3. PLAN OF THE WORK

Figure No. 3.1 Schematic diagram of the plan of work

Collection of plant material

Authentication

Extraction

Phytochemical evaluation

Identification by TLC

Isolation by column chromatography

Characterization & structural elucidation

IR, NMR & Mass spectrometry

Pharmacological evaluation

Acute toxicity study

Anti-anxiety study

Elevated plus Maze method

Hole board test

Staircase exploration method

Open field test

Light dark exploration method

Social interaction test
4. LITERATURE REVIEW

Figure No. 4.1  Aerial view of *Flacourtia indica* Linn
Figure No. 4.2  A twig showing unripe fruits and thorns of

*Flacourtia indica* Linn
4.1. PLANT DESCRIPTION

4.1.1. Scientific Classification

<table>
<thead>
<tr>
<th>Rank</th>
<th>Classification</th>
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<tbody>
<tr>
<td></td>
<td>Kingdom Plantae</td>
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<tr>
<td></td>
<td>Unranked Angiosperms</td>
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<tr>
<td></td>
<td>Unranked Eudicots</td>
</tr>
<tr>
<td></td>
<td>Unranked Rosids</td>
</tr>
<tr>
<td></td>
<td>Order Malpighiales</td>
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<tr>
<td></td>
<td>Family Flacouriaceae</td>
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<tr>
<td></td>
<td>Genus Flacourtia</td>
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<td>Species indica</td>
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</tbody>
</table>

4.1.2. Binomial Name

*Flacourtia indica* Linn is synonymous to *Flacourtia ramontchi* and *Flacourtia inermis*.

4.1.3. Habitat

*Flacourtia indica* is an indigenous medicinal plant widely distributed in Bangladesh and India. In India the species of *F.indica* are found from Punjab to Bihar, the Deccan and the Southern Peninsula. It is a small thorny shrub found in scrub forests and rocky hill up to 900 m.
4.1.4. Synonyms

<table>
<thead>
<tr>
<th>Language</th>
<th>Synonyms</th>
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<tbody>
<tr>
<td>Bengali</td>
<td>Bincha, Bainchi, Bewich</td>
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<tr>
<td>English</td>
<td>Governors plum, Madaraskara plum</td>
</tr>
<tr>
<td>Gujarati</td>
<td>Kankaka</td>
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<tr>
<td>Hindi.</td>
<td>Bilangra</td>
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<tr>
<td>Kannada</td>
<td>Llumanika, Dodda Gejjalakai</td>
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<td>Malayalam</td>
<td>Vavankatak, Vikamkath, Yaliya, Nzerinigal, lolokka</td>
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<td>Marathi</td>
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<td>Oriya</td>
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<td>Punjab</td>
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<td>Sanskrit</td>
<td>Vikankata, Gopakanta</td>
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<tr>
<td>Tamil</td>
<td>Sottaikala, Katukala</td>
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<tr>
<td>Telugu</td>
<td>Putregu, Kanvegu Chettu, Vikankata</td>
</tr>
</tbody>
</table>

4.1.5. Macroscopic

Leaves are simple, sessile, 3 to 5 cm long and 1 to 3 cm wide, ovate to obovate, glabrous above, more or less pubescent beneath, serrate towards apex and crenate in basal region, greenish-grey. Flowers are greenish yellow, in short simple or branched tomentose racemes. Fruits globose, dark purple drupes with juicy pulp and endocarp. Seeds 8-16.

4.1.6. Microscopic

4.1.6.1. Leaf midrib

Epidermis single layered, covered externally with thin cuticle; followed by 1 or 2 layers of collenchymas and 3 to 5 layers of adjacent collenchymas and 2 to
3 layers of parenchyma; vascular bundle single, situated in the centre, covered by fiber sheath on both sides; a few unicellular, hooked, trichomes present on lower surface; a few rosette and prismatic crystals of calcium oxalate scattered in parenchyma cells.

4.1.6.2. Lamina

Epidermis single layered on both surfaces, covered with thin cuticle; a few simple, unicellular hair with blunt tips present on lower surface; 2 layers of palisade cells and 2 or 3 layers of spongy parenchyma cells present; rosette and a few prismatic crystals of calcium oxalate present in epidermis, palisade and spongy parenchyma cells; a few veinlets present in between palisade and spongy parenchyma, stomata anisocytic, present on lower surface; palisade ratio 2 or 3; vein islet number 8 to 10 per sq.mm; veinlet termination number 10 to 12 per sq.mm; stomatal index 24 to 26.

4.1.6.3. Powder

Greenish-grey, shows fragments of collenchymatous and parenchymatous cells; elongated, thick walled pointed fibers; sinuous walled epidermal cells in surface view, containing rosette and a few prismatic crystals of calcium oxalate; palisade cells, a few anisocytic stomata and pieces of unicellular hair present.

4.1.6.4. Therapeutic uses

Ayurvedic pharmacopeia describes this plant as Raktavikara, Sopha and Kamala. *F. indica* is one of the most useful traditional medicinal plant in India. Each and every part has unique pharmacological activity.
4.1.6.5. Leaves

Useful in pruritus and scabies.

4.1.6.6. Bark

Used for treatment of intermittent fever.

4.1.6.7. Fruits

Used as appetizer, diuretic and digestive. Useful in jaundice, splenomegaly, strangury and gastropathy.

4.1.6.8. Roots

Sweet, refrigerant, depurative, alexipharmic and diuretic. They are useful in vitiated conditions of pitta and vata, apthae, poisonous bites, skin diseases, pruritus, erysipelas, strangury, nephropathy and psychopathy.

4.1.6.9. Seeds

Used to prevent rheumatic pains.

4.1.6.10. Gums

Administered along with other ingredients for the treatment of cholera

4.2. REPORTED PHYTOCHEMICAL INVESTIGATIONS

4.2.1. Qualitative analysis

27S.N Tyagi et al., (2010) conducted phytochemical tests and showed the presence of alkaloids, tannins, saponins, flavonoids, glycosides, phenolic compounds, terpenoids and steroids.

28Satyanand Tyagi et al., (2011) conducted phytochemical screening of ethanolic extract and showed the presence of alkaloids, tannins, saponins, flavonoids, glycosides, phenolic compounds, terpenoids and steroids.
4.2.2. Isolated Compounds

29 Ali Mohammed Kaou et al., (2010) performed phytochemical studies on aerial parts and investigated 3 compounds pycocatechol, homaloside D and poliothryoside from decoction of this plant material.

30 Prashata K et al., (1987) isolated a compound Flacourtin from the bark of F.indica.

31 Nazneen M et al., (2002) reported two compounds by name β-sitosterol, β-sitosterol β- D glucopyranoside.

32 Madan et al., (2009) reported the presence of Floucurticin from F.indica.


34 Nilupa.R et al., (2007) obtained a compound by name Flacourside from the fruit juice of this plant.


36 Alokolanga et al., (2014) isolated and characterized 35 phenolic compounds including dicafeolyquinic acid and caffeoylquinic acid glycosides from the fruits of Flacourtia indica and Flacourtia inermis.

37 Satyanarayana et al., (1990) obtained butylrolactone lignan disaccharide from heartwood of Flacourtia romontchi.

4.3. REPORTED PHARMACOLOGICAL ACTIVITIES

Hepato - protective activity

38 Marina Nazneen et al., (2009) studied the hepato-protective properties of the aerial parts of Flacourtia indica (Burm.f.) Merr, by petroleum ether, ethyl acetate
and methanolic extracts. Petroleum ether and ethyl acetate extracts indicated good recovery of paracetamol induced necrosis in histopathological examination.


The effect of *F. indica* leaves against methotrexate induced hepatotoxicity on rats was studied by [40] Joyamma Varkey and Jaya Thomas (2011). *F. indica* treatment in a dose of 350mg/kg orally for 5 days significantly improved the level of marker enzymes for liver function and oxidative stress which was evident in histopathology also, where a relative degree of reversal of methotrexate induced necrosis was observed.

**In vitro Antioxidant Activity**

[27] S.N. Tyagi et al., (2010) conducted phytochemical tests and screening of *in vitro* antioxidant activity on *F. indica* leaves and concluded that it could be a potential source of natural antioxidant that could have great importance as therapeutic agents in preventing or slowing the progress of aging and age associated oxidative stress related degenerative diseases.

**Anti diabetic activity**

[41] Ajay Kumar Singh and Singh J (2010) investigated the acute and sub-acute antihyperglycemic effect of the two different doses (200 and 400 mg/kg b.w.p.o) of *Flacourtia jangomas* (lour) extracts in streptozotocin induced diabetic rats. For all the estimated parameters, the results of the extract treated groups were
restored to the near normal level, there by indicating good anti hyperglycemic activity of the methanolic extract of *Flacourtia jangomas* (lour).

**Antimalarial activity**

28Ali Mohamed Kaou *et al.*, (2010) conducted the phytochemical studies on the aerial parts of *F. indica* and he investigated three compounds pyrocatechol, homaloside D and poliothrysoside which are isolated from the decoction of this plant material. The results elucidated as the poliothrysoside isolated from the AcOEt extract had strong antiplasmodial activity similar to chloroquine.

**Antibacterial Activity**

42Gopal C. Sarker *et al.*, (2011) studied the *in vitro* antibacterial screening (by disc. diffusion method) against 2 Gram positive and 2 Gram negative bacteria by chloroform soluble fraction of *Flacourtia jangomas* and *Flacourtia sepiaria*. Among all tested extract, only *Flacourtia jangomas* extract showed significant MIC value, ranges from 0.325 to 5mg/ml.

**Anti-Inflammatory and Antimicrobial Activity**

43Sulbha Lalsarea *et al.*, (2011) observed that the *Flacourtia ramontchi* is very useful plant in treating inflammation and infectious diseases. Successive screening of chloroform, methanolic and hydromethanolicic extracts of leaves with solvents of increasing polarity for anti-inflammatory (by carrageenan induced rat paw model) and antimicrobial activity (by cup and plate method) and thin layer chromatographic studies using mobile phase i.e. chloroform and
methanolic. The results clearly indicate that all three extracts chloroform, methanolic and hydro methanolic of the leaves having anti-inflammatory activity.

**Anti-asthmatic activity**

Satyanand Tyagi *et al.*, (2011) evaluated the antihistaminic activity by using ethanolic extract of leaves of *F. indica* (EEFI) on experimental models. This bronchodilating effect of *F. indica* was comparable to ketotifen fumarate. Thus, the present study revealed EEFI has significant anti-asthmatic (H$_1$ receptor antagonist) activity. Thus, the anti-asthmatic effect produced by ethanolic extract of *F.indica* suggested that anti-asthmatic activity could be due to its bronchodilator and cell stabilizing property.

**Toxicity studies**

Gopal C Sarker *et al.*, stated that the chloroform fraction of *Flacourtia jangomas* showed toxic effect using brine shrimp lethality bioassay with LC$_{50}$ values of 12.58 µg/ml.

*Joyamma Varkey and Jaya Thomas* (2011) performed acute toxicity study in Petroleum ether extract of aerial parts of *F.indica* and results indicated that dose of 1750mg/kg was tolerated in mice.