Kumar et al., 2022; Figure 8-9**). During the field survey it was revealed that figs of *F. concinna* are consumed by many avian species, such as the red whiskered bulbul and orange-headed thrush.



**Figure 8:** Red whiskered bulbul (*Pycnonotus jocosus*) consuming figs of *F. concinna*



**Figure 9:** Orange-headed thrush (*Geokichla citrina*) consuming figs of *F. concinna*

## CONCLUSION

The comprehensive analysis of *Ficus concinna* revealed a species of significant, yet underexplored, medicinal and ecological value. According to the literature study, it concluded that the traditional knowledge base serves as a crucial basis for further scientific investigation, bridging the gap between ancestral wisdom and modern pharmacological understanding. The isolation of bioactive compounds such as tannins, saponins, terpenoids, reducing sugars and alkaloids underscores the plant's complex chemical profile and its potential as a source of novel drug leads. Beyond its less data on medicinal attributes, *F. concinna* plays a vital ecological role. Its ecological significance further solidifies its position as a species worthy of conservation and continued scientific inquiry. Future research should focus on detailed ethnomedicinal studies to elucidate the precise modes of action of its active compounds, to validate its efficacy and safety in humans, and explore sustainable cultivation practices to ensure its availability for both medicinal uses and ecological preservation.



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## CHAPTER 9

### Exploring the pharmacological properties of *Ficus religiosa*: a phytochemical investigation

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**Abstract:** *Ficus religiosa*, commonly known as the sacred fig or peepal, has been traditionally utilized in various ethnomedical practices for its supposed therapeutic benefits. This phytochemical analysis aims to explore the pharmacological properties of *F. religiosa* bark by elucidating its key secondary metabolites. The chapter will involve the phytoconstituents, pharmacological, ethnomedicinal uses and ecological aspects. Subsequent pharmacological assays will be showing potential biological activity, such as anti-inflammatory, antioxidant, antimicrobial, or antidiabetic effects. This chapter seeks to provide a scientific baseline for the traditional uses of *F. religiosa* and evaluate bioactive compounds present in bark for future drug development.

**Keywords:** Traditional, ecosystem, phytoconstituents, religious, sacred

### INTRODUCTION

Medicinal plants have served as the foundation of healthcare systems for millennia across diverse cultures worldwide. From ancient civilizations to contemporary traditional practices, humanity has consistently relied on the vast biodiversity of the plant kingdom for therapeutic remedies. The World Health Organization (WHO) estimates that a significant portion of the global population still depends on traditional medicine, largely derived from plants,



for their primary healthcare needs (WHO, 2019). This enduring reliance highlights the rich ethnomedicinal knowledge passed down through generations, which often holds invaluable insights into the potential pharmacological activities of various plant species. The resurgence of interest in natural products is driven by several factors, including the escalating costs of conventional pharmaceuticals, the emergence of drug resistance in various pathogens, and a growing consumer preference for natural and holistic approaches to health (Ekor, 2014; Aware et al., 2022). This renewed focus has propelled scientific investigations into the traditional uses of medicinal plants, aiming to validate their efficacy, understand their mechanisms of action, and identify novel bioactive compounds for modern drug discovery.

*Ficus religiosa*, synonym is *Urostigma religiosum* (L.) Gasp. Ric. Caprifico (POWO, 2025). It is commonly known as the sacred fig, Peepal tree, or Bodhi tree, pipal, pipalo, aswatta, jori, usto is a species of fig native to the Indian subcontinent and Indochina. It holds profound cultural, religious, and spiritual significance in Hinduism, Buddhism, Jainism, and Sikhism, where it is revered as a sacred tree and often associated with enlightenment and spiritual awakening. It has several ancient holy texts, like Artha Sastra, Puranas, Upanishads, Ramayana, Mahabharata, Bhagavad Gita, and Buddhist literature (Verma, 2016). Beyond its symbolic importance, *F. religiosa* has been an integral part of traditional Indian medicinal systems, particularly Ayurveda, for centuries. Traditional texts and practices describe the therapeutic applications of various parts of *F. religiosa*, including its bark, leaves, fruits, and roots, for a wide spectrum of ailments. These traditional uses encompass treatments for inflammatory conditions, diabetes, skin disorders, respiratory issues (like asthma and cough), gastrointestinal problems (such as diarrhea and dysentery), and even neurological and reproductive disorders (Thakur et al., 2024). The extensive historical use and anecdotal evidence of its medicinal properties highlight its potential as a rich source of pharmacologically active compounds.

Preliminary phytochemical screenings of *F. religiosa* have revealed the presence of a diverse array of secondary metabolites, including flavonoids, tannins, phenolic compounds, steroids, triterpenoids, alkaloids, and glycosides (Rutuja et al., 2015). Many phytoconstituents are documented in all parts of plants, such as bark, leaves, fruits, and seeds. In bark, it contains phytosterols like lanosterol,  $\beta$ -sitosteryl-D-glucoside, bergapten, bergaptol



and stigmasterol. It also contains tannin, wax, saponin, leucocyanidin-3-O- $\beta$ -D-glucopyranoside, leucopelargonidin-3-O- $\beta$ -D-glucopyranoside, leucopelargonidin-3-O- $\alpha$ -L-rhamnopyranoside, lupeol, ceryl behenate, lupeol acetate,  $\alpha$ -amyrin acetate, leucoanthocyanidin and leucoanthocyanin. In fruits, it contains flavonoids, namely kaempferol, quercetin, myricetin and amino acids, namely asparagine and tyrosine. Leaves contain campesterol, stigmasterol, isofucosterol,  $\alpha$ -amyrin, lupeol, tannic acid, arginine, serine, aspartic acid, glycine, threonine, alanine. Seeds contain phytosterolin,  $\beta$ -sitosterol, glycoside, albuminoids (**Rutuja et al., 2015; Jyothisree and Umadevi, 2021**).

These natural compounds are widely recognized for their potent biological activities and are often responsible for the therapeutic effects attributed to medicinal plants. Indeed, modern pharmacological studies have begun to validate many of the traditional claims associated with *F. religiosa*. Research has demonstrated its potential in various areas, including antioxidant, anti-inflammatory, antimicrobial, antidiabetic, anti-ulcer, wound healing, hepatoprotective, nephroprotective, and even neuroprotective activities (**Devanesan et al., 2018**). Despite the extensive traditional use and emerging scientific validation, a comprehensive phytochemical investigation coupled with targeted pharmacological evaluation of isolated compounds from *F. religiosa* remains crucial. Many studies have focused on crude extracts, making it difficult to attribute specific pharmacological activities to individual chemical constituents or to understand their precise mechanisms of action. There is a need for a systematic approach to identify and characterize the specific bioactive molecules within *F. religiosa* bark that are responsible for its supposed medicinal properties. This chapter aims to bridge this knowledge gap by undertaking a phytochemical investigation of *Ficus religiosa* bark, followed by a rigorous evaluation of the pharmacological properties of its isolated compounds.

## MORPHOLOGY

It is a large tree, epiphytic when young; all parts except the bracts are the glabrous; bark grey, smooth, irregularly pitted when old. Leaves more or less pendulous, broadly ovate, 13-27x 9-17 cm, margin often repand, very long-caudate, coriaceous, dark green and shining above, base cordate or tuncate with 3 strong principle nerves and 2-4 weaker ones, secondary nerves 8-10, looped within the margin, acumen many nerved; petiole slender, 4-11 cm



long; stipules linear subulate, 4.6-8 cm long. Figs axillary, germinate, sessile, depressed-globose, 1-2 cm diam., smooth, glabrous, dark purple when ripe, basal bracts 3, broad, rounded, spreading, ciliate or pubescent, 4-7 m long (**Saxena and Brahmam, 1995; Figure 1-3**).



**Figure 1:** Leaves of *F. religiosa*



**Figure 2:** Fruit of *F. religiosa*



**Figure 3:** Bark of *F. religiosa*

### METHODOLOGY

The bark of *F. religiosa* was collected from the State Botanical Garden, Odisha, India. The plant species was identified by the authors. The Soxhlet extraction method was adopted using three solvents (N-hexane, ethanolic, and methanolic) for phytochemical analysis. Detection of nine secondary metabolites was conducted using standard methods (**Kumar et al, 2013; Marndi et al., 2024; Figure 4-7**).

#### **Qualitative phytochemical analysis (Marndi et al., 2024)**

**Test for tannin:** About 1 ml of the bark extract was taken. Three to five drops of 10% lead acetate solution were added. The gelatinous precipitate formation confirmed the presence of tannin.



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

**Test for flavonoids:** About 1 ml of the bark extract was taken. Two ml of 2% NaOH solution and 3 to 4 drops of dilute HCl were added. The colour initially turned to an intense yellow colour with NaOH solution and later became colourless. This colour changes in appearance confirmed the presence of flavonoids.

**Test for terpenoids:** About 1 ml of the bark extract was added with 5-6 drops of chloroform and placed in the water bath for a few minutes. Then 5-6 drops of concentrated sulphuric acid were added. The reddish-brown interface confirmed the presence of terpenoids.

**Test for phenolic groups:** About 1 ml of the bark 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 bark extract was taken and 2 drops of Fehling's solution A followed by Fehling's solution B were added and kept in the water bath for some time. The presence of red-orange precipitate confirmed the presence of reducing sugar.

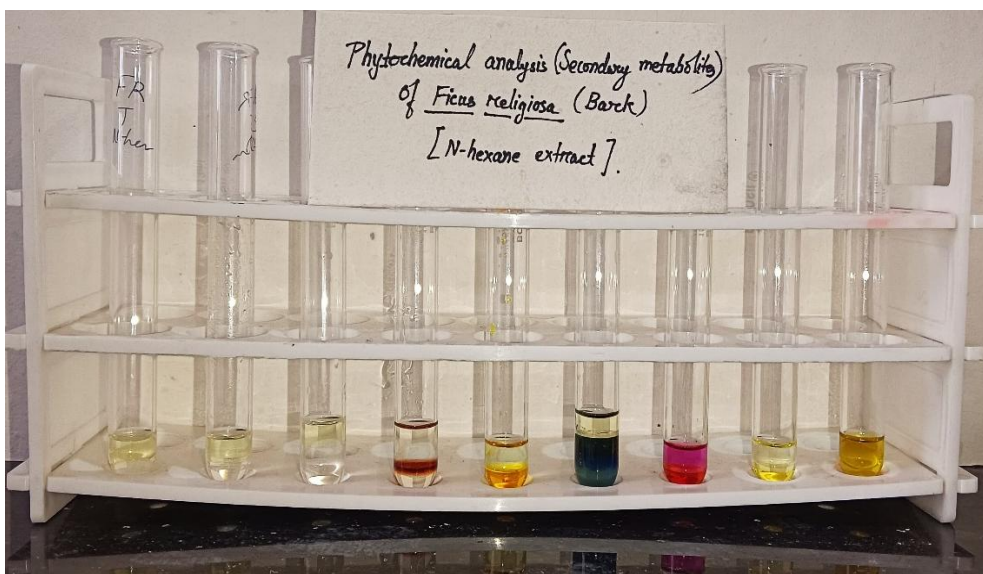
**Test for steroids:** About 1 ml of the bark extract was taken. 1 ml of chloroform and 1 ml of concentrated sulphuric acid was added to it. The appearance of upper red and lower yellow color with green fluorescence provided the presence of steroids.

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

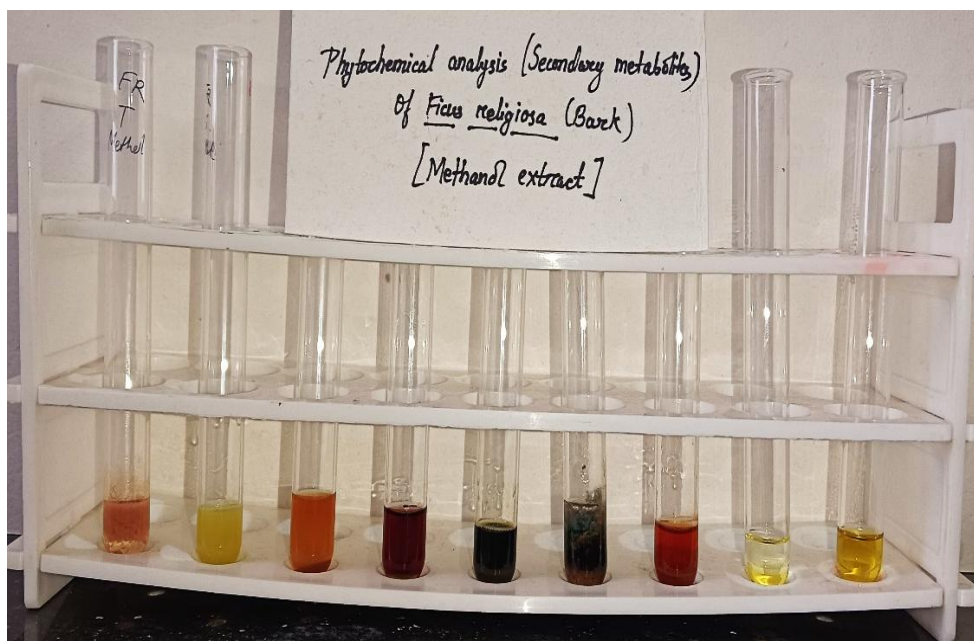
**Test for carbonyl compounds:** About 1 ml of the bark extract was taken and 3 to 4 drops of 2,4- Dinitrophenylhydrazine (DNPH) reagent was added. The formation of yellow crystals confirmed the presence of carbonyl compounds.



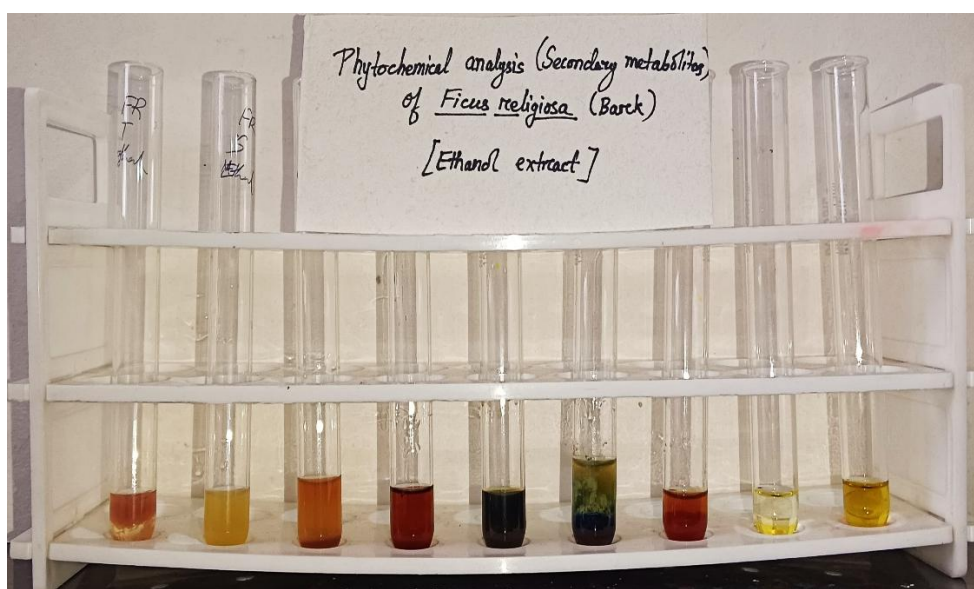
**Figure 4:** Bark of *F. religiosa* sample for phytochemical analysis



**Figure 5:** Phytochemical analysis (Secondary metabolites) of *F. religiosa* (Bark) of n- hexane extract



**Figure 6:** Phytochemical analysis (Secondary metabolites) of *F. religiosa* (Bark) of methanolic extract



**Figure 7:** Phytochemical analysis (Secondary metabolites) of *F. religiosa* (Bark) of ethanolic extract



## RESULTS AND DISCUSSION

During the field and literature survey it concluded that *F. religiosa* has abundant bioactive compounds in leaves, bark, stem, fig, latex, and root. According to researchers all parts has wide range of phytoconstituents are present which has significant role in pharmacological analysis. In Table 1, phytochemical analysis was conducted in different extracts of *F. religiosa* bark. As per Table 1, tannin, and alkaloids are present in methanolic and ethanolic extracts. Saponin and terpenoids are present in only methanolic extracts. Reducing sugars are present in all three extracts (**Figure 4-7; Table 1**).

**Table 1:** Phytochemical analysis using different extracts of *F. religiosa* bark

| Bioactive compounds | N-hexane extract | Methanolic extract | Ethanolic extract |
|---------------------|------------------|--------------------|-------------------|
| Tannin              | -                | +                  | +                 |
| Saponin             | -                | +                  | -                 |
| Flavonoids          | -                | -                  | -                 |
| Terpenoids          | -                | +                  | -                 |
| Phenolic compounds  | -                | -                  | -                 |
| Reducing sugars     | +                | +                  | +                 |
| Steroids            | -                | -                  | -                 |
| Alkaloids           | -                | +                  | +                 |
| Carbonyl compounds  | -                | -                  | -                 |

Among the *Ficus* species one of the *Ficus* species are *Ficus religiosa* has abundant ethnomedicinal value in all over the India. Rendering to literature and field survey it concluded that all plants parts have ethnomedicinal values which used to cure many different ailments. According to Table 2, it concluded that all parts such as bark, fruit, latex, leaves, and roots have a



potential to cure different ailments such as diabetes, cuts, wounds, ulcer, skin infections, fever, astringent, inflammation, toothache etc. Mostly the mode of uses are decoction, paste, infusion, juice and powder (**Table 2**).

**Table 2:** Ethnomedicinal uses of *F. religiosa*

| Plants parts      | Mode of uses | Diseases          | Sources                                          |
|-------------------|--------------|-------------------|--------------------------------------------------|
| Bark              | Decoction    | Diabetes          | Devi et al., (2022)                              |
| Bark              | Paste        | Burns             | Hastir et al., (2021); Rutuja et al., (2015)     |
| Bark              | Infusion     | Ulcer             | Hastir et al., (2021)                            |
| Bark              | Paste        | Skin infections   | Hastir et al., (2021); Shukla and Tiwari, (2023) |
| Bark              | Decoction    | Astringent        | Shukla and Kansal, (2024)                        |
| Dried Fruit       | Decoction    | Fever             | Rutuja et al., (2015)                            |
| Fruit             | Powder       | Asthma            | Sandeep et al., (2018)                           |
| Latex             | Paste        | Inflammation      | Rutuja et al., (2015)                            |
| Leaves            | Juice        | Toothache         | Rutuja et al., (2015)                            |
| Leaves and shoots | Paste        | Wound healing     | Chowdhary et al., (2014)                         |
| Root              | Powder       | Seizures          | Hastir et al., (2021)                            |
| Root              | Paste        | Elephantiasis     | Hastir et al., (2021)                            |
| Stems             | Decoction    | Urinary disorders | Sandeep et al., (2018)                           |
| Tender leaves     | Juice        | Constipation      | Kumar et al., (2022)                             |



As per the literature survey it concluded that *F. religiosa* has wide array of pharmacological activities. In Table 3, all plant parts have significant pharmacological values. Most abundantly stem and bark possess analgesic activity, anti-inflammation, anti-acetylcholinesterase, antiulcer, etc (**Table 3**).

**Table 3:** Pharmacological values of *F. religiosa*

| Plant Parts       | Pharmacological activities         | Sources                                                                                           |
|-------------------|------------------------------------|---------------------------------------------------------------------------------------------------|
| Bark              | Antidiabetic activity              | Pandit et al., (2010); Rutuja et al., (2015); Mahto et al., (2023)                                |
| Bark              | Immunomodulatory activity          | Rutuja et al., (2015)                                                                             |
| Figs              | Anticonvulsant activity            | Shukla and Tiwari, (2023); Shukla and Kansal, (2024)                                              |
| Figs              | Anti-amnesic activity              | Rutuja et al., (2015)                                                                             |
| Leaves            | Antimicrobial activity             | Mahto et al., (2023)                                                                              |
| Leaves            | Wound healing activity             | Chowdhary et al., (2014); Shukla and Kansal, (2024)                                               |
| Stem bark         | Analgesic activity                 | Rutuja et al., (2015); Shukla and Kansal, (2024)                                                  |
| Stem bark         | Anti-inflammation activity         | Rutuja et al., (2015); Shukla and Kansal, (2024)                                                  |
| Stem bark         | Anti-acetylcholinesterase activity | Rutuja et al., (2015)                                                                             |
| Stem bark         | Antiulcer activity                 | Rutuja et al., (2015); Shukla and Kansal, (2024)                                                  |
| Stem bark, leaves | Antioxidant activity               | Rutuja et al., (2015); Devanesan et al., (2018); Hastir et al., (2021); Shukla and Kansal, (2024) |



## ECOLOGICAL SIGNIFICANCE

*Ficus religiosa* is a lifeline for many avifaunal and faunal species. Unlike other species of *Ficus*, *F. religiosa* is a promising plant for ecological services. This designation stems from its ability to produce fruit year-round, even during periods of scarcity when other food sources are limited. These continuous fruiting cycles make *F. religiosa* a critical resource for a diverse range of frugivorous (fruit-eating) birds and mammals, effectively acting as a "lifeline" that sustains wildlife populations. The figs of *F. religiosa* are small, and ripen from green to purple. While they might appear modest, their abundance and consistent availability attract a remarkable variety of animals, creating a vibrant hub of ecological activity around the tree.

Birds play a crucial role as seed dispersers. A wide array of avian species are attracted to *F. religiosa* figs. Common frugivorous birds observed feeding on Peepal figs in India and other regions include: Mynas (e.g., Common Myna, Jungle Myna), Bulbuls (various species like Yellow-vented Bulbul), Doves (e.g., Blue-faced Dove, Lace-necked Dove), Parrots (e.g., Rose-ringed Parakeet), Hornbills (e.g., Great Hornbill), Barbets (e.g., Coppersmith Barbet), crows and Asian Koel (*Eudynamys scolopaceus*) (**Figure 8**) have also been noted (**Sharma et al., 2024; Gogoi et al., 2023**). Beyond birds, several mammalian species also rely on *F. religiosa* figs: Bats: Fruit bats are significant nocturnal frugivores that consume figs and disperse seeds over wide areas (**Aruna et al., 2009**). In wilder areas, even animals like deer, wild boar, and bears may be attracted to the ripe figs, particularly when they fall to the ground (**Shanahan et al., 2001**). The consumption of *F. religiosa* figs by these diverse faunal species is not merely a feeding event; it's a fundamental ecological process that underpins the health and resilience of tropical ecosystems. These trees act as ecological magnets, concentrating biodiversity and facilitating the vital process of seed dispersal, which is essential for maintaining forest structure and promoting regeneration, especially in disturbed or fragmented landscapes.



**Figure 8:** Asian Koel (*Eudynamys scolopaceus*) consuming fruit of *F. religiosa*

## CONCLUSION

According to present scenario, phytochemical investigations have unequivocally demonstrated that *Ficus religiosa* is a rich repository of diverse bioactive compounds, including flavonoids, phenols, tannins, terpenoids, alkaloids, and glycosides. This intricate blend of secondary



metabolites underpins the plant's wide spectrum of pharmacological properties, such as antioxidant, anti-inflammatory, anti-diabetic, antimicrobial, wound healing, and hepatoprotective effects, among others. While traditional knowledge has long celebrated its medicinal virtues, modern scientific scrutiny continues to validate and elucidate the mechanisms behind these beneficial actions, solidifying *F. religiosa* potential as a significant source for novel therapeutic agents and natural health remedies in future.

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## CHAPTER 10

### ***Ficus tinctoria*: analysis of bioactive compounds and their pharmacological potential with smattering of ecological factors**

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**Abstract:** *Ficus tinctoria*, is a hemiepiphytic tree a species within the Moraceae family. This chapter provides a comprehensive analysis of the bioactive compounds present in bark of *F. tinctoria* and evaluates their pharmacological potential. A review of existing literature and present study reveals a diverse phytochemical profile, including tannins, saponins, alkaloids, reducing sugars and terpenoids, which are responsible for its reported therapeutic properties. The chapter incorporates a discussion on the ecological factors influencing the plant's growth and secondary metabolite production. This integrated approach highlights the intricate link between the plant's biochemistry, its ecological context, and its medicinal value, offering a holistic perspective for future research and sustainable exploitation of this valuable resource.

**Keywords:** Ethnomedicinal, ecological, pharmacological, phytochemical



## INTRODUCTION

The genus *Ficus*, a salient of the Moraceae family, is a remarkably diverse and ecologically significant group of plants comprising over 880 species. Found across tropical and subtropical regions, many *Ficus* species are basis resources, providing sustenance for countless animals and shaping forest ecosystems (POWO, 2025). It has countless benefits in terms of medicinal, ecological, food value and economical values. According to literature review it concluded that different *Ficus* species contain sesquiterpenes, monoterpenes, triterpenoids, alkaloids, furanocoumarins, organic acids, volatile components and phenylpropanoids. These bioactive compounds occur in latex, leaves, fruit, stem and roots show a significant role in pharmacological activities such as analgesic, antimicrobial, antiarthritic, anticancer, and antidiabetic (Salehi et al., 2020; Singh and Sharma, 2023).

Among these, *Ficus tinctoria*, commonly known as the humped fig, dyeing fig or hairy figs. It is hemi-epiphytic tree and also known as an intricate growth form because its successional rate depends on many factors, such as the species' ability, the size of the host tree, and the position in the canopy in terms of access to light. It is also one of the species known as strangler fig. It is commonly found in deciduous and semi-evergreen forests. It usually grows on the other *Ficus* trees (Nayak and Kumar, 2023). Flowering and fruiting period on December -May. It is distributed throughout the Bhutan, China, Indonesia, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam. In India, it is found in Bihar, Kerala, Madhya Pradesh, Meghalaya, Odisha, Tamil Nadu, Uttar Pradesh and Andhra Pradesh (Reddy et al., 2020). According to IUCN Red list it is least concern. It has two types of recognized varieties or sub-species such as *Ficus tinctoria* var *tinctoria* and *F. tinctoria* var *gibbosa* (POWO, 2025). Through tentative literature survey it concluded that *F. tinctoria* has many varieties for its morphological factors. Such as multi-scaled intraspecific variation and co-variation in trait-based strategies on *F. tinctoria* are reported (Chen et al., 2020; Li et al., 2024).

Mostly all *Ficus* species has various indigenous traditional knowledge where its leaves, bark, and roots have been used to treat a wide array of ailments, including skin infections, inflammation, and gastrointestinal issues. Unfortunately, *F. tinctoria* has less documentation on its ethnomedicinal as well as pharmacological activities. Despite its less traditional use, a



comprehensive scientific analysis of the bioactive compounds responsible for these therapeutic effects has been a relatively recent endeavor. This chapter aims to bridge this gap by providing an exploration of the phytochemical profile of *F. tinctoria* bark and a critical evaluation of its pharmacological potential. We will first delve into the plant's diverse secondary metabolites, examining key classes such as tannins, saponins, terpenoids, reducing sugars and alkaloids, and the specific compounds that have been isolated and identified. We will then connect these phytochemicals to the plant's documented pharmacological activities, including its potent antioxidant, anti-inflammatory, antimicrobial, and cytotoxic properties, offering a scientific basis for its traditional applications. Furthermore, a complete understanding of *F. tinctoria* is impossible without considering the ecological factors that govern its life and, by extension, its biochemistry. The production of secondary metabolites is not merely a random process but is often a direct response to environmental pressures and ecological interactions. This chapter will therefore also incorporate a discussion on the ecological context of *F. tinctoria*. We will touch upon its unique obligate mutualism with species-specific fig wasps (*Platyscapa* sp.), which are essential for its reproduction, and its role as a crucial resource for frugivorous fauna (Ma et al., 2009). Additionally, by integrating a deep analysis of its phytochemistry and pharmacology with a consideration of its ecological drivers, this chapter offers a holistic perspective on *F. tinctoria*, which has less documentation in medicinal, and pharmacological activities.

## MORPHOLOGY

It is deciduous or evergreen climbing bushy shrub or standing hemi-epiphytic tree up to 10m high. Bark greenish- yellow or grey, smooth. Leaves are alternate, variable, rhomboid-sub rhomboid or elliptic-ovate, 3-15 x2.8-8 cm. Base oblique, entire, apex acute, gibbose, scabrous, hispidulous, sparsely puberulous on both surfaces, dark green and shiny above, pale green and tuberculate beneath, petiole up to 2 cm long. Figs in axillary, solitary or umbellate fascicles, pedunculate, up to 1 cm long; receptacles 1.2 cm diam. Globose-sub-globose, depressed globose, pubescent, papillose, turning yellow-orange or red when ripe (Saxenna and Brahmam, 1995; Figure 1-4).



**Figure 1:** Leaves of *F. tinctoria*



**Figure 2:** Fruits of *F. tinctoria*



**Figure 3:** Bark of *F. tinctoria*



**Figure 4:** Syconium of *F. tinctoria*



## METHODOLOGY

The bark of *F. tinctoria* was collected from the State Botanical Garden, Odisha, India. The plant species was identified by the authors. The Soxhlet extraction method was adopted using three solvents (N-hexane, ethanolic, and methanolic) for phytochemical analysis. Detection of nine secondary metabolites was conducted using standard methods (Kumar et al., 2013; Marndi et al., 2024; Figure 5-8). Literature data was also gathered from Scopus, Web of Science, PubMed, Google Scholar, MDPI, Science Direct, SciFinder, Scirus, and Scientific Electronic Library Online (SciELO) from 2020-2025.

### Qualitative phytochemical analysis (Marndi et al., 2024)

**Test for tannin:** About 1 ml of the bark extract was taken. Three to five drops of 10% lead acetate solution were added. The gelatinous precipitate formation confirmed the presence of tannin.

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

**Test for flavonoids:** About 1 ml of the bark extract was taken. Two ml of 2% NaOH solution and 3 to 4 drops of dilute HCl were added. The colour initially turned to an intense yellow colour with NaOH solution and later became colourless. This colour changes in appearance confirmed the presence of flavonoids.

**Test for terpenoids:** About 1 ml of the bark extract was added with 5-6 drops of chloroform and placed in the water bath for a few minutes. Then 5-6 drops of concentrated sulphuric acid were added. The reddish-brown interface confirmed the presence of terpenoids.

**Test for phenolic groups:** About 1 ml of the bark 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 bark extract was taken and 2 drops of Fehling's solution A followed by Fehling's solution B were added and kept in the water bath for some time. The presence of red-orange precipitate confirmed the presence of reducing sugar.



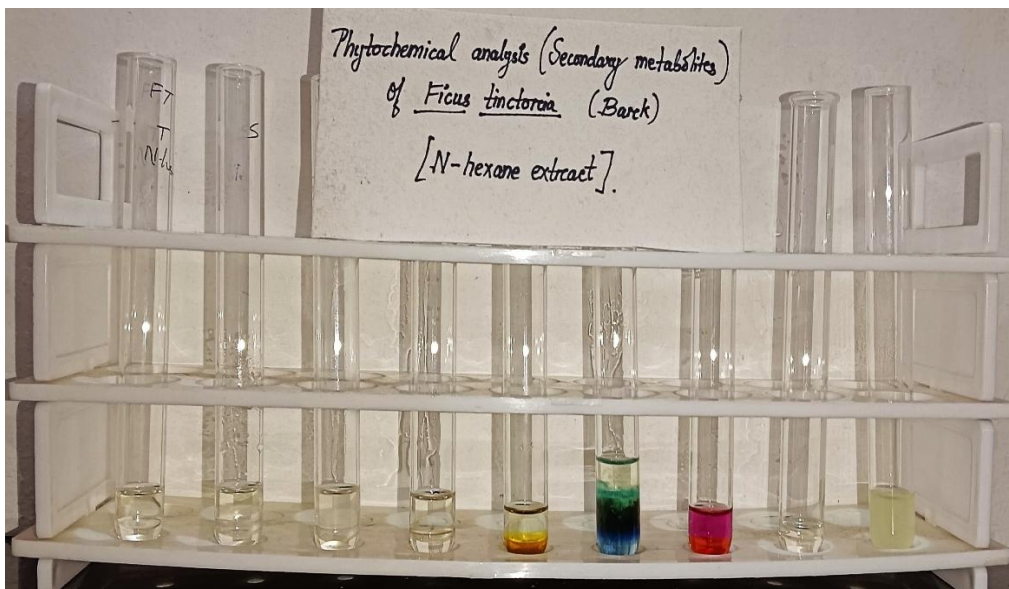
**Test for steroids:** About 1 ml of the bark extract was taken. 1 ml of chloroform and 1 ml of concentrated sulphuric acid was added to it. The appearance of upper red and lower yellow color with green fluorescence provided the presence of steroids.

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

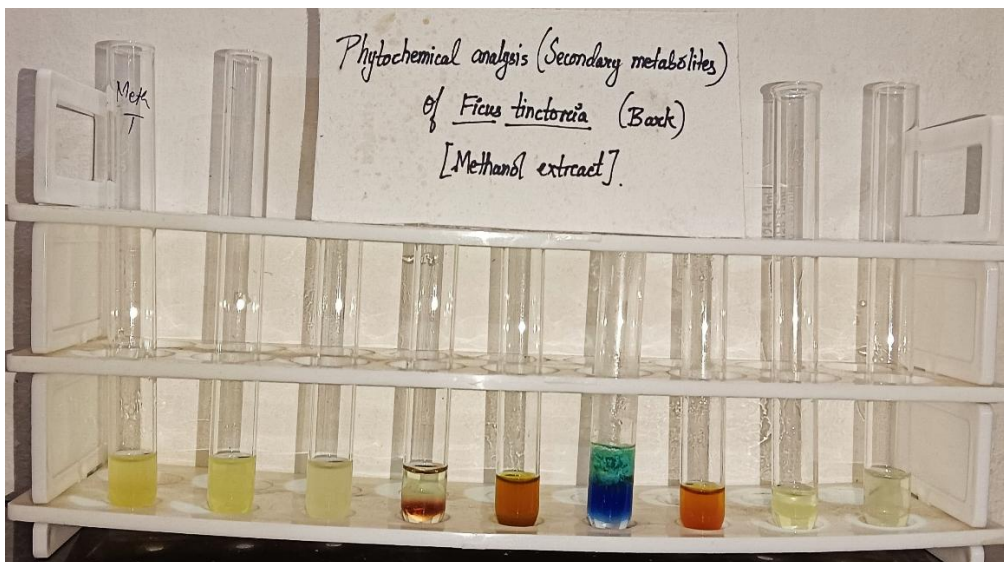
**Test for carbonyl compounds:** About 1 ml of the bark extract was taken and 3 to 4 drops of 2,4- Dinitrophenylhydrazine (DNPH) reagent was added. The formation of yellow crystals confirmed the presence of carbonyl compounds.



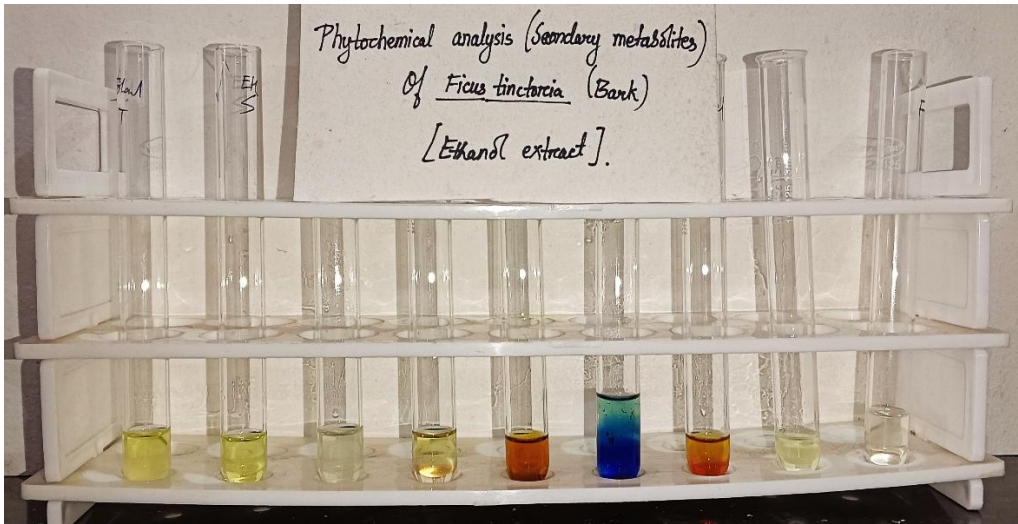
**Figure 5:** Bark sample for *F. tinctoria*



**Figure 6:** Phytochemical analysis (Secondary metabolites) of *F. tinctoria* (Bark) of n-hexane extract



**Figure 7:** Phytochemical analysis (Secondary metabolites) of *F. tinctoria* (Bark) of methanolic extract



**Figure 8:** Phytochemical analysis (Secondary metabolites) of *F. tinctoria* (Bark) of ethanolic extract

**RESULTS AND DISCUSSION**

Through a tentative literature survey, it concluded that less work carried out in phytochemical analysis on *Ficus tinctoria*. According to the phytochemical analysis on the bark shows a range of active compounds such as tannins, saponin, flavonoids, terpenoids, reducing sugars, and alkaloids. Majorly three extract was taken as N-hexane, methanol and ethanol. Tannins, saponins, flavonoids, and alkaloids are present in Methanolic and ethanolic extract. Terpenoids is present in methanolic extract. Reducing sugars are present in all three extracts (Table 1).

**Table 1:** Phytochemical analysis using different extracts of *F. tinctoria* bark

| Bioactive compounds | N- hexane extract | Methanolic extract | Ethanolic extract |
|---------------------|-------------------|--------------------|-------------------|
| Tannin              | -                 | +                  | +                 |
| Saponin             | -                 | +                  | +                 |
| Flavonoids          | -                 | +                  | +                 |



|                    |   |   |   |
|--------------------|---|---|---|
| Terpenoids         | - | + | - |
| Phenolic compounds | - | - | - |
| Reducing sugars    | + | + | + |
| Steroids           | - | - | - |
| Alkaloids          | - | + | + |
| Carbonyl compounds | - | - | - |

(+: Presence; -: Absence)

Relatively limited number of reported studies on the ethnomedicinal uses of *Ficus tinctoria*, reflecting a combination of factors related to its geography, cultural context, and the broader challenges of ethnomedicinal research. Researchers often gravitate towards these (*F. religiosa*, *F. benghalensis* and *F. carica*) more widely recognised and commercially promising species, leaving less attention for others like *F. tinctoria*. In **Table 2**, it concluded that handful of ethnomedicinal uses are available. According to the **table 2**, fruits, leaves, bark and root are used for indigestion, fever, broken bones and diarrhoea. Mode of uses mostly decoction, maceration, raw and juice form.

**Table 2:** Ethnomedicinal uses of *F. tinctoria*

| Plant parts   | Mode of uses | Disease     | Sources                 |
|---------------|--------------|-------------|-------------------------|
| Bark and root | Decoction    | Diarrhoea   | Nayak and Kumar, (2023) |
| Fruit         | Raw          | Fever       | Salehi et al., (2020)   |
| Fruits        | Maceration   | Indigestion | Devi et al., (2022)     |



|        |       |              |                            |
|--------|-------|--------------|----------------------------|
| Leaves | Juice | Broken bones | Nayak and<br>Kumar, (2023) |
|--------|-------|--------------|----------------------------|

As mentioned previously, the traditional knowledge of *F. tinctoria* is a scarcity of reported pharmacological activity studies is a multifaced issue, stemming from a combination of scientific, economic, and logistical challenges. According to the present phytochemical analysis on the bark carried out in **Table 1**, on that basis their probable utilization is listed in **Table 3**.

**Table 3:** Some bioactive compounds from the *F. tinctoria* (Bark) and their probable utilization

| Bioactive compounds | Pharmacological values                                                                   | Sources                                                       |
|---------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| Alkaloids           | Antibacterial, antifungal, antiviral                                                     | Patel and Vdhrodiya, (2022)                                   |
| Flavonoids          | Antioxidant, antidepressant, anticonvulsant, antihypertensive, and antidiabetic          | Sangeetha et al., (2016); Ullah et al., (2020)                |
| Reducing sugars     | Antioxidant                                                                              | Kaur et al., (2020)                                           |
| Saponin             | Anti-hypercholesterolemic, anti-inflammatory, antiallergic, and antitumor                | Barbosa, (2014); Juang and Liang, (2020)                      |
| Tannins             | Antioxidant, antimicrobial, antiviral, anti-mutagenic, anti-carcinogen, and anthelmintic | Hossain et al., (2021); Pizzi, (2021); Maugeri et al., (2022) |
| Terpenoids          | Antitumor, anti-inflammation, antibacterial, antiviral, antimalarial                     | Yang et al., (2020)                                           |



There is a limited documentation on the ethnomedicinal and pharmacological activities of *F. tinctoria* is not a reflection of its lack of medicinal value, but rather the result of several intertwined factors. The geographically dispersed nature of its traditional uses, coupled with the erosion of oral knowledge in the face of modernization, has made systematic ethnobotanical documentation a significant challenge. Furthermore, the immense size and popularity of other *Ficus* species, which often draw more research funding and attention, have left *F. tinctoria* relatively overlooked. This gap in the literature is compounded by the inherent complexities of phytochemical research and the high costs associated with rigorous pharmacological validation. Bridging this knowledge gap requires a concerted, interdisciplinary effort that combines dedicated ethnobotanical surveys, advanced phytochemical analysis, and targeted pharmacological studies, ultimately paving the way for the sustainable and responsible use of this valuable plant resource.

### ECOLOGICAL SIGNIFICANCE

The *Ficus tinctoria* is a mainspring of tropical forest ecosystems, playing a vital role in maintaining stability by providing a consistent food source for a wide variety of frugivores. Figs are exceptionally prolific, capable of producing a large number of fruits, and most species bear fruit year-round. This makes them a crucial resource for frugivores, especially during periods of scarcity. The consumption of figs by these animals directly contributes to the wider distribution of their seeds. This process, known as zoochory, occurs through several mechanisms. Endo-zoochory: Seeds are dispersed after being ingested and passed through the digestive tract of the frugivore. Dys-zoochory: Seeds are dispersed when the fruit is eaten and the seeds are spit out. Exo-zoochory: Seeds are dispersed by attaching to the external body parts of the animal. The physical characteristics of fig fruits have evolved to attract specific dispersers. Fruits with large size, pale colors (often green when ripe), and those that grow directly from the trunk or large branches (cauliflorous/ramiflorous) or on long, trailing stems (flagelliflorous) are commonly preferred by volant mammals, such as bats. In contrast, fruits with bright colors that contrast with the foliage and are located on the leaf axils or at the tips of branches are typically more attractive to birds (**Wijaya and Defiani, 2021**). Fig wasp community associated with male figs of *Ficus tinctoria* in Xishuangbanna, China. The community comprised one pollinator



species *Liporrhopalum gibbosae* and six non-pollinating wasp species: *Sycoscapter* sp., *Philotrypesis ravii*, *Philotrypesis* sp., *Neosycophila omeomorpha* (*Epichrysomallinae*), *Sycophila* sp. (*Eurytomidae*), and *Walkerella* sp. (Ma et al., 2009).

## CONCLUSION

*Ficus tinctoria* is a plant of significant, yet underexplored, potential, embodying a fascinating convergence of ethnomedicinal heritage, and intricate ecological relationships. This analysis has demonstrated that the plant's traditional uses across diverse cultures are underpinned by a complex array of bioactive compounds, including flavonoids, alkaloids, terpenoids, and tannins. The documented bioactive compounds from the *F. tinctoria* (Bark) and their probable utilization of pharmacological activities—spanning antioxidant, anti-inflammatory, antimicrobial, and cytotoxic effects—provide a compelling scientific validation for its historical applications. The presence of these compounds and their associated biological activities strongly positions *F. tinctoria* as a promising candidate for further research and the potential development of novel therapeutic agents. The obligate mutualism with its pollinator fig wasp, its role as a basis resource. Future research should therefore move beyond simple phytochemical screening and incorporate ecological variables to understand how to sustainably cultivate and harvest the plant to maximize the yield of its desired compounds. This integrated perspective, which connects the plant's biochemistry to its environmental drivers, is essential for unlocking its full therapeutic potential while also ensuring the long-term conservation of this ecologically vital species. Therefore, *Ficus tinctoria* represents a prime example of a gap between documentation of traditional knowledge into scientific validation.

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# INDEX

## A

Antimicrobial 1,6, 9, 24, 26, 32, 45, 47, 52, 59, 63, 65, 72, 73, 113, 119, 121, 129, 132, 136, 137, 145, 147

Anti-inflammatory 1, 6, 9, 24, 26, 30, 32, 40, 47, 52, 63, 65, 72, 73, 85, 86, 90, 98, 99, 113, 119, 132, 137, 145, 147

Avifaunal 6, 19, 25, 130

## B

Bark 1, 3, 5, 6, 7, 10, 16, 17, 19, 22, 24, 26, 31, 32, 35, 37, 40, 39, 40, 42, 45, 47, 48, 50, 51, 63, 64, 68, 78, 81, 85, 86

Bioactive 3, 11, 15, 19, 26, 30, 32, 47, 58, 64, 65, 90, 95, 103, 105, 119, 127, 137, 143

## E

Ethnomedicinal 5, 8, 15, 17, 31, 55, 58, 71, 73, 78, 85, 99, 112, 115, 120, 127, 136, 144,

Ecological 5, 10, 17, 25, 41, 42, 48, 58, 65, 73, 91, 103, 105, 114, 130, 136, 137, 146

## F

Ficus 2, 16, 26, 31, 32, 46, 64, 71, 78, 79, 90, 91, 104, 114, 127, 130, 136, 146

Faunal 25, 91, 130

## I

Indigenous 31, 104, 136

## M

Medicinal 6, 7, 16, 19, 31, 42, 46, 64, 73, 79, 90, 99, 104, 105, 109, 119, 120, 121, 137, 146

## P

Phytochemical 1, 5, 19, 26, 31, 35, 42, 52, 58, 65, 73, 78, 81, 90, 94, 105, 110, 120, 121, 127, 131, 146, 147

Pharmacological 3, 5, 9, 11, 17, 24, 36, 40, 46, 48, 56, 65, 72, 73, 78, 79, 86, 91, 99, 105, 113, 120, 121, 127, 129, 136, 145

## T

Traditional 2, 16, 26, 31, 42, 46, 48, 65, 73, 78, 86, 90, 91, 104, 105, 112, 115, 120, 121, 132, 136, 145, 146



# EDITORS PROFILE



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one conference proceeding, one editorial, nineteen book chapters, and four edited books. He has presented more than 83 research papers at various international and national conferences. He is a life member of several renowned associations. He is the Editor-in-Chief of the *International Journal of Advanced Research in Pharmacy & Education*, *Global Academic Journal of Pharmacy and Drug Research*, and the associate editor of *Bioequivalence & Bioavailability International Journal*, *Indian Journal of Research in Pharmacy & Biotechnology*, as well as an editorial board member of twelve other Indian and international journals. He is an active reviewer for several Elsevier, Springer-Nature, and Taylor & Francis journals. He has also delivered numerous lectures in various refresher courses, national, and international conferences in India and abroad. He has been awarded the Best Teacher Award (2002), Jewel of India Award (2014), Young Performer Award (2015), Best Faculty Award (2018), Shikshak Shri Award (2018), Bharat Ratna Dr. Abdul Kalam Gold Medal Award (2018), Nirali's Pharma Recognition Award (2019), Best Researcher Award (2019), Best Educationist Award (2019), Rastriya Vidya Gaurav Gold Medal Award (2019), and SAS Best Principal Award (2020), along with many other accolades.



**Miss Sugimani Marndi,** she is currently working as a Project Assistant at Ambika Prasad Research Foundation, Odisha, India. She is pursuing Ph.D. at CUTM, Odisha. She has completed a Master in Science from Rama Devi Women's University, Bhubaneswar, Odisha, India. She is working on wetland flora, aquatic plants, Saltlick, grasses, and orchid species of Odisha state. She has published about 14 Research papers, 8 books, 80 book chapters and 43 article in the journal of national and international reputation.



**Mr. Rahul Kumar,** Rahul Kumar holds a Master's degree in Botany and is currently pursuing a Ph.D. in Forestry with a specialization in Forest Ecology and Environment from the prestigious Forest Research Institute (FRI), Dehradun. With over six years of research experience, he has actively contributed to various national and community-based ecological research projects, focusing on biodiversity conservation, carbon sequestration, ecosystem services, and restoration ecology. Rahul has a strong academic and scientific publication record, with 16 research and review articles and 4 book chapters to his credit in reputed national and

international journals and edited volumes. His research interests intersect plant ecology, sustainable forest management, and socio-ecological systems, especially in the context of Indian dryland and tribal landscapes. In addition to his academic contributions, Rahul is passionate about translating science into action by engaging with local communities, promoting native species like *Madhuca longifolia*, and supporting ecological restoration and climate resilience initiatives across central and northern India.



**Dr. Sanjeet Kumar,** he is the founder and CEO of Ambika Prasad Research Foundation (APRF), Odisha & Institute of Biological Sciences (IBS), Odisha. He has worked with several reputed organizations & institutes such as RPRC (Regional Plant Resources Centre), Odisha, RIE (Regional Institute of Education), Odisha, IBSD (Institute of Bioresources and Sustainable Development), Imphal, Manipur, NIT (National Institute of Technology), Odisha and Forest & Environment Department, Odisha. His research interests are plant taxonomy, medicinal plants, biodiversity and

conservation, restoration of floral wealth, phytochemistry, and microbiology. He has published about 330 research papers in journals of national and international repute, 88 books (IntechOpen, Apple Academics Press, APRF, LAP Lambert Academic Publishing), with 454 book chapters, 384 articles and 66 presentations. Six PhD scholars are working under his guidance and 45 M. Sc students have submitted their Project work under his able supervision.





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