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Comparative phytochemical profiling, antibacterial activity, and antioxidant potential of fruit extracts of *Ficus hispida* L. and *Ficus exasperata* Vahl

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Abstract

Ficus hispida and Ficus exasperata are medicinally important species traditionally used for the treatment of various ailments; however, comparative information on their phytochemical composition and biological activities remains limited. The present study aimed to evaluate the phytochemical constituents, antibacterial activity, and antioxidant potential of fruit extracts of both species. Fruits were extracted using methanol, chloroform, and petroleum ether, followed by qualitative phytochemical screening, antibacterial evaluation against Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae, and Serratia marcescens using the disc diffusion method, and antioxidant assessment by Ferric Reducing Antioxidant Power (FRAP) assay. Phytochemical analysis revealed that methanolic extracts of both species contained the highest number of bioactive constituents, including flavonoids, phenolics, tannins, terpenoids, cardiac glycosides, phytosterols, and saponins, whereas phlobatannins were absent in all extracts. Antibacterial activity increased with extract concentration, with the chloroform extract of F. exasperata exhibiting the strongest activity against P. aeruginosa (16.16 ± 0.48 mm) and S. aureus (15.50 ± 0.62 mm) at 30 mg concentration. In F. hispida, the maximum inhibition zone was observed against S. aureus (14.50 ± 0.62 mm). FRAP analysis demonstrated concentration-dependent antioxidant activity, with methanolic extracts showing the greatest reducing power. The methanolic extract of F. exasperata exhibited the lowest IC_{50} value (31.63 µg mL^{-1}), followed by F. hispida (33.32 µg mL^{-1}), compared with ascorbic acid (25.50 µg mL^{-1}). The results indicate that both species possess significant antibacterial and antioxidant properties, with F. exasperata showing comparatively superior biological activity, supporting its potential as a natural source of bioactive compounds for pharmaceutical and nutraceutical applications.

Keywords: *Ficus hispida, Ficus exasperate, FRAP assay, antimicrobial, antibacterial, Phenolics*

INTRODUCTION

Nature has provided an important source of remedies to cure all the ailments of mankind. Medicinal plants have served as an indispensable source of healthcare since ancient times and continue to play a significant role in modern medicine (Yuan et al., 2016). According to the World Health Organization (WHO), nearly 80% of the world's population relies on traditional plant-based medicines for primary healthcare needs. In many developing countries, medicinal plants remain an affordable, accessible, and culturally accepted source of treatment for various ailments. India, in particular, possesses a rich heritage of traditional medicinal systems such as Ayurveda, Siddha, Unani, and folk medicine, which extensively utilize plant-derived products for disease prevention and treatment. It is estimated that India harbors over 20,000 medicinal plant species, of which approximately 2,500 are commonly used in traditional healthcare systems (Ballabh and Chaurasia, 2017).

The growing interest in medicinal plants is largely attributed to their rich diversity of bioactive compounds, including alkaloids, flavonoids, phenolics, tannins, terpenoids, glycosides, and saponins (Nwozo et al., 2023). These phytochemicals are known to exhibit a wide range of biological activities such as antimicrobial, antioxidant, anti-inflammatory, antidiabetic, anticancer, and wound-healing properties (Cowan, 1999). Historically, many important therapeutic agents including aspirin, atropine, morphine, quinine, reserpine, and digoxin have originated from medicinal plants or were discovered through observations of traditional medicinal practices (Gilani and Rahman, 2005). Consequently, medicinal plants continue to provide valuable leads for the development of novel pharmaceutical compounds.

One of the major challenges confronting global healthcare today is the rapid emergence of antimicrobial resistance among pathogenic microorganisms (Prestinaci et al., 2015). The indiscriminate use and misuse

of antibiotics have resulted in the development of multidrug-resistant bacterial strains, significantly reducing the effectiveness of conventional antimicrobial therapies. Pathogens such as *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae* are increasingly associated with resistance to commonly used antibiotics, posing a serious threat to public health worldwide. This alarming situation has intensified the search for alternative antimicrobial agents from natural sources. Plant-derived antimicrobial compounds have attracted considerable attention because they often exhibit multiple mechanisms of action and may overcome resistance developed against conventional antibiotics (Eloff, 1998).

In addition to microbial infections, oxidative stress is recognized as a major contributing factor to numerous chronic diseases including cardiovascular disorders, cancer, diabetes mellitus, neurodegenerative diseases, and aging-related complications. Reactive oxygen species (ROS) generated during normal metabolic processes can damage cellular proteins, lipids, and nucleic acids when produced in excess. Antioxidants derived from medicinal plants play an important role in scavenging free radicals and protecting biological systems against oxidative damage. Therefore, plants possessing both antimicrobial and antioxidant activities are of considerable interest for the development of therapeutic agents and functional health products.

Among medicinal plants, the genus *Ficus* (Moraceae) occupies a prominent position due to its extensive ethnomedicinal applications and rich phytochemical diversity. The genus comprises more than 800 species distributed throughout tropical and subtropical regions of the world (Murugesu et al., 2021). Various species of *Ficus* have been traditionally used for the treatment of gastrointestinal disorders, skin diseases, inflammation, diabetes, infections, respiratory ailments, and wounds. Several phytochemical studies have demonstrated that members of the genus are rich sources of flavonoids, phenolics, triterpenoids, sterols, alkaloids, and other secondary metabolites responsible for their pharmacological properties (Walia et al., 2022). *Ficus hispida* L., commonly known as hairy fig, is a medium-sized tree widely distributed throughout India, Sri Lanka, Southeast Asia, and other tropical regions (Ali & Chaudhary, 2011). Different parts of the plant have been traditionally employed in the treatment of dysentery, ulcers, jaundice, psoriasis, anemia, piles, inflammation, and various gastrointestinal disorders. The fruits are also used as tonic, lactagogue, and aphrodisiac in traditional medicine. Phytochemical investigations have revealed the presence of alkaloids, carbohydrates, proteins, amino acids, flavonoids, phenolic compounds, glycosides, saponins, sterols, and terpenoids in different parts of the plant (Ghosh et al., 2004). The fruits contain carbohydrates, proteins, minerals, and ascorbic acid, indicating their nutritional and medicinal significance. Previous studies have reported antioxidant, anti-inflammatory, wound-healing, hypoglycemic, cardioprotective, hepatoprotective, and antimicrobial activities associated with various extracts of *F. hispida* (Mohammad Ali and Chaudhary, 2011). Hossain et al. (2014) demonstrated that methanolic fruit extracts exhibited significant antibacterial activity against several Gram-positive and Gram-negative bacterial pathogens, suggesting the presence of biologically active compounds with therapeutic potential.

Another medicinally important member of the genus is *Ficus exasperata* Vahl., commonly known as sandpaper tree. The species is extensively used in African traditional medicine for the treatment of hypertension, diabetes, fever, inflammatory disorders, microbial infections, hemorrhoids, venereal diseases, and wounds (Ogunmefun, 2025). Ethnomedicinal reports indicate that leaves, roots, bark, and fruits of the plant possess diverse therapeutic applications. Phytochemical studies have shown that *F. exasperata* contains flavonoids, tannins, alkaloids, phenolics, saponins, and cardiac glycosides (Ajayi et al., 2012). Several pharmacological investigations have demonstrated its antioxidant, anti-inflammatory, antimicrobial, anticonvulsant, antiarthritic, antipyretic, hypotensive, and hypoglycemic activities (Ahmed et al., 2012). Lawal et al. (2012) reported significant antibacterial and antifungal activities of root bark extracts against clinically important pathogens, while other studies have highlighted its antioxidant potential owing to the presence of phenolic compounds and vitamins.

Although extensive studies have been conducted on different plant parts of *Ficus hispida* and *Ficus exasperata*, research specifically focusing on their fruits remains relatively limited (Sawadogo et al., 2024). Furthermore, comparative investigations evaluating the phytochemical composition, antibacterial efficacy, and antioxidant potential of fruits from these two medicinally important species are scarce. Most previous studies have examined individual species separately, making it difficult to assess their relative

medicinal value. Scientific validation of their traditional uses through comparative phytochemical and biological investigations is therefore necessary. In view of the increasing demand for plant-based therapeutics and the need for alternative antimicrobial and antioxidant agents, the present study was undertaken to evaluate and compare the phytochemical constituents, antibacterial activity, and antioxidant potential of fruits of *Ficus hispida* and *Ficus exasperata*. The study aims to provide scientific evidence supporting their ethnomedicinal applications and to identify potential sources of bioactive compounds that may contribute to the development of novel phytopharmaceutical products.

MATERIALS AND METHODS

Plant material collection and authentication

Fresh fruits of *Ficus hispida* L. and *Ficus exasperata* Vahl. were collected from Pattambi and Shoranur regions of Kerala, India, during September-December. The collected plant materials were authenticated using standard taxonomic procedures, and voucher specimens were maintained for future reference.

Chemicals and reagents

Analytical-grade solvents including methanol, chloroform, and petroleum ether were procured from Loba Chemie Pvt. Ltd., India. Dimethyl sulfoxide (DMSO) was obtained from Fisher Scientific India Pvt. Ltd. Muller–Hinton Agar (MHA), Nutrient Broth, and cefotaxime were purchased from HiMedia Laboratories Pvt. Ltd., India. Ferric chloride, potassium ferricyanide, hydrochloric acid, sodium dodecyl sulfate (SDS), and ethanol used for antioxidant analysis were of analytical grade and obtained from standard commercial suppliers.

Preparation of plant extracts

The collected fruits were thoroughly washed with distilled water, shade-dried at room temperature for 2-4 weeks, and powdered using a mechanical grinder. Ten grams of powdered material from each species were extracted separately with 100 mL of methanol, chloroform, and petroleum ether by maceration under continuous shaking for 72 h using an orbital shaker.

The extracts were filtered through Whatman No. 1 filter paper, and the solvents were evaporated at room temperature to obtain crude extracts. The dried extracts were stored in sterile microcentrifuge tubes at 4°C until further analysis. For antibacterial assays, stock solutions were prepared by dissolving 100 mg of crude extract in 1 mL DMSO to obtain a concentration of 100 mg mL^{-1}.

Preliminary phytochemical screening

Qualitative phytochemical screening was carried out to detect the presence of primary and secondary metabolites in the fruit extracts using standard phytochemical procedures.

Carbohydrates (Molisch's Test)

Two milliliters of aqueous extract were mixed with two drops of Molisch's reagent, followed by careful addition of concentrated sulfuric acid along the sides of the test tube. Formation of a reddish-violet ring at the interface indicated the presence of carbohydrates.

Proteins (Nitric Acid Test)

The extract was carefully layered over concentrated nitric acid. Formation of a dark ring at the junction of the two layers indicated the presence of proteins.

Alkaloids (Wagner's Test)

The extract was treated with Wagner's reagent. Formation of a brown flocculent precipitate indicated the presence of alkaloids.

Flavonoids (Sulfuric Acid Test)

Equal volumes of extract and concentrated sulfuric acid were mixed. Development of an intense coloration indicated the presence of flavonoids.

Phenolic Compounds (Ferric Chloride Test)

A few drops of ferric chloride solution were added to the extract. Appearance of a dark green or brown coloration indicated the presence of phenolic compounds.

Cardiac Glycosides (Keller–Killiani Test)

Five milliliters of extract were mixed with acetic acid containing ferric chloride, followed by concentrated sulfuric acid. Formation of a characteristic brown ring at the interface indicated the presence of cardiac glycosides.

Tannins

The extract was treated with ferric chloride solution. A blue-black or brownish-green coloration indicated the presence of tannins.

Terpenoids (Salkowski Test)

The extract was mixed with chloroform and concentrated sulfuric acid. Formation of a reddish-brown coloration at the interface indicated the presence of terpenoids.

Saponins (Froth Test)

The extract was vigorously shaken with distilled water. Persistent froth formation indicated the presence of saponins.

Phlobatannins

The extract was boiled with 1% hydrochloric acid. Formation of a red precipitate indicated the presence of phlobatannins.

Fluorescence Analysis

The extracts were subjected to fluorescence analysis under ultraviolet light after treatment with 1 N sodium hydroxide solution to detect characteristic fluorescence behavior.

Antibacterial Assay

Five bacterial strains, namely *Staphylococcus aureus* (ATCC 25923), *Escherichia coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 27853), *Klebsiella pneumoniae*, and *Serratia marcescens*, were used for the antibacterial evaluation. The bacterial cultures were obtained from stock cultures maintained in the Department of Botany, S.N.G.S. College, Pattambi. The cultures were preserved on agar slants at 4°C and sub-cultured prior to use. For inoculum preparation, a loopful of each bacterial culture was transferred aseptically into nutrient broth and incubated at 37°C for 2–4 h to obtain actively growing cultures. Nutrient broth was prepared according to the manufacturer's instructions and sterilized by autoclaving at 121°C under 15 psi pressure for 15 min before use. Muller–Hinton Agar (MHA) medium was prepared by dissolving 38 g of the medium in 1 L of distilled water, followed by sterilization at 121°C for 15 min. After cooling to 45–50°C, approximately 20 mL of the sterile medium was poured into sterile Petri dishes and allowed to solidify. The actively growing bacterial suspensions were subsequently used for antibacterial assays.

Disc diffusion method

The antibacterial activity of methanol, chloroform, and petroleum ether extracts of *F. hispida* and *F. exasperata* fruits was evaluated using the agar disc diffusion method. Fresh bacterial inoculum was uniformly spread on Muller-Hinton agar plates using sterile cotton swabs to obtain a lawn culture. Sterile filter paper discs impregnated with the respective plant extracts were placed on the inoculated agar surface. Cefotaxime served as the positive control, whereas DMSO was used as the negative control. The plates were incubated at 37°C for 24 h. Following incubation, antibacterial activity was determined by measuring the diameter of the inhibition zones (mm) surrounding each disc.

Antioxidant Activity

Ferric Reducing Antioxidant Power (FRAP) Assay

Antioxidant activity of the fruit extracts was determined using a modified Ferric Reducing Antioxidant Power (FRAP) assay following the method of Pulido et al. (2000). Briefly, 0.1 mL of extract (1000 µg mL^{-1}) was mixed with 0.9 mL of 96% ethanol, 5 mL distilled water, 1.5 mL of 1 M hydrochloric acid, 1.5 mL of 1% potassium ferricyanide, 0.5 mL of 1% sodium dodecyl sulfate, and 0.5 mL of 0.2% ferric chloride solution. The reaction mixture was incubated in a water bath at 50°C for 20 min, cooled rapidly, and mixed thoroughly. Absorbance was measured at 700 nm using a colorimeter. An increase in absorbance was considered indicative of higher reducing power and antioxidant activity. Percentage inhibition was calculated using the following equation:

$$Inhibition\ (\%) = \frac{A - A_0}{A} x\ 100$$

where: A = absorbance of the sample; A_0 = absorbance of the control

Statistical Analysis

All experiments were performed in triplicate. Results were expressed as mean ± standard error (SE). Statistical analyses were carried out using standard statistical procedures, and the obtained data were used

to compare the phytochemical composition, antibacterial activity, and antioxidant potential of the two *Ficus* species.

RESULTS

Preliminary Phytochemical Analysis

Qualitative phytochemical screening of methanolic, chloroform, and petroleum ether fruit extracts of *Ficus hispida* (Table 1) and *Ficus exasperate* (Table 2) revealed the presence of several primary and secondary metabolites with variations among solvents and species. Carbohydrates, detected by Molisch's and Benedict's tests, along with proteins (Nitric acid test) and alkaloids (Wagner's test), were present in all three solvent extracts of both species, indicating their widespread distribution in the fruits. The methanolic extracts of both *F. hispida* and *F. exasperata* exhibited the richest phytochemical profile, showing positive reactions for flavonoids, coumarins, phenolics, tannins, terpenoids, cardiac glycosides, phytosterols, and saponins. In contrast, petroleum ether extracts contained comparatively fewer phytoconstituents, with positive results primarily limited to carbohydrates, proteins, and alkaloids. Phlobatannins were absent in all extracts of both species. Comparative analysis revealed that *F. exasperata* possessed a broader spectrum of phytochemicals in its chloroform extract than *F. hispida*. The chloroform extract of *F. exasperata* tested positive for flavonoids, coumarins, phenolics, cardiac glycosides, and saponins, whereas the corresponding extract of *F. hispida* showed positive reactions only for carbohydrates, proteins, alkaloids, cardiac glycosides, and saponins. Phenolic compounds, coumarins, and flavonoids were detected in the chloroform extract of *F. exasperata* but were absent in the chloroform extract of *F. hispida*, indicating a comparatively higher diversity of bioactive secondary metabolites in *F. exasperata*. Overall, the results demonstrated that methanol was the most effective solvent for extracting phytochemicals from the fruits of both species. The abundance of phenolics, flavonoids, tannins, terpenoids, and saponins in the methanolic extracts suggests that these extracts may possess significant biological activities, including antioxidant and antimicrobial properties. Furthermore, the comparatively richer phytochemical composition observed in *F. exasperata*, particularly in the chloroform extract, may contribute to differences in biological activity between the two species.

Table 1. Comparative Phytochemical Profile of Different Solvent Extracts of *Ficus hispida* Fruit

TESTS	Methanol	Chloroform	Methanol
CARBOHYDRATE			
Molisch's test	+	+	+
Benedict's test	+	+	+
PROTEIN - Nitric test	+	+	+
ALKALOID - Wagners test	+	+	+
FLAVANOLD - H_2SO_4 test	+	-	-
COUMARINS			
$FeCl_3$ TEST	+	-	-
Fluorescence test	+	-	-
PHENOL - $FeCl_3$ test	+	-	-
TANNIN - $FeCl_3$ test	+	-	-
TERPENOID - Salkowski test	+	-	-
CARDIAC GLYCOSIDE			
Keller killani test	+	+	-
PHYTOSTEROL	+	-	-
SAPONIN	+	+	-
PHLOBATANNIN	-	-	-

Table 2. Comparative Phytochemical Profile of Different Solvent Extracts of *Ficus exasperata* Fruit

TESTS	Methanol	Chloroform	Methanol
CARBOHYDRATES			
Molisch's test	+	+	+

Benedict's test	+	+	+
PROTEIN - Nitric test	+	+	+
ALKALOID - Wagners test	+	+	+
FLAVANOLD - H_2SO_4 test	+	+	-
COUMARINS			
$FeCl_3$ TEST	+	+	-
Fluorescence test	+	-	-
PHENOL - $FeCl_3$ test	+	+	-
TANNIN - $FeCl_3$ test	+	-	-
TERPENOID - Salkowski test	+	-	-
CARDIAC GLYCOSIDE			
Keller killani test	+	+	-
PHYTOSTEROL	+	-	-
SAPONIN	+	+	-
PHLOBATANNIN	-	-	-

Antibacterial activity of fruit extracts

The antibacterial activity of petroleum ether, chloroform, and methanolic fruit extracts of *Ficus hispida* and *Ficus exasperata* was evaluated against five pathogenic bacterial strains, namely *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Serratia marcescens*. The results demonstrated that all extracts exhibited antibacterial activity against both Gram-positive and Gram-negative bacteria, with the inhibition zones generally increasing with increasing extract concentration, indicating a dose-dependent response. Among the extracts of *F. hispida*, the chloroform extract exhibited the highest antibacterial activity against *S. aureus*, producing a maximum inhibition zone of 14.50 ± 0.62 mm at 30 mg concentration (Table 3). The methanolic extract showed the highest activity against *K. pneumoniae* (11.80 ± 0.37 mm) and *P. aeruginosa* (12.50 ± 0.24 mm), while the petroleum ether extract showed comparatively greater activity against *E. coli* (10.80 ± 0.37 mm). All three solvent extracts displayed moderate inhibitory activity against *S. marcescens*, with inhibition zones ranging from 11.47 to 11.50 mm at the highest concentration tested. Similarly, fruit extracts of *F. exasperata* exhibited concentration-dependent antibacterial activity against all tested microorganisms (Table 4). Among the solvent extracts, the chloroform extract showed the strongest antibacterial effect, producing inhibition zones of 15.50 ± 0.62 mm against *S. aureus*, 11.50 ± 0.62 mm against *K. pneumoniae*, 16.16 ± 0.48 mm against *P. aeruginosa*, 12.16 ± 0.35 mm against *E. coli*, and 12.50 ± 0.24 mm against *S. marcescens* at 30 mg concentration. Methanolic extracts also showed appreciable antibacterial activity, whereas petroleum ether extracts generally exhibited lower inhibition compared to chloroform and methanolic extracts. A comparative evaluation of the two species revealed that *F. exasperata* exhibited stronger antibacterial activity than *F. hispida* against most of the tested bacterial strains. The difference was particularly evident against *P. aeruginosa*, where the chloroform extract of *F. exasperata* produced a maximum inhibition zone of 16.16 ± 0.48 mm compared to 12.16 ± 0.36 mm recorded for *F. hispida*. Likewise, against *S. aureus*, the chloroform extract of *F. exasperata* produced a larger inhibition zone (15.50 ± 0.62 mm) than that of *F. hispida* (14.50 ± 0.62 mm). The methanolic extract of *F. exasperata* also showed higher activity against *E. coli* (11.31 ± 0.23 mm) than the corresponding extract of *F. hispida* (8.30 ± 0.27 mm). Overall, *F. exasperata* demonstrated a broader and stronger antibacterial spectrum, particularly in the chloroform extract.

The antibacterial activities of the plant extracts were compared with the standard antibiotic cefotaxime (Table 5). Cefotaxime exhibited substantially higher inhibitory activity against all tested bacterial strains, with inhibition zones ranging from 13.30 ± 1.65 mm to 36.60 ± 1.44 mm. The highest susceptibility was observed in *S. marcescens*, which recorded an inhibition zone of 36.60 ± 1.44 mm at 0.004 mg of cefotaxime, followed by *S. aureus* (32.30 ± 0.98 mm) and *P. aeruginosa* (25.30 ± 1.18 mm). Although the plant extracts produced lower inhibition zones than cefotaxime, they exhibited considerable antibacterial activity, particularly at higher concentrations, indicating the presence of bioactive phytochemicals with antimicrobial potential. Overall, the results indicate that both *F. hispida* and *F. exasperata* fruits possess noteworthy antibacterial properties, with *F. exasperata*, especially its chloroform extract, showing superior

activity. However, the antibacterial efficacy of the extracts remained lower than that of the standard antibiotic cefotaxime. The observed antibacterial activity may be attributed to the presence of phytochemicals such as flavonoids, phenolics, tannins, terpenoids, alkaloids, and saponins detected during preliminary phytochemical screening.

Table 3. Antimicrobial activity of *F.hispida* fruit against tested microorganisms

Sl. no	Solvent	Dosage (mg)	Inhibition Zone (in mm)				
			S. aureus	*K. pneumoniae*	*P. aeruginosa*	*E. coli*	*5. marcescens*
1	Petroleum ether	. 15	9.26±0.24	6.6±0.25	7.5±0.24	7.510.24	10.810.37
		. 20	10.16±0.14	6.91±0.14	8±0.24	8.5±0.24	10.16:0.14
		.25	11.31±0.27	8±0.24	11.47±0.31	9.16±0.14	11.3110.27
		.30	13.4±0.21	11.31±0.27	12.16±0.36	10.8±0.37	11.47±0.31
2.	chloroform	.15	9.16±0.14	6.66±0.36	6.6±0.25	7.51.24	8.5±0.24
		.20	10.16±0.14	7.7±0.35	7.7±0.35	7.8±0.37	9.16±0.14
		.25	11.5±0.24	10.8±0.37	8.7±0.35	8.5±0.24	10.16±0.14
		.30	14.5±0.62	11.16±0.14	12.16±0.36	10.6±.36	11.5±0.24
3.	Methanol	.15	8.3±.27	6.6±0.25	7.8±0.37	6.66±0.36	7.3±0.27
		.20	10.8±0.37	7.7±0.35	8±0.24	7.5±0.24	8.16±0.14
		.25	11.6±0.24	10.06±0.14	10±0.24	7.7±0.35	10.8±0.37
		.30	12.16±0.36	11.8±0.37	12.5±0.24	8.3±0.27	11.5±0.62

Table 4. Antimicrobial activity of *F.exasperata* fruit against tested microorganisms

Sl. no	Solvent	Dosage (mg)	Inhibition Zone (in mm)				
			S. aureus	*K. pneumoniae*	*P. aeruginosa*	*E. coli*	*S. aureus*
1	Petroleum ether	.15	8.3±0.36	6.5±0.4	6.83±0.36	7.5:0.4	6.6610.36
		.20	9.5±0.24	7.6±0.25	8.17:0.14	8.17±0.13	7.5310.24
		.25	10.5±0.24	8.43±0.19	10.310.28	8.43:0.19	8.17±0.14
		.30	11.16±0.14	10.6±0.14	11.16:0.14	10.310.28	10.5±0.24
2.	chloroform	.15	9±0.24	7.83±0.35	7.7±0.14	6.510.4	7.5:0.23
		.20	10.6±0.14	8.43±0.19	8.17±0.14	7.96±0.24	9.3±0.27
		.25	12.16±0.35	10.3±0.28	12.5±0.24	8.17±0.13	10.16±0.48
		.30	15.5±0.62	11.5±0.62	16.16±0.48	12.16±0.35	12.5±0.24
3.	Methanol	.15	9.53±0.24	6.86±0.38	9.33±0.14	7.5±0.4	7.5310.24
		.20	10.6±0.14	7.1±0.08	10.16±0.48	8.3±0.36	8.17±0.14
		.25	11.5±0.62	8.17±0.14	11.7±0.41	8.17±0.13	10.6±0.19
		.30	13.16±0.48	10.3±0.28	12.16±0.35	11.31±0.23	11.73±0.24

Table 5. Effect of positive control cefotaxime against tested bacterial strains

Sl. no	Solvent	Dosa ge (mg)	Inhibition Zone (in mm)				
			S. aureus	*K.pneumoniae*	*P.aeruginosa*	*E. coli*	*5.marcescens*
1.	0.001	Cefotaxime	23.6±0.72	11.3±0.71	20.6±0.98	12.3±1.18	29.6±2.13
2.	0.002	Cefotaxime	22.6±2.42	13.6±1.18	23±1.24	13.3±1.65	32±1.24

3.	0.003	Cefotaxime	27.6±1.44	13.6±1.44	25.3±0.71	15.3±1.18	35±1.42
4.	0.004	Cefotaxime	32.3±0.98	13.3±1.65	25.3±1.18	16±1.41	36.6±1.44

Antioxidant activity by FRAP assay

The antioxidant potential of petroleum ether, chloroform, and methanolic fruit extracts of *Ficus hispida* and *Ficus exasperata* was evaluated using the Ferric Reducing Antioxidant Power (FRAP) assay. In both species, antioxidant activity increased with increasing extract concentration (20–80 µg mL^{-1}), indicating a concentration-dependent reducing power (Table 6&7). In *Ficus hispida*, all solvent extracts exhibited appreciable antioxidant activity. The methanolic extract showed the highest antioxidant potential, with percentage inhibition increasing from 42.90% at 20 µg mL^{-1} to 75.00% at 80 µg mL^{-1}. This extract also recorded the lowest IC_{50} value (33.32 µg mL^{-1}), indicating the strongest antioxidant activity among the tested extracts. The chloroform extract exhibited inhibition values ranging from 30.00% to 81.40% with an IC_{50} value of 40.49 µg mL^{-1}, while the petroleum ether extract showed inhibition values between 25.00% and 70.00% and an IC_{50} value of 43.49 µg mL^{-1}. The lower IC_{50} value of the methanolic extract suggests greater antioxidant efficiency compared with the other solvent extracts.

Similarly, all extracts of *Ficus exasperata* demonstrated concentration-dependent antioxidant activity. The methanolic extract exhibited the strongest activity, with inhibition increasing from 44.50% at 20 µg mL^{-1} to 75.00% at 80 µg mL^{-1} and an IC_{50} value of 31.63 µg mL^{-1}. The chloroform extract recorded inhibition values ranging from 40.00% to 66.67% and an IC_{50} value of 39.69 µg mL^{-1}, whereas the petroleum ether extract showed inhibition values between 37.50% and 74.00% with an IC_{50} value of 41.38 µg mL^{-1}. A comparative evaluation of the two species revealed that *F. exasperata* possessed slightly stronger antioxidant activity than *F. hispida* in all solvent systems, as evidenced by its lower IC_{50} values. The methanolic extract of *F. exasperata* exhibited the highest antioxidant activity among all plant extracts tested (IC_{50} = 31.63 µg mL^{-1}), followed by the methanolic extract of *F. hispida* (IC_{50} = 33.32 µg mL^{-1}). Chloroform and petroleum ether extracts of both species showed comparatively lower antioxidant activities.

The standard antioxidant, ascorbic acid, exhibited the strongest reducing power with an IC_{50} value of 25.50 µg mL^{-1}, which was lower than all plant extracts tested. However, the methanolic extracts of both *F. exasperata* and *F. hispida* showed considerable antioxidant activity and approached the effectiveness of the standard antioxidant. The superior antioxidant activity observed in methanolic extracts may be attributed to their higher content of phenolic compounds, flavonoids, tannins, and other antioxidant phytochemicals detected during preliminary phytochemical screening. Overall, the results indicate that both *F. hispida* and *F. exasperata* fruits possess notable antioxidant properties, with *F. exasperata* exhibiting slightly greater antioxidant potential. Among the solvents tested, methanol proved to be the most effective extraction solvent for recovering antioxidant compounds from the fruits of both species.

Table 6. Ferric Ion Reducing Antioxidant Activity of *Ficus hispida* fruit extracts

Sl. No	*Ficus hispida*	Concentration (µg)	Absorbance	Inhibition	IC_{50} Value
1	Petroleum Ether	Blank 20 40 60 80	0.03 0.04 0.07 0.09 0.10	 25 57.2 66.7 70	43.49
2	Chloroform	Blank 20 40 60 80	0.14 0.20 0.31 0.40 0.75	 30 54.9 65 81.4	40.49
3	Methanol	Blank 20 40 60 80	0.04 0.07 0.09 0.12 0.16	 42.9 55.56 66.67 75	33.32

Table 7. Ferric Ion Reducing Antioxidant Activity of *Ficus exasperata* fruit extracts

Sl. No	*Ficus exasperata*	Concentration (µg)	Absorbance	Inhibition	IC_{50} Value
1	Petroleum Ether	Blank	0.05		
		20	0.08	37.5	
		40	0.10	50	
		60	0.12	59	41.38
		80	0.19	74	
2	Chloroform	Blank	0.03		
		20	0.05	40	
		40	0.06	50	
		60	0.08	62.5	39.69
		80	0.09	66.67	
3	Methanol	Blank	0.05		
		20	0.09	44.5	
		40	0.11	55	
		60	0.13	61.6	31.63
		80	0.20	75	
4	Ascorbic Acid	Blank	0.05		
		20	0.09	44.5	
		40	0.11	55	
		60	013	61.6	25.50
		80	0.20	75	

DISCUSSION

The present study evaluated the phytochemical composition, antibacterial activity, and antioxidant potential of fruit extracts of *Ficus hispida* and *Ficus exasperata* using petroleum ether, chloroform, and methanol as extraction solvents. The results demonstrated that both species contain a diverse range of bioactive phytochemicals and possess appreciable antibacterial and antioxidant activities, although the magnitude of activity varied among species and solvents. Preliminary phytochemical screening revealed that methanol was the most effective solvent for extracting phytoconstituents from the fruits of both species. The methanolic extract of *F. hispida* contained carbohydrates, proteins, alkaloids, flavonoids, coumarins, phenolics, tannins, terpenoids, cardiac glycosides, phytosterols, and saponins, while phlobatannins were absent. Similar observations were recorded for *F. exasperata*, where the methanolic extract exhibited the richest phytochemical profile. These findings agree with previous reports on *F. hispida*, where Ghosh et al. (2004) reported the presence of alkaloids, flavonoids, phenolics, glycosides, saponins, terpenes, proteins, and carbohydrates in various plant parts. Likewise, Ajayi et al. (2012) reported the occurrence of flavonoids, alkaloids, saponins, and cardiac glycosides in *F. exasperata*. The present findings further indicate that chloroform extract of *F. exasperata* contained a wider spectrum of phytochemicals than the corresponding extract of *F. hispida*, suggesting a greater abundance of moderately polar bioactive compounds in *F. exasperata* fruits.

The observed phytochemical diversity may account for the biological activities recorded in the present investigation. Phenolic compounds and flavonoids are known to possess strong antioxidant and antimicrobial properties due to their ability to donate hydrogen atoms, scavenge free radicals, chelate metal ions, and interfere with microbial cell membranes. Similarly, tannins, terpenoids, alkaloids, and saponins are recognized for their broad-spectrum antimicrobial effects against pathogenic microorganisms. The antibacterial assay demonstrated that all extracts exhibited inhibitory activity against both Gram-positive and Gram-negative bacteria, although the degree of inhibition varied with solvent and bacterial species. The antibacterial activity generally increased with increasing extract concentration, indicating a concentration-dependent response. Among the tested extracts, the chloroform extract of *F. exasperata* showed the strongest antibacterial activity, particularly against *Pseudomonas aeruginosa* and *Staphylococcus aureus*. In contrast, *F. hispida* exhibited comparatively lower activity, with the highest

inhibition observed against *S. aureus*. The lower susceptibility of *Escherichia coli* to *F. hispida* extracts may be attributed to the complex outer membrane structure of Gram-negative bacteria, which restricts the penetration of antimicrobial compounds.

The present results are in agreement with earlier studies on *Ficus* species. Sanowar Hossain et al. (2014) reported significant antibacterial activity of methanolic fruit extracts of *F. hispida* against both Gram-positive and Gram-negative bacteria, including *E. coli* and *Staphylococcus aureus*. Similarly, Lawal et al. (2012) demonstrated notable antibacterial activity of methanolic and ethyl acetate extracts of *F. exasperata* against *S. aureus*, *E. coli*, *Bacillus subtilis*, and *Pseudomonas aeruginosa*. Odunbaku et al. (2008) also reported inhibitory effects of ethanolic leaf extracts of *F. exasperata* against *E. coli* and *Staphylococcus* species. The antibacterial effects observed in the present study therefore support the traditional use of both plants in the treatment of infectious diseases and suggest that their fruits contain compounds capable of suppressing pathogenic bacterial growth. Although cefotaxime produced considerably larger inhibition zones than the plant extracts, the extracts demonstrated substantial antibacterial activity, especially at higher concentrations. This finding is expected because cefotaxime is a purified broad-spectrum antibiotic, whereas crude plant extracts contain a mixture of compounds, only a fraction of which may possess antibacterial properties. Nevertheless, the ability of the extracts to inhibit clinically important pathogens such as *P. aeruginosa*, *K. pneumoniae*, and *S. aureus* indicates their potential as sources of novel antimicrobial agents.

The antioxidant activity assessed through the FRAP assay revealed that all extracts possessed ferric ion reducing ability. In both species, antioxidant activity increased with increasing concentration, indicating a dose-dependent antioxidant response. Methanolic extracts exhibited the strongest activity, reflected by higher percentage inhibition and lower IC_{50} values. Among all extracts tested, the methanolic extract of *F. exasperata* showed the greatest antioxidant activity (IC_{50} = 31.63 µg mL^{-1}), followed closely by the methanolic extract of *F. hispida* (IC_{50} = 33.32 µg mL^{-1}). Although ascorbic acid exhibited superior antioxidant activity, the methanolic extracts of both species showed comparable reducing power, highlighting their potential as natural antioxidants.

These findings corroborate previous reports on the antioxidant potential of *Ficus* species. Sirisha et al. reported that *Ficus* species are rich sources of polyphenols and flavonoids that contribute significantly to antioxidant activity and protection against oxidative stress-related disorders. Similarly, Okenwa et al. reported considerable antioxidant activity in *F. exasperata* leaves associated with the presence of vitamins and phenolic constituents. The strong antioxidant activity observed in the present study may therefore be attributed to the presence of phenolics, flavonoids, tannins, and other reducing compounds identified during phytochemical screening. A comparison of the two species revealed that *F. exasperata* consistently exhibited stronger antibacterial and antioxidant activities than *F. hispida*. This enhanced bioactivity corresponds with the broader phytochemical profile observed in *F. exasperata*, particularly in its chloroform and methanolic extracts. The higher abundance of phenolic compounds, flavonoids, tannins, and glycosides in *F. exasperata* may explain its superior biological performance.

Overall, the present study confirms that fruits of both *F. hispida* and *F. exasperata* are valuable sources of bioactive phytochemicals with significant antibacterial and antioxidant properties. The findings scientifically support their traditional medicinal use and suggest their potential application in the development of natural antimicrobial and antioxidant formulations. Further studies involving isolation, purification, and characterization of the active constituents, together with toxicity and mechanism-of-action studies, are required to fully exploit their therapeutic potential.

CONCLUSION

The present study demonstrated that the fruits of both *Ficus hispida* and *Ficus exasperata* are rich sources of bioactive phytochemicals and possess noteworthy antibacterial and antioxidant properties. Preliminary phytochemical screening revealed that methanolic extracts contained the highest diversity of primary and secondary metabolites, including flavonoids, phenolics, tannins, terpenoids, saponins, and cardiac glycosides, whereas chloroform and petroleum ether extracts contained comparatively fewer constituents. Antibacterial assays showed that all extracts exhibited concentration-dependent inhibitory activity against the tested bacterial pathogens, with *F. exasperata*, particularly its chloroform extract, demonstrating superior antibacterial efficacy compared to *F. hispida*. Both species displayed broad-spectrum antimicrobial

activity, highlighting their potential as natural sources of antimicrobial agents. In the FRAP assay, methanolic extracts exhibited the strongest antioxidant activity, while petroleum ether extracts showed comparatively lower activity. The enhanced antioxidant and antimicrobial activities observed in methanolic extracts may be attributed to their higher content of phenolic and flavonoid compounds. Overall, the findings suggest that *F. hispida* and *F. exasperata*, especially the methanolic and chloroform extracts, possess significant pharmacological potential and warrant further investigation for the isolation, characterization, and development of novel natural antioxidant and antimicrobial compounds.

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Conflict of interest
The authors declares that there is no potential conflict of interest for the study

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