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Unveiling the therapeutic potential of *Ficus benghalensis*: A review of its traditional uses, phytochemistry, and pharmacological activities

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Abstract

Traditional medicinal systems offer a valuable repository of knowledge for identifying biologically active plant species. Plants have been a cornerstone of traditional and modern medicine due to their diverse bioactive compounds. Among the plethora of medicinal plants, the Ficus genus holds particular importance, and Ficus benghalensis stands out for its sacred status and extensive applications. A species revered in Ayurveda and Siddha, it has been extensively utilized in South Asian traditional medicinal systems. Its common name, the Banyan tree, reflects its deep cultural and medicinal roots in the region. This review comprehensively examines the phytochemical profile and pharmacological activities of various plant parts, with a particular emphasis on the fruit's potential therapeutic applications. The plant's phytochemical constituents, including phenolics, flavanols, and terpenes, contribute to its multifaceted pharmacological properties. Advanced analytical techniques have identified key compounds such as bergenin, leukocyanidin, and β-sitosterol, which are largely responsible for its observed bioactivity. These properties encompass antioxidative, antimutagenic, and antidiabetic effects, as well as anti-inflammatory, antitumor, and antiproliferative activities. F. benghalensis exhibits wound healing, antimicrobial, and anti-helminthic properties, along with anticancer and hair growth promotion effects. Its immunomodulatory, hepatoprotective, and antistress activities further underscore its medicinal value. Despite its extensive traditional use, a significant gap remains between empirical applications and validated scientific evidence for many of its purported benefits. Future research directions may involve investigating unexplored pharmacological aspects of F. benghalensis, potentially leading to the development of innovative therapeutic agents. Elucidating the plant's mechanisms of action and optimizing its bioactive compounds through modern drug delivery systems could significantly enhance its therapeutic potential.

Keywords: Ayurveda medicines, Banyan fruit, *F. benghalensis*, Pharmacological uses, Phytoconstituents, Traditional uses

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Introduction

Medicinal plants have been used for thousands of years and are widely recognized for their efficacy in a variety of therapies (Khan et al., 2020; Fazal et al., 2025). The medicinally useful plants were discovered, extracted for pharmacological characteristics, and analyzed to determine functional groupings (Bo et al., 2025). The huge, evergreen, laciferous, moraceous *Ficus benghalensis* tree belongs to the Ficus genus, which has over 2000 subvarieties and 800 species. Ficus species belong to the "Moraceae" family and are found in tropical and subtropical areas across the world. They may produce up to 2,500 distinct species of woody, creeping, and shrubby plants (Gopukumar et al., 2016). Ficus trees are widely grown for religious and cultural purposes, as well as for their therapeutic qualities, throughout South Asia. It can be found in Nepal, Bhutan, Bangladesh, India, and Pakistan. It is typically planted near the temples. Typically, wayside trees like this one are planted primarily for their shade (Logesh et al., 2023). An alternative name for F. benghalensis is the "Indian banyan tree". The tree is enormous, reaching up to 100 feet in height and spanning many acres with multiple branches that reach out far. The gigantic limbs of the tree are upheld by prop roots. When it is young, the bark is thick and smooth, it is green, and when grown, it is grayish white, turning pink when sliced and shedding skin in layers; the wood is porous and spongy, with a sticky, milky latex (Bandekar et al., 2013a). When fully developed, the leaves of the tree are smooth, shiny, and devoid of hair. They have an oval shape, mostly with blunt tips, and a heart-shaped or rounded base. The leaves are thick and leathery, with 3-7 prominent veins originating from the base. The central vein, known as the midrib, is accompanied by 4-6 pairs of secondary veins. The leaf blade measures approximately 10-20 cm in length, while the leaf stalk, or petiole, ranges from 2-5 cm. The shoots of the tree are covered in fine hairs and have a diameter of 1.5 to 2 cm. The tree produces sessile fruits that are initially scarlet and turn red when they ripen (Kmail et al., 2018). It has quite modest, separate flowers for the male and female. In the *F. benghalensis* tree, the female flowers have long styles (part of the female reproductive mechanism) and shorter perianths (outer floral parts), while the male flowers are grouped close to the receptacle entrance. Male and female flowers can be present in the same receptacle (Bandekar et al., 2013a). The fruits of the *F. benghalensis* tree are round, and they grow in pairs directly in the leaf axils. They have a fleshy outer layer called the pericarp, within which small achenes (seeds) are embedded. The fruits typically measure around 1.5-2.0 cm in diameter and undergo a color transformation from scarlet to dark purple as they ripen. The actual seeds are tiny. Although fruit is unfit for human eating, birds and primates eat it.

Banyan fruits are high in mineral content, fiber, and carbohydrates. The proximate composition of banyan fruit (dry basis) is moisture 71.04% (wet basis), 2.84% ash 8.67%, crude fat 17.07% fiber, 4.84% protein, and 66.65% carbohydrate. Fruits are high in ash (minerals), carbs, and crude fibers, and are a strong source of energy. A high mineral content improves digestion by increasing enzyme activity. Consumption of crude fiber increases fecal bulk and hence the pace of intestinal transit. Total metabolizable energy (363.87 kcal/100 g) is an excellent source of human nutrition (Bandekar et al., 2013a). It is widely used in traditional treatment to treat a variety of medical conditions in South Asian countries such as India, Nepal, Pakistan and Sri Lanka. The purpose of this study is to investigate previous research on the F. benghalensis plant and provide an in-depth evaluation of its phytochemistry, ethnomedicinal uses, and pharmacological effects. The study will also look at the possible health advantages of the fruit.

Applications of *F. benghalensis* tree

Traditional medicinal practices

Stem and bark, fruit, leaf, latex, root, and bud of F. benghalensis are among the parts that are frequently used in folk medicine and Ayurvedic treatment formulations to treat many conditions such as asthma, leprosy, dysentery, diabetes, diarrhea, lung infections, leucorrhea, enlarged liver and spleen, and other conditions which are explained in Table.1.

Table 1 Parts of the *F. benghalensis* tree and their various applications

Plant parts	Traditional medicinal uses	References
Leaves	Treatment of skin rashes, pimples and acne	Siddique et al. (2019)
	Treat neurological diseases, menorrhagia, diabetes, diarrhea, and dysentery	Buckner et al. (2016)
Stem bark	Utilized to treat skin conditions	Joseph & Justin Raj, (2010)
	Combat hyperglycemia, diarrhea, and dysentery.	Kumar & Bhagat (2012); Rehamn & Sultana (2013)
	Beneficial for leucorrhea, hemoptysis, hemorrhages, enuresis, hyperpiesia, burning feeling, and gonorrhea	Murti et al. (2010)
Latex	Used to treat ulcers, injured tissues, joint and muscle pain, piles, and sores	Logesh et al. (2023)
	Blood purifier for urinary and urinogenital disorders	Murugesu et al. (2021)
	Neuralgia, otorrhagia, rheumatism, bruising from lumbago, ulitis, hemorrhoids, gonorrhea, nasitis, odontopathy, inflammations, and skin problems might all benefit from it	Manna (2010); Murti et al. (2010)
	Using milky latex to treat rheumatism	Kumar & Bhagat (2012); Sreeramulu et al. (2013)
	Wound with maggots	Naik et al. (2012)
Roots	Therapy for leucorrhea, enhanced hair growth, dysentery, fever, scabies, mouth sores, cholera, atrophy, female sterility, teeth cleaning, insanity, and diarrhea	Manna (2010); Logesh et al. (2023)
	Beneficial for recalcitrant vomiting, and limb osteomalacia	Murti et al. (2010)
	Beneficial in stopping menstrual bleeding	Islam et al. (2011)
Fruit and buds	Vomiting and gastrointestinal illness	Rahman et al. (2007)
	Biliary complications	Singh et al. (2023a)
	Pitta treatment	Murti et al. (2010)
	Tonic and cooling effect	Manna (2010)

Phytochemistry

Despite F. benghalensis' lengthy history of use in traditional medicine, very little research has been done on its phytochemistry (Logesh et al., 2023). Early phytochemical investigation in different regions of the world has found numerous phytochemical constituents that are responsible for the varied medicinal and pharmacological characteristics found in *F. benghalensis* tree (Singh et al., 2023b). F. benghalensis' bark and leaves contain high levels of phenols, terpenoids, flavonoids, and terpenes. Phenolic compounds and fatty acids are abundant in fruit, while sterols and fatty acids are also present in the root extract (Murugesu et al., 2021). Table 2 lists the bioactive substances that are present in different sections of the *F. benghalensis* tree.

Table 2 Bioactive compounds and pharmacological potential of *F. benghalensis* tree

Plant parts	Type of compound	Compound name	References
Leaves	Phenolics	Gallic acid, rhein, anthraquinone, Theaflavins, and theaflavin-3,30-di gallate	Bhaskara Rao et al. (2014)
		Taraxosterol, and quercetin	Gopukumar & Praseetha (2015)
	Terpenes/Terpenoids	beta-amyrin, lupeol and friedelin	
		Beta-sitosterol, betulinic acid, 3-friedelanol, and 20-traxasten-3-ol	Tripathi et al. (2019
	Flavanols/Flavonoids	Quercetin-3-galactoside, rutin, catechin, and gallocatechin	Gopukumar & Praseetha (2015)
	Others	Psoralen, bergapten and β-sisterol	
Bark	Phenolics	Lupeol	Naquvi et al. (2015)
		leucopelargonidin 3-O-β-D-glucopyranoside, leucocyanidin 3-O-β-D-glucopyranoside, Saponin gluanol acetate, , rhamnopyranoside, leucoanthocyanidin, leucopelargonidin 3-O-α-L or leucoanthocyanin	Babu et al. (2010)
		Galactosyl cellobioside, bengalensisteroic acid ester, leuco pelargonidin and rhamnoside.	Joseph & Justin Raj (2010)
	Terpenes/Terpenoids	Leucodelphinidin derivative, leucopelargonin derivative, and leucocynidin derivative,	Gopukumar & Praseetha (2015)
		A-amyrin acetate, beta-sitosterol alpha-D glucose, and lupeol	Naquvi et al. (2015)
	Esters	Lanostadienyl glucosyl cetoleate and heneicosanyl oleate	
		Ceryl behenate	Babu et al. (2010)
		Leucopelargonidin-3-0-α-L, 3-0-α-D galactosyl cellobioside, leucocynidin and rhamnoside	
	Flavonols	Rutin, and quercetin-3-galactoside	
Stem	Phenolics	4H-Pyran-4-one	Manorenjitha et al. (2013)
	Terpenes/Terpenoids	Ergost-5-en-3-ol, stigmasterol, and lanosta-8	
	Esters	Acetic acid 3, beta-dimethoxypheno n-hexa decanoic acid	
	Others	Octadecanoic acid, 2,4-bis (1,1-dimethyl ethyl), and 2,3-dihydro-3,5-dihydroxy-6-methyl	
Aerial roots	Phenolics	Chlorogenic acid, and caffeic acid	Afzal et al. (2020a)
		Leucocyanidin-3-0-β-D-glucopyranoside and Leucopelargonidin-3-0-β-D-glucopyranoside are described	Verma et al. (2015)
	Terpenes/Terpenoids	Sitosterol, β-sitosterol, dihydro brassicasterol, cycloartenol acetate, stigmasterol, ergosterol acetate, protodeacon, and lupeol	
	Flavonoids	cyanidin 3-glucoside (Cy-3-Glu), Cyanidin 3-glucoside equivalent (CGE), quercetin, naringenin, and kaempferol	Afzal et al. (2020a)
	Esters	Methyl ester, lupeol acetate, linoleoyl chloride, dioctyl ester, α-amyrin acetate, palmitic acid, and ceryl behenate.	Verma et al. (2015)
	Fatty acids	Stearic acid, myristic acid, quinic acid, heptadecanoic acid, linoleic acid, and eicosadienoic acid	
	Others	Bengalensinone, phthalic acid, saponin, leucoanthocyanidin, leucoanthocyanin, 4,22-stigmastadiene-3-one, alpha-monostearin, linoleic acid, triacontanol, beta-progesterone, furostano, benganoic acid, and 1-heptatriacotanol	
Fruit	Phenolics	Quercetin, chlorogenic acid, caffeic acid, cyanidin 3-glucoside (Cy-3-Glu), and cyanidin 3-glucoside equivalent (CGE)	Afzal et al. (2020a)
		Methyl ester; 2-methoxy-4-vinyl phenol, dimethyl ester	Pg (2018)
		Ficus bengursenyl diglucoside, β-sitosterol glucuronoside, ursenoic acid glucoside	Akhtar et al. (2021)
	Terpenes/Terpenoids	Stigmasterol, and stigmasterol glucoside	
		Azulene, octadecadienoyl gamma-tocopherol, and alpha-tocopherol	Jayasree Radhakrishnan & Venkatachalam (2020)

	Fatty acids	Hexadecanoic acid, Octadecanoic acid, 9-hexadecenoic acid, Methyl ester, 9,15-octadecatrienoic acid, and 8,11,14-eiscosatrienoic acid are the compounds that make up 7-Tetradecenal (Z)	
		N-docosanyl hexadecanoate, N-docosanyl octadec-9-enoate, and docosanyl octanoate	Akhtar et al. (2021)
	Others	Formic acid, 2-propenyl ester, 5-hydroxy methyl furfural, 1,2,3-propanetriol, gamma-tocopherol, tetra hydro cyclopentadioxin-4-one, 1,2-Benzenedicarboxylic acid, and dibutyl ester are among the compounds that include 4H-Pyran-4-one	Jayasree Radhakrishnan & Venkatachalam (2020)

Pharmacological actions

Anti-diabetic effect

For years of age, traditional medicine has utilized this plant to treat a variety of illnesses, including diabetes. The plant includes flavonoids, alkaloids, and saponins, among other substances whose anti-diabetic properties have been exhibited. It raises the production of insulin, which aids in blood sugar regulation. It also aids in enhancing insulin resistance. In order to investigate the potential hypoglycemic effect of fruit, bark, and powdered aerial roots, (Sharma et al., 2007) ran an animal trial for 50 days. For this purpose, six sets of male albino rats (weighing between 135 and 185 grams) were procured. Groups A, B, and C received an extract made from ethanol of aerial root, bark, and fruit powder (120 mg/kg body weight/day) together with 5 ml of tap water (diabetic control group) and 5 ml of tap water (normal control group). Glibencamide was given to Group F at a dose of 0.55 mg. After 50 days, blood samples were obtained to measure the subjects' lipid profile parameters, blood glucose fasting, and blood glucose at random. This study revealed that extract prepared from *F. bengalensis* is not toxic by using all parameters mentioned in the study. Additionally, research has shown that the fruit extract (120 mg/kg) of the *F. benghalensis* tree significantly lowered the blood glucose level of the experimental subjects as compared to the aerial roots and barks. It revealed the same effect shown by the standard drug used for diabetes treatment glibenclamide at dose of 0.55mg. The same anti diabetic effect was shown by other parts of plants in another experiment which is conducted by (Khanal & Patil, 2020) using the same biochemical and hematological parameters.

Anti-inflammatory effect

Numerous research has shown that the *F. benghalensis* tree has antiphlogistic qualities. A study conducted by (Nandita & Rajeshkumar, 2023) demonstrated that using 2.5 mg/mL and 5 mg/mL of *F. benghalensis* extract dramatically decreased inflammation in zebrafish embryos. A total of three milliliters (3 mL) of E3 medium were used with about 15 larvae. In contrast, the larvae treated with extract had the characteristic morphology of paw edema brought on by carrageenan, and it was clear from the comparison that the larvae were dead. According to a different study, the leaf extract prevented lipopolysaccharide-stimulated macrophages from producing pro-inflammatory cytokines. Many phytochemicals, such as flavonoids, tannins, and saponins, are probably responsible for *F. benghalensis's* anti-inflammatory properties (Mazumder et al., 2022).

Analgesic and anti-pyretic activity

The ethanol-based and aqueous extracts of the bark's bioactive components demonstrated potent analgesic and antipyretic effects (Taur et al., 2007). This result is explained by the yeast-induced hyperthermia and hot plate acetic acid-induced writhing method in an animal model. Eight groups, each containing six animals, were created from the animals used in this investigation. Rats were injected with 20% yeast suspension at a dosage of 1 milliliter/100 grams of body weight, and the animals' rectal temperatures were measured both before and after the rats were made hyperthermic. The antipyretic effects of the ethanolic extract and water were measured at doses ranging from 100–400g, and their results were contrasted with those of the medication paracetamol. According to the findings, the 400g dose of aqueous extract significantly affected rectal temperature in a manner like that of the popular drug paracetamol. When 0.01 milliliters of acetic acid solution were injected into the animal model, an analgesic effect was seen. The albino rat groups were given ethanolic and aqueous extracts in three different dosages (400, 100, and 200, mg/kg body mass each day), and the results were contrasted with aspirin's effects. The dosage-dependent extract of F. benghalensis, as indicated by the popular medicine aspirin, shows that the 400 mg/kg dose of aqueous extract has a significant influence on acetic acid-induced writhing (Garg & Paliwal, 2014).

Anti-bacterial effect

According to research, leaves, fruits, and roots had antibacterial action against four different types of strains of bacteria, including *E. coli, Staphylococcus aureus, Bacillus cereus and Pseudomonas protobacterium.* These strains were grown on a nutrient agar plate at five degrees Celsius for one day. The ethanolic and methanolic extracts of *F. benghalensis* were administered at three doses: 150 microliters, 100 microliters, and 50 microliters. Several phenolic chemicals, such as glycoside, lutein, caffeic acid, and chlorogenic acid, were found in the fruit, root, and leaves in an HPLC examination (Afzal et al., 2020b). In another study by

(Chaudhary et al., 2014) The leaves display the same effect. Methanolic extract was shown to have the most in vitro antibacterial effectiveness, with aqueous and chloroform extracts coming in second and third. Gram positive bacteria were more effectively inhibited by the extract than gram negative bacteria. The investigation goes on to say that *S. typhi* has shown total resistance to every extract.

Anti-hypertensive effect

The primary cause of cardiovascular problems, including stroke, renal illness, sudden cardiac death, etc., is hypertension. An animal model research by (Ahmed, 2021), revealed hypertensive action in the bark of *F. benghalensis*. 12 male albino rats in total were split up into four groups and administered four different treatments: bark extracts diluted in 0.2 mL of normal saline, bark extracts 10 mg per kilogram, 0.55 microgram between angiotensin and regular saline, and bark extract. Significant changes in heart rate, mean, diastolic blood pressure, systolic blood pressure and arterial blood pressure were seen in the groups that received bark extract and bark plus angiotensin 11, respectively. This study shows that chemicals like gallic acid, quercetin, and chlorogenic acid exhibit a range of biological effects, including antioxidants, neuroprotective, and anti-hypertensive properties.

Wound healing effect

Injuries are inevitable aspects of life that arise from physical, chemical, or microbiological infections. It entails a methodical sequence of cellular and metabolic processes that result in tissue regeneration and repair. In an animal model trial, a study compares the effects of ethanolic and hydro-alcoholic bark extracts from two different Ficus species on wound healing. The albino rats group received both hydroalcoholic and ethanolic extracts of both *Ficus* species during the 20-day experiment. By the time the trial is over, the results indicate that both species have a notable impact on wound healing and hemolysis of red blood cells. Within seventeen days, the wound healed entirely. On the other hand, the hydro-alcoholic extract of *F. benghalensis* produces similar results as the ethanolic extract of *F. religiosa*. This research also reveals that the antioxidant qualities of some Ficus species' phenolic compounds account for these plants' capacity to heal wounds (Raisagar et al., 2019).

Effect on chronic ulcer

There are countless remedies for all of humanity's ailments in nature. Ulcers have been a serious gastrointestinal problem and a major cause of GI disorders-related deaths for over 20 years. For many years, a number of illnesses, most notably stomach ulcers, have been treated using *F. benghalensis* in traditional Indian medicine (Kulshreshtha et al., 2011). In an animal model trial, it also demonstrated some noteworthy effects against ulcers. There were six experimental rats in each of the six groups of albino rats. As a control group, Group 1 received standard saline (2.0 ml/kg). In the acetic acid-induced chronic ulcer, HCL-induced chronic ulcer induction and aspirin-induced chronic ulcer models, the other groups received oral ethanolic extracts of F. benghalensis at dosages of 100, 200, and 400 mg/kg body weight, respectively. All three ulcer models showed an anti-ulcer effect from an extract of F. benghalensis, indicating that the dosage is dependent on the result (Kumar et al., 2016).

Neuroprotective effect

Many pharmaceuticals, including serotonin inhibitors, have been shown to be effective in treating diabetic neuropathy. Although several treatments have been tried, none are thought to be the best for diabetic neuropathy. An demonstration happened by (Stalin et al., 2016) where six groups of six albino rats each were allocated. 1st Group received standard saline as the group under control and was used to evaluate and compare the neuroprotective effect of glibenclamide at a standard dose of 0.5 ml per kg body mass. The methanolic extract was administered at dosages of 200 mg and 400 mg/kilogram, appropriately, to groups 4 and 5. The significant effect of a 400 mg per kilogram dose of the extract on the behavioral test was seen on the 28th day of this 28-day experiment using the standard drug glibenclamide. It also makes a positive difference in the albino rats' body weight, food and liquid composition.

Hypolipidemic effect

F. benghalensis may have a hypolipidemic impact. To examine its impact (Priya et al., 2013) researched to compare the effects of a standard drug (gliclazide) at a dosage of 5 milligrams per kilogram of body weight prior to treatment using a 250 mg dose of an ethanolic fruit extract from *F. benghalensis*. 24 albino males in this investigation, Wister rats weighing 150–180 grams were employed. For thirty days, the animal will be fed under standard circumstances in four different groups of six rats each. The albino rats' weight was monitored on a regular basis during the trial. Rats were seen to have their blood glucose levels checked during this time after an overnight fast. The blood glucose levels are determined using a glucometer following the ingestion of glucose (2 grams per kilogram). Research indicates that in diabetic rats, the ethanolic fruit extract considerably influences blood glucose, triglycerides, The quantities of LDL (low density lipoprotein) and HDL (high density lipoprotein) cholesterol when compared with conventional medicine (Singh, 2017).

Anti-arthritic activity

One autoimmune disease that causes joint discomfort is rheumatoid arthritis. Numerous other tissues and organs, including blood vessels, skin, the heart, lungs, and muscles, may also be affected. Bark has been shown to have bioactive compounds that may help alleviate arthritis. The thirty albino mice, each weighed between 150 and 200g, were divided into five groups and given 300 mg/kg of an ethanol-based and hydrophilic bark extract. *F. benghalensis* bark extract's anti-arthritic properties were contrasted with those of indomethacin, a traditional treatment. On day 28 of the 28-day experiment, the rats were given blood to test a range of hematological parameters, including hemoglobin content, erythrocyte sedimentation rate, and the quantity of red and white blood cells. According to the findings, the groups who received ethanolic extract plus indomethacin treatment acquired noticeably higher body weight than the group that received aqueous extract. Additionally, there was a notable improvement in WBC, RBC, and ESR (erythrocyte sedimentation rate) levels as well as a reduction in paw edema in the groups that received the extract plus indomethacin (Bhardwaj et al., 2016).

Hair growth promotion

A pattern of loss of hairs among both genders caused by endocrine and genetic factors is referred to as androgenic alopecia (Devjani et al., 2023). It is brought on by 5 α-reductase being overactive, malnutrition, stress, and addiction to drugs, chemotherapy, and genetic illness. There are three stages to the hair follicle cycle; 1) resting phase, 2) regression phase 3) growth which is also the period for hair shaft production and coloration. A variety of treatments, including hair transplants and stem cell transplants have been developed to address hair loss. Certain bioactive components found in *F. benghalensis* aid in hair growth and prevent androgenic alopecia. The hair growth combination was sprayed into the exposed region once a day for twenty-eight days, and the animal trail model revealed that *F. benghalensis* leaf extract was prepared and administered to the eight male albino rabbit groups. By the 28th day, the leaves extract's impact was assessed, including its inhibition of 5 α-reductase and the minerals iron, zinc, and potassium that are important for hair development. The data revealed that *F. benghalensis* leaf extract had a substantial effect on hair growth (Iltaf et al., 2021).

Hepatoprotective activity

In both humans and animals, the liver is the largest and most important organ. Numerous essential functions, such as the removal of metabolites from food, drugs, and other dangerous materials, are carried out by it. Drugs and chemicals that are used as medicines for a variety of ailments can cause liver toxicity. Liver damage and toxicity are also caused by ROS. In the past, the *F. benghalensis* plant was used to treat a range of ailments in Ayurveda and other forms of medicine. These plants' components are rich in polyphenols and flavonoids, which have hepatoprotective, anti-oxidant, and liver-damage-preventing properties (Parameswari et al., 2012). The impacts of *F. benghalensis* fruit concentrate on antioxidant enzymes like catalase were examined in various models of liver-induced toxicity, including carbon tetrachloride, using doses of 100, 250, and 500 mg per kilogram given to the goat liver. By lowering the amount of the antioxidant enzyme catalase, which protects liver damage, fruit extract exhibits a dose-dependent effect (Karmakar et al., 2020).

Anti-stress activity

Stress is a serious mental health problem that, if addressed, can be lethal. It can cause morbidity such hypertension, ulcers of the stomach and other conditions, as well as having a large negative impact on an individual's health. Numerous social, environmental, and dietary factors contribute to stress. *F. benghalensis* is one of many plant-based medications used as alternative and complementary therapies to manage stress (Malik et al., 2020). A study demonstrates fruit's ability to reduce stress. Five sets of six male albino rats each were used in this experimental setup. Group 2 is regarded as a favorable comparison group, and Group 1 as a negative control group. Whereby somniferous 100 mg per kilogram oral dose is used to produce stress. The remaining group, however, received doses of 125 mg, 250 mg, and 500 mg of fruit powder methanolic extract per kilogram of body weight. Next, they assess its impact using biochemical estimation, immobilization stress in rats, anoxia stress tolerance testing, and swimming endurance testing in mice. Based on the findings, the 500 mg per kilogram extract effect was shown to be quite similar to the usual medication used to treat stress (Jahagirdar et al., 2020).

Memory, seizure in animal models, and muscle co-ordination

In an experiment carried out using a quantitative model by (Panday & Rauniar, 2016) it was discovered that the root extract was used for several neurological diseases. Four groups of twenty to thirty grams each were randomly selected from the 144 Swiss male albino rats utilized in this experiment. Normal saline was given to Group 2 as positive control and to Group 1 as negative control. Groups 3 and 4 received daily dosages of 100 and 200 mg of aqueous root extract, respectively. To validate the effect, six tests were performed: pentobarbital-induced sleep potentiation, Rota rod, open field, passive avoidance, and maximum electroshock seizure. The findings of all experiments suggest that the *F. benghalensis* roots extract has a strong and dose-dependent impact (Chandra et al., 2013).

Immunomodulatory and antioxidant action

The human body's primary defensive mechanism, the immune system, is essential for protecting the body against infections and other pathogens. Failure in the immune system or bodily immunity can lead to several abnormalities and chronic diseases, such as diabetes, cancer, and (CVDs). Immune system suppression, including decreased phagocytosis, neutrophils, macrophages, and other immune modulatory cells, is the cause of these dysfunctions. An experiment was carried out for this objective by (Bhanwase & Alagawadi, 2016) which the scavenging activity of four distinct fractions of hydro-alcoholic extract from the leaves and root tips of the *F. benghalensis* plant was assessed using DPPH and ABTS activity as well as phagocytosis and other responses. This study examined the cellular and humoral immunity of Wistar rats to determine the immunomodulatory effect of *F. benghalensis* extract.

Anti-fungal effect

Fungus illness is a severe health concern that can arise from various fungus species at different body sites. In a study of anti-fungal effect of *F. benghalensis* conducted by (Singh et al., 2023b) on the *C. albican* from 50 molar plaque at various plant extract levels using DMSO once the inhibitory concentration was established. The findings demonstrate that the plant extract, when applied with an alternate solvent, lyses the fungal cells in the test tube and leaves them absent.

Anti-hemorrhoid effect

Hemorrhoids are characterized as veins surrounding the anus that may swell or protrude because of pressure. It is another name for pile, a prevalent anorectal condition (Wei et al., 2023). Hemorrhoids are treated with a variety of medications and surgical techniques. Hemorrhoids can also be treated with some bioactive substances found in plant *F. benghalensis*. A study conducted by (Chatterjee et al., 2020) in which six groups of four male albino rats were assigned to the study. The usual food was provided to groups 1, 2, and 4, while the *F. benghalensis* root extract was administered to groups 3, 4, and 5 at concentrations of 150, 300, and 450 mg/kg body mass, appropriately. Hemorrhoidal, hemorrhoidal exudation, biochemical, and histological indicators were used to evaluate the outcomes. In comparison with conventional medications, the *F. benghalensis* extract exhibits more efficient effects.

***F. benghalensis* fruit**

Bandekar et al. (2013b) conducted studies on the fruits of the banyan tree (*F. benghalensis*) as possible dietary sources. It was found that banana fruits had a lot of nutrients, fiber, and carbohydrates. Soaking, blanching, heating, and other techniques could be used to bring the amount of tannins, alkaloids, and saponins, anti-nutrients down to levels that are acceptable for a food product. Calli produced by nodal explants can be used to explore their potential for synthesizing anthocyanins, offering a different source in vitro for natural pigments and a variety of industrial uses pertaining to food and color. Fruit moisture content on a wet basis was 71.02; 2.83 for ash; 8.66 for crude fat; 17.08 for fiber; 4.83 for protein; and the percentage of carbohydrates was 66.63%. It has been shown that these compounds, oxalates 0.11, cyanogenic glucosides 0.066, tannins 1.87, alkaloids 9.77, and saponins 4.15 are anti-nutritional. Total polyphenols were measured using the Folin-Ciocalteau technique (276 mg/g). A measurement of 28.67 ug per milliliter was made of the antioxidant DPPH scavenging activity. A study conducted by Jayasree Radhakrishnan and Venkatachalam (2020) who investigated the use of a novel approach called Microwave-Assisted Solvent Extraction technique (MASE) to extract and identify phytochemicals from *F. benghalensis* fruits. The immune system uses altering components including the solid-solvent ratio, irradiation time, and microwave power. According to their findings, the maximum total phenolic content (TPC) and total flavonoid content (TFC) could only be obtained with a solid-solvent ratio of 1:177g milliliter, 420 W of microwave power, and a shorter 5-minute extraction time. GC chromatogram examination revealed 26 active secondary metabolites, with 7-tetradecane, n-hexadecenoic acid, and octadecanoic acid being the most abundant. The discovery of these compounds, which have been related to a multitude of health benefits, including antioxidants, anticancer, and antibacterial activity, has bolstered the traditional use of fruits from the *F. benghalensis* plant as medical supplements.

Gopukumar et al. (2016a) conducted a study in which three solvents; methanol, chloroforms, and water were used to conduct phytochemical screening of *F. benghalensis* fruit. Subsequently, the extracts were put through established procedures for both quantitative and qualitative screening for phytochemicals. Fruit extracts with methanol had a high concentration of phytochemicals. Functional group characterization was done using FT-IR spectroscopy. The FT-IR analysis revealed a significant peak in the C-H stretching range of 2800–3000 percent and carboxyl (C=O) groups in the 1600-1750-centimeters range. These results suggest that the crude extract contains a lot of flavonoid groups. These findings also support the use of F. benghalensis fruit extract for various medicinal applications. Thamburaj et al. (2022) conducted a study utilizing a variety of drying techniques to examine the antioxidant, antibacterial, anti-inflammatory, and polyphenolic properties of fruits. The crude polyphenol isolates' total phenol and flavonoids were quantified. The antioxidant activity of crude polyphenols was assessed using the DPPH method. A protein denaturation experiment was utilized to assess the anti-inflammatory potential of crude polyphenols from F. benghalensis plant fruits. According to a quantitative analysis, micro-oven dried fruit possesses considerable tannin levels (38.17 mg GAE per gram) and total phenolics (92.11 mg GAE per gram). Crude polyphenolics from fruit that was air- and shade-dried demonstrated higher antioxidant activity. Oven-dried fruits' higher phenolic content (44.72% at 0.5 mg sample) protects against protein denaturation, but it inhibits S. Typhi growth the least (1.02% at 0.55 mg). To examine how heat processing affected the fruit and polyphenolics of *F. benghalensis*, Fourier-transformed infrared spectroscopy was employed. Therefore, fruits can produce resistant to heat polyphenolics with substantial biological activity by using shade and hot air drying.

Tharini et al. (2018) conducted a study to evaluate the antioxidant activity and GC MS analysis of *F. benghalensis* ethanol fruit extract. Using the fruit extract, tests for DPPH radical, OH radical, phosphor molybdenum reduction, ABTS radical cation, Fe^{3+} reducing power and NO radical scavenging were conducted. The IC50 was 32.20 g per milliliter, and the highest DPPH radical scavenging activity was 75.33% at a concentration of 60 g/mL. The greatest NO radical scavenging activity was 51.3% at 60g/mL, with an IC50 of 57.65g/mL. The IC50 was 13.66g/mL, while the maximal radical cation scavenging activity was 79.53% at 30 g/mL concentration. The maximal scavenging activity for OH radicals was 57. 90% at a concentration of 60 g per milliliter, with an IC50 of 34.33g/milliliter. The RC50 was 13.75g per milliliter, with the highest phosphor molybdenum reduction of 80.48% at a concentration of 60g per milliliter. The concentration of 60g/mL yielded the maximum Fe^{3+} reduction of 69.18%, with an RC50 of 18.71 g/mL. Several compounds with ester derivatives were found in the fruit extract of *F. benghalensis*, according to a GC-MS analysis.

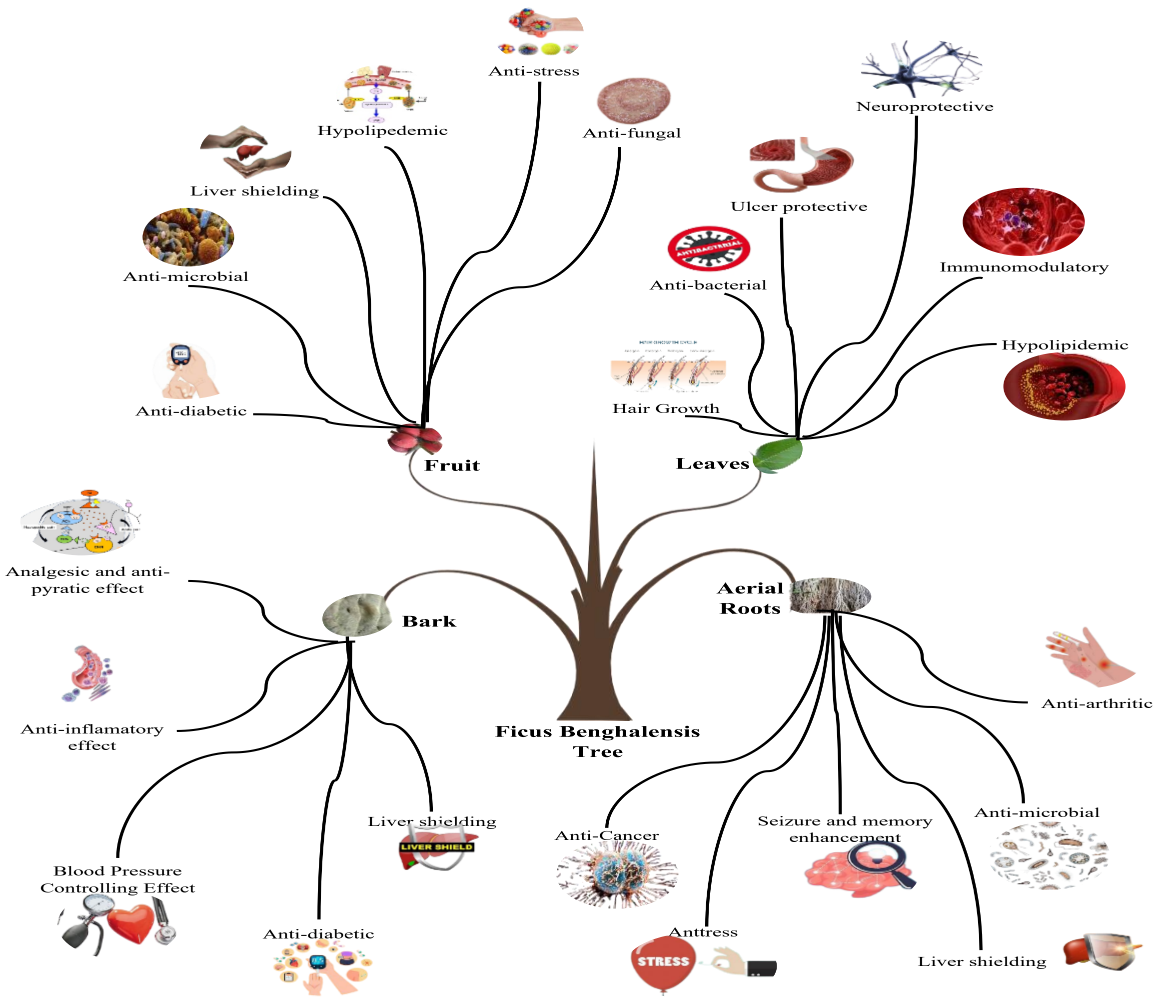

Fig. 1 Different pharmacological effects exhibited by different parts of *F. benghalensis* tree

Conclusions and future perspectives

In conclusion, the study on *F. benghalensis* plant parts has provided valuable insights into its phytochemistry, traditional uses, and pharmacological activity. The fruit's anticancer, antibacterial, anti-inflammatory, and antioxidant properties underscore its medicinal potential; while it's nutritional and phytochemical composition suggests that it might be used as a food source. To fully comprehend the specific mechanisms of action and possible synergistic effects of the discovered phytochemicals, more study is necessary. To verify *F. benghalensis* safety and efficacy in treating a range of ailments, clinical trials are also required. Filling up these gaps might enable *F. benghalensis* to reach its full therapeutic potential, providing encouraging paths for the development of medicines and nutraceuticals.

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