Phytopharmacology of *Ficus religiosa* L. and its significance as nanoparticulate carrier

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Abstract

India is renowned for the development of health science based on Ayurveda, Unani, Siddha and Homeopathy. *Ficus religiosa* L. is most popular species in these indigenous system of medicines. *F. religiosa*, entire plant parts like flowers, leaf, fruit, root, bark, inner part of stem, seeds are used as bioactive ingredients. Recently, some pharmacological reports presented that medicinally active molecules which are important for future medication are obtained majorly from trees. These reports also established an explanation related to anti diabetic, anticancer, antiiulcer, anticonvulsant, cell reinforcement, and wound recuperating properties of various parts of *F. religiosa*. Different parts of *F. religiosa* (roots, leaves, bark, fruit and seed) contains different types of active constituents which may help to treat various diseases. Extractions of *F. religiosa* in solvents (Ethnolic extraction, Water extraction, Methanolic extraction, etc.) are depend on the type of disease. Particulate frameworks like nanoparticles have been utilized as a physical way to deal with adjust and improve the pharmacokinetic and pharmacodynamics properties of different kinds of drug molecules. Nanoparticles are very small materials in the size range from 1 to 100 nm. Distinctive kind of nanomaterials are being created by utilizing copper, zinc, titanium, magnesium, gold, alginate and silver. Nanoparticles of *F. religiosa* improve the medicinal property on different diseases like malignant growth, arthritis and so on. In this manner, the main intention behind writing this article is to present an advanced study on phytochemistry, pharmacological properties and nanotechnology of *F. religiosa*.

Key words: *Ficus religiosa* L., Ayurveda, nanoparticles, biomedically, medicinally, antibacterial, antiviral, antiulcer, anticonvulsant utilization (Aiyegoro and Okoh, 2009). *F. religiosa* is one of the different plant generation as compare to other plants that developed with deciduous and enduring unattached trees, stranglers, climbers, little bushes and lithophytes (Ronsted, et al., 2008). Aqueous and alcoholic extract of *F. religiosa* show the antibacterial action against some type of bacteria like *Bacillus subtilis*, *Pseudomonas aeruginosa*, *E. coli* and *Salmonella typhi* (Preethi et al., 2019). Restorative plants are normally gifted with precious bioactive mixes which structure the foundation of traditional drugs (Ramakrishnan and Hariprasad, 2012). In order to expand the wider use of medicine, at present new drugs show less or no symptoms of specific disease with an increasingly rapid and desired activity (Roy et al., 2009).

From a long time period, the herbal medicines are used for treating different type of diseases, as they have remedial properties because of the nearness of different complex compounds of different synthesis, which are found as auxiliary plant metabolites in at least one piece of these plants (Sathyavati et al., 1976). Indian traditional medicine depends on different frameworks including Ayurveda, Siddha, Unani, and Homeopathy (Foye et al., 2008). Any piece of the plant may contain active parts like bark, leaves, roots, natural products, seeds, and so on. The beneficial medicinal impacts of plant materials normally result from the blends of auxiliary items present in the plant (Gordon and David, 2001). Bark of *F. religiosa* is used as antibacterial, antiviral...
Ficus is a class of around 800 species and 2000 assortments, which are woody trees, shrubs and vines in the family Moraceae happening in most tropical and subtropical woodlands overall (Hamed, 2011). Ficus is one of the most adoredbonsai. It is a phenomenal tree for beginners, as the most type of Ficus is quick growers, tolerant of most any soil and light conditions. About half portion of the species of Ficus are monoecious, and the rest are practically dioecious (Singh et al., 2011; Salem et al., 2013).

Numerous Ficus species are generally utilized in conventional medicine to treat different diseases. Sometimes they have been used as carminatives, vermicides, astringents, stomachic, anthelminthic and hypotensive drugs (Trivedi et al., 1969). Numerous species are developed for shade and decoration in nurseries. A few categories produce consumable Fig of differing acceptability. All species have latex-like material inside their vasculatures that give assurance and self-recuperating from physical ambushes (Srirsha et al., 2010). The Fig is an exceptionally supporting nourishment and utilized in modern items. Figs contain water, fats, high measures of amino acids, for example, leucine, lysine, valine, and arginine, and minerals (potassium, calcium, magnesium, sodium, phosphorus and Nutrients) (Joseph and Raj, 2010).

### 2. Materials and Methods

#### 2.1 Phytochemistry of *F. religiosa*

Phytochemistry is the chemistry of *F. religiosa*, involve the chemical constituents of *F. religiosa* obtained from different parts of plant like are roots, bark, fruit, seed, etc., which are discussed below in Table 1:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Plant part</th>
<th>Active constituents</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Roots</td>
<td>Tannins, wax, saponin, leucoanthocyanins, delphinidin-3-O-Lrhamnoside(II), Pelargonidin-3-O-Lrhamnoside, Leucocyanidine-3-Oβ-D-galactosyl-cerrubioside(III), Leucoanthocyanidin-20-tetraconten-2-one, pentatriacontan-5-one, 6 heptatria content-10-one, mesoanisostal</td>
<td>Asolakar et al., 1992</td>
</tr>
<tr>
<td>2</td>
<td>Bark</td>
<td>Phenols, tannins, steroids, alkaloids, avonoids, β-sitosteryl-d-glucoside, vitamin K, noctacosanol, methyl oleanolate, lanosterol, stigma sterol, lupen-3-one</td>
<td>Asolakar et al., 1992</td>
</tr>
<tr>
<td>3</td>
<td>Fruit</td>
<td>Proteins (4.9 %), essential amino acids (isoleucine and phenylalanine), avonols (kaempferol, quercetin, myricetin), also contain good amount of total phenolic contents, total avonoids, percent inhibition of linoleic acid, asgaragine, tyrosine, undecane, tridecane, tetradecane, (±)-β-ocimene, α-thujene, α-pinene, β-pinene, α-terpine, limonene, doldrolsine, 2-ylangene, 2-copaene, β-bourbonene, β-caryophyllene, α-trans bergamotene, aromandendrene, α-humulene, alloaromandendrene, germacrene, δ-cadinene, γ-cadinene.</td>
<td>Oliver and Bever, 1980</td>
</tr>
<tr>
<td>4</td>
<td>Seeds</td>
<td>Phytosteroline, β-sitosterol and its glycoside, albuminoids, carbohydrates, fatty matter, colouring matter, caoutchous 0.7-1.5%</td>
<td>Bushra and Farooq, 2008</td>
</tr>
<tr>
<td>5</td>
<td>Leaves</td>
<td>Campesterol, stemia sterol, isofucosterol, α-amyrin, lupeol, tannic acid, arginine, serine, asparagic acid, glycine, threonine, alanine, proline, tryptophan, tyrosine, methonine, valine, isoleucine, leucine, n-nonacosane, n-hentriacontanen, hexa-cosanol</td>
<td>Panda, 1976; Verma and Bhatia, 1986; Belarti et al., 1984</td>
</tr>
</tbody>
</table>

*F. religiosa* discharges oxygen constantly which makes it different from other plants. The majority of the plants take-up carbon dioxide (CO₂) to the great extent and in the presence of sunlight, they exhale oxygen, this process is called as photosynthesis. On the opposite of photosynthesis process at night *F. religiosa* tree uptake oxygen and discharge carbon dioxide. Some plants inhale CO₂ during the day as compare to day in light, because of their capacity to perform photosynthesis is called as Crassulacean Acid Metabolism (CAM). Peepal is a hemi-epiphyte in its local environment, for example, the seeds develop and grow as an epiphyte on different trees and afterward when the host tree dies, they build on the soil. Ficus mainly use Crassulacean Acid Metabolism (CAM) pathway for deliver carbohydrates when they live as epiphyte. But in case of soil, they change to C₃ type photosynthesis (Goutam et al., 2014).

#### 2.2 Antibacterial activity

Antibacterial action of *F. religiosa* against *Staphylococcus aureus*, *Salmonella paratyphi*, *Shigella dysenteriae*, *S. typhimurium*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *S. aureus*, *Escherichia coli*, *S. typhi* are indicated by using aqueous and ethanolic extract. (Mousa et al., 1994; Valsaraj et al., 1997; Farrukh and Iqbal, 2003). Ethnolic extract of leaves is also used in antifungal impact against *Candida albicans*. (Farrukh and Iqbal, 2003). For the antibacterial and antifungal action, aqueous, methanol and chloroform extract of leaves of *F. religiosa* is used. Chloroform extract inhibit the wide range of bacterial movement, i.e., 10-21 mm, the extract of *F. religiosa* inhibit the vast majority of microorganisms (Farrukh and Iqbal, 2003; Hemaiswarya et al., 2009).

#### 2.3 Anthelmintic activity

Methanolic extract of *F. religiosa* bark was active against *Haemonchus contortus* worms (Kaushik et al., 1981). Latex of some Ficus species, i.e., *Ficus insipida*. *F. carica* is active against parasitic infection, so it is reported for anthelmintic activity against some parasites like, *Syphacia obvelata*, *Aspiculuris tetraperta*, and *Vamipirelis nana* (De Amorin et al., 1999). Due to proteolytic division of Ficus, i.e., known as ficin (Hansson et al., 1986).

#### 2.4 Immunomodulatory activity

Alcoholic extract of *F. religiosa* bark show the immunomodulatory
activity in mice and investigation was completed by different hematological and serological tests. Extract improve the cell and humoral counter acting agent reaction (Malluwar et al., 2008).

2.5 Antioxidant activity

*F. religiosa* extract in different sundry solvents produce the anti-inflammatory activity (Bushra and Muhraf, 2009). The common endpoints of chronic infections are oxidative pressure and oxidative harm to tissues, for example, diabetes, atherosclerosis, and rheumatoid joint inflammation (Kuntal et al., 2019).

When the antioxidant status is decreases then the oxidative pressure in diabetes exists, which can increase the harmful effects of free radicals. Oxidative stress is decreases by using *F. religiosa* extract in water which help to induce experimentally type 2 diabetes in rats and improves the body weight of diabetic rats (You and Nicklas, 2006). The CAT and GSH-Px activity is controlled by the aqueous extract of *F. religiosa* bark (Kirana et al., 2009).

Methanolic extract of leaf of *F. religiosa* inhibits the nitric oxide and proinflammatory cytokines formation of in lipopolysaccharide (LPS) stimulated microglia through the pathway of mitogen activation protein kinase (MAPK) by using cell viability assay, nitric oxide test, and enzyme-linked immunosorbent assay (ELISA) (Hyo et al., 2008). Recently, neurotropic impacts and acetyl choline-mesterase inhibitory action has been produced by the methanolic extract of *F. religiosa* (Vinutha et al., 2007).

2.6 Wound-healing activity

Hydro-alcoholic extract of *F. religiosa* leaves are shown wound healing property on rats using different wound models. An emulsifying ointment is formulated in 5% and 10% concentration and apply in different types of wounds and that shown fast result on wound rupturing. The topical use of leaf extract of *F. religiosa* shown dose-dependent wound healing activity (Naira et al., 2009).

2.7 Anticonvulsant activity

The Figs of *F. religiosa* in methanol have anticonvulsant activity without neurotoxicity in dose dependent manner such as, in picrotoxin induced convulsion and most extreme electroshock. This action was analyzed at 100 mg/kg as compare to phenytoin (Damanpreet and Rajesh, 2009).

2.8 Hypolipidemic activity

The dietary fiber substance affects the lipids, cholesterol, triglycerides and phospholipids of the liver to different extents. A significant relationship between liver cholesterol and serum shown by the dietary hemicellulose and also show the positive connection with fecal bile acids. Dietary fiber substance show the 10% nourishment dietary level in rats and induced more resistance from hyperlipidemia than cellulose (Agarwal and Chauhan, 1988).

2.9 Hypoglycemic activity

This activity is shown by the root and bark parts of *F. religiosa* from which β-sitosterol-d-glycoside was isolated (Ambike and Rao, 1967). To STZ (streptozotocin) diabetic rats, 25, 50 and 100 mg/kg dose given orally. A significant reduction in blood glucose level in rats shown by using bark extract of *F. religiosa* and the effect is increasingly articulated in 50 and 100 mg/kg than 25 mg/kg. It is also demonstrated that this show a critical antilipid per oxidative in pancreas of diabetic rat. This results show that bark aqueous extract has antidiabetic activity (Panit et al., 2010).

2.10 Anti-inflammatory activity

The effect of *F. religiosa* leaf extract in methanol is shown in lipopolysaccharide-prompted creation of NO and pro-inflammatory cytokines. A result is found in research on Ficus, the methanolic extract is active in case of tumor putrefaction factor-alpha, interleukin beta (IL) and IL-6 in BV-2 microglial cells. The methanolic extract of leaf inhibit LPS-induced production of NO and proinflammatory cytokines in a dose-dependent manner.

The methanolic concentrate of stem bark has indicated anti-inflammatory activity orally. In the models of acute and chronic inflammation, significant ant-inflammatory effect has been observed; the extract has also protected the mast cells from the degradation formed by various DE granulators (Vishwanthan et al., 1990) for the treatment of inflammation and burns the paste of powdered bark is used which have good absorbent property (Joy et al., 1998; Madhav et al., 2008).

2.11 Anti-diabetic activity

In glucose-loaded hyperglycemic and streptozotocin-induced diabetic rats, the blood glucose level is shown by using 50 and 100 mg/kg dose. Later on, the reported results were compared with glibenclamide. The levels of serum, insulin, body weight, glycojen significantly rose up by the aqueous extract of *F. religiosa* in the liver and skeletal muscle of STZ induced diabetic rats, (Pandit et al., 2010).

2.12 Antifungal activity

Antifungal activity of *F. religiosa* against some microorganisms like *Staphylococcus aureus, Escherichia coli, Penicillium gluacum*, and *Paramecium* are shown by the benzene extract at a concentration of 0.2% for aqueous bark extract and for isolated compounds (Akhtar et al., 2000).

2.13 Antiulcer activity

In case of cold limited pressure induced gastric ulcer, and pylorus ligation, the ethanolic extract of stem bark of *F. religiosa* is used. The chances ulcer is decreased by the ethanolic extract of *F. religiosa* because Ficus increased the gastric acid pH as well decreased the total acidities and also decrease the volume of gastric juice (Swami and Bisht, 1996).

2.14 Bronchospasm activity

Methanolic extract of *F. religiosa* does show any significant effect on the potential to create histamine-induced pre-convulsive dyspnea. In isolated guinea pig's tracheal chain and ileum preparation the methanolic extract of *F. religiosa* potentiated, the EC doses of both histamine and acetylcholine. High amount of serotonin is demonstrated in HPLC analysis of methanolic extract (Malluwar and Pathak, 2008).

2.15 Proteolytic activity

Latex of some species of Ficus (near about 46) is used in case of proteolytic activity and, i.e., examine by electrophoretic and
chromatographic properties of the protein components, and *F. religiosa* has demonstrated a critical proteolytic activity (Ahuja et al., 2011).

### 2.16 Anti-acetyl cholinesterase activity

For inhibition of acetyl cholinesterase enzyme methanolic concentrate of stem bark of *F. religiosa* is used, and help to get the half-life of acetylcholine is prolonged. In Alzheimer's infections treatment, cholinesterase inhibitors are used, *i.e.*, determine the individually half inhibitory dose was found to be 73.69 µg/ml. The result justifies the use of *F. religiosa* for the treatment of Alzheimer's disease (William, 1968).

### 3. Results

#### 3.1 Nutritional composition of *F. religiosa*

All parts of *F. religiosa* are balanced according to their nutritional composition. In fresh fruits, 62.4 g/100 g of moisture content and these are rich source of macro and micro nutrients. Carbohydrate content in fresh fruits 21.2 g/100 g and crude fiber 9.9 g/100 g and fresh fruit reported as a good source of carbohydrates. The quantity of protein (2.5 g/100 g), fats (1.7 g/100 g), ash content 2.3 g, moisture content 62.4 g and calcium (289 mg/100 g) is present in fresh fruit (Bhogaonkar et al., 2014). In dried fruits of *F. religiosa* the net quantity of moisture content of 18.8 g/100 g, ash content of 4.44 g/100 g, fats 0.143 g, carbohydrates approximately 68.33 g/100 g and protein 8.48 g/100 g on drying. Dietary fiber, calcium and iron has reported 69.43 g, 848 mg and 6 mg/100 g, respectively in dried fruit (Verma and Gupta, 2015).

#### 2.17 Anti-amnesia activity

Anti-amnesia action was carried out using the methanol extraction of Figs on the scopolamine-induced anterograde and retrograde amnesia in mice and figs of *F. religiosa* contain high serotonergic substance. In pathogenesis of amnesia, modulation of serotonergic neurotransmission play very important role.

#### 2.18 Antimicrobial activity

Antimicrobial study of *F. religiosa* is done by using different solvent like methanol, ethanol, water, acetone, etc. There are different studies carried out to detect the action of *F. religiosa* against microbes such as *E. coli, A.niger, F. vulgaris*, etc., and some antimicrobial studies of *F. religiosa* are describe in Table 2:

### Table 2: Different studies for antimicrobial activity in recent years on *F. religiosa*

<table>
<thead>
<tr>
<th>Part of <em>F. religiosa</em></th>
<th>Solvent for extraction</th>
<th>Method of extraction</th>
<th>Active strains for antimicrobial test</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bark and Leaves</td>
<td>Methanol, diethyl ether</td>
<td>Disk diffusion</td>
<td><em>E. coli, P. aeroginosa, S. aureus, A. niger</em></td>
<td>Ramakrishnaiah et al., 2013</td>
</tr>
<tr>
<td>Leaves</td>
<td>Water and ethanol</td>
<td>Disk diffusion</td>
<td><em>E. coli, P. vulgaris</em></td>
<td>Tambekar et al., 2003</td>
</tr>
<tr>
<td>Bark</td>
<td>Acetone, methanol</td>
<td>Disk diffusion</td>
<td><em>B. subtilis, E. coli</em></td>
<td>Manimozhi et al., 2012</td>
</tr>
<tr>
<td>Bark, Fruit, Leaves, Stem</td>
<td>Water</td>
<td>Disk diffusion</td>
<td><em>S. aureus, A. niger, P. vulgaris, S. typhi</em></td>
<td>Rajiv and Siraj, 2012</td>
</tr>
<tr>
<td>Leaves</td>
<td>Water, methanol</td>
<td>Dish diffusion</td>
<td><em>S. aureus, S. typhi,</em></td>
<td>Preethi et al., 2010</td>
</tr>
<tr>
<td>Bark</td>
<td>70% ethanol</td>
<td>Pylori agar plates</td>
<td><em>H. pylori</em></td>
<td>Zaidi et al., 2002</td>
</tr>
<tr>
<td>Bark</td>
<td>Methanol, water, chloroform</td>
<td>Disk diffusion</td>
<td>Three enteroxigenic, <em>E. coli</em></td>
<td>Uma et al., 2009</td>
</tr>
<tr>
<td>Leaves</td>
<td>Chloroform</td>
<td>Well diffusion</td>
<td><em>S. typhi, S. typhimurium, P. vulgaris, K. pneumoniae, P. aeruginosa, A. niger, P. chrysogenum</em></td>
<td>Hemaitswarya et al., 2009</td>
</tr>
<tr>
<td>Leaves</td>
<td>Methanol</td>
<td>Well diffusion</td>
<td><em>S. typhi, P. aeruginosa, K. pneumoniae, P. vulgaris, A. niger, P. chrysogenum</em></td>
<td></td>
</tr>
<tr>
<td>Leaves</td>
<td>Water</td>
<td>Well diffusion</td>
<td><em>S. aureus, E. coli, S. paratyphi, S. typhimurium, S. dysenteriae, P. aeruginosa</em></td>
<td>Aqil and Ahmad, 2007</td>
</tr>
<tr>
<td>Bark</td>
<td>Water, Ethanol</td>
<td>Disc diffusion</td>
<td><em>B. cereus</em></td>
<td>Nair and Chanda, 2007</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Well diffusion</td>
<td><em>B. cereus, P. mirabilis, S. aureus, A. foecalis, S. typhimurium</em></td>
<td></td>
</tr>
</tbody>
</table>

Leaves and bark of *F. religiosa* are also used for their medicinal purpose and treat various diseases (Ruby et al., 2000). Moisture content, carbohydrates, proteins in leaves are 50.50 g, 19.20 g/100 g, 13.55 g/100 g and fats is 2.5 g/100 g (Wangkheirakpam and Laitonjam, 2012). According to report bark contain more moisture content as compare to leaves, *i.e.*, 62.4 g/100 g. But, the carbohydrate and protein content of bark are less than leaves, *i.e.*, 15.4 g/100 g, 2.5 g/100 g, respectively. Bark of *F. religiosa* is rich source of minerals and iron so that contain high mineral content of 13.1 g/100 g and iron content is 623 mg/100 g (Singh et al., 2015).

### 3.2 Ayurvedic formulations of *F. religiosa*

In Ayurvedic therapeutic system for the treatment of some diseases, *F. religiosa* is used as herbal drug. Plant parts of *F. religiosa* used in the form of oil, capsule, tablet, ointment or in crude form. Each...
formulation has own capacity to treat a particular disease. *F. religiosa* also consume in the form of powder being expanded in the powder structure by drying it and crush in grinders. Powder of *F. religiosa* is also used for treating certain conditions like diabetes mellitus (DM), urinary issue and so on. In the powder form of stem bark of *F. religiosa* give effectiveness in treatment of different diseases, if taken with honey (Singh et al., 2018). There are different formulations for different sickness, i.e., given in Table 3:

**3.3 Mode of action of phytochemicals activity of plants**

There are different active constituents are present in *F. religiosa* plant with their different activity and mechanism of action on body. The phytochemicals in *F. religiosa* act in different ways on different diseases, i.e., shown in Table 4:

### Table 3: Some Ayurvedic formulations of *F. religiosa*

<table>
<thead>
<tr>
<th>Name/product</th>
<th>Used in disease</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand sanitizer and soap</td>
<td>Antimicrobial, acne, eczema,</td>
<td>(Afsar and Khanam, 2016)</td>
</tr>
<tr>
<td>Sarivadayasava/Kerala Ayurveda Saribadyasavam, Kottakkal Saribadyasavam</td>
<td>Urinary diseases, renal diseases</td>
<td><a href="https://www.bimbima.com">https://www.bimbima.com</a></td>
</tr>
<tr>
<td>Panchavalkadi Talaim/Ayurvedic skin care oil (Arya Vaidya Pharmacy)</td>
<td>Dermatitis, eczema, herpes and skin conditions with bleeding</td>
<td><a href="https://ayurmedinfo.com">https://ayurmedinfo.com</a></td>
</tr>
</tbody>
</table>

### Table 4: Mode of action and activity of active constituents

<table>
<thead>
<tr>
<th>Phytochemicals</th>
<th>Activity</th>
<th>Mechanism of action</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quinones</td>
<td>Antimicrobial</td>
<td>Inactivates enzymes</td>
<td>Sahoo and Nayak, 2012</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>Antimicrobial</td>
<td>Complex with cell wall, binds to adhesions Inhibit the release of autacoids and prostaglandins</td>
<td></td>
</tr>
<tr>
<td>Polyphenols and Tannins</td>
<td>Anti diarrhoeal</td>
<td>Normalization of the DE arranged water transport across the mucosal cells, Inhibits GI of acetylcholine</td>
<td></td>
</tr>
<tr>
<td>Polyphenols and Tannins</td>
<td>Antimicrobial</td>
<td>Binds to adhesions, substrate deprivation, enzyme inhibition, complex with cell wall, membrane disruption , metal ion complexion</td>
<td></td>
</tr>
<tr>
<td>Caumarin</td>
<td>Antiviral</td>
<td>Interaction with eukaryotes DNA</td>
<td>Sahoo and Nayak, 2012</td>
</tr>
<tr>
<td>Terpenoids and essential oil</td>
<td>Antimicrobial</td>
<td>Membrane disruption</td>
<td></td>
</tr>
<tr>
<td>Alkaloids</td>
<td>Anti diarrhoeal</td>
<td>Inhibits release of autacoid's and prostaglandins</td>
<td></td>
</tr>
<tr>
<td>Lectins and polypeptides</td>
<td>Anthelmintic</td>
<td>Paralysis</td>
<td></td>
</tr>
<tr>
<td>Glycosides</td>
<td>Anti diarrhoeal</td>
<td>Increases supply of digestive protein of animals by forming protein complexes in rumens, interferes with energy generation by uncoupling oxidative phosphorylation, causing a decrease in GI metabolism.</td>
<td></td>
</tr>
<tr>
<td>Saponin</td>
<td>Anti diarrhoeal</td>
<td>Inhibits release of autacoids and prostaglandins</td>
<td></td>
</tr>
<tr>
<td>Steroids</td>
<td>Anti diarrhoeal</td>
<td>Increase histamine release Possesses membrane permealizing properties leads to vacuolization</td>
<td></td>
</tr>
</tbody>
</table>
4. Discussion

Nanotechnology plays an important role in the field of pharmaceutical science and drug development and use of nanotechnology increases day by day. Nanotechnology is concerned with the production, manipulation and use of materials in the range of nanometer and mainly with the nanoparticles having size range is 1-100 nm and due to its size they are differ from the bulk material (Kavitha et al., 2013).

Nanotechnology plays an important role in human's life in all spheres (Jannathul et al., 2012). Nanoparticles mainly concerned with medicinal chemistry, atomic physics, and all other known field. Richard Feynman was the first person who give the idea about nanotechnology in 1959 and later on there are many foundations inspired by the concept of nanotechnology. In nanotechnology, synthesis and development of nanomaterials are involved.

Recently, different metallic nanomaterials are produced by using silver, copper, zinc, titanium, magnesium, gold, and alginate. For different purposes, nanoparticles are used in different sectors like in medical treatment, industry production such as solar and oxide fuel batteries, cosmetic and cloths, etc. (Dubchuk et al., 2010). Nanoparticle are classified in different types like carbon-based NP, metal NP, ceramic NP, semiconductor NP, polymeric NP and lipid-based NP. There are some formulations of leaf extract of F. religiosa are shown in Table 5:

Table 5: Nanoparticles of F. religiosa for different disease

<table>
<thead>
<tr>
<th>Plant part</th>
<th>Activity</th>
<th>Nanoparticles</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf extract</td>
<td>Antiulcer, antidiabetic</td>
<td>Silver nanoparticles</td>
<td>Abdul et al., 2018</td>
</tr>
<tr>
<td>Leaf extract</td>
<td>Anticancer</td>
<td>Copper oxide nanoparticles</td>
<td>Shankar et al., 2014</td>
</tr>
<tr>
<td>Leaf extract</td>
<td>Antitumor</td>
<td>Zinc oxide nanoparticles</td>
<td>Arvind et al., 2017</td>
</tr>
<tr>
<td>Leaf extract</td>
<td>Antibacterial</td>
<td>Silver nanoparticles</td>
<td>Antony et al., 2013</td>
</tr>
<tr>
<td>Leaf extract</td>
<td>Wound healing</td>
<td>Green synthesized nanoparticles</td>
<td>Nakkala et al., 2017</td>
</tr>
<tr>
<td>Leaf extract</td>
<td></td>
<td>Green synthesized copper oxide nanoparticles</td>
<td>Shankar et al., 2015</td>
</tr>
</tbody>
</table>

5. Conclusion

Medicinal plants are the local heritage with the worldwide significance. F. religiosa is a rich source of supplements just as phytocemicals. It has been utilized generally to treat numerous illnesses and is also a significant element of Ayurveda herbs. In future, F. religiosa may use in nutraceuticals and food preparation because it can fulfill the demand of nourishment and food sources. The present article shades lights on F. religiosa contains a few phytoconstituents like β-sitosterol, D-glucoside, nutrient K, nootcaosanol, kaempferol, and myricetin and nanotechnology of F. religiosa for treating different diseases and also on the different pharmacological activities like antibacterial, antifungal, anticonvulsant, immunomodulatory, antioxidant, hypoglycemic, hypolipidemic, anthelmintic, and wound healing. Nanoparticles helps to enhance the activity of F. religiosa and also the pharmacodynamics and pharmacokinetic property of F. religiosa.

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Conflict of interest

The authors declare that there are no conflicts of interest in the course of conducting the research. All the authors had final decision regarding the manuscript and decision to submit the findings for publication.

References


