

CHAPTER 08

Wood Apple (*Limonia acidissima* L.): medicinal potential and traditional culinary uses

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ABSTRACT

Limonia acidissima L., commonly known as wood apple, is a medicinally and nutritionally valuable plant widely distributed in the Indian subcontinent and Southeast Asia. The fruit pulp is valued for its astringent, stomachic, antioxidant, hepatoprotective, and cardiogenic properties, and it is traditionally employed in the management of diarrhoea, dysentery, asthma, cough, and liver disorders. The leaves exhibit hepatoprotective, antimicrobial, and anti-ulcer activities, while the bark and gum show anti-inflammatory and demulcent effects. Phytochemical investigations reveal the presence of flavonoids, tannins, saponins, phenolic compounds, and coumarins, which contribute to its broad pharmacological profile. In addition to its medicinal significance, *L. acidissima* plays an important role in traditional cuisine. The ripen fruit pulp is consumed raw or blended into refreshing beverages, chutneys, jams, and curries, appreciated for its sweet-sour taste and digestive benefits. The plant thus serves as a bridge between nutrition and traditional medicine, offering a rich source of bioactive compounds with therapeutic and culinary importance. Considering the importance of this tree species, the scattered information has been compiled and presented in this chapter to highlight its utilization and promote its conservation.

KEYWORDS: Wood apple, traditional medicinal uses, food values, pharmacological potential

INTRODUCTION

Limonia acidissima, belonging to the family Rutaceae, represents a monotypic genus, *Limonia*, confined to India, Pakistan, Sri Lanka, and Southeast Asia (Dhakar et al. 2019). Commonly known as wood apple, elephant apple, monkey fruit, curd fruit, kath bel, or kaitha, and is the only representative of its genus (Syn: *Feronia elephantum*, *Hesperethusa crenulata*, *Schinus limonia*) (Dhakar et al. 2019). In India, *L. acidissima* primarily occurs in dry regions, particularly in Punjab, Gujarat, Delhi, Rajasthan, Madhya Pradesh, West Bengal, Arunachal Pradesh, Maharashtra, Goa, Karnataka, Tamil Nadu, and Andhra Pradesh (Bhavsar et al. 2022).

It is a deciduous, slow-growing, erect tree characterized by a few upward-reaching branches that spread outward near the top, where they subdivide into slender branchlets drooping gracefully at their tips (Dhakar et al. 2019). The species holds considerable ethnomedicinal and pharmacological importance across South Asia. The fruit is extensively used in Indian traditional medicine as a liver and heart tonic, and the unripe fruit serves as a remedy for diarrhoea and dysentery. Additionally, it is regarded as an effective treatment for cough, sore throat, and gum diseases (Nayak and Kumar 2023).

Pharmacologically, *L. acidissima* is considered a potent hepatoprotectant and exhibits a variety of biological activities, including adaptogenic, anti-inflammatory, and detoxifying effects. It is traditionally employed against blood impurities, leucorrhoea, dyspepsia, and jaundice (Pandey et al. 2014). Studies on the leaves and stem bark have demonstrated anti-tumour and antimicrobial activities, while the fruit pulp exhibits anti-inflammatory and antipyretic properties (Sharma et al. 2024). Phytochemical investigations have revealed that the fruit contains flavonoids, responsible for its antioxidant activity, and saponins, which contribute to its foaming and antifungal properties. Moreover, the presence of glycosides, tannins, coumarins, and tyramine derivatives enhances its medicinal potential. The fruit shells of *L. acidissima* have been found to contain several antifungal compounds, including psoralen, xanthotoxin, 2,6-dimethoxybenzoquinone, and osthonol (Bagul et al. 2019).

Keeping in view the importance of *L. acidissima*, the chapter focuses on emphasizing its culinary and pharmacological values. The chapter aims to create awareness about the necessity of preserving it for future generations and

for sustainable management and conservation strategies to ensure its continued existence.

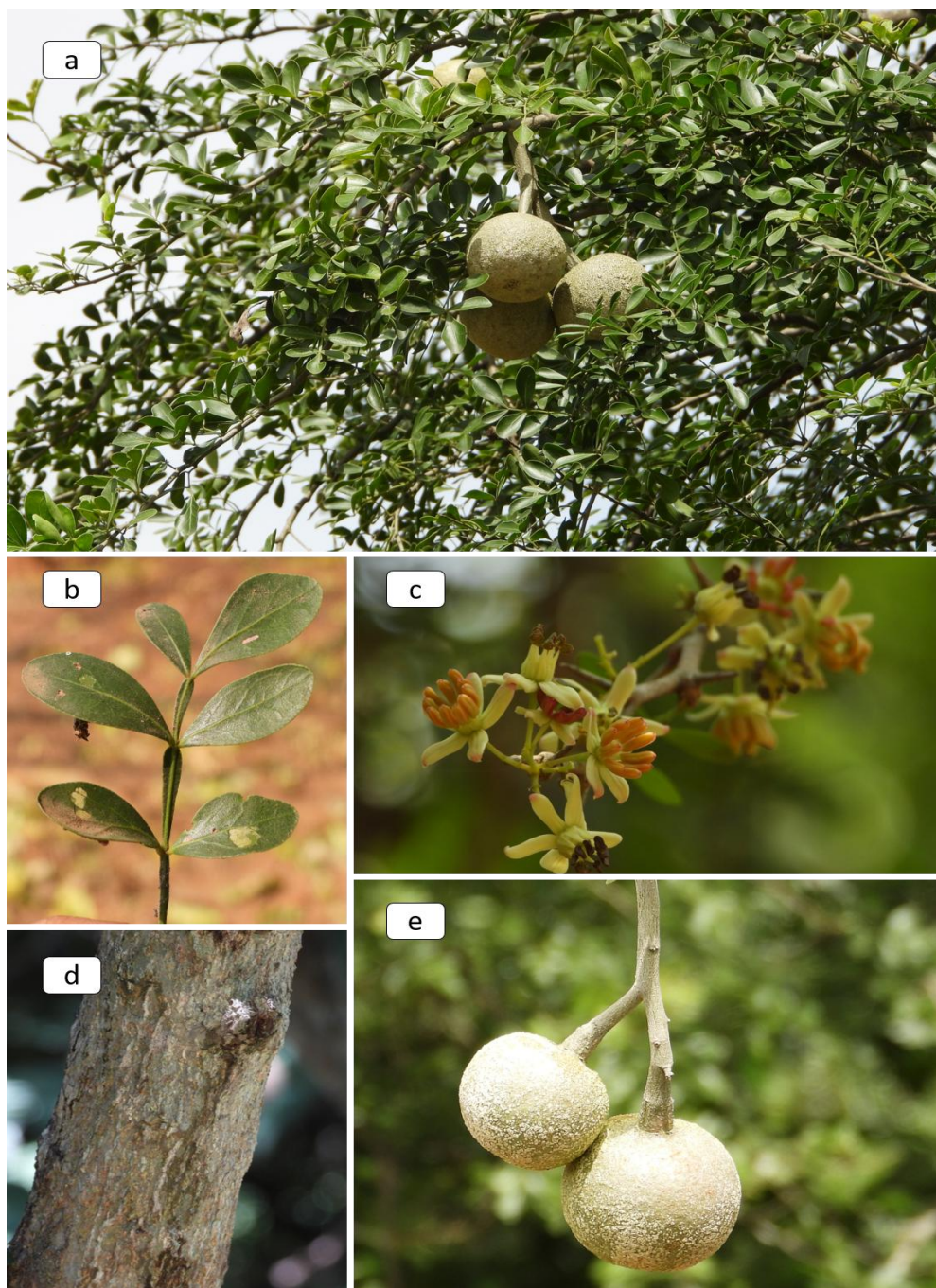


Figure 1: Vegetative parts of *L. acidissima*; a) Canopy, b) Leaves, c) Flowers, d) Bark, e) Fruits

MORPHOLOGY

Limonia acidissima L. is a moderate-sized, deciduous tree that typically grows up to 9 metres in height. The tree has an erect posture, with a few upward-reaching branches that bend outward near the top, where they divide into slender drooping branchlets (Bhavsar et al. 2022; Nayak and Kumar 2023; Figure 1).

Bark: Bark is rough, greyish, and spiny in appearance. The spines are axillary, short, and straight, measuring about 2-5 cm long, and are found on certain zigzag twigs.

Leaves: The leaves are pinnate, bearing 5-7 leaflets, which are opposite in 2-3 pairs with a terminal leaflet at the end. Each leaflet measures about 25-35 mm in length and 10-20 mm in breadth. When crushed, the leaves emit a pleasant citrus-like aroma. The leaflets are elliptic to ovate, glabrous, and have entire margins with a slightly pointed apex.

Flowers: *L. acidissima* typically bears small, white to greenish-yellow flowers, which are fragrant and borne in axillary panicles.

Fruit and seeds: The fruit is a berry, globose in shape, and measures about 5-9 cm in diameter. It may be sweet or sour in taste and has a very hard rind that is 6 mm thick and greyish-white in colour. The outer shell is woody and extremely hard. Inside, the pulp is sticky, brown, and aromatic, acidic to sweetish. Numerous small white seeds are embedded within the pulp. The seeds are 5–6 mm long, hairy, and contain thick green cotyledons.

TRADITIONAL MEDICINAL USES

Fruit: The fruit of *L. acidissima* is highly valued in traditional medicine and is considered refrigerant, stomachic, stimulant, astringent, aphrodisiac, diuretic, and tonic to the liver and heart. It is used to treat cough, hiccups, asthma, consumption, tumours, ophthalmia, and leucorrhoea (Vijayvargia and Vijayvargia 2014). The unripe fruit acts as an astringent and is prescribed in cases of diarrhoea and dysentery, often as a substitute for bael (*Aegle marmelos*) (Bagul et al. 2019). Ripe fruits are used to manage liver and heart diseases, reduce cholesterol levels, and purify blood when mixed with warm water and sugar (Vidhya and Narain 2011; Mishra and Garg 2011; Vasant and Narasimhacharyaa 2011). The pulp of the fruit is applied externally on insect bites and stings and is known for its potential to block UV rays, thus offering protection against skin cancer. In Myanmar and Sri Lanka, a traditional face

paste called Thanaka, prepared from the pulp, is used to remove skin spots and lesions (Rathayake et al. 2009; Pandey et al. 2014). The pulp's low fat content (4.38%) makes it beneficial for overweight individuals (Pandey et al. 2014).

Leaves: The leaves of *L. acidissima* are astringent and carminative, used to treat vomiting, indigestion, hiccups, and dysentery (Vijayvargia and Vijayvergia 2014). They are also known for hepatoprotective activity and are used to manage liver ailments (Ilango and Chitra 2009). Traditionally, the leaves are given to children mixed with milk and sugar to relieve biliousness and intestinal problems (Vasant and Narasimhacharyaa 2011). Crushed leaf oil is applied externally to cure itching and aid digestion. The leaves contain tannins effective against peptic ulcers and are used for treating breast and uterine cancer, infertility, progesterone deficiency, flu, and respiratory disorders. Moreover, they are used in the treatment of snake bites and as antibacterial agents (Ilango and Chitra 2009). In Ayurveda, they are recommended for disorders associated with vitiated vata and pitta (Vasant and Narasimhacharyaa 2011).

Seeds: The seeds of *L. acidissima* are used in the treatment of heart diseases and cardiac weakness (Jadeja et al. 2005; Senthilkumar et al. 2010). Seed extracts are believed to possess cardiogenic and rejuvenating properties that enhance heart function and circulation (Senthilkumar et al. 2010).

Bark: The bark is used in traditional medicine for treating vitiated conditions of *vata* and *pitta* (Vijayvargia and Vijayvergia 2014). It contains coumarins such as marmesin, aurapten, and bergapten. When crushed, the bark is applied to venomous wounds due to its antiseptic and detoxifying properties. It also has anti-inflammatory and wound-healing potential, contributing to its traditional role in managing skin infections and injuries (Parvez and Sarker 2021).

Gum: The gum of *Limonia acidissima* has demulcent, constipating, and anti-diarrhoeal properties. It is traditionally used for treating diarrhoea, dysentery, gastropathy, haemorrhoids, and diabetes. Its soothing effect on the intestinal mucosa helps alleviate irritation in the gastrointestinal tract and supports bowel regularity (Vijayvargia and Vijayvergia 2014; Parvez and Sarker 2021).

Spines: The spines of the tree are traditionally used as a remedy for menorrhagia. They are also reported to possess haemostatic and detoxifying properties and are used in certain folk remedies for controlling excessive menstrual bleeding (Parvez and Sarker 2021).

Whole plant: Traditionally, all parts of *L. acidissima* are utilized as natural remedies for various ailments, including diarrhoea, dysentery, asthma, wounds, tumours, hepatitis, and cardiac debility. The plant is also considered effective against snakebites and possesses blood-purifying and detoxifying properties (Rathayake et al. 2009; Pandey et al. 2014).

TRADITIONAL CULINARY USES

L. acidissima, holds a unique place in traditional cuisines across India, Sri Lanka, Bangladesh, Thailand, and Myanmar (Kerkar et al. 2020). The ripe fruit, which has a hard woody shell enclosing aromatic brown pulp, is widely consumed for its tangy, sweet flavour and refreshing aroma. In India, particularly in Odisha, West Bengal, Bihar, and Tamil Nadu, the ripe pulp is eaten fresh with added jaggery, sugar, or a pinch of black salt to enhance taste. The fruit is also mashed with milk or curd to make traditional beverages, which are valued for their cooling and digestive properties during summer (Bagul et al. 2019; Kerkar et al. 2020). In rural and tribal communities, *L. acidissima* pulp is commonly used in chutneys, jams, and pickles. The natural acidity of pulp makes it a flavourful ingredient in spicy and tangy chutneys prepared with chili, cumin, and tamarind (Present study). In Sri Lankan cuisine, the ripe fruit is used to prepare a traditional drink called wood apple juice or divul kiri, which is made by mixing the pulp with coconut milk and jaggery. This beverage is not only refreshing but is also believed to aid digestion and prevent heat-related ailments. The unripe fruit is sometimes used as a souring agent in curries and lentil dishes, similar to tamarind, imparting a distinct tartness. In addition, the pulp is occasionally sun-dried and stored for later culinary use during off-season months. The seed kernel, though less commonly consumed, can be roasted and eaten as a snack in some regions (Zanwar et al. 2023). *L. acidissima* serves both nutritional and therapeutic roles in traditional diets providing dietary fibre, natural sugars, minerals, and organic acids that promote digestive health and improve appetite (Patil et al. 2025).

PHARMACOLOGICAL USES

L. acidissima exhibits diverse pharmacological activities (Figure 2).

Antioxidant activity: *L. acidissima* exhibits strong antioxidant potential due to the presence of bioactive compounds such as phenolics, flavonoids, tannins, and ascorbic acid. Methanolic and aqueous extracts of the fruit and leaves have shown high free radical scavenging capacity in DPPH, FRAP, and ABTS

assays. These compounds neutralize reactive oxygen species and prevent oxidative damage to cells and tissues (Pandey et al. 2014).

Antimicrobial and antifungal activity: Extracts of *L. acidissima* possess broad-spectrum antimicrobial properties against several pathogenic bacteria and fungi. Studies have reported significant inhibitory effects of fruit pulp, leaves, and bark extracts against *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Bacillus subtilis*. Ethanolic and methanolic extracts also show antifungal activity against *Candida albicans* and *Aspergillus niger*. These effects are attributed to the presence of alkaloids, coumarins, and essential oils, making the plant a valuable source of natural antimicrobial agents for pharmaceutical applications (Bandara et al. 1988; Sharma et al. 2024).

Antidiabetic activity: The fruit extract has demonstrated remarkable antidiabetic properties in experimental studies using alloxan-induced diabetic rats. Administration of methanolic fruit extract significantly reduces blood glucose levels and enhances insulin secretion. The presence of bioactive compounds such as flavonoids, saponins, and triterpenoids is believed to improve glucose metabolism and pancreatic function (Baheti et al. 2023).

Anti-inflammatory and analgesic activity: Extracts from the bark and leaves of *L. acidissima* possess significant anti-inflammatory and analgesic effects. In animal studies, ethanolic and chloroform extracts effectively reduce carrageenan-induced paw oedema and demonstrate pain-relieving activity in acetic acid-induced writhing tests. The pharmacological effects are mainly due to the presence of flavonoids, alkaloids, and triterpenoids that inhibit inflammatory mediators such as prostaglandins and cytokines (Sharma et al. 2024).

Anticancer activity: The ethanolic extract of *L. acidissima* fruit has shown cytotoxic and antiproliferative effects against various human cancer cell lines, including HeLa (cervical cancer) and MCF-7 (breast cancer). The plant's anticancer activity is associated with bioactive constituents such as coumarins, phenolic acids, and flavonoids that induce apoptosis and inhibit cell proliferation (Sharma et al. 2024).

Hepatoprotective activity: *L. acidissima* fruit pulp extract has demonstrated hepatoprotective effects in experimental models of liver injury induced by carbon tetrachloride (CCl₄). Treatment with the extract significantly reduces elevated liver enzymes such as SGOT, SGPT, and bilirubin levels, indicating

protection against hepatic cell damage. The hepatoprotective activity is attributed to the antioxidant properties and membrane-stabilising action of its phenolic and flavonoid constituents (Sharma et al. 2024).

Wound healing activity: Topical application of *L. acidissima* leaf extract has been shown to accelerate wound healing by promoting collagen synthesis, tissue remodeling, and epithelialization. In experimental models, wounds treated with the extract exhibit faster contraction and reduced healing time compared to control groups. Additionally, the extract displays antidermatophytic and antibacterial properties, which help prevent infection and support skin regeneration. These effects are attributed to the presence of flavonoids, tannins, and phenolic compounds that enhance tissue repair and protect skin health (Yusnaini et al. 2023).

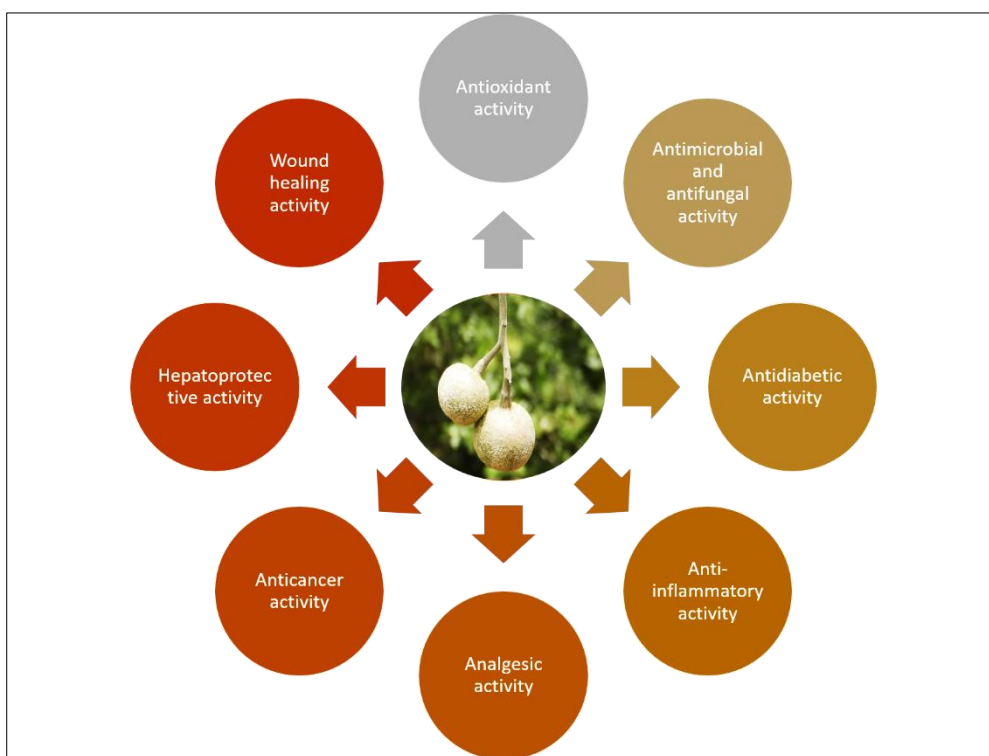


Figure 2: Pharmacological activity of *L. acidissima*

CONCLUSION

Limonia acidissima represents a multipurpose plant with immense ethnomedicinal and nutritional value. Its diverse pharmacological properties, ranging from hepatoprotective and antioxidant to anticancer and cardiotonic,

are supported by both traditional knowledge and modern scientific studies. The fruit, leaves, bark, and gum each contribute uniquely to human health, demonstrating the holistic medicinal potential of this species. Beyond its therapeutic applications, its widespread use in traditional culinary preparations emphasises its cultural and nutritional relevance in South and Southeast Asian communities. Further phytochemical and pharmacological research, along with sustainable conservation and utilisation practices, can help harness the full potential of *L. acidissima* as a natural source of medicine and functional food.

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