Limonia acidissima

Scientific Name

***Limonia acidissima* L.**

Synonyms

Feronia elephantum Correa, *Feronia limonia* (L.) Swingle, *Schinus limonia* L.

Family

Rutaceae

Common/English Names

Curd Fruit, Elephant Apple, Indian Wood-Apple, Monkey Fruit, Wood Apple.

Vernacular Names

Arabic: Tuffâhh El Fîl;
Bangladesh: Kath Bel;
Burmese: Thibin, Thanaka, Tha Nap-Hka;
Chinese: Mu Ping Guo, Mu Ping Kuo;
Danish: Elefantæble;
Dutch Olifants Appel;
Fiji: Kabeet, Kabut, Vellam Pelam, Vakandra (Hindu);
French: Citron Des Mois, Citronnier Des Éléphants, Féronie De L'inde, Pomme De Bois, Pomme Des Éléphants, Pommier D'éléphant;
German: Elefantenapfel;
India: Kath Baei (Assamese), Bela, Kait, Kainta, Kapittha, Kath Bel, Kathbel, Kayet Bel, Kayetabela (Bengali), Kotha (Gujarati), Barnah, Barnahi Billan, Barnasi, Beli, Bernahi, Bilan, Bilin, Dadhiphal, Dantasath, Kabut, Kaith, Kaitha, Katbel, Kath Bel Kabeet, Katori, Kavita, Khatha, Manamath, Pushpaphal, (Hindu), Aranamullu, Aruna Mullu, Arunamullu, Baela, Baelada, Baeladahannu, Baelada Hannina Mara, Baelada Hannu, Baelada Mara, Baeladakaayi, Baluvali, Baloola Kaayi, Bela, Belada Mara, Belakudi, Belaruhi, Belavu, Byaalada Mara, Byala, Dadhiphala, Danthashata, Graaha, Kaadu Baela, Kadbela, Kadinimbi, Kadubela, Kadunimbe, Kaduvelada, Kapithha, Kotamiria, Malura Mara, Manmatha Mara, Naibel, Naibela, Naibyalada, Nayibel, Nayibela, Nimbai, (Kannada), Belpatre (Konkani), Blanka, Cerukattunarakam, Cherrukatnarragam, Cherukattunarakam, Katnaragam, Kattunarakam, Mlanka, Naivelam, Tsjeroukatounarigam, Tsjeru-caatnaregam, Vilankai,Vilarmaram, Vilavu (Malayalam),Kapith,Kauth,Kavant,Kavanti,Kavat, Kaveet, Kawath Kovit, Sit-Ranlimbi (Marathi), Kaintha, Koyito (Oriya), Katha (Punjabi), Dadhinama, Dadhiphala, Dadhittha, Danthashatha, Kapipriya, Kapita, Kapitha, Kapithama, Kapittha, Kapitya, Kapityama, Pushpaphala

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(Sanskrit), Kapittam, Kavittam, Narivila, Nilavila, Norivila, Tantacatam, Vila, Vilaa, Vilamaram, Vilampazam,Vilanga, Vilankay Maram (Tamil), Kapithhamu, Parupuvelaga, Pulivelaga, Pushpaphalamu, Taruvelaga, Tholuvelaga, Thorelaga, Thorrivelaga, Tolielaga, Tollivelam, Torelega, Toriallega, Toriyelaka, Torravelaga, Torravelagu, Torrayelaka, Torriyelaka, Velaga, Velagachettu, Velagapandu, Volaga (Telugu);
Indonesia: Kawista (Java), Kusta (Bali);
Italian: Pomo D'elefante;
Japanese: Feronia Rimonia, Rimonia Akidisshima, Tanaka, Zou No Ringo;
Khmer: Kramsang;
Laotian: Ma Fit;
Malaysia: Belinggai, Gelinggai;
Pakistan: Kaith Bel;
Philippines: Ponoan;
Reunion Island: Tanaka;
Russian: Feroniia Limonnaia, Slonovaia Iabloni, Slonove Iabloko;
Thai: Makhwit (Central), Mafit (Northern);
Tibetan: Ka Bi Ta, Ka Pi Ta, Ka-Pi-Rtha;
Vietnamese: Cân Thâng.

Origin/Distribution

This species is indigenous to the Indian subcontinent and Sri Lanka. In India, it is reported from the states of Punjab, Delhi, Rajasthan, Madhya Pradesh, West Bengal, Arunachal Pradesh, Maharashtra, Goa, Karnataka, Tamil Nadu and Andhra Pradesh occurring throughout the plains especially in the drier regions. It was introduced, cultivated and naturalised throughout southeast Asia – Myanmar, Thailand, Malaysia, Vietnam, Kampuchea, Laos and Indonesia.

Agroecology

Wood-apple thrives in a monsoonal or seasonally dry tropical climate. It is found on a wide diversity of soils from sea level to 450 m altitude. It is best adapted to light soils and is tolerant to drought and mild water-logging.

Edible Plant Parts and Uses

The hard rind of the ripe fruit must be cracked open with a hammer and the pulp scooped out. The pulp is eaten raw with or without sugar, or is blended with coconut milk and palm-sugar syrup. In Indonesia, the pulp is beaten with pal suagra and eaten at breakfast. The pulp can also be processed and drunk as a beverage or sherbet, or frozen as an ice cream. Ripe fruit juice is a good health drink and provides a rich source of antioxidants. The pulp is also made into chutney, preserves, jelly, marmalade, jams or processed into treacle or toffee. In Sri Lanka, wood apple cream is processed from the fruit pulp and is canned and exported. Young leaves, tender shoots and ripe fruits are also eaten fresh in Thailand. The bark also produces an edible gum. Seeds contain a bland, non-bitter, oil high in unsaturated fatty acids.

Botany

A small to medium sized, thorny, deciduous tree growing up to 6–15 m high with shallowly furrowed, grey bark. The spines are axillary, short, straight and the young branchlets and foliage are covered with minute, short hairs becoming glabrous with age. Leaves are alternate, imparipinnate with narrowly winged rachis. Leaflets number 5–9, are subsessile, opposite in arrangement with obovate, 25–35 mm long by 10–20 mm wide lamina with tip often notched, entire to crenulated margin (Plates 1 and 2) and dotted with fragrant filled glands. Flowers are small, fragrant, reddish, bisexual and formed in axillary and terminal panicles. Flower are 4–6-merous, calyx small, deltoid, flat, dentate and caducous; petals are spreading, oblong to ovate-lanceolate, imbricate in bud with a short, finely pilose disk; stamens are usually twice as many as petals bearing large, linear-oblong, basifixed anthers; ovary is globose, incompletely 4–6 (–7)-locular (empty in male flowers), becoming 1-locular with parietal placentae. Fruits are large, 7–10 cm diameter, globose, berry with a hard, woody shell, borne on

Plate 1 Fruits and leaves of wood apple

Plate 2 Close-up of compound leaves and spines of wood apple

Plate 3 Large, woody fruit with a stout woody stalk

stout, woody stalks (Plates 1 and 3) and are unilocular, the parietal placentae bearing numerous oblong, compressed, white seeds embedded in sticky brown, edible pulp.

Nutritive/Medicinal Properties

Nutrient composition of the fresh, ripe fruit per 100 g edible portion was reported (Gopalan et al. 2002) as: energy 87 kcal, moisture 77.5 g, protein 2.6 g, fat 0.2 g , carbohydrate 18.8 g, fibre 2.9 g, ash 0.9 g, β carotene 55 ug, vitamin C 9 mg, Fe 0.6 mg, Ca 38 mg. The fruit also contained polysaccharides - pectic polymers with galactosyl and arabinofuranosyl groups, hemicellulosic polymers and insoluble cellulose-rich material (Mondal et al. 2002). The unripe fruits contained 0.015% stigmasterol. Leaves contained stigmasterol (0.012%) and bergapten (0.01%) (Morton 1987). The bark also contained marmesin and the root bark contained aurapten, bergapten, isopimpinellin and other coumarins (Morton 1987).

Chemical investigations on different parts of *Limonia acidissima* plant have afforded various constituents, including coumarins, steroids, triterpenoids, benzoquinones, and tyramine derivatives with various pharmacological activities.

Anticancer Activity

An acidic heteropolysaccharide with a partially carboxymethylated α-(1–4) polygalacturonan backbone structure with 2- and 2,4-O-α-L-rhamnopyranosyl, 2- and 2,3-O-α-L-arabinofuranosyl and 3-, 2,4-and terminal α-D-galactopyranosyl bearing side chains was isolated from *F. limonia* and showed significant in-vivo Ehrlich ascites carcinoma cell growth inhibition (Saima et al. 2000).

Diuretic Activity

Methanolic leaf extracts exhibited diuretic effect (Parial et al. 2009). At a dose of 200 mg/kg a significant increase in urine output was produced. The extract increased the urinary excretion of

sodium, potassium and chloride ions. The findings supported the traditional uses of *Limonia acidissima* leaves as diuretic agents.

Antimicrobial Activity

The leaf on distillation yielded 0.45% light green essential oil containing estragol (72.68%) and anethol (26.24%) and the oil exhibited antimicrobial activity against several fungi and bacteria (Mehta et al. 1983). Feronia leaf extract was found ineffective on *Bacillus pumilus* and *Xanthomonas campestris*, but *Vibrio cholerae* was quite sensitive to the extract.

The heartwood was found to contain ursolic acid and a flavanone glycoside, 7-methylporiol-D-xylopyranosyl-D-glucopyranoside. The stem bark yielded a pyranoflavanone (−)-(2S)-5,3′-dihydroxy-4′-methoxy-6″,6″-dimethylchromeno-(7,8,2″,3″)-flavanone along with several known compounds including an alkaloid, five coumarins, a flavanone, a lignan, three sterols and a triterpene (Rahman and Gray 2002). The antimicrobial screening of these compounds by a microdilution technique resulted in MICs in the range 25–100 μg/ml.

Antiinflammatory Activity

Three benzamide derivatives, N-{[P-(3,7-dimethyl-6 R,7-dihydroxy-4 R-octadecanoyloxy-2-octenyloxy)phenyl]ethyl} benzamide (1); N-{[P-(3,7-dimethyl-6 R,7-dihydroxy-4 R-9‴(E)-octadecenoyloxy-2-octenyloxy)phenyl]ethyl} benzamide (2) and N-{[P-(3,7-dimethyl-6 R,7-epoxy-4 R-9‴(E)-octadecenoyloxy-2-octenyoxy) phenyl] ethyl} benzamide (3) together with ten known compounds (4–13), were isolated from *Limonia acidissima* bark (Kim et al. 2009a). Among the isolates, 13 α,14 β,17 α-lanosta-7,9,24-triene-3 β,16 α-diol (8); 4-methoxy-1-methyl-2(1H)-quinolinone (10); and 13 α,14 β,17 α-lanosta-7,24-diene-3 β,11 β,16 α-triol (13) potently inhibited nitric oxide (NO) production in microglia cells. In additional studies, the scientists (Kim et al. 2009b) isolated a new dimeric coumarin, limodissimin A (1), together with four known coumarins: osthenol (2), 17 (2′R)-7-hydroxy-8-(2′,3′-dihydroxy-3′-methylbutyl)-2H-1-benzopyran-2-one (3), columbianetin (4), and seselin (5). Limodissimin A (1) was isolated as a yellow gum and showed a fluorescence at UV-365 nm. Compounds 2, 3, 4 and 5 significantly inhibited the LPS-induced NO production, with IC_{50} values of 22.3, 21.6, 33.5 and 23.1 μM, respectively. Compound 1 did not show the significant inhibitory effect on NO production in ranges from 5 to 20 μM. The study demonstrated that coumarins (compounds 2, 3, 4 and 5) isolated from *L. acidissima* exerted antiinflammatory effects in LPS- stimulated microglia cells and might be good lead compounds to modulate neurological diseases associated with inflammatory processes.

Insecticidal Activity

In Myanmar, wood apple root bark paste is used as a cosmetic locally, leaves are used to treat epilepsy, the roots are used as a purgative, and the fruit as a tonic. Pregnant Karen women in the camps at the Thai–Myanmar border used insect repellents which were mixed with ‘thanaka’, a root paste made from the wood apple tree against malarial parasites transmitted by *Anopheles minimus* and *Anopheles maculatus* (Lindsay et al. 1998). Bioassays using a laboratory strain of *Aedes aegypti* demonstrated that thanaka to be slightly repellent at high dosages and the mixture with deet provided protection for over 10 h. The treatment would therefore also provide some personal protection against dengue transmitted by *Aedes aegypti* and *Aedes albopictus* biting during the daytime. Another study reported that dried leaves afforded a potent mosquito larvicide, identified as n-hexadecanoic acid that was found to be effective against fourth instar larvae of *Culex quinquefasciatus*, *Anopheles stephensi* and *Aedes aegypti*, with LC_{50} of 129.24, 79.58 and 57.23 ppm, respectively (Rahuman et al. 2000).

Traditional Medicinal Uses

Various parts of *Limonia acidissima* have been used in folkloric medicine. Ripe fruit exhibit cooling, astringent and tonic properties and is

used as a stomachic. Ripe fruit juice is a good health drink and it is a rich source of antioxidants. In Indo-China, the spines and bark are used in medicinal preparations for the treatment of excessive menstruation (menorrhagia), liver disorders, bites and stings and nausea. In India, the fruit is more popular as medicine than as food. The tannin in the fruit has an astringent effect that once led to its use as a general tonic and as a traditional cure for dysentery, diarrhoea, liver ailments, chronic cough and indigestion. In India, after the rainy season, a reddish brown gum like substance called *Feroni*a gum is obtained from the trunk, which is of medicinal value and a substitute for gum Arabic. The powdered gum, mixed with honey, is given to overcome dysentery and diarrhoea in children. The bark, leaves, fruits and gum is used to treat snake-bites, diarrhoea, anorexia, vomiting, cough, bronchitis, hiccough, gingivitis and cardiac debility. Unripe fruit is astringent and useful in diarrhoea, dysentery and provides an effective treatment for hiccough, sore throat and diseases of the gums. The pulp and the powdered rind are used as poultices on bites and stings of venomous insects. The seed oil is a purgative, and the leaf juice mixed with honey is a folk remedy for fever. The tannin-rich and alkaloid-rich bark decoction is a folk cure for malaria. Sap of young leaves is mixed with milk and sugar candy and given as a remedy for biliousness and intestinal disorders of children.

Other Uses

The rind of the fruit is so thick and hard it can be carved and used as a utensil such as a bowl or ashtray. The tree has hard wood which can be used for woodworking. The timber is employed in the construction of houses, posts, rollers for mills, hubs and agricultural implements. The wood also serves as fuel-wood. A gum (*Feronia* gum), obtained from the trunk and branches, is utilized like gum Arabic and used for medicinal purposes and in making water colour paints, ink, dyes and varnish. The leaves are lopped for fodder. In Thailand the plant also has been used as root-stock for *Citrus* because of its water tolerance.

Comments

The wood-apple is usually propagated from seeds. It is also propagated by root cuttings, air-layers, or by budding.

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