Review Article

A Review on *Limonia acidissima* l.: Multipotential Medicinal Plant

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ABSTRACT

Plants provide a major resource for a large number of traditional medicines that have been in existence for thousands of years in country like India. Ayurveda, one of the oldest medicinal systems in the world, provides leads for a vast number of therapeutically useful compounds. The combination of traditional and modern knowledge can produce better source of the active constituents for the treatment of diseases with fewer side effects. With the ever increasing interest of today's population towards natural products, *Limonia acidissima* L. emerged out to be one of the most eyes catching plant bearing multiple medicinal properties, belonging to family Rutaceae. Following various claims for cure of numerous diseases, efforts have been made by researchers to verify the efficacy of the plant through scientific biological screening. This review majorly deals with the traditional and recent pharmacological activities of different parts of *Limonia acidissima* L.

Keywords: Limonia acidissima L., Rutaceae, Active constituents, Pharmacological activities.

INTRODUCTION

Due to the increasing awareness among the people towards natural products, natural medicine is attracting more attention than allopathic system. Moreover this system of medicine is pollution free and less toxic without side effects[1].The different systems of medicinal usage practiced in India, Ayurveda, Siddha, Unani, Amchi and local health traditions, utilize a large number of plants for treatment of human and animal diseases. Those plants used were called as medicinal plants. The medicinal plants are referred to plants that are used for their therapeutic or medicinal values. The presence of various life sustaining constituents in plants made scientists to investigate these plants for their uses in treating certain infective diseases and management of chronic wounds[2].

The whole plant or its different parts may be valued for its therapeutic, medicinal, aromatic or savoury qualities. Medicinal plants are cheaper, more accessible to the most of the population in the world. Thus, there is need to encourage the use of medicinal plants as potential sources of new drugs. There has been as highly increased interest for herbal remedies in several parts of the world[3].

India is one of the leading countries in Asia in terms of the wealth of traditional knowledge systems related to the use of plant species. India is also known to harbor a rich diversity of higher plant species (about 17000 species) of which 7500 are known as medicinal plants[4].

With the chemically synthesized drugs for number of diseases, natural products of plant origin has its own importance and has maintained the most important resource for developing new drugs to treat various diseases. One of the medicinally important plants is *Limonia acidissima*, upon which the presence of phytochemicals and scientific importance is being reviewed.

TAXONOMY

Kingdom	: Plantae
Sub-kingdom	: Tracheobionta
Superdivision	: Spermatophyta
Division	: Magnoliophyta
Class	: Magnoliospida
Subclass	: Rosidae
Order	: Sapindales
Family	: Rutaceae
Genus	: Limonia L.
Species	: L. acidissima.

Synonyms[5]

Feroniaele phantum Correa,

Feronia limonia (L.) Swingle,

Schinus limonia L.

Vernacular names

English	: Wood Apple, Elephant Apple, Monkey Fruit or Curd Fruit
Hindi	: Kaitha, Kath Bel or Kabeet
Oriya	: Kaitha
Sanskrit	: Kapittha or Dadhistha.
Telugu	: Vellaga Pandu
Tamil	: Vilam Palam

Malayalam : Vilam Kai

Bengali : Koth Bel

Gujarati : Kothu

Malaysia : Belingai

Distribution

Limonia acidissima is native to India and also cultivated in Bangladesh, Pakistan and Srilanka[6].

Ecology

The wood-apple is native and common in dry plains. It prefers a monsoon climate with a distinct dry season. The tree grows up to an elevation of 450 m in the western Himalayas. It is apparently drought tolerant and best adapted to light soils[7].

NUTRITIONAL INFORMATION

Hundredgrams of wood apple pulp contains 140kcal. The fruit contains carbohydrates and proteins. It is also rich in beta carotene, vitamin B, vitamin C, thiamin and riboflavin. Wood apple fruits that grow in the wild tend to have more tannin than those cultivated for commercial purposes.

Figure 1: (a) Mature Plant (b)Inflorescence (c) Seeds in fruit

BOTANICAL DISCRIPTION

*Limoniaacidissima*is a moderate sized deciduoustree grown throughout India. It is an aromatic, slow growing up to 9m tall, grows all over India in dry and warm areas up to 450m elevation, Often polygamomonoecious tree with rough, spiny bark. The spines are axillary, short, straight, 2-5 cm long on some of the zigzag twigs[8].

The leaves are deciduous, alternate, dark-green, leathery, 3 to 5 inch long. Often minutely toothed, blunt or notched at the apex, dotted with oil glands and slightly lemon- scented when crushed.Flowers small numerous, dull- red or greenish, born in small, loose, terminal or lateral panicles[5].

The fruit is berry, round to oval, globose, large, 2 to 5 inch wide, with a hard, woody rind, which is grayish-white, scurfy rind about 6 mm thick. The pulp is sticky brown, aromatic odorous, resinous, astringent, acid or sweetish, white seeds scattered through it[9, 7]. Feronia is a monotypic genus in the family Rutaceae. There are 2 forms, one with large, sweet fruits and the other with small, acid fruits.

Biology

Flowers are normally bisexual. In India, the fruits ripen from early October through March. Seedlings will not bear fruit until at least 15 years old.

MEDICINAL PROPERTIES

All the parts of *Limonia*are prescribed in indigenous system of medicine for the treatment of various ailments. Fruits are refrigerant, stomachic, stimulant, astringent, aphrodisiac, diuretic, cardiotonic, tonic to liver and lungs, cures cough, hiccup and good for asthma, consumption, tumours, opthalmia and leucorrhoea[10].Unripe fruit is astringent while seeds are used in heart diseases. The fruits are used as a substitute for bael (*Eagle marmelos*) in diarrhea and dysentery[11]. The bark and leaves are used for vitiated conditions of vata and pitta[12]. Leaves are astringent and carminative, good for vomiting, indigestions, hiccup and dysentery. The leaves have hepatoprotective activity [13].The gum is demulcent and constipating, and is useful in diarrhoea, dysentery, gastropathy, haemorrhoids and diabetes[14].

OTHER USAGE

Wood apple fruit can be eaten plain or mixed into a variety of beverages and desserts, or preserved as jam. The scooped-out sticky pulp, is eaten raw with or without sugar, or is blended with coconut milk and palm-sugar syrup and frozen as an ice cream. In Indonesia, wood apple is mixed with honey and eaten in breakfast. In Thailand, leaves are eaten in salads while in India the pulp is used in savory chutneys. The wood serves as fuel.

PHYTOCHEMICALS

The preliminary phytochemical analysis of *Limonia acidissima* plant parts showed the presence of alkaloids, flavonoids, phenols, terpenoids, tannins,fats steroids, saponins, glycosides, gum, mucilage and fixed oils[15-18]. The unripe fruits contain stigmasterol. Fruit pulp contains large quantity of citric acid and other fruit acids, mucilage and minerals. Alkaloids, coumarins, fatty acids and sterols have been detected in the pericarp. It also contains umbelliferone, dictamnine, xanthotoxol, scoparone, xanthotoxin, isopimpinellin, isoimperatorin and marmin[19].Leaves contain stigmasterol, psoralen, bergapten, orientin, vitedin, saponarin, tannins and an essential oil[20]. Marmesin, feronolide and feronone have been isolated from the bark[21].Seeds contain fixed oil,

carbohydrates, proteins and amino acids. Roots contain feronia lactone, geranylum belliferone, bargapten, osthol, isopimpinellin, marmesin and marmin[22].

PHARMACOLOGICAL ACTIVITY

Anti Diarrhoeal activity

Plants have various useful chemical constituents which are used in the treatment of diarrhea[23]. The antidiarrhoeal activity and gastrointestinal motility reducing activity of alcoholic and aqueous extract of bark of *Limonia acidissima* Linn, was evaluated. In the gastrointestinal motility test, the both extracts, showed antidiarrhoeal activity in the concentration of 200mg/kg compared with the control group. Ethanolic extract showed a significant antidiarrhoeal activity and significantly decreased the propulsion of charcoal meal through the gastro intestinal tract[11].

Antidiabetic activity

The anti-diabetic activity was performed on the alloxan induced wistar rats by using methanolic extract of fruit pulp of *Limonia acidissima*. It has been shown that *Limonia acidissima* extract markedly improved the glucose tolerance in alloxan induced diabetes in rats as compared to control ($p<0.01$). Extract showed dose dependent effect, 200 and 400 mg/kg dose shows reduction in glucose level. More over *Limonia acidissima* extract showed significant reduction in blood urea and creatinine in treated rats but significantly increased total protein level[24]. A significant dose dependent antidiabetic effect of methanolic fruit extract[25]and aqueous leaf extract[26] of *Limonia* in streptozotocin induced diabetic rats have been well documented.

Wound healing

Albino rates of either sex were used to check the wound healing activity by screening with methanol extract of fruit pulp of *L. acidissima*. In the excision wound model, the wound contracted progressively when treated with the extracts and required a mean period of 16.0 ± 0.8 days for optimum healing. Incision wound model showed increased wound breaking strength and decreased epithelization period when treated with MELA[27].Different extracts of *L. acidissima* possesses significant dose-dependent wound healing activity; this supports traditional claims for the plant as a wound healer.

Anticancer activity

The fruit extract of *L. acidissima* Linn. shows anticancer effect[28]. Fruit extracts from fractions 1 to 4 and also the crude extract (ethanolic extract) were used to determine the ED50 value (50% inhibition of cancer cell growth) in two different breast cancer cell lines, SKBR3 and MDA-MB-435. The bio-assays of extracts from *L. acidissima* Linn. showed that a fraction (fraction 3) from an ethanolic extract had an anticancer effect on SKBR3 and MDA-MB-435 human breast cancer cells. After 48 h of exposure, this fraction at a concentration of 100 µg/ml, significantly reduced cell proliferation in both cancer cells. In MDA-MB-435 cells, cell cycle analysis showed that the fruit extract fraction 3 induced the accumulation of cells in G_2/M phase, whereas no significant change in cell cycle was detected in SKBR3 cells[29].

Antioxidative property

The crude methanol extract of the stem bark of *Limonia acidissima* L. and its different organic soluble partitionates were screened for antioxidant activities[30]. The antioxidant (free radical scavenging) activity of the partitionates on the stable radical 1,1-diphenyl- 2-picrylhydrazyl (DPPH) was determined. The chloroform soluble fraction (CL) of crude methanolic extract showed the highest free radical scavenging activity. At the same time the pet ether soluble fraction (PE) also exhibited strong antioxidant potential. The methanolic extract of *Limonia* fruit was also screened for their free radical scavenging properties by Ferric reducing antioxidant power (FRAP) assay and DPPH radical scavenging assay[31]. In vitro antioxidant activity of different extracts from leaves of *Limonia acidissima* has been well documented[32,33].

Hepatoprotective

Hepatoprotective activity of them ethanolic extract of fruit pulp of *L. acidissima* (MELA) was investigated against carbon tetra chloride (CCl_4) induced hepatic injury in rats. 200 and 400 mg/kg p.o doses of MELA were administered to group of animals for 10 days. MELA exhibited significant dose dependant protective effect against CCl_4 induced liver damage which can be mainly attributed to the antioxidant property of the extract. This study rationalized the ethno-medicinal use of the plant for curing hepatic injuries[27].

Biosorbent

The waste fruit shell of *Limonia acidissima* is used as a biosorbent. The powdered raw material and treated material (raw material treated with acid) of specific micron size were used for the removal of the methylene blue from aqueous solution. The results showed that the removal of dye by chemically treated material is effective than raw material at higher temperature. Temperature rise affects the solubility and chemical potential of the adsorption, the latter being a controlling factor for adsorption. The percentage removal of dye is maximum at 35^0C for treated material and at 25^0C for raw material[34].

Diuretic Agent

Diuretic activity of methanolic extracts obtained through the Microwave assisted extraction (MAE) and Bath Sonicator extraction (BSE) of *Limonia acidissima* was investigated. The extract (obtained through the BSE) produced a significant increase ($P<0.001$) in urine output at the same dose. Urinary electrolyte extraction was also affected by the extract (obtained through the MAE) increase the urinary excretion of Sodium, potassium and

chloride ions. These findings support the traditional uses of *Limonia acidissima* leaves as diuretic agents[35].

Antibacterial activity:

It was found that ethanolic extract of *Limonia acidissima* L. leaves possess abroad spectrum of activity against Gram-positive and Gram-negative bacterial strains responsible for the most common bacterial diseases[36,18,15]. The antibacterial activity was evaluated against Gram-negative and Gram-positive bacteria by agar well diffusion method. Methanol extract showed good antibacterial activity with the high inhibition zones while chloroform extract exhibited mild to moderate activity and hexane extract was found to be less active[37].

Antifungal Activity

The different extracts (petroleum ether, chloroform, methanol and aqueous) of *Feronia limonia* Linn fruit pulp exhibited antifungal activity against some pathogenic fungus[16].The essential oil from the leaves of the plant exhibited antifungal activity against eight tested fungi[38].

Antispermatogenic activity

Ethanolic extract of fruit pulp of *F. limonia* impair reproductive activities in male rats possibly by inhibiting spermatogenesis. It was found that administration of this extract to male rats brought about a significant weight loss of the reproductive organs of the rats, alterations in motility, viability and morphology of spermatozoa. From whole study it was finally concluded that *Feronia limonia* fruit pulp may have reversible antispermatogenic activity, and could then partially support the scientific rationale for the traditional use of this plant in inducing sterility in male[39].

Antihistaminic activity

Ethanol extract of *Feronia elephantum* bark significantly inhibited clonidine-induced catalepsy. Clonidine releases histamine from mast cells which is responsible for different asthmatic conditions. Catalepsy produced by clonidine is mediated by histamine via H_1 receptor. Thus it is concluded that ethanol extract of bark of *Feronia elephantum* has antihistaminic effect[40].

Antilarvicidal Activity

Acetone extract of the dried leaves found to be effective against larvae of *Culexquinque fasciatus, Anopheles stephensi* and *Aedesaegypti*, with LC_{50} of 129.24, 79.58 and 57.23 ppm, respectively[41].

CONCLUSION

It is quite evident from this review that *Limonia acidissima* L. is an important medicinal plant. It contains a number of phytoconstituents, which are the key factors in the medicinal value of this plant. Almost all parts of this plant such as leaf, fruit, seed, bark and root are used to cure a variety of diseases. The present review summarizes some important pharmacological studies on *Limonia acidissima* and phytochemical investigations and isolated principles from them. Thorough screening of literature available on *L.acidissima* depicted the fact that it is a popular remedy among the various ethnic groups, Vaidyas, Hakims and ayurvedic practitioners for cure of variety of ailments. A systemic research and development work should be undertaken for the development of products for their better economic and therapeutic utilization.

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