



Review article

The Genus *Ficus*: a review of its phytochemicals and pharmacological studies

Subhash Chandra^{1*}, Kanishk Kala², Manbeer Singh Negi³ and Anuj Nautiyal²

¹Department of Pharmaceutical Chemistry, School of Pharmaceutical Sciences, Shri Guru Ram Rai University, Patel Nagar, Dehradun-248001, Uttarakhand, India

²Department of Pharmacy Practice, School of Pharmaceutical Sciences, Shri Guru Ram Rai University, Patel Nagar, Dehradun-248001, Uttarakhand, India

³Department of Social Work, School of Humanities and Social Sciences, Shri Guru Ram Rai University, Patel Nagar, Dehradun-248001, Uttarakhand, India

*Corresponding author. E-mail: subhashkothiyal@gmail.com

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ABSTRACT

The Genus *Ficus*, belonging to the family Moraceae, is well known for its medicinally important members. Particularly, the Indian *Ficus* tree is used in Ayurvedic medicine for many health conditions. Some *Ficus* species possess anticancer, immunostimulating, antidiabetic, antibacterial, antioxidant, antifungal, anti-arthritis, wound-healing, and neuroprotective properties. It has been discovered that different species of the Genus *Ficus* contain flavonoids, phenols, terpenoids, alkaloids, sugars, tannins, proteins, saponins, glycosides, volatile oils, and steroidal compounds. Indian *Ficus* has recently gained attention due to its high-value antioxidative property. The present review describes the phytochemistry, ethnomedicinal uses and pharmacological activities of different Indian *Ficus* species. The clinical and toxicological aspects for the exploration of their potential in the pharmaceutical sector are also included with recent developments in the field.

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INTRODUCTION

In various developing countries, medicinal plants play an essential role in primary healthcare due to the lack of modern infrastructure, healthcare, traditional acceptance, a huge amount of pharmaceutical drugs, and the efficacy of medicinal plants for treating certain disorders not treated with modern therapeutics (Saklani and Chandra, 2011). Over 800 *Ficus* species exist, including plants, vines, shrubs, epiphytes, and hemiphytes. Figs or fig trees are called *Ficus* plants. Despite its tropical and subtropical distribution, the genus is mainly found in Asia, America, Australia, and Africa (Rahman and Khanom, 2013). Herbal medicine stretches back to the cult of humanity. Indian traditional medical systems including Ayurveda, Siddha, Unani, and Homeopathy are playing a key role in healthcare (Saklani and Chandra, 2012a).

As part of the Ayurvedic healthcare system and the Chinese Materia Medica, a vast amount of information is provided regarding folklore practices and traditional uses of medicinal herbs. As conventional medicine systems are being adopted and studied worldwide and their potential exploited based on a variety of healthcare systems, morphological, phytochemical, pharmacological, and various instrumental techniques, such as chromatography, are primarily used for evaluating their rich heritage of therapeutically active herbs. Since human history, foods

have been used to cure a variety of ailments and improve health. A recent study indicates that figs have been cultivated for over 11,000 years, one of the oldest foods on the planet (Kislev et al., 2006). There are several species of *Ficus* found here, including *Ficus palmata*, *F. lingua* (box-leaved fig) syn. *F. diversifolia*, *F. benghalensis* (Indian banyan), *F. auriculata* Syn. *F. altissima* (council tree), *F. roxburghii*, *F. deltoidea* (mistletoe fig) syn. *F. benjamina* (weeping fig), *F. carica* (common edible fig), *F. celebinsis* (willow ficus), *F. elastica* (Indian rubber tree), *F. lyrata* (fiddle-leaf fig), *F. microcarpa* var. *crassifolia* (wax ficus), *F. pseudopalma* (Philippine fig), *F. pumila* (creeping fig) syn. *F. repens* *F. religiosa* (bo tree or sacred fig), *F. rubiginosa* (Port Jackson fig or rusty fig), *F. rubiginosa* 'Variegata', *F. saussureana*, syn. *F. dawei*, *F. salicifolia*, *F. tikoua* (Waipahu fig), *F. sagittata* 'Variegata', syn. *F. aspera* (clown fig), *F. radicans* 'Variegata', *F. microcarpa*, *F. binnendykii* (narrow-leaf ficus), *F. buxifolia*, *F. macrophylla* (Moreton Bay fig), *F. lacor* (Pakur tree), *F. stricta*, *F. subulata*, etc.

Ficus plants contain alkaloids, flavonoids, tannins, phenolic acids, glycosides, steroids, saponins, coumarins, and triterpenoids i.e., oleanolic, ursolic, protocatechuic, hydroxy ursolic and maslinic acids. Non-enzymatic constituents include phenolic constituents, flavonoids, and vitamin C and enzymatic components include ascorbate peroxidase, ascorbate oxidase, catalase, and peroxidase are

also reported from these plants. Selected species of the Genus *Ficus* are given below with their important properties.

Ficus palmata

The Garhwal Himalaya region is famous for its abundance of *Ficus palmata* fruit, or Bedu (Fig. 1) (Chandra and Saklani, 2016). Fresh fruit from local markets can also be dried, jelly, jammed, squashed, pickled, or processed into marmalade. It is used as a diuretic, to treat stomach ulcers, digestive system complaints, bronchitis, eczema, and haemorrhoids, and to relieve dizziness. Traditional uses for it include gastrointestinal and metabolic disorders, hypoglycemia, insulinase, tumour cures, ulcer healing, diabetes control, lipid-lowering, and anticarcinogenic, antifungal, and anti-inflammatory properties (Chandra and Saklani, 2017).

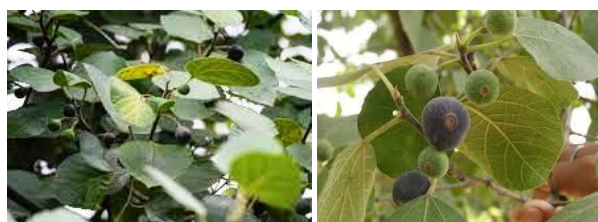


Fig. 1. Morphological features of *Ficus palmata*

Ficus auriculata

Ficus auriculata (Fig. 2) contains polyphenolic compounds and flavonoids with strong antioxidant properties. These compounds help treat, prevent, and prevent oxidative stress-related diseases including neurodegenerative and hepatic disorders. They treat dysentery and diarrhoea. In cases of mumps, cholera, diarrhoea, and vomiting, root latex is used. Fruit is used to make squash, jam, and jelly (Saklani and Chandra, 2012b).



Fig. 2. Morphological features of *Ficus auriculata*

Ficus benghalensis

F. benghalensis is known as the Banyan tree, Indian fig, and Nyagrodha (Fig. 3). Typically, Ayurvedic remedies are prepared with plant parts in India (Patel and Gautam, 2014). Plant parts are astringent because they contain tannins. Despite its astringency, this herbal remedy is cooling and demulcent at the same time. *F. benghalensis* stem, bark, and root are usually prepared in decoction form to treat a variety of ailments. This symptom may be caused by a variety of conditions, such as dysentery, diarrhoea, skin conditions, inflammation, and diabetes. It is also used to treat leucorrhoea, vaginal discharge, and boost the immune system. Latex from this plant is useful for a variety of purposes, including aiding conception, purifying

blood, and preventing urinary tract and urinogenital problems. The seeds of *F. benghalensis* are used as a dietary supplement by traditional medicine practitioners for the treatment of peptic ulcers. However, *F. benghalensis* flesh is not suitable for consumption because it is laxative (Tripathi et al., 2015).



Fig. 3. Morphological features of *Ficus benghalensis*

Ficus religiosa

Ficus religiosa is a member of the subgenus Urostigma and is locally known as the Peepal tree, also known as Pimpala (Fig. 4). It is a large tree with hypanthodia and the leaves of this tree are sessile or pedicellate (Pierantoni et al., 2018). The bitter-sweet and acrid nature of this plant makes it astringent, refrigerant, purgative, aphrodisiac, and laxative. There is evidence that its root bark can treat gout, stomatitis, ulcers, and other inflammatory conditions. This fruit's laxative properties aid digestion and prevent vomiting (Yadav, 2015).



Fig. 4. Morphological features of *Ficus religiosa*

SOURCES AND METHODOLOGY

The literature data was gathered from Core Collection, Scopus, Web of Science, PubMed, Google Scholar, MDPI, Science Direct, Google Academic, Clarivate Analytical, and Scientific Electronic Library Online (SciELO) from 1990-2023. In the search, the following keywords were used: *Ficus*, traditional uses, medicinal plants, phytochemistry, and pharmacological activity. We evaluated these articles for their various pharmacological activities, backed by scientific proof.

CHEMICAL CONSTITUENTS

Plants cure health problems with phytochemical constituents. It is possible to treat those conditions with the variety of plant metabolites available to humans. Plant species such as *Ficus* are among the largest in the plant kingdom. They contain phytoconstituents from various classes of compounds, including terpenoids, flavonoids, phenols, steroids, tannins (ellagitannins and hydrolyzable tannins), and many others. In addition, the chemical structures of various compounds isolated from different parts of the genus *Ficus* are shown in Fig. 5.

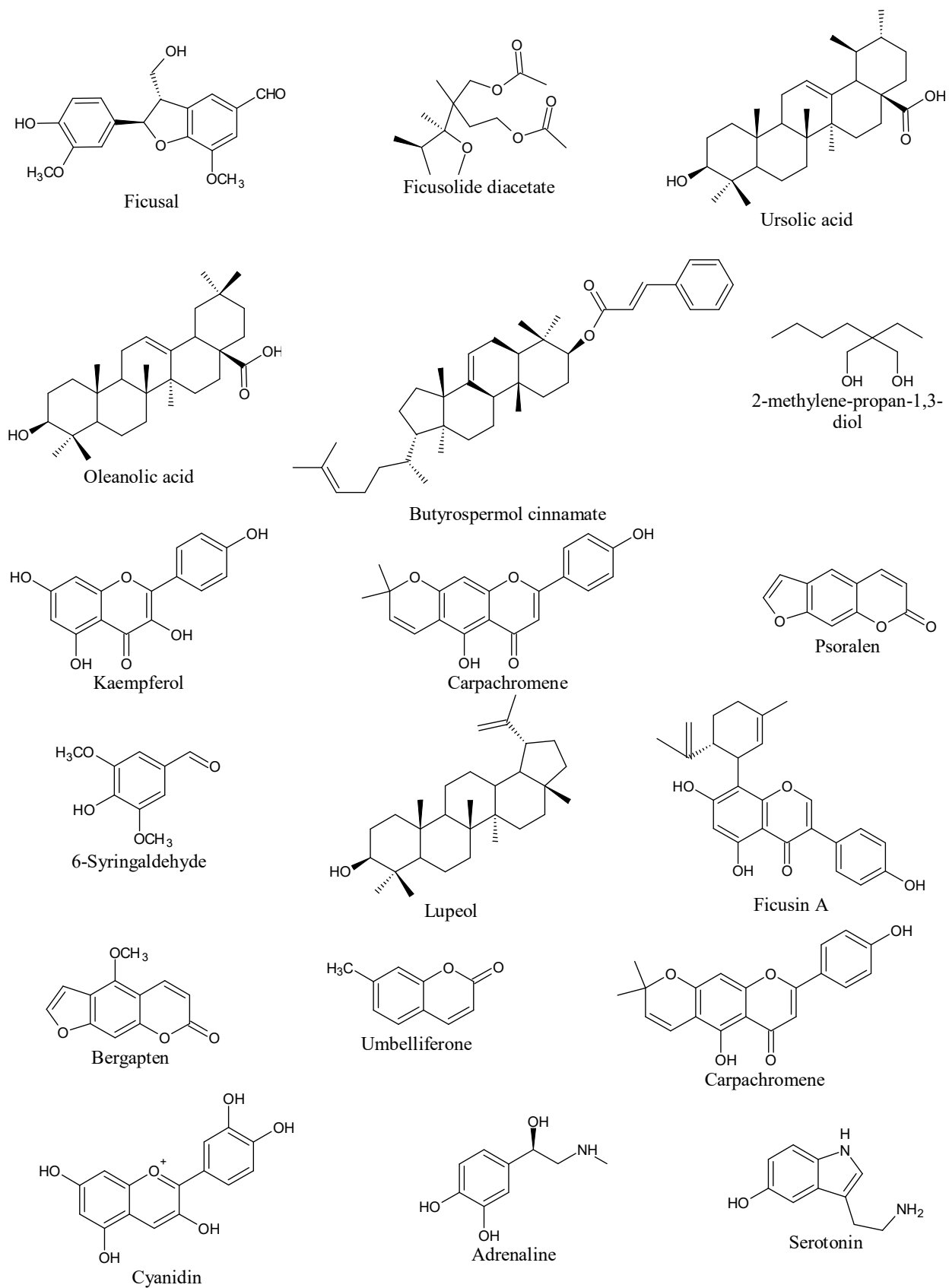


Fig. 5. Phytoconstituents isolated from different *Ficus* species

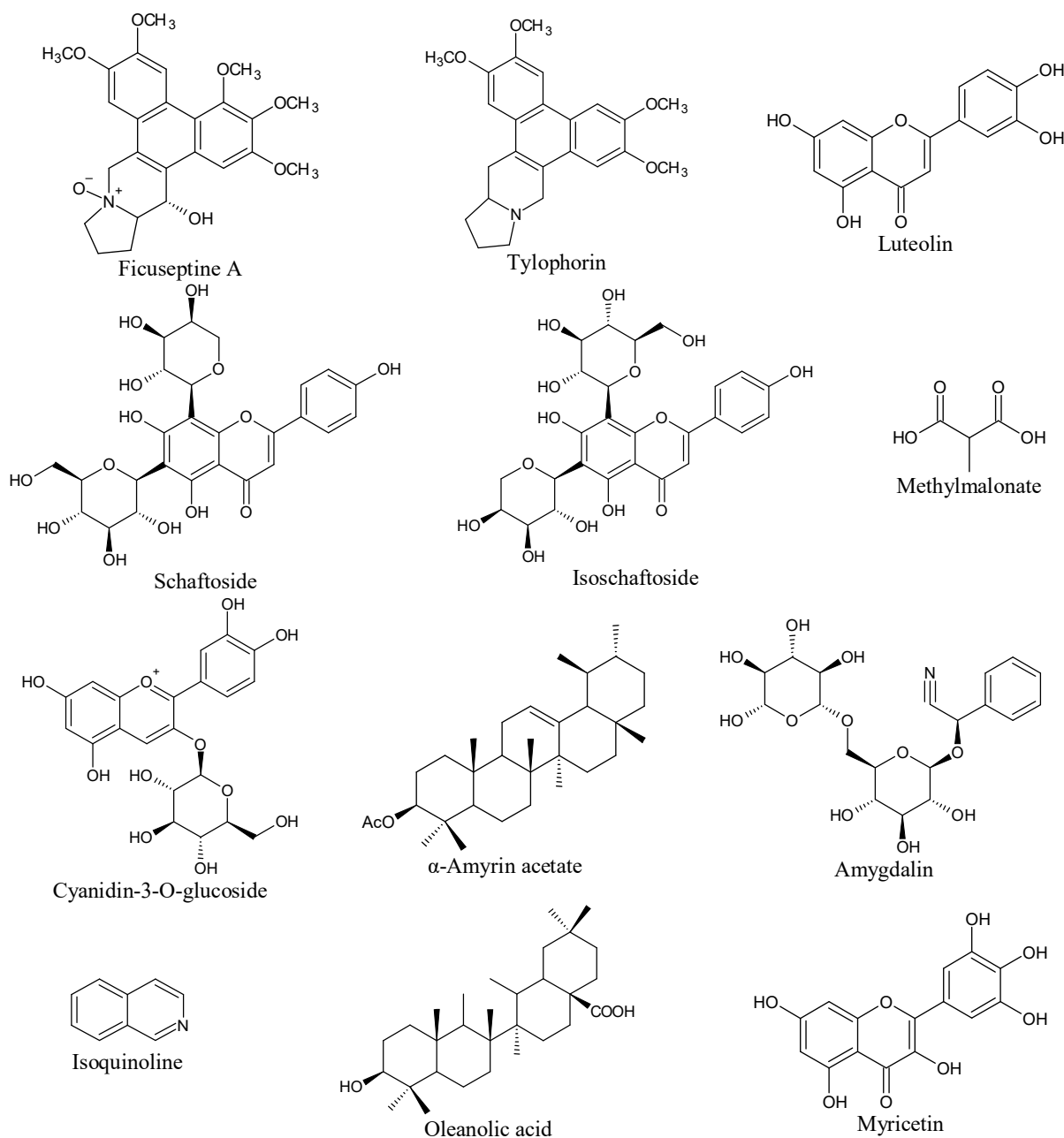


Fig. 5. Phytoconstituents isolated from different *Ficus* species (contd.)

PHARMACOLOGICAL APPLICATIONS

Ficus species are used in folk medicine as anti-HIV, antidiabetic, antimicrobial, antidiarrheal antioxidant, anti-inflammatory, tonic medicines, and anti-tumour (Lansky et al., 2008; Kitajima et al., 1999). *Ficus* extracts have also been reported to treat epilepsy and jaundice (Noumi and Fozzi, 2003; Betti, 2004) enteritis, bronchitis, toothache, whooping cough, influenza, bacillary dysentery, bruises, and tonsillitis. There are several pharmacological actions such as anti-diabetic, anti-ulcer, lipid-lowering, and antifungal effects.

Anti-HIV activity

The aqueous and ethanolic wood extract of *Ficus glomerata* was screened for its inhibitory activities against

HIV-1 integrase (1N) using the multi-plate integration assay (MIA). The ethanolic and aqueous wood extracts of *F. glomerata* were found to exhibit anti-HIV-1 integrase activity. *F. glomerata* wood extracts showed potent activity with an IC_{50} value of 7.8 μ g/ml (Manohar et al., 2013).

Antineoplastic activity

The fruit extracts of *F. sycomorou*, *F. benjamina*, *F. bengalensis* and *F. religiosa* have anti-tumour and antibacterial activity (Mousa et al., 1994). *F. bengalensis* roots exhibit anthelmintic properties. Fruit extracts exhibit anti-tumour activity (Aswar et al., 2008). Fresh and dried fruit of *F. carica* treats cancer, carcinoma, ulcers, hepatomegaly, and splenomegaly. The leaves treat cancer, tumours, and dermatitis. A study published by Pratumvinit

et al. (2009) demonstrated a positive effect of crude ethanol, water, methanol, water, methanol, and ethyl acetate fractions on SKBR3, MDA-MB435, MCF7, and T47D breast cancer cell lines. It was only the ethanolic fraction that had anti-neoplastic activity against T47D cells.

Hypoglycemic activity

The chloroform and methanolic extracts of the leaves, roots, and bark of *F. glomerata* exhibited significant hypoglycaemic activity (Balaji et al., 1996). *F. arnottiana* and *F. hispida* bark showed hypoglycaemic activity (Mazumder et al., 2009; Ghosh et al., 2004). The *F. hispida* bark exhibits hypoglycemic properties in diabetic albino rats. The ethanolic extract of the bark reduced blood glucose levels and increased glucose uptake. In addition, it increased liver, skeletal, and cardiac muscle glycogen content. Additionally, its constituents interacted with insulin when taken concomitantly (Venkatachalam and Mulchandani, 1982). *F. racemosa* latex is an aphrodisiac, and the bark treats diabetes.

Anti-inflammatory and antipyretic

The anti-inflammatory and analgesic effect of the aqueous and methanolic bark extract of *F. bengalensis* has been evaluated. The methanolic extract shows significant anti-inflammatory potential compared to aqueous extract (Thakare et al., 2010). *F. carica* fruit possesses spasmolytic and antiplatelet properties mediated by K⁺-ATP channels. Hence, it is useful in inflammation and gut motility disorders (Gilani et al., 2008). According to Vishnoi and Jha (2004), the treatment reduced inflammation by approximately 64.07% compared to only 45.13% with standard diclofenac sodium. This was in an albino rat model induced by carrageenan.

Neuroprotective effects

Sivaraman and Muralidharan (2010) found that methanolic extract of *F. hispida* leaves protects mice against β -amyloid-induced cognitive deficits and oxidative stress. This study showed that the extract inhibits cognitive behaviour and memory deficits. It also suppresses increased levels of thiobarbituric acid reactive species in the brain. Moreover, glutathione reductase, glutathione peroxidase, and superoxide dismutase activity were also increased. Holistic treatment for Alzheimer's disease and other age-related memory problems might be possible through these activities (Yokota et al., 2006).

Anti-lipidemic activity

The aqueous extract of *F. bengalensis* bark has been evaluated in hypercholesterolaemic rabbits. As a result, serum cholesterol, triacylglycerol, and LDL+VLDL levels increase. Administration of the aqueous extract of the plant to hypercholesterolaemic rabbits decreases the level of lipid peroxidation products by scavenging free radicals like superoxide anion, hydroxyl and peroxy (Shukla et al., 2004).

Antidiarrheal activity

F. hispida leaf extract inhibited castor-oil-induced diarrhoea and PEG2-induced interpolation in rats. A

methanolic extract from the leaves demonstrated significant and dose-dependent antidiarrheal activity and reduced charcoal meal propulsion through the gastrointestinal tract when taken orally. The study also established the extract dose and found that 600 mg/kg produced the same results as 5 mg/kg of diphenoxylate (Sivaraman and Muralidharan, 2010).

Anti-ulcerogenic effect

The roots of *F. bengalensis* are used to treat ulcers and gout. The ethanolic extract of *F. glomerata* exhibited anti-ulcer properties (Sree, 2011). An experiment with *F. hispida* root methanolic extract in aspirin-ulcerated rats was conducted by Sivaraman and Muralidharan (2010). The results showed that 200 and 400 mg/kg significantly decreased ulcer incidence, enhanced ulcer healing, and significantly reduced free and total acidity (Huong and Trang, 2006).

Sedative and anticonvulsant effects

Methanolic leaf extract of *Ficus platyphylla* was found effective in phenobarbitone-induced sleeping time and whole-board exploratory behaviour in Swiss albino mice at doses of 200 and 400 mg/kg, as well as strychnine, picrotoxin, and pentylenetetrazole-induced convulsion. In this study, phenobarbitone significantly reduced sleep onset and lengthened sleep duration, and the effects were dose-dependent. Furthermore, exploratory actions were suppressed. At a dose of 400 mg/kg, it completely inhibited seizures induced by picrotoxin and strychnine. Furthermore, both clonic and tonic seizures were significantly prolonged (Ghosh et al., 2004).

Hepatoprotective effect

The *F. carica* hepatoprotective activity was carried out on albino rats and administration of CCl₄ led to significant hepatocellular damage as evident from the increase in serum activities of SGOT, SGPT, Alkaline phosphatase, 177.76, 112.38, 73.74 units/ml respectively and total bilirubin 2.29 mg/dl (Mujeeb et al., 2011). It showed hepatoprotection in rats when paracetamol was used to induce acute liver damage. In comparison with a standard Liv-52 formulation, which is hepatoprotective, the results were similar. *F. racemosa* leaves juice (50-100 ml) should be taken with water for 10 days to treat gastrointestinal problems (Rout et al., 2009). Ethanolic extract of *F. glomerata* fruit has gastroprotective effects. *F. glomerata* is a gastro-protective agent (Rao et al., 2008). The methanolic extract of *F. hispida* leaves was successfully demonstrated to protect Wistar rats against cyclophosphamide-induced oxidative liver injury. In another study, methanolic leaf extract was used as an anti-azathioprine agent in liver injury in Wistar rats (Bai et al., 2007).

Antimicrobial activity

F. religiosa is reported to have many therapeutic uses e.g. asthma, cough, sexual disorders, diarrhoea, haematuria, ear-ache and toothache, migraine, eye troubles, gastric problems, and scabies; leaf decoction has

been used as an analgesic for toothache; fruits for the treatment of asthma, other respiratory disorders and scabies; stem bark is used in gonorrhoea, bleeding, paralysis, diabetes, diarrhoea, bone fracture; it also functions as an antiseptic, astringent and antidote. *F. exasperata* leaf extract contains *antibacterial properties* (Odunbaku et al., 2008). Leaves exhibit hypotensive activity (Buniyamin et al., 2007). The results of the antimicrobial activity of methanolic extract of *F. carica* against five bacterial strains *B. cereus*, *E. aerogens*, *K. pneumoniae*, *B. subtilis*, *S. epidermidis* at different concentrations (30, 40, 50, 60 µg/ml) were found in the following decreasing order: *S. epidermidis* > *K. pneumoniae* > *B. subtilis* > *B. cereus* > *E. aerogens* (Ahmad et al., 2013). The overall phenolic and flavonoid content was 135.8 mg in gallic acid equivalent/g extract and 60.5 mg in quercetin equivalent/g extract respectively (Mujeeb et al., 2011).

Anticonvulsant activity

In Ayurveda, *Ficus religiosa* possesses anticonvulsant activity. Many of these reports were validated pharmacologically for their actions on the CNS. Different parts of *Ficus religiosa* show acetylcholinesterase inhibitory and anti-anxiety activity. Figs (fruits) of the plant contain numerous amino acids like asparaginase and tyrosine in the edible part of the fruits alanine, threonine, tyrosine, and valine in seeds (Singh and Goel, 2009).

Antioxidant activity

The methanolic extracts of *Ficus microcarpa* bark, fruits, and leaves exhibited strong antioxidant activity assayed by four different methods including DPPH, ABTS, free radical scavenging, PMS–NADH system, superoxide radical scavenging, and β-carotene–linoleic acid system (Ao et al., 2008).

CLINICAL STUDIES

In the drug and cosmetic industries, plant-derived medicines have been used since prehistoric times. WHO records show that millions of people in developing countries use plant-derived medicines (Kulkarni and Dwivedi, 2019). Ras Shastra literature shows Panchavalkal heals Dushta Vranas (infected wounds). The patient was treated with Panchavalkal ointment for 21 days, and 35.7% of the wounds healed. Three *F. carica* paste packs (300g/day) improved colon transit time in 109 individuals with functional constipation (P=0.045). No serious adverse effects were observed in patients during the treatment period. It took 56 days to complete the treatment. Irreversible bowel syndrome symptoms such as pain frequency, distention, frequency of defecation, and stiff stool are less frequent in people with the condition. In this case, 90 grams of fruit are consumed each day. Treatment lasts 120 days (Pourmasoumi et al., 2019). It was found that Melfi cream (*F. carica* aqueous extract of sun-dried fruit and cream base; topical use) significantly reduced the SCORAD index, pruritus, and intensity scores compared to hydrocortisone (1%). An aqueous extract of *F. racemosa* stems, and bark, given two times before meals, significantly increased insulin levels (P<0.05).

TOXICOLOGICAL EFFECTS

Most people in developing countries regularly use medicinal plants to treat various diseases without prescription (WHO, 2002). Traditionally, medicinal plants have been used for a long time and have low toxicity. It relies on medicinal plants that have adverse effects. Around the world, traditional medicines get substantial support in health debates. The rats showed negative behavioural changes following the administration of 5000, 5500, 5750, and 6000 mg/kg aqueous extracts of *F. carica* leaves. The LD₅₀ was higher than 6000 mg/kg (Odo et al., 2016). In a period of 72 hours to 14 days, no acute toxicity symptoms, behavioural changes, or mortality were reported. The ethanol extract of *F. deltoidea* leaves (2000 mg/kg dose) did not affect the mice weight. Following methanol extraction of *Feronia exasperate* leaves, toxicity symptoms include unease, sluggishness, and dizziness. *F. religiosa* ethanol extracts (2000 mg/kg/p.o.) decreased water intake in Wistar rats (Singh and Sharma, 2023).

CONCLUSION

The current study was designed to compile the inventory of *Ficus* species plants with reported pharmacological activities. It also compiled the evidence supporting their use in various health problems. As a traditional medicine source, *Ficus* species have proven effective in treating various ailments, including anaemia, cancer, diabetes, leprosy, liver diseases, paralysis, skin diseases, and ulcers. For the development/formulation of novel drugs and future clinical applications, it is a promising candidate in pharmaceutical biology.

AUTHOR CONTRIBUTIONS

SC: outlined the work; SC, KK and AN: drafted the manuscript; SC and KK: edited and reviewed the paper.

CONFLICTS OF INTEREST

The author(s) declare(s) no conflicts of interest.

DECLARATION

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