

Phytochemistry and Pharmacology of *Ficus religiosa*

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ABSTRACT

Herbal medicine is one of the oldest valuable bestowal that was given to mankind. Many plants and herbs hold their prestigious position in the field of medicine among which *Ficus religiosa* belonging to the family Moraceae is the vital one. It is commonly named as "sacred fig", "Bo tree" "Peepal" or "Ashwattha" in Sanskrit. It is found all over India, as it is one of the sacred tree worshipped by Hindus. The different parts of the *F. religiosa* species tree namely bark, fruits, leaves, seeds and latex are used as chief indigenous medicines to cure various ailments. Recent studies have reported that *F. religiosa* is used in the traditional medicine to relieve about 50 types of disorders including diabetes, diarrhea, epilepsy inflammatory disorders, and gastric problems, sexual and infectious disorders. Green synthesis of Nano Particles (NPs) plays significant roles in medicines, clinical applications and in vitro diagnostic applications. This has also attracted the use of *F. religiosa* in the process of green synthesis of NPs where specific targeted treatment and theranostics are made easier. The applications of the green nanotechnology using *F. religiosa* has shown that the phytochemical investigation of plant extracts exhibits the presence of flavonoids,

tannins, phenoids, alkaloids, saponins and terpenoids. The studies also prove that the extracts express pharmacological activities like anti-oxidant, anti-bacterial, hypoglycemic, hypo-lipidemic, wound-healing, anti-helminthic, immune-modulatory, anti-convulsant and anti-ulcer in Humans. The present study is an attempt to compile and provide a brief review on the phytochemical investigations and pharmacological applications of *F. religiosa*.

Key words: *Ficus religiosa*, Phytochemistry, Pharmacology.

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INTRODUCTION

In India, the herbs have always been the prime type of medicine like Ayurveda, Siddha, Unani and Homeopathy. Medicinal plants are the native heritage with the universal importance. Natural product extracts are very important source of new drugs. In ancient medical system, various parts of plants such as stem bark, root bark, aerial roots, vegetative buds, leaves, fruits and latex are used to cure various ailments.¹ Herbs and medicines derived from plants have been extensively used in traditional cultures all over the world and are popular in modern medicine as alternatives to produce new prospective natural therapeutic compounds for aggressive diseases. Herbal medicines are natural and are favored over synthetic remedies. Medicinal plants are the sources of a large number of combinations of herbs and modern medicine. Indian people have an incredible passion for medicinal plants and they use them for a lot of health related applications. Approximately, 25000 plant based formulations are available in the ethnic medical texts.² Also, the modern medicine contains minimum 25% drugs produced from plants and many others which are artificial drugs manufactured on original compounds isolated from plants.³ India is one of the richest medicinal herbal granaries in the world that is of remarkable modern application, ensuring health security to millions of people.

Ficus religiosa (L.) is a large perennial tree largely planted as a roadside tree. Especially, in Southeast Asia this tree is commonly planted in the temple areas. The common name of *F. religiosa* (Moraceae) is Bodhi tree and is considered as a sacred tree for both Buddhists as well as Hindus.⁴ This tree has various nicknames such as the Tree of Life, Bodhi Tree, Wisdom Tree, Sacred Tree bestowing to the numerous benefits it provides. *F. religiosa* is considered as an herb. Six parts of the trees (i.e., bark, leaves, seeds, fruits, roots and latex) are assessed for their therapeutic qualities. The wood is not used for therapeutic purposes because it is highly porous in nature. All the parts of the plants have medicinal properties. They are used in different forms and it also gives best results when combined with other medicinal herbs.⁵ Traditionally in breast cancer

cell lines, the *F. religiosa* induces apoptosis,⁶ wound healing,⁷ used as an anti-bacterial,⁸ anti-convulsant,⁹ anti-viral, anti-protozoal, anti-diarrheal, astringent, anti-cholinergic and also treats gonorrhoea, amnesia, anti-diabetic.¹⁰ In other few Asian countries, their bark is used to treat various diseases like cervical cancer, epilepsy, inflammation,¹¹ ulcers, infectious diseases,¹² acetyl cholinesterase inhibitory activity¹³ and anti-anxiety activity and also used for skin diseases resulting from kumkum (bindhi) application.¹⁴ The leaves are testifying for its anti-venom activity, it regulates the menstrual cycle. The tender branches of *F. religiosa* are used as toothbrush.¹⁵ The latex of this plant is used as a tonic, and can be treated by the powder of its fruits.¹⁶

MORPHOLOGICAL CHARACTERS

F. religiosa is a perennial or deciduous tree, 20 m tall and 1.5-2 m dbh, irregularly-shaped, with wide-spreading branches and without aerial roots from the branches. The leaves are glossy, slim, and have 5–7 veins. The fragmented bark is white or brown in color. The fruits are small, about ½ inches in diameter, and it looks like the pupil of the eye. It is compressed and round in shape. The green color fruit turns black, when it ripens. The fruits are produced in summer and get ripened by the rainy season. The leaves are dark green leaves, glossy, alternate, coriaceous (leathery), broadly ovate and spirally arranged by 7.5-10 cm, base -cordate, pink when young, stipulate and with unusual tail-like tips. The leaves possess lesions on it. Flowers are axillary sessile, unisexual. Figs are in pairs, rounded, flat-topped green to 1.5 cm across, smooth, sessile, axillary, basal bracts and ripening to purple with red dots. Petioles are slender and 7.5-10 cm long.

The vasculature consists of a main vein (the midrib), followed by the secondary, tertiaries, quaternaries and the intermediary veins. The areoles count per square millimeter reduces from 16 to 3, but the count of vein tips and vein endings show no relationship with one another.¹⁷

PHYTOCHEMISTRY

The aqueous extract of dried bark of *F. religiosa* is stated that they have flavonoids, tannins, phytosterols and begapitol and bergapten (furanocoumarin derivatives). The stem bark of *F. religiosa* is affirmed the phytoconstituents of tannins, phenols, flavonoids, alkaloids and steroids, vitamin K, n-octacosanol, methyl oleanolate, lanosterol, β -sitosteryl-D-glucoside, stigmaterol, lupen-3-one.¹⁸ The root bark of *F. religiosa* has active constituents such as β -sitosteryl-D-glucoside, that reveals a hypoglycemic effect in diabetic rats and rabbits. 4.9% of the ficus fruits have protein with the essential amino acids, phenylalanine and isoleucine.¹⁹ The *F. religiosa* seeds contain fatty matter, albuminoids, coloring matter, phytosterolin, carbohydrate, glycoside and β -sitosterol.²⁰ The fruits and leaves of *F. religiosa* have protein, carbohydrate, lipid and minerals such as calcium, sodium, potassium, and phosphorus.²¹ The fruits of *F. religiosa* contain natural flavonols namely quercetin, myricetin and kaempferol.²² They also contain significant amounts of total flavonoid, total phenolic contents and linoleic acid.²³

In a recent review given by Damanpreet, the studies reveal that the phytochemical analysis of the leaves of *F. religiosa* have given rise to the isolation of phytosterols, triterpene alcohols, long-chain hydrocarbons, aliphatic alcohols, amino acids, fibres, tannins and minerals.²⁴

PHARMACOLOGY

Anti-oxidant Activity

The anti-oxidative properties of extract of *F. religiosa* bark and fruit extracts have been proved by using different solvents. The radical scavenging ability was calculated on the basis of oil stability index against 1, 1-diphenyl-2-picrylhydrazyl (DPPH).²⁵ In chronic diseases such as rheumatoid arthritis, atherosclerosis, diabetes, and the oxidative damage and oxidative stress to tissues are common. In diabetic rats, the oxidative stress harmonizes the reduction of anti-oxidant status, and increases the toxicity in free radicals. When the type 2 diabetes rats are treated with the aqueous extract of *F. religiosa*, it was found that the oxidative stress was reduced. Not only had that, during the progression of development when compared to the normal rats, the type 2 diabetes rats showed less weight. The weight loss is due to the less usage of glucose and induced β -oxidation in the adipose tissue. The aqueous extract of *F. religiosa* increases the body weight of diabetic rats.²⁶

The aqueous extract of *F. religiosa* modifies the superoxide dismutase (SOD) activities and minimizes the catalase (CAT) activity. This is conceivable due to less accessibility of NADPH. The action of the catalase and glutathione peroxidase (GSH-Px) is upregulated by the aqueous extract of *F. religiosa* bark.²⁷

The nitric oxide production and pro-inflammatory cytokines in lipopolysaccharide (LPS) are inhibited by the methanolic extract of *F. religiosa* leaf. The strong anti-inflammatory properties in microglial activation are carried out by the extract. It is expected that extract has inflammatory mediators like cytokines and nitric oxide that act as a neuroprotective effect against inflammation.²⁸ Recently, neurotrophic effects and acetylcholinesterase inhibitory activity is affected by the methanolic extract of *F. religiosa* is found.²⁹

Anti-bacterial Activity

The anti-bacterial effect against *Salmonella paratyphi*, *Staphylococcus aureus*, *Shigella dysenteriae*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Escherichia coli*, are studied by the ethanolic and aqueous extracts of *F. religiosa* leaves.³⁰ In another study, the anti-microbial effect against *Azobacter chroococcum*, *B. megaterium*, *Bacillus cereus*, *Streptomyces lactis*, *Streptococcus faecalis* and *Klebsiella pneumonia* were shown by the chloroform extract of fruits.³¹ The anti-fungal effect against *Candida*

albicans is calculated by the ethanolic extract of the leaves.³² The wide range of anti-bacterial activity inhibits 10–21 mm by the chloroform extract of *F. religiosa*. A few bacterial strains were treated with methanolic extracts, less anti-bacterial activity was found. No activity occurred when treated with aqueous extracts. The *F. religiosa* extracts were found to be dynamic against *Aspergillus niger* and *Penicillium notatum*. Most of the microorganisms showed different inhibitory effects when tested with the leaf extracts.³³

The report given by Kumara and Sreedharamurthy showed that the leaf extracts of *Ficus religiosa* do not show any antifungal activity against plant pathogenic fungi but, when it was only supplemented with petroleum ether and methanol extracts it showed restrained and substantial antifungal activity against *C. albicans*.³⁴

Hypoglycemic Activity

The root bark of *F. religiosa*, has β -Sitosterol-D-glycoside which has a hypoglycemic activity.³⁵ The *F. religiosa* bark extract in doses of 25, 50 and 100 mg/kg was administered orally and is studied in glucose-loaded, and STZ (streptozotocin) diabetic rats and normal rats. A major decrease in blood glucose levels is seen in the three doses of bark extract. The reduction was highly evident in 50 and 10mg/kg than 25mg/kg. The body weight, serum insulin and glycogen amount in skeletal muscle and liver of STZ-induced diabetic rats are increased significantly by the *F. religiosa*, when there was a substantial decrease in total cholesterol and serum triglyceride levels. *F. religiosa* also exposed substantial anti-lipid-peroxidative effect on the pancreas of STZ-induced diabetic rats. The anti-diabetic activity is highly effective in the aqueous extract of *F. religiosa* bark.³⁶

Hypolipidemic Activity

Lignin, dietary fiber (peepalbanti) and cellulose, were the dominating elements in peepal. When 10% dietary level is fed to rats, they showed a high opposition to hyperlipidemia when compared to cellulose. Dietary hemicellulose revealed a negative relationship with liver cholesterol and serum and a good relationship with excretory bile acids. The dietary fiber inclined triglycerides, cholesterol, phospholipids and total lipids of the liver to fluctuating levels. Hyperlipidemia associated with diabetes mellitus is treated by the stem-bark of *F. religiosa*.³⁷

Wound-healing Activity

The incision wound, excision wound and burn wound induced to the rats were healed by the wound healing activity of the hydro-alcoholic extract of *F. religiosa* leaves. 5% and 10% concentration of the leaf extract is applied to the wounds as an ointment. The extract also showed significant change in the healing of wound and burn wound models. When compared to the control a significant increase was found in an incision wound model. The result recommends that the wound healing activity depends on the provided dose of the leaf extract of *F. religiosa*.³⁸ When all extracts of *Ficus bengalensis* were screened for its anti-allergic and anti-stress potential in asthma by milk-induced leucocytosis and milk-induced eosinophilia, species such as *Ficus Racemosa*, *Ficus insipida*, *Ficus religiosa*, *Ficus elastica*, *Ficus Indica*, and *Ficus carica* showed anti-inflammatory activity whereas, *Ficus bengalensis* did not show any such activity was the report given by Patil *et al.*³⁹

Anthelmintic Activity

Haemonchus contortus worms are highly lethal to a methanolic extract of *F. religiosa* bark.⁴⁰ The *Ascaridiagalli* in *in vitro* are killed by the bark and stem extracts of *F. religiosa*. The latex of *F. religiosa* has anthelmintic activity against *Syphaciaobvelata*, *Aspiculuristetraptera*, and *Vampirolepis nana*.⁴¹ The methanolic extracts of *F. religiosa* possess anthelmintic

effect and it is due to ficin (a proteolytic fraction).⁴²

Immunomodulatory Activity

The alcoholic extract of the bark of *F. religiosa* (moraceae) shows the immunomodulatory effect in experimental rats. The effect was studied by different serological and hematological tests. Sheep red blood cells were injected as an anti-genic material to sensitize the mice. Both cellular and humoral anti-body responses are ameliorated by the administration of extracts. The immune-stimulant properties are responsible for its immune-modulatory activity.⁴³

Anti-convulsant Activity

The anti-convulsant activity against picrotoxin-induced convulsions and maximum electroshock (MES) with no neurotoxic effect depends on the dosage of the methanolic extract of fruits of *F. religiosa*. A major protection in picrotoxin-induced convulsion and MES models are studied by the dosage of *F. religiosa* extract. When the mice were treated with the doses (25, 50, and 100 mg/kg) in MES model, they showed a substantial reduction in the period taken for the extension of hind limbs, when compared to control group. The anti-convulsant activity of the extract is similar to that of the phenytoin-treated group. Though a substantial increase in the dormancy is observed in the 50 and 100 mg/kg dose of the extract it is lesser when compared to that of the control group. The extract mediates its consequences through glutamergic neurotransmission, due to the anti-epileptic inhibition effect of extract by cyproheptadine treatment.

Anti-ulcer Activity

The ethanolic extract of *F. religiosa* leaves have the anti-ulcer activity and are proved by arresting the production of ulcers encouraged by stress. When compared to the rats treated with the standard drug ranitidine, and there is no drastic change in the gastric secretion volume of the animals treated with *F. religiosa* leaf extract 500 mg/kg. When examined through microscope, the stomachs of animals showed complete ulceration when not treated with either ranitidine or *F. religiosa*. Ranitidine is used to treat the animals, 250 mg/kg and 500 mg/kg ethanolic extract of *F. religiosa* showed a preventive effect against ulceration. The leaf extract *F. religiosa* have substantial anti-ulcer activity in animal models. The extract is not toxic even at moderate high concentrations. The flavonoids in the extract are responsible for the anti-ulcer activity.⁴⁴

The study given by Parameswari *et al.*, show that the phytochemical investigation of methanolic extracts contains flavonoids which were confirmed by the chemical test and TLC. The plant extract also inhibits the activity of hydrazine, an evident compound that plays a key role in induced liver damage in rats, which result in higher rate of inhibition of biliary secretion and an increase in liver cell lipid peroxidation, and cytochrome P450.⁴⁵

CONCLUSION

The wide literature review has discovered the *F. religiosa* as a holy and significant medicinal plants used for the treatment of different ailments. The World is blessed with an amusing prosperity of medicinal plants. Medicinal plants show a significant role in the lives of poor people, with few medical facilities. Phytochemical research is done in *F. religiosa* that led to the discovery and isolation of plant metabolites. This review exposes that the *F. religiosa* has various phytochemicals like β -sitosterol-D-glucoside, vitamin K, n-octacosanol, kaempferol, quercetin, and myricetin. Various pharmacological activities like anti-oxidant, anti-bacterial, hypoglycemic, hypolipidemic, wound healing activities, anti-helminthics, immunomodulatory, anti-convulsant and anti-ulcer activities have been studied in *F. religiosa*, one of the natural treasures of India.

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