J Herbmed Pharmacol. 2024; 13(4): 537-549.

http://www.herbmedpharmacol.com doi: 10.34172/jhp.2024.52557

Journal of Herbmed Pharmacology

A critical review of antioxidant potential and pharmacological applications of important *Ficus* species

Rahul Gaur*, Anjali Chauhan, Chandra Kanta*

School of Applied and Life Sciences (SALS), Uttaranchal University, Dehradun - 248007, Uttarakhand, India

ARTICLE INFO

Article Type:
Review

Article History:
Received: 1 May 2024
Accepted: 1 August 2024
epublished: 1 October 2024

Keywords:
Antioxidant
Ficus benghalensis
Ficus carica
Ficus krishnae
Novel therapeutic agents
Traditional medicine

ABSTRACT

The *Ficus* genus is universally recognized for its medicinal properties. This article aims to comprehensively review the antioxidant potential and pharmacological properties of some key *Ficus* species within the genus, regarding their natural antioxidants and pharmacological properties. An extensive literature search was conducted across multiple databases using keywords such as *Ficus* species, antioxidant activity, and pharmacological applications. This review revealed notable differences in antioxidant capacity among the selected *Ficus* species. Comparative studies within the review indicated that factors such as geographical location, extraction method, and specific part of the plant used, significantly influenced the antioxidant activity and phytochemical content. Among these, *F. benghalensis*, *F. carica*, and *F. krishnae* exhibited the highest antioxidant capacities. Regarding overall pharmacological effectiveness, the species that out were *F. religiosa*, *F. carica*, and *F. elastica*. In sum, *Ficus* species emerge as a promising source of natural antioxidants with substantial pharmacological potential. Future research should focus on clinical trials to validate their medicinal uses, exploring the mechanism of actions, and potential applications in developing novel therapeutic agents.

Implication for health policy/practice/research/medical education:
This study highlights the antioxidant and pharmacological benefits of *Ficus* species, supporting their potential inclusion in health policies. This study can serve as a foundation for further research into the antioxidant domain of *Ficus* species and their bioactive compounds. With evidence from the study, clinicians may develop more informed protocols for using *Ficus* species in managing oxidative stress and related conditions.

Please cite this paper as: Gaur R, Chauhan A, Kanta C. A critical review of antioxidant potential and pharmacological applications of important *Ficus* species. J Herbmed Pharmacol. 2024;13(4):537-549. doi: 10.34172/jhp.2024.52557.

Introduction

In recent years, there has been a rise in research interest surrounding the antioxidant potential of natural compounds due to the growing recognition of their deep impact on human health and well-being (1,2). Among the vast array of botanical resources, various *Ficus* species have emerged as promising candidates, due to their rich phytochemical composition and wide-ranging traditional uses in varying medical systems worldwide (3,4). The *Ficus* genus belongs to the Moraceae family, which encompasses a diverse array of flowering plants, including over 800 species distributed predominantly across tropical and subtropical regions globally (5). They are commonly known as figs or fig trees, which exhibit remarkable ecological versatility, ranging from towering trees to tiny shrubs, which are renowned for their symbiotic relationships with pollinator wasps, a phenomenon very important for their reproduction (6). *Ficus* species have a wide spectrum of morphological characteristics, with distinct leaves, fruits, and growth habits (7).

Antioxidants are beneficial in mitigating oxidative stress caused by free radicals, which are involved in the pathogenesis of numerous chronic diseases like cancer, cardiovascular disorders, diabetes, and neurodegenerative conditions (8,9). Recently, the antioxidant properties of plant-derived compounds have gathered significant attention, encouraging extensive research into the potential health benefits of various botanical sources (10,11). *Ficus* species are noteworthy as they are rich in bioactive compounds such as alkaloids, coumarins, flavonoids, glycosides, phenolic compounds, sterols, tannins, triterpenoids, and vitamins, which

***Corresponding authors**: Rahul Gaur, Email: rahulgaursince1998@gmail.com; Chandra Kanta, Email: ck.pathak116@gmail.com

contribute to their antioxidant potentials (12). The pharmacological applications of *Ficus* species are way beyond their antioxidant properties. These plants have been traditionally used to treat a wide array of ailments, e.g., diabetes, diarrhea and dysentery, digestive health, fertility and menstrual disorders, inflammation, joint and muscle pain, oral health, reproductive issues, respiratory conditions, wound healing, infections, and metabolic syndromes (13). Modern pharmacological studies have provided empirical support for many of these traditional uses, revealing the presence of compounds with anticancer, antidiabetic, anthelmintic, anti-inflammatory, antimicrobial, antimutagenic, and antiproliferative activities (14).

Despite the rich traditional knowledge and growing scientific interest in this domain, a comprehensive review of the antioxidant capacity and medicinal applications of different *Ficus* species is lacking. Such review is crucial for introducing the most promising species for specific therapeutic applications and understanding the mechanisms of their health benefits. Furthermore, the comprehensive evaluations on the antioxidant potential of different *Ficus* species can also help future research and development in the field of nutraceuticals, functional foods, and medicine, since natural antioxidants are becoming preferable and safer alternatives to synthetics as these compounds have adverse side effects. Ultimately, this review aims to provide a detailed comprehensive and comparative analysis of the antioxidant potential and pharmacological applications of medicinally important *Ficus* species.

Methods

Numerous search engines and databases were used to access scientific information about ten selected *Ficus* species: *F. benjamina*, *F. benghalensis*, *F. carica*, *F. elastica*, *F. krishnae*, *F. microcarpa*, *F. racemosa*, *F. religiosa*, *F. retusa*, and *F. virens* (Figure 1). All these literature searches were conducted on platforms like Google Scholar, Science Direct, Research Gate, MDPI, Wiley Online Library, and Scopus. The search terms encompassed a range of keywords including botany, traditional medicinal uses, bioactivity, phytoconstituents, phytochemistry, pharmacological activities, therapeutic properties, and antioxidant potential related to *Ficus* species. A total of 187 publications were examined, including research articles, review papers, mini-reviews, book chapters, and short communications. However, to present comprehensive, comparative, and up-to-date knowledge on this topic, only research articles, review papers, and book chapters were considered.

Phytochemistry

The phytochemistry of *Ficus* species presents a rich array of bioactive compounds (Figure 2), contributing to their diverse pharmacological potential). *F. benjamina* is known for its abundance of flavonoids such as quercetin and kaempferol, alongside phenolic compounds like chlorogenic acid (15). *F. benghalensis* exhibits a similar profile with significant concentrations of quercetin and rutin, compounds renowned for their antioxidant properties (16). *F. carica*, contains bioactive compounds such as ficin, bergapten, and psoralen, contributing to its traditional medicinal uses (17). *F. elastica*, valued for its latex, contains significant amounts of isoprenoids, including phytosterols and triterpenoids, which exhibit anti-inflammatory properties (18). *F. krishnae* is characterized by its high content of polyphenolic compounds like gallic acid and catechin, known for their antioxidant and antimicrobial activities (19). *F. microcarpa* is rich in phenolic compounds such as epicatechin and chlorogenic acid, which contribute to its antioxidant

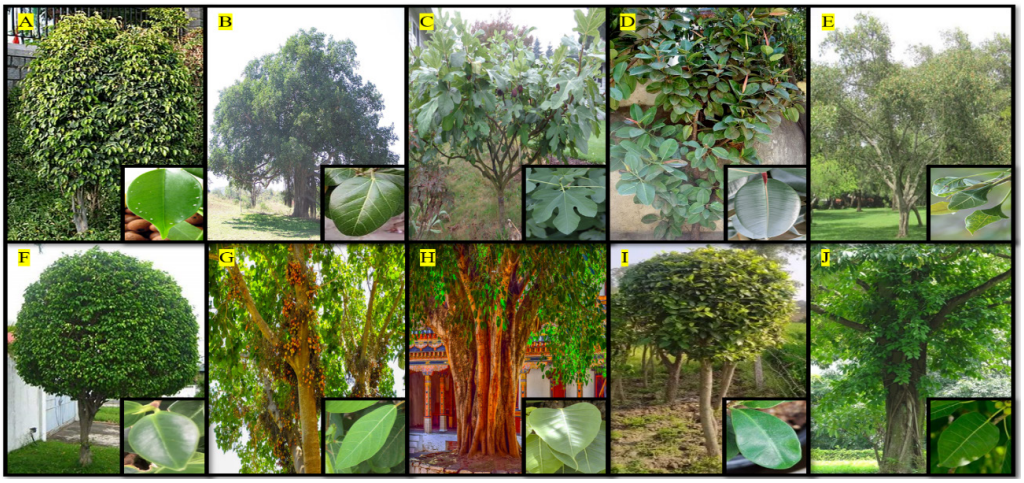

Figure 1. *Ficus* species. A: *F. benjamina*, B: *F. benghalensis*, C: *F. carica*, D: *F. elastica*, E: *F. krishnae*, F: *F. microcarpa*, G: *F. racemosa*, H: *F. religiosa*, I: *F. retusa* and J: *F. virens*.

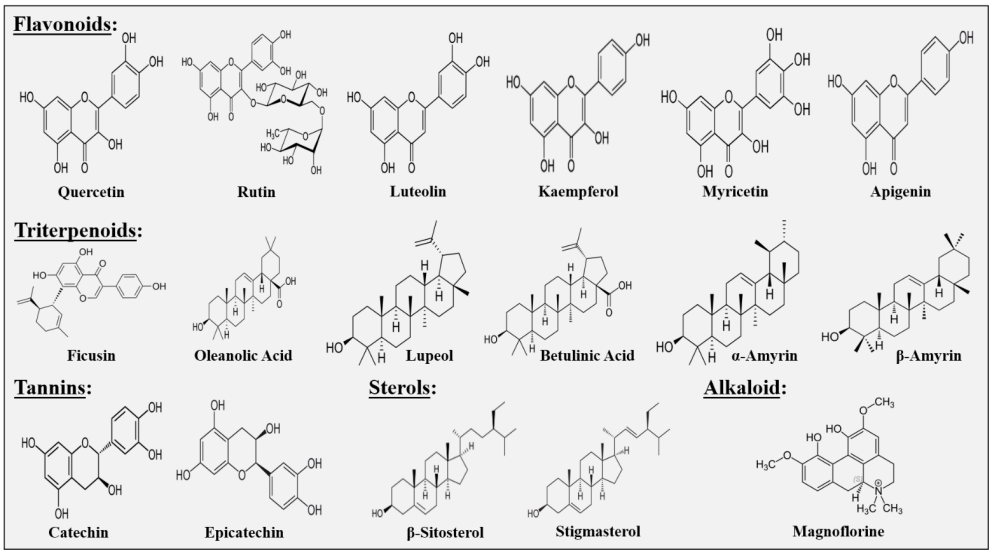

Figure 2. Important bioactive compounds of *Ficus* species.

potential (20). *F. racemosa* contains bioactive constituents such as flavonoids, tannins, and saponins, which contain diverse pharmacological activities, including anti-inflammatory and antimicrobial effects (21). *F. religiosa*, revered in traditional medicine, contains a plenty of phytochemicals, including flavonoids, alkaloids, and tannins, which contribute to its broad pharmacological spectrum (22). *F. retusa,* which is less discovered compared to other *Ficus* species, is notably rich in bioactive compounds like quercetin and kaempferol, which possess antioxidant and anti-inflammatory properties (23). Finally, *F. virens* contains compounds such as lupeol and β-sitosterol, which exhibit potential anti-inflammatory and anticancer activities (24).

Antioxidant potential

Antioxidants are vital in maintaining cellular integrity and health by neutralizing harmful oxidative stress, which is a condition that arises due to an imbalance between the production of reactive oxygen species (ROS) and antioxidant defenses (25). Oxidative stress leads to harm cellular macromolecules such as lipids, proteins, and nucleic acids finally initiating a series of pathological processes like aging, chronic diseases, and degenerative disorders (26). Antioxidants, by their electron-donating properties, mitigate this oxidative damage which offers cytoprotective benefits that are important for reducing disease risk and maintaining overall health (27). This protective role is highlighted by the importance of incorporating antioxidant-rich dietary sources into daily routines to strengthen the body's defenses against oxidative challenges (28). Antioxidants can be categorized into endogenous, which are produced by the body (e.g., enzymes like superoxide dismutase, catalase, and glutathione peroxidase), and exogenous, derived from natural sources (e.g., vitamins C and E, minerals like selenium, and phytochemicals such as flavonoids and polyphenols) (29). Various *Ficus* species are known for their rich phytochemical contents which represent their potent antioxidant properties (Table 1), highlighting their historical and potential future roles in traditional medicine, therapeutic agent development, and dietary supplementation (30). This interaction between endogenous and exogenous antioxidants highlights their essential roles in cellular homeostasis and human health, emphasizing the need for a balanced diet rich in antioxidants to combat oxidative stress and its associated risks.

Pharmacological and therapeutic applications

Numerous *Ficus* species are renowned for their diverse pharmacological and therapeutic activities (Figure 3), which are discussed in the sub-headings below, reflecting a rich storehouse of traditional and modern medicinal applications. Studies have explored almost all parts (roots, bark, leaves, latex, and figs) of these *Ficus* species for their potential pharmacological applications (30).

Anticancer activity

A study on *F. benjamina* chloroform extract, derived from the leaves, did not demonstrate any inhibitory effects on human embryonic kidney (HEK) cells. This suggests that the extracts from *F. benjamina* leaves possess selective cytotoxicity, primarily affecting cancer cells while leaving normal cells unharmed. Such selectivity is important in the development of cancer therapies, as it mitigates the potential for side effects and enhances both the safety and effectiveness of the treatment (45).

The latex of *F. benghalensis* was investigated using various solvents to assess its anticancer potential across multiple cell lines like humanoid breast, colorectal, lymphocytes, and neuroblastoma (46). The ethanol extract

Table 1. Antioxidant potential of *Ficus* species

Ficus species	Part used	Extracting solvent	Mechanism	IC_{50} value (µg/mL)	References
F. benjamina	Leaves	Methanol	DPPH	59.07	(29)
F. benghalensis	Leaves	Methanol	DPPH	2.01	(31-33)
	Aerial Roots	Chloroform		68	
		Ethyl Acetate		101.2	
	Bark	Aqueous	TBARS	80.24	
F. carica	Leaves	Methanol	DPPH	275	(34-36)
	Latex			5.0	
	Fruits	Aqueous		0.492	
F. elastica	Leaves	Ethanol	DPPH	13.82	(37)
F. krishnae	Bark	Petroleum Ether	DPPH	1.88	(38)
		Chloroform		82.5	
F. macrocarpa	Aerial Root	Ethyl Acetate	DPPH	6.0	(20)
			ABTS	1.8	
			PMS-NADH	89.7	
F. racemose	Leaves	Ethanol	DPPH	150	(39,40)
			NO	100	
			SO	100	
	Roots	Methanol	DPPH	5.8	
	Heartwood			4.49	
F. religiosa	Leaves	Aqueous	DPPH	16.85	(41-43)
		Methanol		187.62	
F. retusa	Leaves	Ethyl Acetate	DPPH	0.85	(23)
F. virens	Leaves	Aqueous	DPPH	14	(24,44)
	Bark			35	

IC_{50}: Half maximal inhibitory concentration; DPPH: 2,2-Diphenyl-1-picrylhydrazyl; TBARS: Thiobarbituric acid reactive substances; ABTS: 2,2'-Azinobis(3-ethylbenzothiazoline-6-sulfonic acid); PMS-NADH: Phenazine methosulfate-nicotinamide adenine dinucleotide (reduced); NO: Nitric oxide scavenging; SO: Superoxide anion scavenging.

exhibited promising effects in contrast to colorectal and neuroblastoma cells, whereas the ethyl acetate extract demonstrated favorable outcomes on human breast cell lines. Additionally, both extracts demonstrated a reduction in toxicity when interacting with peripheral blood lymphocytes (47). Furthermore, researchers evaluated the anticancer properties of the ethyl acetate extract derived from the aerial roots against lung cancer, breast cancer, and cervical cancer cell lines, revealing significant activity with IC_{50} (Half Maximal Inhibitory Concentration) values of 17.81 µg/mL, 97.89 µg/mL, and 49.27 µg/mL, respectively (48).

The crude ethanolic extract from *F. carica* leaves was tested to determine its potential antineoplastic effects on numerous cancer cell lines, including breast cancer, hepatocellular carcinoma, colon cancer, and human laryngeal carcinoma. The findings indicated substantial inhibitory effects across all tested cell lines. Notably, the *F. carica* extract exhibited potent activity against Hep2 (human epithelial cell line) and HepG2 (human liver cancer cell line) with inhibition percentages ranging from 66.9%-80.7% (49).

Ficusamide, derived from the bark of *F. elastica*, demonstrated a reasonable anticancer effect in human A549 NSCLC (non-small cell lung cancer) cells, with an IC_{50} value of 79 µM. In contrast, Friedelin showed weaker activity. Even though the methanol extract did not exhibit any significant anticancer properties, the ursolic acid and betulinic acid isolated from this extract demonstrated anticancer effects when tested against melanoma, glioma, and lung cancer cell lines (4,50). These conclusions suggest the capability of *F. elastica* as a valuable source of natural anticancer agents.

The stem bark of *F. krishnae* was examined in MTT (3-(4,5-dimethylthiazol-2)-2,5-diphenyltetrazolium bromide) assay, demonstrating the cytotoxicity against ovarian cancer cell lines. This suggests the capability of this species to inhibit the growth of multi-drug-resistant *Staphylococcus aureus* bacteria (51).

In the case of *F. microcarpa*, the cytotoxic potential of 15 triterpenes from the aerial roots was evaluated using the MTT assay. These compounds were tested against three different cancer cell lines: HONE-1 nasopharyngeal carcinoma, KB oral epidermoid carcinoma, and HT29 colorectal carcinoma. Notably, both ursonic acid and ursolic acid exhibited effective cytotoxic action against all three cell lines, with IC_{50} values ranging from 4.0 to 8.8 µM, respectively. Specifically, 3β-Acetoxy-25-

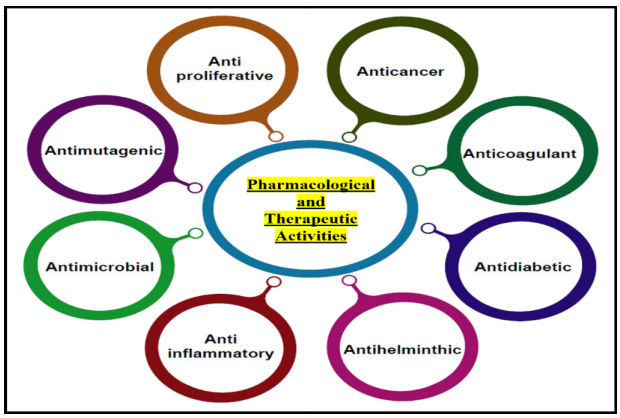

Figure 3. Potential pharmacological and therapeutic activities of *Ficus* species.

hydroxylanosta-8, 23-diene showed effectiveness against Human colorectal adenocarcinoma cell line (HT-29), while acetylursolic acid was effective against KB cells (52). Furthermore, plectranthoic acid, a pentacyclic terpenoid from the aerial roots, demonstrated remarkable activation properties for 5'-AMP-activated-kinase (AMPK). Notably, its activation of AMPK surpassed that of metformin, a well-known drug in this regard. Treatment with plectranthoic acid effectively restrained the propagation of prostate cancer cells by persuading cell cycle detention in the G0/G1 phase and promoting programmed cell death, with these effects dependent on AMPK activation. This suggests that plectranthoic acid holds promise as a potent AMPK activator with therapeutic potential for managing prostate cancer (53,54).

Oral management of *F. racemose* extract at doses of 200 mg/kg and 400 mg/kg were important in reductions of lipid peroxidation, xanthine oxidase activity, glutamyl transpeptidase levels, topoisomerase-II activity, and hydrogen peroxide (H_2O_2) generation. Moreover, it led to a decrease in renal glutathione content and in the production of antioxidant enzymes induced by potassium bromate, a nephrotoxic agent known to induce renal carcinoma in rats. However, the administration of *F. racemosa* extract led to a significant recovery in renal glutathione levels. These findings strongly indicate that *F. racemosa* extract possesses potent chemopreventive properties, effectively inhibiting $KBrO_3$-induced nephrotoxicity in rats (55).

Gulecha and Sivakumar conducted a study demonstrating the efficacy of *F. religiosa* leaves extract in reducing breast cancer cell feasibility through apoptosis and cell cycle arrest in the G_1 phase. The extract also triggered chromatin condensation and loss of mitochondrial membrane potential, while upregulating caspase 9 expression, facilitating mitochondria-mediated cell death (56). Another study evaluated the ethanol extract from *F. religiosa* latex against neuroblastoma, colorectal, and breast adenocarcinoma cell lines, showing toxicity with the lowest inhibitory concentration observed in the neuroblastoma cell line. Cell cycle investigation exposed arrest in the G_1 phase for adenocarcinoma and colorectal cell lines and the G_2/M phase for neuroblastoma cells. The extract influenced apoptosis, with increased expression of pro-apoptotic genes (caspase-3 and p53) and decreased the expression of anti-apoptotic genes (Bcl-2 and AKT) (51). Additionally, Shankar *et al.* showed the positive effects of methanolic bark extract on human breast adenocarcinoma cells at a concentration of 91 µg/mL (57). Lastly, from the ten selected *Ficus* species, eight ones (*F. benjamina*, *F. benghalensis*, *F. carica*, *F. elastica*, *F. krishnae*, *F. microcarpa*, *F. racemose*, and *F. religiosa*) exhibited anticancerous properties and the remaining two, *F. retusa* and *F. viren* did not show any significant anticancerous activity.

Anticoagulant activity

Anticoagulant activity refers to the process of inhibiting the formation of blood clots, thereby preventing excessive coagulation, especially in individuals at a heightened risk of stroke. It is worth noting that prolonged use of anticoagulant agents may lead to gastrointestinal issues. Thus, there is strong encouragement for exploring potential anticoagulant agents sourced from medicinal plants. Among the ten selected *Ficus* species examined, three species, namely *F. benghalensis*, *F. elastica*, and *F. religiosa*, have shown anticoagulant activity. Evaluation of methanolic extracts from the leaves of these species in human plasma revealed substantial anticoagulant activity, with PT (Prothrombin time) ranging from 17.7 to 26.7 seconds and APTT (Activated partial thromboplastin time) varying from 47.7 to 72.3 seconds. Particularly, the extract from *F. religiosa* exhibited superior anticoagulant activity compared to the other species (58).

Antidiabetic activity

The use of different *Ficus* species has been a traditional and alternative approach to control blood glucose levels. The leaf extracts of *F. benjamina* effectively inhibited the activities of α-glucosidase and α-amylase enzymes. Among the extracts tested, the 80% ethanolic leaf extract of *F. benjamina* emerged as the most effective inhibitor of carbohydrate hydrolyzing enzymes. The occurrence of bioactive metabolites in the 80% ethanolic extract further supported these results, contributing to the strong anti-diabetic effects of the extract (59).

In an *in-vitro* study, the *F. benghalensis* bark extract has shown possible activity in inhibiting carbohydrate hydrolyzing enzymes (60). On the other hand, in an *in-vivo* study using the ethanolic leaves extract on alloxan-induced diabetic albino rats, the extract was reported to reduce triglycerides, cholesterol, and glucose levels. This indicates the traditional use of plant leaves as antidiabetic agents (61).

The inhibitory effect of *F. carica* cultivars against α-amylase and α-glucosidase was also investigated. The findings indicated that there was significant inhibition

of α-amylase but only mild inhibition of α-glucosidase. The cultivars of α-amylase inhibitors were arranged in the following order: Campera (IC_{50} = 3.58 mg/mL) was superior to Calabacita (IC_{50} = 3.78 mg/mL) and Verdal (IC_{50} = 4.86 mg/mL). The cultivar order for α-glucosidase inhibitors was as follows: Verdal brevas and figs (IC_{50} = 15.4 mg/mL and 15.9 mg/mL, respectively) were more abundant than Colar brevas (IC_{50} = 18.3 mg/mL). It reveals that the majority of the phenolic components from these *F. carica* cultivars may have antidiabetic benefits (62).

F. krishnae has been identified as a source of two phytosterols, CA (Clerodendranoic acid) and 24-MCA (24-Methylclerodendranoic acid), both of which exhibit antidiabetic activities. They achieve this by protecting β-cells from the harmful effects of glucotoxicity associated with diabetes, increasing the β-cells population and restoring normal insulin release from pancreatic β-cells. These terpenoids, CA and 24-MCA, also can normalize altered serum biochemical parameters in diabetic animals to healthy levels. Furthermore, in a short-term toxicity assessment, CA and 24-MCA did not show any notable toxic symptoms even when given at doses up to 150 times higher than the therapeutic dose. This safety profile underscores the potential of CA and 24-MCA as promising phytochemicals for the development of next-generation antidiabetic drugs (63).

F. microcarpa has multiple uses, both medicinal and non-medicinal. It has been used in traditional folk medicine to treat diabetes for a long time. Its therapeutic potential, notably from the aerial roots, is well-studied, with a wide array of bioactive compounds like triterpenoids, phenylpropanoids, flavonoids, and many more. Future perspectives should involve researching its pharmacological properties using animal models through isolated bioactive compounds (54).

F. racemosa has been widely utilized by traditional practitioners for many centuries in the mitigation of diabetes. The fruit, bark, latex, seeds, or leaves of this plant have been reported to lower blood glucose levels and progress body weight in diabetic animals when administered in various pharmacological preparations (64). The extract from leaves demonstrated a notable reduction in glucose transport across the membrane when compared with the control group (65). The findings indicate that as the concentration of the leaf extract increased, the rate of glucose uptake also increased, while it decreased with increasing extracellular glucose levels. The authors suggested that glucose transportation across the yeast cell membrane relied on facilitated diffusion in a concentration gradient manner. They concluded that glucose transport only takes place when intracellular glucose levels are sufficiently reduced. It appears that leaves possess superior anti-diabetic properties and might be utilized for diabetes management (65).

An *in-vitro* assay to assess the inhibition of α-amylase was conducted using extracts from *F. racemosa* leaves. The findings indicated that the methanol extract from *F. racemosa* exhibited substantial inhibitory activity, with inhibition percentages ranging from 8 to 25% within the concentration range of 500-1000 µg/mL. These results indicated that the methanol extract of *F. racemosa* could effectively inhibit α-amylase activity (65). When given orally twice daily for a period of 15 days with an oral hypoglycemic drug, the bark extract of *F. racemosa* led to a reduction in blood glucose levels. Notably, a significant reduction in blood glucose levels was detected in male subjects after 1.5 hours. This outcome suggests that the hypoglycemic impact of the *F. racemosa* bark extract is more distinct in diabetic patients (66).

The oral dosage of 100 and 200 mg/kg of an aqueous extract from *F. religiosa* reduced fasting blood glucose levels in streptozotocin (STZ) induced type 2 diabetic rats by influencing enzymes in the defense system. This resulted in a decrease of glutathione (GSH, reduced form) and suppression of malondialdehyde formation, although the 200 mg/kg dose exhibited a more significant impact. Furthermore, the hypoglycemic properties of the aqueous extract of *F. religiosa* bark were examined at doses of 25, 50, and 100 mg/kg in both normal glucose-loaded and STZ diabetic rats. All three doses led to a substantial reduction in blood glucose levels in both experimental models, with the 50 and 100 mg/kg doses demonstrating a more pronounced effect than the 25 mg/kg dose (67).

Hypoglycemic extracts from *F. virens* leaves have blood sugar-lowering effects. These effects are because of certain bioactive compounds like flavonoids and tannins. These compounds help in reducing the blood glucose levels. *F. virens* is known to contain antioxidants that can help protect cells from oxidative stress, which is often associated with diabetes and its complications. Some reports have indicated that *F. virens* helps to moderate complications associated with diabetes, such as diabetic nephropathy and diabetic neuropathy (24,44). From the ten, eight *Ficus* species namely, *F. benjamina*, *F. benghalensis*, *F. carica*, *F. krishnae*, *F. microcarpa*, *F. racemosa*, *F. religiosa*, and *F. virens* have shown the antidiabetic activity.

Anthelmintic property

Ficus racemose, *F. religiosa* and *F. virens* have been traditionally used in some cultures for their potential antihelminthic (anti-parasitic) activities. Different parts of the tree (leaves and bark) have been studied for their potential in managing parasitic worm infections. Some studies suggest that extracts from *F. racemosa* leaves and *F. religiosa* bark have antiparasitic properties, because of the flavonoid and tannin bioactive compounds present in them. In traditional medicine systems, *F. racemosa* has been used since ancient times to treat parasitic infections. *F. racemose* also helps to control and eliminate parasitic worm infections, particularly those caused by intestinal parasites (24,68).

Anti-inflammatory activity

Inflammation represents a natural reaction of the immune system to injuries, infections, or irritants. While acute inflammation is a protective response that helps the body heal, chronic inflammation can be detrimental and is associated with various diseases and conditions, including arthritis, cardiovascular disease, and autoimmune disorders. *F. carica*, *F. racemose,* and *F. religiosa* have been traditionally associated with anti-inflammatory property. The root, bark, leaves, fig, and latex, have been studied for their potential anti-inflammatory effects. *F. carica* leaves, fig, and latex, *F. racemose* bark, leaves and fig, as well as *F. religiosa* root, bark and leaves contain various bioactive compounds, specifically flavonoids, polyphenols, ultimately helping in reducing the inflammation. In traditional medicine systems, figs, leaves and latex have been used to alleviate various inflammatory conditions, such as skin inflammations, inflammatory joint conditions, and respiratory ailments. Some studies have explored the anti-inflammatory effects of fig extracts from *F. carica*. These studies have shown promise in reducing inflammation and related symptoms (69-71).

Antimicrobial activity

This activity refers to the capacity of biochemicals to prevent the growth or kill microbes, like fungi, bacteria, protozoa, viruses, etc. The primary goal of antimicrobial activity is to prevent or treat infections caused by these microorganisms. There are various classes of antimicrobial agents (antibacterial, antiviral, antifungal, etc) each designed to target specific types of microorganisms. *F. benghalensis* (roots, bark, and leaves), *F. carica* (leaves, figs, and seeds), *F. elastica* (aerial roots, leaves, and latex), *F. krishnae* (bark), *F. microcarpa* (roots, leaves, and figs), *F. racemose* (figs), *F. religiosa* (leaves), *F. retusa* (leaves), and *F. virens* (leaves) are potential sources of anti-inflammatory properties because of the phytoconstituents like flavonoids, polyphenols, sulfated polysaccharides, epicatechin, coumaric acid, quercetin, gallic acid, and rutin. Generally, the antimicrobial effectiveness of the ethyl acetate and ethanoic extracts is better than the water, hexane, and chloroform extracts. Furthermore, the ethyl acetate extract demonstrated notable antibacterial effectiveness when assessed using a well-diffused method. The antimicrobial activity was tested against various bacteria and fingi like *Escherichia coli*, *Staphylococcus aureus*, *Micrococcus luteus, Pseudomonas aeruginosa*, *Candida albicans*, and *Aspergillus niger* (23,44,72-78).

Antimutagenic activity

Antimutagenic activity refers to the capacity of certain compounds to diminish or obstruct the creation of mutations in genetic material such as DNA. Mutations involve alterations in the DNA sequence that may result in genetic instability and a heightened risk of diseases, notably cancer. *F. benghalensis* and *F. religiosa* methanolic bark extracts were examined on *Salmonella typhimurium* strain TA100, suggesting that they both had potential as antimutagenic agents (30,31).

Antiproliferative property

This activity refers to the inhibition of the process by which cells multiply and divide to produce new cells. proliferative activity plays a critical role in various physiological processes, such as tissue growth, tissue repair, and immune responses. However, uncontrolled or excessive cell proliferation can lead to the development of diseases mainly cancer. Antiproliferative agents are used to slow down or inhibit this uncontrolled cell growth, often in the context of cancer prevention or its treatment. Various studies have been done on the selected *Ficus* species out of them, *F. benghalensis*, *F. carica,* and *F. elastica* came out as potential antiproliferative sources. The extracts of *F. benghalensis* bark, *F. carica* figs and latex, and *F. elastica* aerial roots were tested on various human cell lines in *in-vitro* conditions for antiproliferative activity, which gave positive IC_{50} values (80-83).

A summarized version of these pharmacological and therapeutic activities is presented in Table 2.

Conclusion and future perspective

This comprehensive review of the antioxidant potential and pharmacological applications of selected *Ficus* species highlights their significant role in health and medicine. Considering overall pharmacological and therapeutic effectiveness, *F. religiosa*, *F. racemose*, and *F. carica* emerge as the leading species. These species showcase comprehensive pharmacological and therapeutic activities, including anticancer, antidiabetic, anti-inflammatory, antimicrobial, and antiproliferative properties, making them particularly valuable in medicinal applications. The findings of this review emphasize the potential of *Ficus* species as effective sources of natural antioxidants and pharmacologically active compounds.

In the future, researchers should focus on elucidating the mechanisms of action responsible for the antioxidant and pharmacological activities of these selected *Ficus* species, including their interactions with cellular pathways, oxidative stress markers, and potential synergistic effects with other antioxidants. Also, more comparative studies are needed to better understand the variations in antioxidant potency among different species of *Ficus* and their specific pharmacological applications. Moreover, efforts should be made to standardize extraction and purification methods to ensure consistency in the quality and bioactivity of *Ficus*-derived antioxidants. This will facilitate their integration into pharmaceutical formulations and functional food products for therapeutic and preventive purposes. Lastly, exploring the potential synergistic effects of *Ficus* species with conventional antioxidant therapies

Table 2. Pharmacological activities of *Ficus* species

Ficus species	Pharmacological activities	Part used	Solvent	Mechanism	Dosage/IC_{50}/DIZ/MIC/BE/VA	Ref.
F. benjamina	Anticancer	Leaves	Chloroform	CellTiter-Glo	Dosage: 10 µg/mL, 50 µg/mL	(45)
	Antidiabetic	Bark	Ethanol	α-glucosidase	IC_{50} = 77 µg/mL	(59,60)
				Sucrase inhibition	IC_{50} = 141 µg/mL	
		Leaves		α-glucosidase	IC_{50} = 9.65 µg/mL	
				α-amylase	IC_{50} = 13.08 µg/mL	
F. benghalensis	Anticancer	Aerial parts, roots	Ethyl acetate	MTT	Lung cancer: IC_{50} = 17.81 µg/mL	(46,48)
					Breast cancer: IC_{50} = 97.89 µg/mL	
					Cervical cancer: IC_{50} = 49.27 µg/mL	
		Latex	Ethanol		IMR 32 human neuroblastoma cell line: IC_{50} = 123.27 µg/mL	
					HCT 116 human colon cancer cell line: 99.82 µg/mL	
			Ethyl acetate		MDA-MB-231 Human Breast Cancer Cell Line: IC_{50} = 75.66 µg/mL	
	Anticoagulant	Leaves	Methanol	PT	21.7 s	(58)
				APTT	67.3 s	
	Antimicrobial	Bark	Aqueous	Agar well diffusion	*Escherichia coli*: 19 mm	(72)
					Candida albicans: 12 mm	
		Leaves			*Escherichia coli*: 10 mm	
					Candida albicans: 8 mm	
		Root			*Escherichia coli*: 15 mm	
					Candida albicans: 10 mm	
	Antimutagenic	Bark	Methanol	Ames Test	MIC: 8 µg/mL	(30,31)
	Antiproliferative	Bark	n-Butanol	*Allium cepa* root tip	Dosage: 4 mg/mL	(81)
F. carica	Anticancer	Leaves	Ethanol	Neutral Red	Hep2: 80.7 %, HepG2: 66.9 %	(49)
	Antidiabetic	Figs	Methanol	α-Amylase	Campera: IC_{50} = 3.58 mg/mL Calabacita: IC_{50} = 3.78 mg/mL Verdal brevas: IC_{50} = 4.86 mg/mL Verdal figs: IC_{50} = 5.12 mg/mL	(62)
				α-Glucosidase	Verdal brevas: IC_{50} = 15.4 mg/mL Verdal figs: IC_{50} = 15.9 mg/mL Colar brevas: IC_{50} = 18.3 mg/mL Colar figs: IC_{50} = 19.0 mg/mL	
	Anti-inflammatory	Branches	Hexane	NO	50 µg/mL: 100 % Inhibition	(69)
			Ethanol		50 µg/mL: 98 % Inhibition	
			Ethyl acetate		50 µg/mL: 85 % Inhibition	
			Hexane	TNF-α	50 µg/mL: 75 % Inhibition	
			Ethanol		50 µg/mL: 75 % Inhibition	
			Ethyl acetate		50 µg/mL: 75 % Inhibition	
	Antimicrobial	Leaves	Ethanol	Agar well diffusion	*Salmonella typhi*: 14 mm	(73)
					Fusarium oxysporum: 16 mm	
		Latex			*Salmonella typhi*: 15 mm	
					Fusarium oxysporum: 17 mm	
	Antiproliferative	Figs	Ethanol	MTT	IC_{50} = 0.18-18.76 µM	(82,83)
		Latex	Methanol	Peroxidase like activity	Dosage: 40 µg/mL	
F. elastica	Anticancer	Aerial parts, roots	Methanol	MTT	A549 human lung cancer cell line: IC_{50} = 79 µM	(4,50)
	Anticoagulant	Leaves	Methanol	PT	18.3 s	(58)
				APTT	58.7 s	
	Antimicrobial	Aerial parts, roots	Methanol	Microbroth dilution	MIC = 4.9 µg/mL	(74)
	Antiproliferative			MTT	IC_{50} = 14 µM	(83)

Table 2. Continued

Ficus species	Pharmacological activities	Part used	Solvent	Mechanism	Dosage/IC_{50}/DIZ/MIC/BE/VA	Ref.
F. krishnae	Anticancer	Bark	Aqueous	MTT	IC_{50} = 1000 µg/µL	(51)
	Antidiabetic	Bark	Hexane	OGTT	1 mg/kg	(63)
		Leaves	Methanol		1 mg/kg	
	Antimicrobial	Bark	Petroleum ether	Microbroth dilution	*Escherichia coli*: MIC = 100 µL	(75)
					Aspergillus niger: MIC = 100 µL	
			Chloroform		*Escherichia coli*: MIC = 100 µL	
					Aspergillus niger: MIC = 100 µL	
			Methanol		*Escherichia coli*: MIC = 100 µL	
					Aspergillus niger: MIC = 100 µL	
			Aqueous		*Escherichia coli*: MIC = 100 µL	
					Aspergillus niger: MIC = 100 µL	
F. microcarpa	Anticancer	Aerial parts, Roots	Ursonic acid Ursolic acid	MB	HONE-1 Human Nasopharyngeal Carcinoma Cell Line: IC_{50} = 4.0 µM KB Human Oral Epidermoid Carcinoma Cell Line: IC_{50} = 6.3 µM HT29 human colorectal adenocarcinoma cell line: IC_{50} = 8.8 µM	(52)
	Antidiabetic	Aerial parts, Roots Leaves	Ethanol	α-Glucosidase	100 mg/kg, 200 mg/kg, 400 mg/kg	(54)
	Antimicrobial	Roots	Methanol	Microbroth dilution	*S. aureus*: MIC = 7.11 mg/mL	(76)
		Leaves			*S. aureus*: MIC = 10.48 mg/mL	
F. racemose	Anticancer	Whole Plant	Petroleum ether	Potassium bromate	200 mg/kg BW, 400 mg/kg BW	(55)
	Antidiabetic	Bark Figs Latex Leaves Seeds	Methanol	α-Amylase inhibition	Dosage: 500-1000 µg/mL	(64-66)
	Anti-inflammatory	Bark	Hot water	Albino denaturation	Concentration: 0.01 µg/mL	(70)
	Antimicrobial	Figs	Aqueous	Microbroth dilution	*Escherichia coli*: MIC = 3.21 mg/mL	(77)
					Candida albicans: MIC = 1.56 mg/mL	
			Alcohol		*Escherichia coli*: MIC = 1.56 mg/mL	
					Candida albicans: MIC = 0.78 mg/mL	
			Hexane		*Escherichia coli*: MIC = 6.16 mg/mL	
					Candida albicans: MIC = 6.56 mg/mL	
			Chloroform		*Escherichia coli*: MIC = 6.25 mg/mL	
					Candida albicans: MIC = 3.12 mg/mL	
			Ethyl acetate		*Escherichia coli*: MIC = 1.32 mg/mL	
					Candida albicans: MIC = 2.19 mg/mL	
F. religiosa	Anticancer	Leaves	Petroleum ether	Trypan blue exclusion	MCF-7 human breast cancer cell line: IC_{50} = 160.3 µM	(56,57)
		Latex	Methanol	MTT	IMR-32 human neuroblastoma cell lines: IC_{50} = 4.8 µg/mL	
	Anticoagulant	Leaves	Methanol	PT	20.3 s	(58)
				APTT	71.0 s	
	Antidiabetic	Bark	Aqueous	STZ	Dosage: 100 mg/kg, 200 mg/kg	(67)
	Anthelmintic	Bark	Methanol	EHA	Dosage: 5 mg/kg for 100 % lethality	(78)
	Anti-inflammatory	Bark Leaves Roots	Methanol	AutoDock Vina	COX-2 Receptor with Campesterol: 11.83 kcal/mol	(71)
	Antimicrobial	Leaves	Aqueous	Agar aiffusion	*Escherichia coli*: 10 mm	(78)
			Methanol		*Escherichia coli*: 12 mm	
	Antimutagenic	Bark	Methanol	Ames test	MIC: 6.2 µg/mL	(30,31)
F. retusa	Antimicrobial	Leaves	Ethanol	DIZ	*Escherichia coli*: 16 mm	(23)
					Candida albicans: 17 mm	
F. virens	Antimicrobial	Leaves	Methanol	VIA	CVB4: 20.3 %	(79)
					HAV: 12.3 %	

APTT: Activated partial thromboplastin time; BE: Binding energy; DIZ: Diameter of inhibition zone; EHA: Enzyme histochemical assay; IC_{50}: Half maximal inhibitory concentration; MB: Methylene blue; MIC: Minimum inhibitory concentration; MTT: 3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide; NO: Nitric oxide; OGTT: Oral glucose tolerance test; PT: Prothrombin time; STZ: Streptozotocin; TNF-α: Tumor necrosis factor-α; VA: Virus activity; VIA: Virus inhibitory activity.

and pharmaceutical drugs can lead to the development of novel combination treatments with enhanced efficacy and reduced adverse effects.

Authors' contributions

Conceptualization: Rahul Gaur.
Data curation: Rahul Gaur.
Formal analysis: Rahul Gaur and Anjali Chauhan.
Investigation: Rahul Gaur, Anjali Chauhan, and Chandra Kanta.
Methodology: Rahul Gaur.
Supervision: Chandra Kanta.
Validation: Chandra Kanta.
Visualization: Rahul Gaur.
Writing–original draft: Rahul Gaur.
Writing–review and editing: Rahul Gaur, Anjali Chauhan, and Chandra Kanta.

Conflict of interests

There is no conflict of interest.

Ethical considerations

Not applicable.

Funding/Support

There was no financial support for the conduct of this review paper.

References

1. Pizzino G, Irrera N, Cucinotta M, Pallio G, Mannino F, Arcoraci V, et al. Oxidative stress: harms and benefits for human health. Oxid Med Cell Longev. 2017;2017:8416763. doi: 10.1155/2017/8416763.
2. Saloufou KI, Boyode P, Simalou O, Eloh K, Idoh K, Melila M, et al. Chemical composition and antioxidant activities of different parts of *Ficus sur*. J Herbmed Pharmacol. 2018;7(3):185-92. doi: 10.15171/jhp.2018.30.
3. Salem MZ, Salem AZ, Camacho LM, Ali HM. Antimicrobial activities and phytochemical composition of extracts of *Ficus* species: an over view. Afr J Microbiol Res. 2013;7(33):4207-19. doi: 10.5897/ajmr2013.5570.
4. Arsyad AS, Nurrochmad A, Fakhrudin N. Phytochemistry, traditional uses, and pharmacological activities of *Ficus elastica* Roxb. ex Hornem: a review. J Herbmed Pharmacol. 2023;12(1):41-53. doi: 10.34172/jhp.2023.04.
5. Debbarma S, Banik B, Baishnab B, Datta BK, Majumdar K. Diversity and distribution of figs in Tripura with four new additional records. J Threat Taxa. 2020;12(11):16548-70. doi: 10.11609/jott.4975.12.11.16548-16570.
6. Rasplus JY, Aumeeruddy-Thomas Y, Cruaud A, Kjellberg F, Rafidison VM, Mckey D, et al. Figs of Madagascar, their wasps, their frugivores, their importance for humans. In: Goodman SM, ed. The New Natural History of Madagascar. Princeton University Press; 2022. p. 617-34.
7. Adamu FU, Abubakar BY, Musa AO. Morphological characteristics of different *Ficus* species found in Samaru-Zaria, Nigeria. Dutse J Pure Appl Sci. 2021;7(3A):176-83. doi: 10.4314/dujopas.v7i3a.19.
8. Sharifi-Rad M, Anil Kumar NV, Zucca P, Varoni EM, Dini L, Panzarini E, et al. Lifestyle, oxidative stress, and antioxidants: back and forth in the pathophysiology of chronic diseases. Front Physiol. 2020;11:694. doi: 10.3389/fphys.2020.00694.
9. Karimi A, Moradi MT. Total phenolic compounds and in vitro antioxidant potential of crude methanol extract and the correspond fractions of *Quercus brantii* L. acorn. J Herbmed Pharmacol. 2015;4(1):35-9.
10. Femenia A. High-value co-products from plant foods: cosmetics and pharmaceuticals. In: Waldron K, ed. Handbook of Waste Management and Co-Product Recovery in Food Processing. Woodhead Publishing; 2007. p. 470-501. doi: 10.1533/9781845692520.4.470.
11. Olasehinde OR, Afolabi OB. Identification of bioactive constituents of chloroform fraction from *Annona muricata* leaf, its antioxidant activity and inhibitory potential against carbohydrate-hydrolyzing α-amylase and α-glucosidase activities linked to type II diabetes mellitus: in vitro study. J Herbmed Pharmacol. 2023;12(1):100-8. doi: 10.34172/jhp.2023.09.
12. Putra KW, Pitoyo A, Nugroho GD, Rai M, Setyawan AD. Phytochemical activities of *Ficus* (Moraceae) in Java Island, Indonesia. International Journal of Bonorowo Wetlands. 2020;10(2):98-125. doi: 10.13057/bonorowo/w100204.
13. Begum S, Barua IC. *Ficus* species and its significance. Int J Comput Appl Eng Sci. 2012;2(3):273-5.
14. Al Rashid MH, Kundu A, Mandal V, Wangchuk P, Mandal SC. Preclinical and clinical trials of Indian medicinal plants in disease control. In: Sen S, Chakraborty R, eds. Herbal Medicine in India: Indigenous Knowledge, Practice, Innovation and its Value. Singapore: Springer; 2020. p. 119-42. doi: 10.1007/978-981-13-7248-3_9.
15. da Cruz RC, Agertt V, Boligon AA, Janovik V, Anraku de Campos MM, Guillaume D, et al. In vitro antimycobacterial activity and HPLC–DAD screening of phenolics from *Ficus benjamina* L. and *Ficus luschnathiana* (Miq.) Miq. leaves. Nat Prod Res. 2012;26(23):2251-4. doi: 10.1080/14786419.2011.650637.
16. Pandey B, Rajbhandari M. Estimation of total phenolic and flavonoid contents in some medicinal plants and their antioxidant activities. Nepal J Sci Technol. 2014;15(1):53-60.
17. Alsenani F, Alsufyani M, Taib M, Almalki W, Bdirah F. A comprehensive review on phytoconstituents, bioactivities, and clinical studies on *Ficus carica* L. (Moraceae) and its role in human health and disease management. Nat Vol Essent Oil. 2023;10(1):15-43. doi: 10.53555/nveo.v10i1.4273.
18. Preeti, Jain A, Kumar G, Karthik L, Rao KV. Phytochemical composition and antioxidant activity of *Ficus elastica* Roxb. (Moraceae) leaves. Res J Pharm Technol. 2015;8(3):259-64. doi: 10.5958/0974-360x.2015.00043.8.
19. Joshi MK, Gorwadiya HC, Pandya DJ. Phytopharmacognostical study on 'Makhan katori': *Ficus krishnae*. Int J Biomed Res. 2012;3(11):427-30.
20. Ao C, Deba F, Tako M, Tawata S. Biological activity and composition of extract from aerial root of *Ficus microcarpa* L. fil. Int J Food Sci Technol. 2009;44(2):349-58. doi: 10.1111/j.1365-2621.2008.01732.x.
21. Chaware GK, Kumar V, Kumar S, Kumar P. Bioactive

compounds, pharmacological activity and food application of *Ficus racemosa*: a critical review. Int J Fruit Sci. 2020;20(Suppl 2):S969-86. doi: 10.1080/15538362.2020.1774467.
22. Koirala B, Pakuwal E, Rai HJ, Shrestha A. Evaluation of antioxidants and antimicrobial properties of indigenous plants: *Elaeocarpus sphaericus* and *Ficus religiosa*. Int J Environ. 2021;10(2):48-63. doi: 10.3126/ije.v10i2.42821.
23. Sarg TM, Abbas FA, El-Sayed ZI, Mustafa AM. Two new polyphenolic compounds from *Ficus retusa* L. "variegata" and the biological activity of the different plant extracts. J Pharmacogn Phytother. 2011;3(7):89-100.
24. Patel MH, Desai B, Jha S, Patel D, Mehta A, Garde Y. Phytochemical, pharmacognosy and ethnobotanical importance of the *Ficus virens* Aiton. Pharma Innov J. 2023;12(5):4017-21.
25. Unsal V, Dalkıran T, Çiçek M, Kölükçü E. The role of natural antioxidants against reactive oxygen species produced by cadmium toxicity: a review. Adv Pharm Bull. 2020;10(2):184-202. doi: 10.34172/apb.2020.023.
26. Valko M, Leibfritz D, Moncol J, Cronin MT, Mazur M, Telser J. Free radicals and antioxidants in normal physiological functions and human disease. Int J Biochem Cell Biol. 2007;39(1):44-84. doi: 10.1016/j.biocel.2006.07.001.
27. Rolt A, Cox LS. Structural basis of the anti-ageing effects of polyphenolics: mitigation of oxidative stress. BMC Chem. 2020;14(1):50. doi: 10.1186/s13065-020-00696-0.
28. Ungvari A, Gulej R, Csik B, Mukli P, Negri S, Tarantini S, et al. The role of methionine-rich diet in unhealthy cerebrovascular and brain aging: mechanisms and implications for cognitive impairment. Nutrients. 2023;15(21):4662. doi: 10.3390/nu15214662.
29. Jain A, Ojha V, Kumar G, Karthik L, Rao KV. Phytochemical composition and antioxidant activity of methanolic extract of *Ficus benjamina* (Moraceae) leaves. Res J Pharm Technol. 2013;6(11):1184-9.
30. Murugesu S, Selamat J, Perumal V. Phytochemistry, pharmacological properties, and recent applications of *Ficus benghalensis* and *Ficus religiosa*. Plants (Basel). 2021;10(12):2749. doi: 10.3390/plants10122749.
31. Satish A, Punith Kumar R, Rakshith D, Satish S, Ahmed F. Antimutagenic and antioxidant activity of *Ficus benghalensis* stem bark and *Moringa oleifera* root extract. Int J Chem Anal Sci. 2013;4(2):45-8. doi: 10.1016/j.ijcas.2013.03.008.
32. Bhaskara Rao KV, Ojha V, Preeti, Kumar G, Karthik L. Phytochemical composition and antioxidant activity of *Ficus benghalensis* (Moraceae) leaf extract. J Biol Active Prod Nat. 2014;4(3):236-48. doi: 10.1080/22311866.2014.936902.
33. Ramasamy A, Anandakumar K, Kathiresan K. In-vitro antioxidant potential and acetylcholinesterase inhibitory effect of *Ficus benghalensis* aerial root extract. Afr Health Sci. 2022;22(4):291-9. doi: 10.4314/ahs.v22i4.34.
34. Ayoub L, Hassan F, Hamid S, Abdelhamid Z, Souad A. Phytochemical screening, antioxidant activity and inhibitory potential of *Ficus carica* and *Olea europaea* leaves. Bioinformation. 2019;15(3):226-32. doi: 10.6026/97320630015226.
35. Kebal L, Pokajewicz K, Djebli N, Mostefa N, Poliwoda A, Wieczorek PP. HPLC-DAD profile of phenolic compounds and In vitro antioxidant activity of *Ficus carica* L. fruits from two Algerian varieties. Biomed Pharmacother. 2022;155:113738. doi: 10.1016/j.biopha.2022.113738.
36. Shahinuzzaman M, Yaakob Z, Anuar FH, Akhtar P, Kadir NH, Hasan AK, et al. In vitro antioxidant activity of *Ficus carica* L. latex from 18 different cultivars. Sci Rep. 2020;10(1):10852. doi: 10.1038/s41598-020-67765-1.
37. Ginting CN, Lister IN, Girsang E, Riastawati D, Kusuma HS, Widowati W. Antioxidant activities of *Ficus elastica* leaves ethanol extract and its compounds. Mol Cell Biomed Sci. 2020;4(1):27-33. doi: 10.21705/mcbs.v4i1.86.
38. Kanjikar AP, Aruna LH, Londonkar R. A novel investigation of in-vitro anti-inflammatory and antioxidant activity of *Ficus krishnae*. Eur J Biomed Pharm Sci. 2017;4(10):313-7.
39. Khan A, Anand V, Badrinarayanan V, Thirunethiran K, Natarajan P. In vitro antioxidant and cytotoxicity analysis of leaves of *Ficus racemosa*. Free Radic Antioxid. 2017;7(1):8-12. doi: 10.5530/fra.2017.1.2.
40. Jain R, Rawat S, Jain SC. Phytochemicals and antioxidant evaluation of *Ficus racemosa* root bark. J Pharm Res. 2013;6(6):615-9. doi: 10.1016/j.jopr.2013.06.004.
41. Abusufyan S, Ibrahim M, Mohib K. Comparative in vitro antidiabetic and antioxidant activity of various extracts of *Ficus* species. Pharmacogn J. 2018;10(2):349-54. doi: 10.5530/pj.2018.2.59.
42. Nawaz H, Waheed R, Nawaz M. Phytochemical composition, antioxidant potential, and medicinal significance of *Ficus*. In: Modern Fruit Industry. IntechOpen; 2019. doi: 10.5772/intechopen.86562.
43. Dutta R, Bhattacharya E, Pramanik A, Hughes TA, Mandal Biswas S. Potent nutraceuticals having antioxidant, DNA damage protecting potential and anti-cancer properties from the leaves of four *Ficus* species. Biocatal Agric Biotechnol. 2022;44:102461. doi: 10.1016/j.bcab.2022.102461.
44. Orabi MA, Orabi EA. Antiviral and antioxidant activities of flavonoids of *Ficus virens*: experimental and theoretical investigations. J Pharmacogn Phytochem. 2016;5(3):120-8.
45. Obafemi FA, Umahi-Ottah G. *Ficus benjamina* as a candidate for cancer therapy due to its selective toxicity property. J Cancer Res Treat Prev. 2023;1(3):148-58. doi: 10.37191/Mapsci-JCRTP-1(3)-012.
46. Tulasi CD, Lakshmi NM, Saida L. Cell viability assay of *Ficus benghalensis* latex solvent extracts on different cell lines. Asian J Pharm Clin Res. 2018;11:335-9.
47. Tulasi CD, Narasu ML, Saida L. Cytotoxic effect of *Ficus religiosa* and *Ficus benghalensis* latex extracts on MCF-7 cell line. Int J Sci Res Biol Sci. 2018;5(6):96-100.
48. Saloni J, Sakthivel J. Evaluation of antioxidant and anticancer potential of flavonoids from aerial roots of *Ficus benghalensis* Linn. Int J Pharm Res. 2019;11(1):12-20.
49. Abdel-Rahman R, Ghoneimy E, Abdel-Wahab A, Eldeeb N, Salem M, Salama E, et al. The therapeutic effects of *Ficus carica* extract as antioxidant and anticancer agent. S Afr J Bot. 2021;141:273-7. doi: 10.1016/j.sajb.2021.04.019.
50. Teinkela Mbosso EJ, Assob Nguedia JC, Meyer F, Ndjakou Lenta B, Ngouela S, Lallemand B, et al. Ceramide, cerebroside and triterpenoid saponin from the bark of aerial roots of *Ficus elastica* (Moraceae). Phytochemistry. 2012;83:95-103. doi: 10.1016/j.phytochem.2012.07.010.
51. Kanjikar AP, Hugar AL, Londonkar RL. Characterization of phyto-nanoparticles from *Ficus krishnae* for their

antibacterial and anticancer activities. Drug Dev Ind Pharm. 2018;44(3):377-84. doi: 10.1080/03639045.2017.1386205.
52. Chiang YM, Chang JY, Kuo CC, Chang CY, Kuo YH. Cytotoxic triterpenes from the aerial roots of *Ficus microcarpa*. Phytochemistry. 2005;66(4):495-501. doi: 10.1016/j.phytochem.2004.12.026.
53. Akhtar N, Syed DN, Khan MI, Adhami VM, Mirza B, Mukhtar H. The pentacyclic triterpenoid, plectranthoic acid, a novel activator of AMPK induces apoptotic death in prostate cancer cells. Oncotarget. 2016;7(4):3819-31. doi: 10.18632/oncotarget.6625.
54. Chan EW, Tangah J, Inoue T, Kainuma M, Baba K, Oshiro N, et al. Botany, uses, chemistry and pharmacology of *Ficus microcarpa*: a short review. Syst Rev Pharm. 2017;8(1):103-11. doi: 10.5530/srp.2017.1.18.
55. Khan N, Sultana S. Modulatory effect of *Ficus racemosa*: diminution of potassium bromate-induced renal oxidative injury and cell proliferation response. Basic Clin Pharmacol Toxicol. 2005;97(5):282-8. doi: 10.1111/j.1742-7843.2005.pto_163.x.
56. Gulecha V, Sivakuma T. Anticancer activity of *Tephrosia purpurea* and *Ficus religiosa* using MCF 7 cell lines. Asian Pac J Trop Med. 2011;4(7):526-9. doi: 10.1016/s1995-7645(11)60139-9.
57. Saida L, Tulasi CD, Narasu ML. Evaluation of chemo-preventive efficacy of *Ficus religiosa* latex extract by flow cytometry analysis and gene expression studies performed by RT-PCR in various cell lines. Futur J Pharm Sci. 2021;7(1):37. doi: 10.1186/s43094-021-00182-x.
58. Ambreen S, Tariq M, Masoud MS, Ali I, Qasim M, Mushtaq A, et al. Anticoagulant potential and total phenolic content of six species of the genus *Ficus* from Azad Kashmir, Pakistan. Trop J Pharm Res. 2019;18(6):1245-51. doi: 10.4314/tjpr.v18i6.14.
59. Mumtaz MW, Al-Zuaidy MH, Abdul Hamid A, Danish M, Akhtar MT, Mukhtar H. Metabolite profiling and inhibitory properties of leaf extracts of *Ficus benjamina* towards α-glucosidase and α-amylase. Int J Food Prop. 2018;21(1):1560-74. doi: 10.1080/10942912.2018.1499112.
60. Ahmed F, Chavan S, Satish A, Punith KR. Inhibitory activities of *Ficus benghalensis* bark against carbohydrate hydrolyzing enzymes - an in vitro study. Pharmacogn J. 2011;3(20):33-7. doi: 10.5530/pj.2011.20.7.
61. Saraswathi S, Senthamarai R, Sundari S. Antidiabetic activity of leaves extract of *Ficus benghalensis* Linn on alloxan induced diabetic rats. Int J Pharmacol Biol Sci. 2013;7(3):47-51.
62. Wojdyło A, Nowicka P, Carbonell-Barrachina ÁA, Hernández F. Phenolic compounds, antioxidant and antidiabetic activity of different cultivars of *Ficus carica* L. fruits. J Funct Foods. 2016;25:421-32. doi: 10.1016/j.jff.2016.06.015.
63. Nair AN, Nair RV, Nair AP, Nair AS, Thyagarajan S, Johnson AJ, et al. Antidiabetes constituents, cycloartenol and 24-methylenecycloartanol, from *Ficus krishnae*. PLoS One. 2020;15(6):e0235221. doi: 10.1371/journal.pone.0235221.
64. Amin MM, Bhakta S, Das SK. Anti-diabetic potential of *Ficus racemosa*: current state and prospect especially in the developing countries. J Biosci Agric Res. 2015;5(2):65-72.
65. Sethuraman J, Nehru H, Shanmugam K, Balakrishnan P. Evaluation of potent phytochemicals and antidiabetic activity of *Ficus racemosa* Linn. World J Pharm Res. 2017;6(15):909-20. doi: 10.20959/wjpr201715-10140.
66. Gul-e-Rana, Karim S, Khurhsid R, Saeed-ul-Hassan S, Tariq I, Sultana M, et al. Hypoglycemic activity of *Ficus racemosa* bark in combination with oral hypoglycemic drug in diabetic human. Acta Pol Pharm. 2013;70(6):1045-9.
67. Al-Snafi AE. Pharmacology of *Ficus religiosa*-a review. IOSR J Pharm. 2017;7(3):49-60.
68. Bhalerao SA, Sharma AS. Ethenomedicinal, phytochemical and pharmacological profile of *Ficus religiosa* Roxb. Int J Curr Microbiol Appl Sci. 2014;3(11):528-38.
69. Park S, Han J, Im K, Whang WK, Min H. Antioxidative and anti-inflammatory activities of an ethanol extract from fig (*Ficus carica*) branches. Food Sci Biotechnol. 2013;22(4):1071-5. doi: 10.1007/s10068-013-0185-7.
70. Dharmadeva S, Galgamuwa LS, Prasadinie C, Kumarasinghe N. In vitro anti-inflammatory activity of *Ficus racemosa* L. bark using albumin denaturation method. Ayu. 2018;39(4):239-42. doi: 10.4103/ayu.AYU_27_18.
71. Utami W, Aziz HA, Fitriani IN, Zikri AT, Mayasri A, Nasrudin D. In silico anti-inflammatory activity evaluation of some bioactive compound from *Ficus religiosa* through molecular docking approach. J Phys Conf Ser. 2020;1563(1):012024. doi: 10.1088/1742-6596/1563/1/012024.
72. Ogunlowo OP, Arimah BD, Adebayo MA. Phytochemical analysis and comparison of in-vitro antimicrobial activities of the leaf, stem bark and root bark of *Ficus benghalensis*. IOSR J Pharm. 2013;3(4):33-8.
73. Rashid KI, Mahdi NM, Alwan MA, Khalid LB. Antimicrobial activity of fig (*Ficus carica* Linn.) leaf extract as compared with latex extract against selected bacteria and fungi. J Babylon Univ Pure Appl Sci. 2014;5(22):1620-6.
74. Mbosso Teinkela JE, Siwe Noundou X, Fannang S, Meyer F, Vardamides JC, Mpondo Mpondo E, et al. In vitro antimicrobial activity of the methanol extract and compounds from the wood of *Ficus elastica* Roxb. ex Hornem. aerial roots. S Afr J Bot. 2017;111:302-6. doi: 10.1016/j.sajb.2017.03.026.
75. Kanjikar AP, Londonkar RL. Pharmacognostic evaluation, phytochemical screening and antimicrobial activity of stem bark of *Ficus krishnae*. Int J Pharmacogn Phytochem Res. 2017;9(5):733-8.
76. Rjeibi I, Ncib S, Alimi H, Ben Saad A, Saïd I, Souid S. Comparison of phytochemicals, antimicrobial, and antioxidant capacities in different anatomical parts of *Ficus microcarpa* (Moraceae). J Food Biochem. 2017;41(3):e12354. doi: 10.1111/jfbc.12354.
77. Pingale T, Duse P, Ogale S. Antibacterial and antifungal approaches of *Ficus racemosa*. Pharmacogn J. 2019;11(2):355-7. doi: 10.5530/pj.2019.11.53.
78. Prakash V, Gandotra S, Kumar P, Singh N. Phytochemical screening and antimicrobial activity of *Ficus religiosa*. J Pharm Sci Res. 2017;9(2):100-1.
79. Mawa S, Husain K, Jantan I. *Ficus carica* L. (Moraceae): phytochemistry, traditional uses and biological activities. Evid Based Complement Alternat Med. 2013;2013:974256. doi: 10.1155/2013/974256.
80. Raheel R, Saddiqe Z, Iram M, Afzal S. In vitro antimitotic, antiproliferative and antioxidant activity of stem bark

extracts of *Ficus benghalensis* L. S Afr J Bot. 2017;111:248-57. doi: 10.1016/j.sajb.2017.03.037.
81. Liu YP, Guo JM, Yan G, Zhang MM, Zhang WH, Qiang L, et al. Anti-inflammatory and antiproliferative prenylated isoflavone derivatives from the fruits of *Ficus carica*. J Agric Food Chem. 2019;67(17):4817-23. doi: 10.1021/acs.jafc.9b00865.
82. Boyacıoğlu O, Kara B, Tecimen S, Kılıç M, Delibaş M, Erdoğan R, et al. Antiproliferative effect of *Ficus carica* latex on cancer cell lines is not solely linked to peroxidase-like activity of ficin. Eur J Integr Med. 2021;45:101348. doi: 10.1016/j.eujim.2021.101348.
83. Mbosso Teinkela JE, Siwe Noundou X, Nguemfo EL, Meyer F, Djoukoue A, Van Antwerpen P, et al. Identification of compounds with anti-proliferative activity from the wood of *Ficus elastica* Roxb. ex Hornem. aerial roots. Fitoterapia. 2016;112:65-73. doi: 10.1016/j.fitote.2016.05.002.