Chapter 3

Literature Survey
3.1 Plant profile - *Ficus microcarpa* L.f. (Synonym- *F. retusa* L.)

3.1.1 Vernacular names

- **English**: Indian laurel, Chinese banyan
- **Hindi**: Kamrup, Pinwal
- **Gujarati**: Pilala
- **Marathi**: Nandruk, Tunivriksha
- **Sanskrit**: Kantalaka, Kuberaka

3.1.2 Taxonomy

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Plantae – plantes, Planta, Vegetal, plants</th>
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<tr>
<td>Subkingdom</td>
<td>Viridaeplantae – green plants</td>
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<tr>
<td>Infrakingdom</td>
<td>Streptophyta – land plants</td>
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<tr>
<td>Division</td>
<td>Tracheophyta – vascular plants, tracheophytes</td>
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<td>Subdivision</td>
<td>Spermatophytina – spermatophytes, seed plants, phanérogames</td>
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<td>Infradivision</td>
<td>Angiospermae – flowering plants, angiosperms, Magnoliopsida</td>
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<td>Class</td>
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<tr>
<td>Superorder</td>
<td>Rosanae</td>
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<td>Order</td>
<td>Rosales</td>
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<tr>
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<tr>
<td>Genus</td>
<td>Ficus L. – fig</td>
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<td>Species</td>
<td><em>Ficus microcarpa</em> L.f. – laurel fig, curtain fig, Chinese banyan</td>
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**Botanical name**: *Ficus microcarpa* L.f.; synonyms- *F. retusa*

3.1.3 Part used: Rootlets, bark and leaves
3.1.4 Distribution
It is well distributed in forests at low and medium altitudes ascending to 1,500 meters. It occurs throughout India, southern China, and Taiwan.

3.1.5 Description
It is an evergreen tree, full grown to highest of 15 m (50 ft) or more, with a rounded dense crown, smooth gray bark, milky sap, and long, thin, dangling aerial roots. Leaves alternate, simple, leathery, deep glossy green, oval-elliptic to diamond-shaped, 13 cm (5 in) long, with short pointed, ridged tips. Flowers tiny, unisexual, numerous, hidden within the “fig,” a fleshy, specialized receptacle that develops into a multiple fruit (syco-nium), this green turning to yellow or dark red when ripe, sessile, in pairs at leaf axils, small, to 1 cm (0.5 in) in diameter.

3.1.6 Chemical composition
It consists of wide range of phytochemicals: sterols, terpenoids, glycoside, flavonoids, polyphenols, proteins and carbohydrates.

3.1.7 Medicinal properties and uses
The aerial roots used to treat dental caries and odontalgia. The bark and leaves are astringent, refrigerant, acrid and stomachic. They are useful in wounds, ulcers, bruises, flatulent colic, diarrhea, dysentery, diabetes, hyperdipsia, burning sensation, haemorrhages, ulcerative colitis, leucorrhoea, psychopathy and hepatopathy. The bark is given in buttermilk to cure liver diseases for seven days (Kirtikar and Basu, 1987a; Warrier et al., 1995).

3.2 Literature review of *F. microcarpa* (*F. retusa*)

3.2.1 Phytochemical review
The bark leaves and aerial roots of *F. microcarpa* were well explored for their phytochemistry. The different part of plant majorly contains triterpenoids and steroids along with other phytoconstituents. The Li, Chiang and Kuo have done remarkable research in phytochemistry.

3.2.1.1 Bark
Li and Kuo (1997) were isolated phytoconstituents from *F. microcarpa* bark. The methanol extract obtained from cold maceration was partitioned with *n*-butanol and
water. The \textit{n}-butanol fraction was purified by silica gel column chromatography with a gradient solvent system (hexane-ethyl acetate), yields crude compound 1 and 2. Further purification by HPLC gave pure 1 (Ficuisoflavone) and 2 (Isolupinisoflavone E). In another study, Kuo and Li (1997) isolated 28 phytoconstituents from the same fraction. Among them fourteen triterpenoids (friedelin; friedelinol; canophyllol; \(\alpha\)-amyrin acetate; 3\(\beta\)-acetoxy-12-ursen-11-one; 12-oleanene-3,11-dione; lupeol; betulinic acid; cycloart-23-ene-36\(\beta\),25-diol; cycloart-25-ene-3\(\beta\),24-diol and taraxerone) eight steroids (\(\beta\)-sitosterone; \(\beta\)-sitostenone; \(\beta\)-sitosterol; stigmasterol; 6-hydroxystigmast-40en-3-one; ergosetrol peroxide, 6′-(\(\beta\)-sitosteryl-3-O-\(\beta\)-gucopyranoside) two 4-hydroxy benzoates (methyl 4-hydroxy-3-methoxybenzoate; methyl 4-hydroxybenzoate), one flavones (catechin), one coumarin (marmesin), one carotenoid like (4,5-dihydroblumenol) and one fatty alcohol (mixture of 1-penta- and 1-heptaeicosanol) were identified.

3.2.1.2 Aerial roots and leaves

Chiang and Kuo (2000), isolated ten new taraxastane-type triterpenes from the aerial roots of \textit{Ficus microcarpa} [20-taraxastene-3\(\beta\),22\(\alpha\)-dial, 3\(\beta\)-acetoxy-20-taraxasten-22\(\alpha\)-ol, 3\(\beta\)-acetoxy-22\(\alpha\)-methoxy-20-taraxastene, 3\(\beta\)-acetoxy-20\(\alpha\),21\(\alpha\)-epoxytaraxastan-22\(\alpha\)-ol, 3\(\beta\)-acetoxy-19\(\alpha\)-methoxy-20-taraxastene, 3\(\beta\)-acetoxy-19\(\alpha\)-hydroperoxy-20-taraxastene, 3\(\beta\)-acetoxy-20\(\alpha\),21\(\alpha\)-epoxytaraxastane, 3\(\beta\)-acetoxy-11\(\alpha\)-hydroxy-11(12→13)abeoolean-12-al, 3\(\beta\)-hydroxy-20-oxo-29(20→19) abeolupane, and 29,30-dinor-3\(\beta\)-acetoxy-18,19-dioxo-18,19-secolupane], six new triterpenes of ursane-type (3\(\beta\) -acetoxy-11\(\alpha\)-methoxy-12-ursene, 3\(\beta\) -acetoxy-11\(\alpha\)-ethoxy-12-ursene, 3\(\beta\)-acetoxy-11\(\alpha\)-hydroperoxy-12-ursene, 3\(\beta\) -hydroxy-11\(\alpha\)-hydroperoxy-12-ursene), and two oleanane-type triterpenes (3\(\beta\) -acetoxy-11\(\alpha\)-ethoxy-12-oleanene, 3\(\beta\) -acetoxy-11\(\alpha\)-hydroperoxy-12-oleanene (Kuo and Chiang2000). Chiang and Kuo (2001), isolated novel peroxytriterpenes 3 beta-acetoxy-12 beta,13 beta-epoxy-11 alpha-hydroperoxyursane, 3 beta-acetoxy-11 alpha-hydroperoxy-13 alpha H-ursan-12-one, 3 beta-acetoxy-1 beta,11 alpha-epidioxy-12-ursene, (20S)-3 beta-acetoxy-20-hydroperoxy-30-norlupane, 3 beta-acetoxy-18 alpha-hydroperoxy-12-oleanen-11-one, and 3 beta-acetoxy-12-oleanen-11-one; except (20S)-3 beta-acetoxylupan-29-oic acid) ; while in additional study Chiang and Kuo (2003) isolated novel \(\alpha\)-tocopheroids (\(\alpha\)-tocospiros A, B, together with \(\alpha\)-tocopherol). Ouyanga and Kuo (2006), isolated ficuscarpanoside B, (7\(E\), 9\(Z\))-dihydrophaseic acid 3-O-\(\beta\)-d-glucopyranoside and
ficuscarpanic acid were isolated from the aerial roots of Ficus microcarpa. Their structures were elucidated by spectral methods. Chiang et al. (2005) isolated oleanonic acid, acetylbetulinic acid, betulonic acid, acety lursonic acid, ursolic acid, 3-oxofriedelan-28-oic acid, and 3β-acetoxy-25-hydroxylanosta-8, 23-diene isolated from aerial roots of F. microcarpa, these compounds showed significant cytotoxic activity against human nasopharyngeal carcinoma HONE-1, oral epidermoid carcinoma KB, and colorectal carcinoma HT29 cancer cell lines. Wang et al. (2010) identified orientin, isovitexin-3″-O-glucopyranoside, isovitexin, and vitexin flavone C-glycosides from leaves. New water-soluble phenylpropanoid constituents, ficuscarpanoside A, guaiacylglycerol 9-O-β-D-glucopyranoside, and erythro-guaiacylglycerol 9-O-β-D-glucopyranoside, along with known guaiacylglycerol, erythro-guaiacylglycerol, 4-methoxy guaiacylglycerol 7-O-β-D-glucopyranoside, and 3-(4-hydroxy-3-methoxy phenyl) propan-1,2-diol, have been isolated from the aerial roots of Ficus microcarpa (Ouyang et al., 2007).

3.2.2 Ethnopharmacological review

F. microcarpa dried leaves, aerial roots, and bark are used for diverse health ailments in traditional and folklore remedies. Traditionally, the bark has a reputation for efficacy in the treatment of liver diseases (Kirtikar and Basu, 1987a). In China, adventitious rootlets used for toothaches, for which they are dried, powdered and applied to the decaying or aching tooth. The ash from F. microcarpa provides the best quality lye for preparing Okinawa Soba, the famous traditional food of Okinawa (Nakama, 2003). In Kerala, plant used for treatment of leucoderma, ulcers, leprosy, itching, and biliousness. Bark used for liver diseases. Powdered leaves and bark used for rheumatic headaches. Leaves and roots used for wounds and bruises (Sasidharan et al., 1985).

3.2.3 Pharmacological review

3.2.3.1 F. microcarpa bark (FMB)

- Antioxidant and hyaluronidase activity

In preliminary antioxidant studies on different parts of F. microcarpa, the methanol extract of FMB showed strong antioxidant activity. The study on methanol extract of FMB was extended, where methanol extract was fractioned with solvents of different polarity such as hexane, ethyl acetate, butanol and water. The highest antioxidant
activity was observed in ethyl acetate fraction. This fraction was subjected for isolation of phytoconstituents using preparative HPLC and purified on Sephadex LH-20 column chromatography. Seven compounds were isolated from ethyl acetate fraction and identified as protocatechuic acid, chlorogenic acid, methyl chlorogenate, catechin, epicatechin, procyanidin B1, and procyanidin. All isolated compounds showed strong antioxidant activity while catechin, epicatechin, procyanidin B1, and procyanidin B3 exhibited excellent inhibitory activity against hyaluronidase (Ao et al., 2010).

- **Antibacterial and antioxidant activity**

Ao et al. (2008) studied the antioxidant and antibacterial activity of different part of *F. microcarpa*. The methanol extracts of bark, fruits and leaves of *F. microcarpa* exhibited excellent antioxidant potential and antibacterial activity against tested gram-positive and gram-negative bacteria. Amongst extracts, methanol extracts of *F. microcarpa* bark exhibited strongest antioxidant activity and shown to posses highest total phenolic content. Furthermore, methanol extract of bark were fractioned with hexane, ethyl acetate and water; ethyl acetate fraction of bark extract exerted strong antioxidant and antibacterial effects with high amount of total phenolics (436 GAE mg/g extract). EC$_{50}$ values of bark ethyl acetate fraction were 4.83, 1.62 and 63.2 µg/ml in DPPH, ABTS$^+$, superoxide radicals scavenging methods, respectively. Inhibition zones of ethyl acetate fraction against *Bacillus brevis*, *Bacillus cereus*, *Bacillus subtilis*, *Escherichia coli* and *Achromobacter polymorph* were 18.0, 15.5, 16.5, 16.0 and 8.0 mm, respectively. Twelve phenolic compounds (Catechol; coumaran; p-vinylguaiacol; syringol; p-propylphenol; vanillin; p-propylguaiacol; isovanillic acid; 4-n-propylresorcinol; syringaldehyde; protocatechuic acid; oleanolic acid) were identified in ethyl acetate fraction by GC–MS and HPLC analyses. Ao et al. (2009) extended antioxidant and antibacterial study on aerial roots of *F. microcarpa*, with similar kind of extraction and fractionation scheme. The ethyl acetate fraction possessed the highest amount of phenolic content, antioxidant potential and antibacterial activity against gram positive and negative bacteria. The similar twelve phenolic compounds were identified using GC-MS and HPLC analyses. The study concluded that high level of phenolic compounds may be responsible for strong antioxidant and antibacterial activities of *F. microcarpa* bark extract.
Anti-secretary activity

Anti-secretary activity of ethanolic extract of *Ficus retusa* L. stem bark was evaluated using ethanol, and cold-restraint stress induced gastric ulcer models in albino Wistar rats (Rao and Kumar, 2012). Ethanol extract showed dose dependent inhibition in ethanol induced gastric lesions (70.02 and 59.75% protection; 500 and 250 mg/kg) and cold-restraint stress induced gastric lesions (69.67 and 60.28% protection; 500 and 250 mg/kg) indicating anti-secretary potential.

3.2.3.2 Leaves and aerial roots

Anti-inflammatory activity

Anti-inflammatory and hepatoprotective activity of ethyl acetate and methanol extract (100, 200 and 400 mg/kg) of *F. microcarpa* leaves was assessed in carrageenan induced rat paw odema and carbon tetra chloride induced hepatotoxicity, respectively. The extracts showed dose dependant pharmacological response. Amongst them, ethyl acetate extract showed potent anti-inflammatory and hepatoprotective activity in experimental animal models (Jayaraju and Sreekanth 2011a, b). In the similar study, Bairagi et al. (2012) observed the significant anti-inflammatory and analgesic activity for crude methanol extract of leaves.

Antidiabetic activity

The methanol and water extracts of *Ficus retusa* leaves were evaluated for anti-diabetic potential in experimental animals. The extracts showed significant blood glucose lowering ability in a dose-dependent manner. No over sign of hepatotoxicity and renotoxicity were observed in chronic toxicity studies. The study established *F. retusa* leaves as a potential and safe alternative diabetic (Joshi et al., 2010).

Anti-histaminic activity

Li et al. (2009) studied the antiasthmatic activity of *F. microcarpa* leaves water extracts and their fractions. The some of the water extract was filtered through membrane filter to obtain membrane fraction, and remaining half was dried and extracted successively with *n*-butanol, ethyl acetate and methanol fractions. These fractions and extracts were evaluated for antitussive and expectorant activity in experimental animals. The membrane fraction had remarkable antitussive and
expectorant activities. The water and methanol fractions able prolong latency time of cavy and thus reported as effective anti-asthmatic fractions.

- **Antihyperlipidemic activity**

  Awad et al. (2011) has evaluated hypolipidaemic and antioxidant effects of unsaponifiable fraction of hexane extract of *Ficus microcarpa* leaves in hypercholesterolemic rats (cholesterol administration; 30 mg/0.3 ml 0.7% tween/animal). The leaves extract (500 mg/kg body weight) was administered 5 times/week for 9 weeks to animals. The effect of the extract on the lipid profile was recorded by measuring the levels of total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), triglycerides, and total lipids. The Lipid peroxides, glutathione and superoxide dismutase were measured as antioxidants. The study demonstrated the unsaponifiable fraction of hexane extract possess significant antioxidant and hypolipidemic activity through its role in counteracting LDL oxidation, enhancement of HDL synthesis and inhibition of lipid peroxidation.

- **Antioxidant activity**

  Abdel-Hameed (2009) reported strong antioxidant activity of ethyl acetate fraction followed by *n*-butanol of methanolic extract *F. microcarpa* leaves. Further, it was concluded that the antioxidant property was attributed due to presence of high phenolic content.

- **Antifungal activity –latex**

  Taira et al. (2005) identified and reported new three chitinases from the latex of gazyumaru (*Ficus microcarpa*), designated gazyumaru latex chitinase (GLx Chi)-A, -B, and -C. GLx Chi-A,-B, and -C are an acidic class III (33 kDa, pI 4.0), a basic class I (32 kDa, pI 9.3), and a basic class II chitinase (27 kDa, pI > 10) respectively. All GLx Chi showed effect on antifungal activity based on ionic strength. The chitin-binding activity of GLx Chi-B was enhanced by increasing ionic strength. The results suggested that the chitin-binding domain of basic class I chitinase binds to the chitin in fungal cell walls by hydrophobic interaction and assists the antifungal action of the chitinase.
3.3 Plant profile - *Luffa acutangula* (L.) Roxb. var. *amara* C.B. Clarke
(Synonyms: *L. amara*)

3.3.1 Vernacular names

English: Ridged gourd, angled loofah, ribbed gourd, Chinese okra, silk squash (En)

Hindi: Turai, Kadaviturai.

Gujarat: Kadvanturian, Kadvighisodi

Marathi: Dodaki

Sanskrit: Tiktakoshataki, Katukoshataki

3.3.2 Taxonomy

3.2 Table The taxonomical classification of *Luffa acutangula* (L.) Roxb. var. *amara* C.B. Clarke

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Plantae – plantes, Planta, Vegetal, plants</th>
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<td>Variety</td>
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<td><em>Luffa acutangula</em> (L.) Roxb. var. <em>amara</em> C.B. Clarke</td>
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</table>
3.3.3 **Part used:** leaves, fruits

3.3.4 **Distribution**

*Luffa amara* (LA) is believed to have originated in India, distributed in south India and West Bengal

3.3.5 **Description**

It is monoecious, annual, climbing or trailing herb, with acutely 5-angled stem; tendrils up to 6-feet, hairy. Male inflorescence racemose with 15–35 cm long peduncle.

*Leaves* alternate, simple; stipules absent; petiole up to 15 cm long; blade broadly ovate to kidney-shaped in outline, 10–25 cm × 10–25 cm, shallowly palmate 5–7-lobed with broadly triangular to broadly rounded lobes, cordate at base, shallowly sinuate-dentate, pale green, scabrous, palmately veined.

*Flowers* unisexual, regular, 5-merous, 5–9 cm in diameter; 0.5 cm long, lobes triangular, 1–1.5 cm long; petals free, pale yellow; male flowers with 3 free stamens inserted on the receptacle tube, connectives broad; female flowers solitary, on pedicels 2–15 cm long, with inferior, densely pubescent, longitudinally ridged ovary, stigma 3-lobed.

*Fruit* a club-shaped, dry and fibrous capsule 15–50 cm × 5–10 cm, acutely 10-ribbed, brownish, dehiscent by an apical operculum, many-seeded. Seeds are broadly elliptical.

3.3.6 **Chemical composition**

All the parts of plant are extremely bitter due to presence of triterpenoids; major cucurbitacin-B. Seed contains maximum concentration i.e. 0.12%. It also consists of steroids and α-amyrin, flavonoids, carotenoid like compounds and phenolic acids. Seed consist of mixture of saturated and unsaturated fatty acids.

3.3.7 **Medicinal properties and uses**

The wild verity, i.e. *L. acutangula var amara* has high value in traditional system of medicine; this is widely used by local healers and traditional practitioner for treatment of various diseases. The plant posses laxative and purgative properties and reported to be useful in skin diseases and asthma. It is used as a diuretic and given in splenic
enlargements. The 2-3 drops of juice of the fresh fruit or decoction of the dried fruits without seed recommended as nasya in jaundice. Seeds are used emetic, expectorant and demulcent (Kirtikar and Basu, 1987b).

3.4 Literature review of *Luffa acutangula* (L.) Roxb var. *amara* C.B. Clarke

3.4.1 Phytochemical review

In the phytochemical screening, Torvi and Hunashal (2012) noted the presence of important secondary metabolite such as, steroid and glycoside in *L. amara* fruits. Nagao et al. (1991) isolated and identified the seven oleanane type of triterpenoids saponins, acutoside A-G and H-I, from the 50% methanolic extract of LA fruits. In Recent studies on fruit Wang et al. (2002), isolated luffanguline from LA seeds as a novel ribosome inactivating peptide. The plant also reported to present β-carotene, luffin, amarin and 2-deoxy cucurbitacin (Nardkarni, 1994). The flavonoids distribution among the luffa species was studied by Schilling and Heiser (1981), they found the presence of luteolin and apigenin in leaves and flowers.

![Figure 3.3 Phytoconstituents of *L. amara*](image)

3.4.2 Ethnopharmacological review

During the ethnopharmacological survey in Rajasthan, Katewa et al. (2008) collected the information on uses of medicinal plants, based on the exhaustive interviews with local physicians practicing indigenous system of medicine in tribal folks of Aravalli.
hills of Mewar region tribes; Bhil, Garasia, Damor and Kathodia. They found that half tea spoon of *L. amara* seed powder is taken orally with water for 3–4 days for urinary bladder stone.

Samvatsar and Diwanji, (2000), documented plant utilized for jaundice by tribes of Western Madhya Pradesh of India. Where, LA commonly known as Kadwiturai, and their leaf and fruit parts was used for treatment of jaundice. About 2-3 drops of leaf or green fruit juice without using water dropped into one of the nostrils for 4 days.

Kanaka et al. (2013) documented that local inhabitants of reserve forests of Mahadevpur, Karimnagar utilizes *L. amara* fruit for treatment of diabetes.

### 3.4.3 Pharmacological review

- **Antioxidant activity**

  Kalyani et al. (2011) reported *Luffa amara* seed oil from petroleum extracts contains fatty acids such as lauric, myristic, palmitic, stearic, oleic and linoleic acid. Furthermore, the study demonstrated significant antioxidant activity of this extract.

- **Anti-inflammatory activity**

  Gill et al. (2011) evaluated ethanol extracts of *Luffa amara* seeds for analgesic and anti-inflammatory activity. The ethanol extracts reduced paw edema in a dose-dependent manner, with a maximum inhibition of 60.8% at 300 mg/kg and comparable with standard diclofenac sodium. Further, extract showed significant analgesic activity with reaction time 6.25 ± 0.52 and 5.80 ± 0.52 at 400 mg/kg in tail flick and tail immersion experimental models, as compared with standard (pentazocin).

  In another similar study, Iyyamperumal et al. (2013) evaluated the antioxidant and anti-inflammatory effect in acute and chronic animal models. The study results revealed that ethanol and ethyl acetate extracts of LA leaves possess significant dose dependent manner activity. Ethanol extracts demonstrates the highest anti-inflammatory activity i.e. 72.5% (500 mg/kg) at 5th hrs after carrageenan administration when compared with ethyl acetate extract (65%; 500 mg/kg). Likewise, in chronic cotton pellet granuloma model, ethanol extracts exhibited maximum inhibition i.e. 56.9% (500 mg/kg) compared with ethyl acetate extract (52%).
Similarly, the antioxidant ability of ethanol extract was better than ethyl extract of LA leaves.

- **Anti-diabetic and gastroprotective activity**

Pimple et al. (2011) investigated antidiabetic and antihyperlipidemic potential of petroleum ether, methanol and aqueous extracts of *Luffa acutangula* (LA) fruits. The methnolic extracts of fruits showed the highest antioxidant activity, which may be due to high polyphenolic content. The methnolic and aqueous extracts showed potent antidiabetic and antihyperlipidemic in streptozotocin induced non-insulin dependent diabetes mellitus in rats. In another study of Pimple et al. (2012) reported that methanol extract gave ulcer maximum protection in diabetic rats.

- **Hepatoprotective activity**

Jadhav et al. (2010) demonstrated hepatoprotective activity of hydro-alcoholic extracts edible species of *L. acutangula* in CCl₄ and rifampicin induced hepatotoxicity. The hydro alcoholic extracts prevented the elevation of serum biochemical marker enzymes and restore the total protein, in dose dependent manner, in both the models. The study revealed the hepatoprotective activity of hydroalcoholic extract by potentiating the endogenous antioxidant system and inhibition of lipid peroxidation.

- **Antimicrobial activity**

Dandge et al. (2012) examined antimicrobial activity of *Luffa amara* fruit and leaf water extracts. The fruit exhibited more potent antibacterial and antifungal activity than leaf extract. *E. coli* showed highest sensitivity than *Staphylococcus aureus*, *Pseudomonas aeruginosa*; while fungi *Curvularia lunata* was found highly sensitive to leaf and fruit extract.

In another study, chloroform and aqueous extract of LA fruit were evaluated for antimicrobial potential. Chloroform extract showed higher antimicrobial potential compared with aqueous extract (Torvi and Hunashal, 2012).

- **CNS depressant activity**

Missar et al. (2004) evaluated CNS depressant activity of ethanol extract of LA fruits using behavioral changes, exploratory activity, barbiturates sleeping time in animal models. The extract exhibited dose-dependent CNS depressant activity.
**Ameliorative activity**

Jadhav et al. (2013) reported protective effect of hydroalcoholic effect of *L. acutangula* in doxorubicin induced cardiac and nephrotoxicity in mice. Pretreatment with hydroalcoholic extracts significantly reversed the serum biomarkers such as alanine amino transferase, lactate dehydrogenase and creatinine phosphokinase in heart and kidney tissue in doxorubicin treated mice. In addition, the LA extract demonstrated inhibition of elevated MDA level and restored depleted glutathione, catalase, and superoxide dismutase in heart and kidney tissue. The ameliorative effect in cardio and nephro-toxicity in mice was found to be related to its antioxidant property which finally results in membrane stabilization.

**3.5 Conclusion**

The detail literature review showed that the selected plants are traditionally and in folk used for liver diseases. The phytochemistry of *F. microcarpa* was extensively studied. The plant was not yet standardized for pharmacognostically. The pharmacological activity limited to antioxidant, antimicrobial and cytotoxic studies; while no reports were available for hepatoprotective evaluation and phytochemical correlation.

The *L. acutangula* has two variety that are edible known as *L. acutangula* var. *acutangula* and other wild i.e. *L. acutangula* var. *amara* (*L. amara*). Their morphology and phytochemistry is distinct. The most of literatures were published without clear identification. The fruit of the plant is highly recommended in traditional and folk medicine for liver disease. Despite of this, the plant has not standardized for pharmacognostically and pharmacologically. The preliminary reports on phytochemistry of *L amara* fruit were available. Thus, indicates the need of pharmacological evaluation with phytochemical correlation.

**3.6 References**


Literature Review


mucosal glycoproteins and antioxidants. *Asian Pacific journal of tropical medicine, 5*(8), 610-615.


