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ETHNOPHARMACOLOGY AND ANTIMICROBIAL PROPERTIES OF *FICUS RACEMOSA* AND *FICUS HISPIDA*: A COMPARATIVE REVIEW

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ABSTRACT

Background: Antimicrobial resistance keeps rising around the world, turning into one of the most serious health concerns of our time. This trend has pushed researchers to take a fresh look at medicinal plants as new sources for antibacterial agents. Within the huge range of Ayurvedic plants, *Ficus racemosa L.* (*Udumbara*) and *Ficus hispida L.f.* (*Kakodumbara*), both from the Moraceae family, have always played important roles in traditional Indian medicine and have been described in classics like the *Charaka Samhita* and *Sushruta Samhita.* **Objective:** This review sets out to compare the ethnopharmacological uses, phytochemical makeup, and *Ficus racemosa* bark contains leucocyanidin glycosides, tannins, β-sitosterol, lupeol, and quercetin. All these show solid antibacterial activity. *Ficus hispida* bark has β-sitosterol, hispidin, bergapten, psoralen, tannins, and phenanthroindolizidine alkaloids. These compounds feature antimicrobial, anti-inflammatory, and wound-healing effects. Extracts from both species can inhibit gram-positive and gram-negative bacteria. Methanolic bark extracts from both show strong inhibition of S. aureus and E. coli. Known antimicrobial activities—especially against Escherichia coli and Staphylococcus aureus—of these two closely related species. **Methods:** The search pulled information from PubMed, Google Scholar, Science Direct, and traditional Ayurvedic texts published up to 2025. **Conclusion:** Both species have promising phytochemicals that support their use as antimicrobial agents in traditional treatments. Direct comparisons through in vitro and in vivo studies, and digging into their mechanisms, will help confirm and distinguish each species' antibacterial strength.

KEYWORDS: *Ficus racemosa*, *Ficus hispida*, *Udumbara*, *Kakodumbara*, Ethnopharmacology, Antibacterial, Phytochemistry, Moraceae, Ayurveda.

1. INTRODUCTION

Antimicrobial resistance (AMR) doesn't just threaten global health; it's become one of the top concerns for modern medicine. The World Health Organization (WHO) has singled AMR out as a top priority because more and more strains of Escherichia coli and Staphylococcus aureus now resist multiple drugs. Both bacteria are known for causing a wide range of illnesses, from routine urinary tract infections to serious, sometimes deadly, cases of septicemia. With drug resistance spreading, researchers are turning back to medicinal plants for new, safer, and more dependable antibacterial options.

India stands out in this search. It's got a vast variety of plants and thousands of years of traditional medical wisdom. Ayurveda, among the oldest medical traditions in the world, uses plant-derived treatments for many infectious diseases. The *Ficus* genus (*Moraceae* family) holds a special place here—more than 800 species spread through tropical and subtropical areas around the globe.

Within this genus, *Ficus racemosa L.* (known as *Udumbara* in Sanskrit, Gular in Hindi) and *Ficus hispida L.f.* (*Kakodumbara* or *Kathodumbara*) are some of the most prominent. Acharya *Dalhana*, an authoritative figure in Ayurveda, even lists them as two botanical varieties (*pratinidhi dravya*) in the same drug group. Even though the two species are closely related in terms

of taxonomy and have a long history of similar traditional use, researchers have mostly studied each species separately, and no one has really compared their ethnopharmacology and antimicrobial properties side by side.

This review aims to fill that gap. It pulls together information about their botanical identity, traditional uses, phytochemical compounds, and antimicrobial effects, especially against E. coli and S. aureus. The goal is to lay a solid groundwork for deeper comparative studies in the future.

2. Botanical Description and Taxonomy

2.1 Ficus racemosa L. (Udumbara)

Ficus racemosa L. (also known as *F. glomerata Roxb*.) is a large tree, either semi-evergreen or deciduous, from the *Moraceae* family. People often call it the cluster fig or country fig tree. It usually grows between 9 and 30 meters tall. Its bark is smooth, greyish-red outside, about 0.7 to 1.9 centimeters thick, and the inside is light brown with a slightly sticky and astringent taste. The leaves are dark green, shaped somewhere between ovate and elliptic, and range from 8 to 20 centimeters in length. Their edges are entire, not toothed or lobed. One thing that stands out is cauliflory—its fruit, the syconium, grows in large clusters straight from the trunk or main branches, not from the ends of shoots with leaves. The fruits themselves are round or nearly so, 2 to 5 centimeters across, turning red to orange as they ripen.

You'll find this tree spread wide across India, Sri Lanka, Myanmar, China, and Australia. It prefers moist deciduous or semi-evergreen forests, growing at elevations up to 1,800 meters. In classical Ayurvedic texts, *F. racemosa* falls under *Nyagrodhadi Gana* in *Sushruta Samhita* and *Kashaya Skandha* in *Charaka Samhita*. All parts—the bark, leaves, fruits, roots, and latex—are valued for their medicinal properties.

2.2 Ficus hispida L.f. (Kakodumbara)

Ficus hispida L.f.—known as *Kakodumbara*—is a rough, hairy shrub or small tree that grows anywhere from 5 to 10 meters tall. Part of the *Moraceae* family, it's called 'hispida' because its branches and leaves are covered in stiff, bristly hairs. You'll see it spread across India, China, Sri Lanka, Australia, and Myanmar, usually in moist forests or along riverbanks.

One thing that sets this plant apart: its leaves grow opposite each other, which is pretty unusual for a *Ficus*. The leaves themselves are broad, rough to the touch, and about 10 to 20 centimeters long. The plant's fruit is pear-shaped, yellowish, and clusters right on the main branches and trunk—much like what you see in *F. racemosa.* Break the bark and you'll find a milky, white latex.

In Ayurveda, *Kakodumbara* is known for cooling and soothing the body, especially for managing *Pitta dosha*. Classic texts mention it for treating skin conditions like vitiligo and leucoderma, as well as fevers, piles, and diarrhea. *Dalhana*, an important Ayurvedic commentator, singles out *Ficus hispida* as the plant meant by *Kasthodumbara/Kakodumbara*—considered a sort of backup or substitute for *Udumbara* (*F. racemosa*). This makes it a textbook example of drug substitution, or *pratinidhi dravya*, in Ayurveda.

3. Ethnopharmacological Uses

3.1 Traditional Uses of Ficus racemosa

People have used *F. racemosa* in Ayurveda, Unani, and Siddha medicine for over 2,000 years. Old medical texts describe its bark as astringent, cooling, and good for healing wounds. Some of its main uses.

For stomach problems: Bark decoctions treat diarrhea, dysentery, and hemorrhoids. The fruit helps with gas and worms.

For diabetes and metabolism issues: Bark powder goes into formulas for diabetes (*Prameha*) and high cholesterol.

For gynecological problems: Decoctions from the bark are used for heavy periods, leucorrhea, and to prevent miscarriages.

For healing wounds: The latex gets applied directly to wounds, infections, and skin diseases.

For cough and respiratory infections: People make leaf decoctions for bronchitis and other respiratory issues.

Folk medicine across South Asia, sub-Saharan Africa, and Australia also uses this plant for jaundice, liver problems, urinary difficulties, and skin diseases.

3.2 Traditional Uses of Ficus hispida

Ficus hispida shows up in both Chinese and Indian traditional practices, mainly for.

Skin problems: Root bark powder, rubbed on the skin, treats eczema, vitiligo, and leukoderma especially in Ayurveda.

Fever: Decoctions of the bark (about 40–50 ml) bring down fever and reduce inflammation.

Digestive complaints: Decoctions made from the fruit or bark treat jaundice, hemorrhoids, diarrhea, and digestive issues.

Boosting breast milk: The ripe fruits help increase lactation.

Stopping bleeding: Juice from the fruit, mixed with honey, helps with heavy menstrual bleeding.

In China, healers also use *F. hispida* for inflammatory issues, breathing problems, urinary disorders, cancer, and anemia. In Sri Lanka, Myanmar, and Australia, it has much the same reputation for healing.

3.3 Comparative Ethnopharmacological Overview

Both Ficus racemosa and Ficus hispida are used in similar ways, mainly for digestive problems, skin disorders, healing wounds, and lowering fevers. Table 1 (below) lays out the key similarities and differences.

Table 1: Comparative Ethnopharmacological Uses.

Disease Category	*F. racemosa (Udumbara)*	*F. hispida (Kakodumbara)*
Gastrointestinal	Diarrhea, dysentery, hemorrhoids, jaundice	Diarrhea, jaundice, piles, abdominal distension
Skin Conditions	Skin infections, wound healing, complexion	Vitiligo, leucoderma, eczema, wound healing
Diabetes/Metabolic	Diabetes (*Prameha*), hyperlipidemia	Limited references; fruit decoction used
Gynecological	Menorrhagia, leucorrhoea, threatened abortion	Excessive menstrual bleeding
Infections/Fever	Bacterial infections, wound infections	Fever, inflammatory conditions, skin infections
Respiratory	Cough, bronchitis, antitussive	Respiratory diseases (especially in China)
Urinary	Urinary disorders, gonorrhea	Urinary diseases (documented in multiple countries)

4. Phytochemical Constituents

4.1 Phytochemistry of Ficus racemosa Bark

The bark of *Ficus racemosa* has been deeply studied. It's packed with bioactive metabolic compounds.

Flavonoids and Polyphenols: Includes compounds like leucocyanidin-3-O-β-D-glucopyranoside, berginin, racemosic acid, and quercetin. These are known to be antibacterial—especially by blocking bacterial DNA enzymes and breaking down cell membranes.

Triterpenoids and Sterols: β-sitosterol, lupeol, stigmasterol, and others. Stigmasterol, based on recent computer modeling, latches tightly onto multiple antibacterial target sites.

Tannins and Alkaloids: Both are responsible for the astringent, antimicrobial effects. Tannins block bacterial enzymes and proteins in the cell wall. - Other constituents: Saponins, ceryl behenate, malonic acid, and minerals like calcium, potassium, magnesium, phosphorus, iron. Its latex is especially high in mucilage.

4.2 Phytochemistry of Ficus hispida Bark

More than 76 compounds have been found in *Ficus hispida*, and the bark contains.

Sterols and Triterpenoids: β-sitosterol, β-amyrin, and others.

Unique Compounds: Hispidin (a stilbenoid), along with bergapten and psoralen (furanocoumarins)—these two are famous for antimicrobial and light-sensitive actions, making them useful in treating skin conditions like vitiligo.

Tannins and Glycosides: The bark holds tannins, glucosides, saponins, and wax—these substances explain its astringent, antibacterial effects, similar to *F. racemose*.

Alkaloids: Especially in the leaves, phenanthroindolizidine alkaloids have shown anticancer, anti-inflammatory, and antimicrobial effects.

4.3 Comparative Phytochemical Analysis

Both species share common classes of active chemicals—

Sterols (like β-sitosterol), tannins, saponins, and flavonoids—which explain their similar uses. Still, there are differences: - F. racemosa has leucocyanidin glycosides, quercetin, and racemosic acid, which boost its antioxidant and liver-protective strengths. –

F. hispida stands out due to hispidin, psoralen, bergapten, and phenanthroindolizidine alkaloids—compounds you won't find in F. racemosa, and key to its role in treating vitiligo and other skin disorders.

Table 2: Comparative Phytochemical Profile of Bark Extracts.

Compound Class	*F. racemosa*	*F. hispida*	Key Bioactive Compounds
Tannins	+	+	*Condensed tannins, procyanidins*
Flavonoids	+	+	*Quercetin (Fr); Hispidin (Fh)*
Triterpenoids/Sterols	+	+	*β-sitosterol, lupeol, β-amyrin*
Leucocyanidin glycosides	+	−	*Leucocyanidin-3-glucoside*
Furanocoumarins	−	+	*Psoralen, bergapten*
Phenanthroindolizidine alkaloids	−	+	*Tylophorine analogues*
Saponins	+	+	*Present in both*
Bergenin	+	−	*Racemosic acid (Fr)*
Gluanol acetate	+	+	*Antibacterial/antioxidant*
Quercetin	+	±	*Free radical scavenging*

+ = Present; − = Absent; ± = Trace amounts; Fr = F. racemosa; Fh = F. hispida

5. Antimicrobial Activity

5.1 Antimicrobial Activity of Ficus racemosa

Many in vitro (lab-based) studies confirm that *F. racemosa* extracts act against both gram-positive and gram-negative bacteria.

Against E. coli and S. aureus: *Mandal et al. (2000)* showed that leaf extracts beat down S. aureus and E. coli, with the petroleum ether extract proving most potent—even compared to antibiotics like chloramphenicol.

Pingale et al. (2019) found ethanolic and ethyl acetate extracts work well against bacteria like E. coli, Staph aureus, Klebsiella, and Salmonella; the ethyl acetate extract came out strongest.

Bark extracts: Faiyaz et al. (2010) found that methanolic and ethyl acetate extracts taken from the stem bark were the most effective, especially against gram-positive bacteria like S. aureus.
Mathur et al. (2011) also saw that extracts from bark, leaves, and fruit all had antimicrobial activity.
Phytochemicals: These studies link observed effects directly to the tannins, flavonoids, alkaloids, and saponins in the extracts. Newer computational research pinpoints stigmasterol as a particularly strong antibacterial component, fitting drug-likeness screens.

5.2 Antimicrobial Activity of Ficus hispida

Ficus hispida hasn't been studied as exhaustively for antibacterial effects, but existing research is still pretty solid
General tests: *Cheng et al. (2020*) reviewed the evidence and confirmed that extracts contain alkaloids, flavonoids, and tannins that all deliver antimicrobial effects. Both bark and leaf extracts show inhibition against various harmful bacteria. –
Hispidin and furanocoumarins: Compounds unique to *F. hispida*, like *hispidin* and the furanocoumarins psoralen and bergapten, offer a special light-activated way of fighting bacteria—psoralen can actually break bacterial DNA when exposed to UV light. - Against specific bacteria.
Sivaraman and Muralidharan (2011) showed the root extract can kill S. aureus and E. coli. Ali and *Chaudhary (2011)* highlighted broad-spectrum antibacterial activity in bark and leaf extracts.

5.3 Mechanisms of Antibacterial Action

The antibacterial punch in both Ficus species comes from multiple chemical attacks.
Tannins clog up bacterial cell wall proteins and enzymes, ruin cell membrane barriers, and stop vital bacterial processes. –
Flavonoids mess with DNA copying and tear up bacterial membranes **quercetin**, in particular, targets gram-positive bugs. –
Alkaloids get inside and tangle with DNA, blocking transcription.
Saponins cut holes in bacterial membranes, making cells leak and die.
Furanocoumarins (just in F. hispida) break up bacterial DNA when activated by UV light, making this mechanism unique.
All these chemicals work together to deliver a broad-spectrum hit, which is why crude bark extracts usually perform better than any single purified compound.

5.4 Solvent Extract Comparison

The solvent used for extraction matters a lot. Methanol tends to pull out a wider range of active chemicals (tannins, flavonoids, alkaloids, and triterpenoids) than other solvents.
For F. racemosa: Methanolic bark extract fights S. typhi at just 1 mg/100 µL and is strong against S. aureus and E. coli as well. Active chemicals-Mainly tannins, alkaloids, saponins, flavonoids.
For F. hispida: Ethanolic and methanolic extracts show antibacterial action against a handful of different bacteria, with bark and root extracts usually working better than leaf extracts.

6. DISCUSSION

Looking at both species side by side, it's clear they share a wealth of antibacterial compounds and traditional uses. Their place in medical traditions from India to Australia lines up well with what scientific research is now confirming.

That said, far more lab work has gone into *F. racemosa* than *F. hispida*. This isn't really because *F. hispida* is less interesting—if anything, its unique compounds (like furanocoumarins and special alkaloids) could point toward slightly different, or even stronger, antibacterial action. Ayurveda has long treated *F. racemosa* as the main drug and *F. hispida* as a sort of alternate, and the chemistry partly supports this: both contain the usual antibacterial suspects, but *F. racemosa* boasts extra leucocyanidin glycosides and quercetin, while *F. hispida* brings photodynamic weapons to the fight.

Methanolic bark extracts make the most sense scientifically—they capture the broadest range of the good stuff in both plants. Moving forward, what's really needed is head-to-head laboratory work using the same test conditions, so researchers can compare the two species directly.

7. CONCLUSION

Both Ficus racemosa (Udumbara) and Ficus hispida (Kakodumbara) are heavy hitters in Ayurvedic medicine, loaded with active phytochemicals and proven to knock out important bacteria like E. coli and S. aureus. They're linked by their shared role as substitute (*pratinidhi*) drugs in Ayurveda and by their similar chemical makeups.

Still, each plant stands apart chemically—*F. racemosa* with its special glycosides and quercetin, *F. hispida* with its furanocoumarins and unique alkaloids—giving each species its own medicinal edge. If you're looking for a plant-based antibacterial, you can't go wrong with methanolic bark extracts from either species. But there's still plenty of lab work left to do: direct comparison, targeted isolation of active compounds, and animal tests. Only then will we see exactly how these two ancient medicines stack up—and whether they truly can be swapped for one another in clinical use.

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