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MULTIPOTENTIAL TRADITIONAL PLANT WOOD APPLE (*LIMONIA ACIDISSIMA*): A REVIEW

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ABSTRACT: Plants are a significant source of medicine and are crucial to attaining WHO goals for the welfare of all people. As more people become aware of natural goods, *Limonia acidissima* L. (wood apple, elephant apple, monkey fruit) of the Rutaceae family has emerged as one of the most valued plants due to its numerous medical characteristics. The major goal of the current investigation is to recognize and identify various chemical components of the plant that are significant in the field of medicine. So, this article has tried to research the literature on various phytoconstituents, therapeutic benefits, pharmacological activity and ethnobotanical applications, and herbal formulation of *Limonia acidissima* L. The compiled plant knowledge can be applied to a variety of medical fields.

INTRODUCTION: Native to the arid plains of India and Ceylon, elephant apples are frequently seen growing wild there. They are also frequently grown in orchards, along highways, and along the borders of fields. Moreover, it is cultivated in Southern America, northern Malaysia, tropical and temperate Asia. *Limonia acidissima* (L.) is a member of the monotypic genus Limonia, which is only found in Southeast Asia, India, Pakistan, and Sri Lanka. It is a member of the Rutaceae (Citrus family) family [1]. It goes by several other names, including kath bel, kaitha, curd fruit, monkey fruit, and wood-apple. For the treatment of a number of illnesses, this plant is administered as medication. *L. acidissima* is a slow-growing, deciduous tree that is upright with a few upward-reaching branches that curve outward at the summit and are split into thin branchlets with drooping ends. A wood-apple. It has long been known that medicinal herbs or plants may be a valuable source of therapies or curative help. India is renowned worldwide for its ancient expertise of "Ayurveda." Ayurvedic knowledge has been used to treat a wide variety of illnesses.

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FIG. 1: *LIMONIA ACIDISSIMA* L. PLANT

Wood apples are very valuable medicinally. Each component of the fruit has therapeutic value. By lowering blood glucose levels, wood apples have antidiabetic and antioxidant properties.

Due to its potential radical scavenging activity of various phytochemicals, wood apple fruit is regarded as one of the natural sources of antioxidants. Its antioxidant properties using various extracts have been extensively studied [2].

FIG. 2: *LIMONIA ACIDISSIMA* L FRUIT

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: Belinga

Classification:

Family: Rutaceae

Kingdom: Plantae

Sub-kingdom: Tracheobionata

Super division: Spermatophyta

Division: Magnoliophyta

Class: Magnoliophyta

Subclass: Rosidae

Order: Sapindales

Genus: Limonia. L

Species: *L. acidissima*

TABLE 1: CHEMICAL CONSTITUENTS OF DIFFERENT PARTS OF *LIMONIA ACIDISSIMA* L. [1, 2, 3, 5]

Plant part	Chemical Constituents
Fruit	Polyphenols, Vitamins, Saponins, Coumarins, Amino acids, Tri-terpenoids, Phytosterols, Tannins, Flavonoids, Steroids, Glycosides, Fat, Calcium, Magnesium, Iron, Umbelliferone, Dictamnine, Xanthotoxol, Scoparone, Xanthotoxin, Isopimpinellin, Isoimperatorin and Marmin
Leaves	Acidissimi, Acidissiminol. Alkaloids, Phenolsresins, Gum and mucilage, Fixed oils and fats, Stigmasterol, Psoralen, Bergapten, Orientin, Vitedin, Saponarin, Tannins, Essential oil.
Bark	Marmesin, Feronolide, Feronone
Fruit pulp	Carbohydrates, Protein, Fatand dietary fibre
Seed	Fixed oil, Carbohydrates, Proteins, Amino acid
Roots	Bargapten, Osthol, Isopimpinellin, Marmesin, Marmin. Feronia lactone, Geranylum, Belliferone
Shell	Psoralene, Xanthotoxin, 2, 6-dimethoxybenzoquinone, Osthenol Amino acid
Unripe Fruit	Stigmasterol
Pulp	5,4-dihydroxy-3-(3-methyl-but-2-enyl) 3,5,6-trimethoxyflavone7-O-b-D-glucopyranoside, Citric acid ,fruit acids, Mucilage, minerals, Alkaloids, Coumarins, Fatty acids, Sterols, Umbelliferone, Dictamnine, Xanthotoxol, Scoparone, Xanthotoxin, Isopimpinellin, Isoimperatorin, Marmin

TABLE 2: MEDICINAL USES OF *LIMONIA ACIDISSIMA* L [1, 3, 4]

Plant part	Medicinal Uses
Fruit	Liver tonic, Astringent, Cardiac tonic, Sore throat and Diseases of the gums, Peptic ulcer, tumors, hepatitis, In blood purification, , Stomachic, Stimulant, Diuretic, aphrodisiac, liver tonic, anti-as, stomachic, Stimulant, diuretic, Aphrodisiac, liver tonic, anti-asthmatic, antidiarrheal, leucorrhoeal, antidiarrheal, leucorrhoeal
Leaves	Astringent, Flatulence, Diarrhoea, Dysentery (especially in children) and Haemorrhoids, Indigestion, Breast cancer, Uterus cancer, Infertility, Progesterone deficiency, flu and respiratory disorders, Astringent, Carminative and Hepatoprotective activity
Bark	Venomous wounds, Poncrushing, Demulcent, Constipating, Anti-diarrheal and Anti-haemorrhoidal

Traditional uses of *Limonia acidissima* L: Wood Apple is thought to be quite effective in preventing sunstroke and many other summertime health problems. To help prevent piles and ulcers, wood apples contain tannin and phenolic compounds that are strong in antioxidant qualities. It also aids in treating diarrhoea, dysentery, and other conditions. Wood apples help cleanse the body because they contain riboflavin and thiamine molecules. Its juice keeps the intestines healthy while reducing any renal issues. Because of its known expectorant qualities, wood apples are thought to be beneficial in treating a variety of respiratory illnesses like asthma, bronchitis, and sore throats. It boosts defenses against bacterial, fungal, and viral infections. Due to its high fibre content, it has laxative qualities and hence aids in digestion. The leaves contain tannins and an essential oil. They are astringent and are used internally, often combined with milk and sugar, in treating indigestion, flatulence, diarrhoea, dysentery (especially in children) and haemorrhoids [1]. Oil derived from the crushed leaves is applied on itchy skins [1]. The powdered gum, mixed with honey, is given to overcome dysentery and diarrhoea in children [1].

Effect of Active Constituents *Limonia acidissima* L and Cosmetic [6]:

Flavonoids: Polyphenolic substances known as flavonoids are found in nature. Flavonoids are secondary plant metabolites that have antioxidant properties and share the chromane ring with tocopherols. In this activity, the primary mechanisms involve the direct induction of oxygen and nitrogen free radicals and the inhibition of enzymes that produce oxygen radicals. During tissue inflammation and reperfusion, "iron chelation and decrease of leukocyte adherence to the blood vessel wall is used.

Cosmetics: Flavonoids play a key role in the skin's aging process. Flavonoids like kaempferol postpone skin aging by preventing extracellular matrix-degrading enzymes like collagenase, elastases, and hyaluronidases from breaking down the extracellular matrix. Flavonoids provide the best Antioxidant activity and protect the product from rancidity. The pulp of *Limonia acidissima* L. contains ascorbic acid, which is responsible for antioxidant activity. Flavonoids also have antibacterial, antimicrobial, and antifungal properties. Quercetin has been reported to inhibit the growth of Staphylococcus aureus completely.

Tannins: Tannins are a diverse category of high molecular weight polyphenolic chemicals that include proteins, polysaccharides, alkaloids, nucleic acids, and minerals, among other things. Gallotannins, Ellagitannins, Complex Tannins, and Condensed Tannins are the four groups of tannins based on their structural similarities. In 1905, (Maximilian Nierenstein) investigated the natural tannins in many plant species.

Cosmetics:

- Tannin contains precipitate proteins that are used to heal burns and protect inflamed skin surfaces,
- Tannins have antimicrobial, antioxidant, and astringent properties.
- Tannins slow down the aging process of the skin.
- Tannins also protect against hair loss.

Saponins: Saponins are bioactive substances that plants mostly produce. Chemically, they exist as polycyclic triterpenes or steroid glycosides. They can interact with cell membranes and lower the surface tension of an aqueous solution due to their lyobipolar characteristics. The term "saponin," which is derived from the Latin word "sapo," alludes to the stable soap-like foam that results from this process in an aqueous solution.

Cosmetics:

- Saponins are recognized as natural surfactants; aqueous solutions like soap produce stable foam.
- They are a foaming agent in toothpaste, liquid detergent, and shampoo.
- As an emulsifier and long-lasting foaming agent, saponins are also employed.
- Cosmetics use antioxidant, anti-aging, and regenerative saponin extract as an active component.

Alkaloids: Alkaloids get their name from the word "alkaline," which was once used to denote any base that included nitrogen. They are often organic bases that combine with acids to generate salts, which, when soluble, result in alkaline solutions. Alkaloids are a class of chemical substances that exist in nature and mostly include basic nitrogen atoms. Several related chemicals with neutral or even mildly acidic characteristics are also a part of this group.

Cosmetics:

- Alkaloids are in charge of an object's antibacterial and antifungal properties.
- Due to their capacity to operate as scavengers of free radicals, donate hydrogen or electrons, or have metal-chelating activity, pyridine alkaloids have been reported to have significant antibacterial capabilities and antioxidant activities.
- Alkaloid has a warming effect that might be applied, for example, to the treatment of the feet.
- Alkaloids work to prevent wrinkles.
- Moreover, alkaloids aid with skin tightening.

Pharmacological Activity of *Limonia acidissima* L:

Anti-Diarrhoeal Activity: Plants include a variety of beneficial chemical compounds that are used to alleviate diarrhoea. Alcoholic and aqueous extracts of *Limonia acidissima* Linn's bark were tested for their ability to treat diarrhoea and reduce gastrointestinal motility. The passage of charcoal meal through the gastrointestinal system was greatly slowed by ethanol extract, demonstrating notable anti-diarrheal action.

Antidiabetic Activity: Plants include a variety of beneficial chemical components, including flavonoids and phenols that are used to treat diabetes. Methanolic extract, aqueous stem bark extract, and fruit extract were used to carry out the antidiabetic activities. In streptozotocin-induced diabetic rats, the antidiabetic activity of 95% ethanolic extracts of unripe wood apple fruits was assessed at 250mg/kg body weight, and it was discovered that it significantly decreases blood glucose levels in the fasted, fed and streptozotocin-induced diabetic rats. In rats with diabetes brought on by alloxan, hypoglycemic effects are also seen [2].

Anticancer Activity: *L. acidissima* Linn fruit's extract has anticancer properties [13]. Fruit extracts from fractions one through four and the crude extract (ethanolic extract) were utilised to ascertain the ED50 value in two distinct breast cancer cell lines, SKBR3 and MDAMB-435, representing a 50% reduction of cancer cell growth. The bio-assays of *L. acidissima* Linn extracts. The ethanolic extract demonstrated an anticancer impact in the human breast cancer cells SKBR3 and MDAMB-435. This fraction, at a concentration of 100 g/ml, dramatically decreased cell growth in both cancer cells after 48 hours of treatment. Cell cycle examination of the fruit extract fraction 3 in MDAMB-435 cells revealed that it caused an increase of cells in the G2/M phase, however in SKBR3 cells, no appreciable alteration in the cell cycle was found [14].

Antioxidative Property: Antioxidant activity of the crude methanol extract of *Limonia acidissima* L. stem bark, and its various organic soluble partitionates were examined [15]. On the stable radical 1,1-diphenyl-2-picrylhydrazyl (DPPH), the partitionates' antioxidant (free radical scavenging) activity was assessed. The crude methanolic extract's chloroform soluble fraction (CL) has the greatest capacity to scavenge free radicals. The pet ether soluble fraction (PE) also showed significant antioxidant activity at the same time. Using the FRAP and DPPH radical scavenging assays, the methanolic extract of Limonia fruit was further examined for its capacity to scavenge free radicals [15]. Several *Limonia acidissima* leaf extracts have been shown to have in vitro antioxidant activity [16, 17].

Hepatoprotective: The ethanolic extract of *L. acidissima* fruit pulp's hepatoprotective potential was examined in rats whose livers had been injured by carbon tetra chloride (CCl_4). MELA demonstrated a notable dose-dependent protective effect against CCl_4-induced liver damage, mostly attributable to the extract's antioxidant properties [18].

Biosorbent: As a biosorbent, *Limonia acidissima's* leftover fruit shell is employed. To eliminate methylene blue from the aqueous solution, powdered raw materials and treated materials (raw materials treated with acid) of certain micron sizes were utilized. The outcomes show that chemically treated material removes colour more successfully than raw material at higher temperatures. The latter is a regulating element for adsorption. Temperature rise impacts the solubility and chemical potential of the adsorption. The highest amount of dye is removed from treated material (35°C) and raw material (25°C) [19].

Antibacterial Activity: It was discovered that *Limonia acidissima*. leaves' ethanolic extract has a wide range of action against both Gram-positive and Gram-negative bacterial strains that cause the most prevalent bacterial illnesses [36, 18, 15]. The antibacterial activity was assessed against Gram-positive and Gram-negative microorganisms using the agar well diffusion technique. Hexane extract was less active, whereas chloroform extract had mild to moderate activity and methanol extract showed strong antibacterial activity with substantial inhibition zones [20].

Antifungal Activity: The pulp of the *Feronia limonia* Linn fruit showed antifungal activity against various pathogenic fungi when it was extracted using different solvents (petroleum ether, chloroform, methanol, and water). Eight different fungus were examined, and the plant's essential oil showed antifungal effectiveness against all [21].

Antihyperlipidemic Activity: Fruit powder administered for 28 days at doses of 2.5, 5, and 10 g/kg body weight decreased lipid profiles and hepatic glucose-6-phosphatase while significantly raising hepatic glycogen, hexokinase, and HDL. The presence of fibres, phytosterols, saponins, polyphenols, flavonoids, and ascorbic acid may cause it.

Antimicrobial Action: According to reports, Gram-positive and Gram-negative bacteria, which cause most bacterial illnesses, are both sensitive to ethanolic extract from *Limonia acidissima* L. leaves.

Wound Healing Properties: Rate experiments were conducted using methanol extract of *Limonia acidissima* L. fruit pulp. When the extracts were applied to the wound in the excision model, the wound gradually shrank and needed a mean of 16.0 +/- 0.8 days to heal properly. Incision wound models treated with MELA showed increased wound-breaking strength and shorter epithelization times [23].

Adsorbent: *Limonia acidissima* L.'s leftover fruit shell is employed as an adsorbent. In this procedure, activated carbon made from the shell of the *Limonia acidissima* L. plant was used to remove the methylene blue dye from any solution. The agitation time, dye concentration, adsorbent dosage, and temperature 24 significantly influence the adsorptive removal of the dye methylene blue.

Diuretic Activity: The diuretic activity of the *Limonia acidissima* may be due to the presence of triterpenoids, glycoside, flavonoid, polyphenols, and coumarin found in the methanolic extracts (obtained through the MAE and BSE).

Anti-inflammatory Activity: Wood apple is also rich in anti-inflammatory properties, helping reduce the risks of cardiovascular diseases. Having wood apples during monsoons will help prevent infections due to bacteria and viruses. Wood apple is also known to improve and boost your metabolism.

Analgesic Activity: A daily spoonful of dried apple peels for 12 weeks resulted in subjects with moderate loss of range of motion in their joints and related chronic pain experiencing improvements in their necks, shoulders, backs, and hips, as well as lower pain scores.

Neuroprotective Activity: Wood apple's neuroprotective properties were examined, and it was discovered that at doses of 250 mg and 500 mg per kilogram of body weight, it protects rats' brains from damage caused by ischemia and reperfusion.

Spermatotoxic Activity: By administering ethanolic extracts at 250 and 500 mg/kg to adult male rats for 55 days, researchers were able to study the wood apple fruit pulp's antispermatogenic activities and determine that they were the cause of the drop in sperm count, motility, and viability. Moreover, by 24.58% and 29.86%, respectively,

they increased the fraction of defective sperm and decreased testicular protein content [27].

Larvicidal Activity: The larvicidal and pupicidal activities of the extracts are excellent. L. acid isomer's hexane extract has ovicidal efficacy against *Cx. Quinquefasciatus* and *Ae. aegypti* eggs at 79.2% and 60% at 500 ppm concentration [28].

At 3% aqueous extract, wood apple leaf kills *Culexquinque fasciatus* larvae with a 90% success rate. Moreover, the chloroform and methanol extract exhibits 95% mortality at 100 ppm. The presence of a terpene in wood apple leaves, which prevents Aedesaegypti eggs, larvae, and pupae from developing, led to the discovery of mosquitocidal action [30].

Antiulcer Activity: The fruit's phenolic compounds are responsible for protecting against ulcer on gastric wall and leucocytes infiltration of submucosal layers.

Side Effect of Wood Apple (Elephant Apple Fruit):

- Ripened fruit is heavy for digestion, and intake of excess quantity can lead to decrease digestive capacity
- Hyperacidity if taken in excess quantity
- Unripe fruit is not ideal in case of the throat or voice disorder

Ayurvedic Medicines Containing Kapitta-Elephant Apple:

- Vajra Kapat rasa- For treatment of diarrhea and malabsorption syndrome
- Nyagrodhadi choorna-In urinary obstruction, dysuria, urinary disorder, diabetes
- Dashamoolarishta- Usedd in anemia, after delivery care of mother, cold, cough, digestive disorder

CONCLUSION: Wood apple, or *Limonia acidissima* L., is another name for this member of the Rutaceae family. The wood apple is well recognized for a variety of qualities in several sectors. Fully ripe fruit may be eaten right away, and it is well known for its blend of sweet and bitter flavours and the variety of meals it can be used in. Wood apple has a variety of medical purposes, including as a tonic for the heart and lungs, an anti-diarrheal in unripe fruit, an antidiabetic in wood apple leaves, and an anti-sore throat remedy in fruit pulp. Along with its therapeutic benefits, wood apple also demonstrates a number of pharmacological actions, including those for wound healing, antioxidant defense, adsorption, and antibacterial, antifungal, antidiabetic, and serum protective effects. All of these properties are covered in this article. The main aspect of this article is to focus on the cosmetic properties of the wood apple. The various components of the wood apple are in charge of various functions, and we may utilize those functions while making cosmetics. We can utilize an essential oil extract from wood apple leaves in cosmetic products since it has antibacterial properties.

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