3 Pharmacological and therapeutic uses of *Calophyllum inophyllum* L.

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ABSTRACT

Calophyllum inophyllum L. is a tropical evergreen tree widely distributed in coastal regions of Asia, Africa and the Pacific islands and is well known for its diverse medicinal properties. The plant has been extensively used in traditional medicine for the treatment of various ailments including skin diseases, wounds, inflammation and infections. Different parts of the plant contain a wide range of bioactive compounds including coumarins, xanthones, flavonoids, triterpenoids and fatty acids. These phytochemicals contribute to numerous pharmacological activities such as antimicrobial, anti-inflammatory, antioxidant, antiviral, analgesic, wound-healing and anticancer effects. The seed oil, commonly known as Tamanu oil, is particularly valued for its dermatological and therapeutic applications, especially in the treatment of burns, ulcers, scars and skin infections. Recent pharmacological investigations have also reported antiviral compounds like calanolides and inophyllums that show potential against viral infections. Due to its rich phytochemical composition and wide spectrum of biological activities, *C. inophyllum* has attracted increasing attention in pharmaceutical, cosmetic and biomedical research. This review highlights the pharmacological potential and therapeutic uses of the plant and emphasizes its importance as a promising source for the development of novel therapeutic agents.

Keywords: Ethnomedicinal uses, medicinal plants, Tamanu, traditional medicine

INTRODUCTION

Calophyllum inophyllum L., commonly known as tamanu, is a tropical evergreen tree belonging to the family Calophyllaceae. It is widely distributed across tropical regions, including Thailand, particularly in coastal areas, and thrives in diverse habitats such as forests, mangroves, coastal zones, and other tropical ecosystems **(**Ruangsuriya et al. 2023). The generic name *Calophyllum* is derived from the Greek words "kallos" meaning "beautiful" and "phyllon" meaning "leaf," referring to the attractive foliage of the species. *C. inophyllum* is known by numerous vernacular names that vary across regions and countries, reflecting its wide geographical distribution and cultural significance (Susanto et al. 2019). *C. inophyllum* has an extensive global distribution, predominantly in tropical regions. It is commonly found across a wide range of countries, including Australia, Cambodia, the Cook Islands, Fiji, French Polynesia, India, Indonesia, Japan, Kiribati, Laos, Madagascar, Malaysia, the Marshall Islands, Myanmar, New Caledonia, Norfolk Island, Papua New Guinea, the Philippines, Reunion, Samoa, the Solomon Islands, Sri Lanka, Taiwan, Thailand, Tonga, Vanuatu, and Vietnam. This broad distribution highlights its adaptability to tropical and coastal ecosystems worldwide (Ong 2014). Within India, it is distributed in the coastal regions of Odisha, Andhra Pradesh, Maharashtra, Karnataka, Kerala, Tamil Nadu and the Andamans (Saravanan et al. 2011).

It is well recognized in traditional medicine systems for its extensive therapeutic applications and ethnobotanical significance. Different parts of the plant, including roots, bark, leaves, latex, resin, and seeds, have been traditionally used to treat a wide range of ailments such as ulcers, skin diseases, eye infections, rheumatism, and inflammatory conditions. The seed oil, in particular, is highly valued for its antiseptic, anti-inflammatory, and wound-healing properties, making it an important component in traditional healthcare practices (Leguillier et al. 2015; Gupta and Gupta 2020).

The medicinal potential of *C. inophyllum* is attributed to the presence of diverse bioactive compounds, including coumarins, xanthones, flavonoids, triterpenoids, and fatty acids (Ferdosh 2024). These phytochemicals contribute to various pharmacological activities such as antimicrobial, antioxidant, antiviral, anti-inflammatory, and anticancer effects. Notably, compounds like calanolides have shown promising antiviral activity, particularly against HIV-1 (Oo 2018; Ferdosh 2024).

In recent years, scientific studies have increasingly validated the traditional uses of this species, highlighting its importance in both traditional and modern medicine. Owing to its broad therapeutic potential, *C. inophyllum* is considered a rich source for the development of novel natural drugs and herbal formulations.

MORPHOLOGY

C. inophyllum L. is a slow-growing, medium to large-sized evergreen tree attaining a height of approximately 8-20 m. The tree exhibits a widely spreading canopy forming an irregular crown. The trunk is thick, with grey, fissured bark characterized by a rough and cracked texture. The plant exudes a milky white latex upon injury. Leaves are arranged oppositely, with a broadly elliptical to ovate lamina measuring about 10-20 cm in length and 6–9 cm in width. The leaves are thick, leathery, and glossy dark green in appearance. They possess a blunt apex and are marked by numerous fine, closely spaced parallel veins that run perpendicularly from a prominent, slightly raised yellowish-green midrib to the leaf margins. It bears fragrant, white flowers arranged in axillary clusters of 4-15. Each flower consists of 4-8 delicate, oblong petals. The flowers are bisexual, containing numerous golden-yellow stamens and a centrally positioned pink pistil with a slender, elongated style and a superior ovary. Individual flowers measure approximately 2.5 cm in diameter and are borne on long, sturdy pedicels. Flowering is most profuse during late spring to early summer. Fruits develop in clusters and are globose, measuring 2-5 cm in diameter. Immature fruits are light green with a smooth surface and a thin outer layer. Upon ripening, the fruit turns yellow to brown and develops a wrinkled texture. Each fruit contains a single large seed, 2-4 cm in diameter, enclosing a pale-yellow kernel. The species typically bears fruit twice annually, with peak fruiting periods from April to June and October to December **(**Shanmugapriya et al. 2016; Gupta and Gupta 2020; Figure 1).

ETHNOMEDICINAL USES

C. inophyllum is widely recognized in traditional medicine systems for its diverse therapeutic applications across different plant parts (Table 1). The root decoction is traditionally used for the treatment of ulcers, boils and ophthalmia, while the bark is employed in managing orchitis. The milky latex is topically applied to alleviate rheumatism and psoriasis, and leaf decoctions are commonly used to treat eye infections (Gupta and Gupta 2020). Various pharmacological properties have been reported from the leaves, bark, and seed oil, reflecting significant ethnomedicinal importance with regional variations.

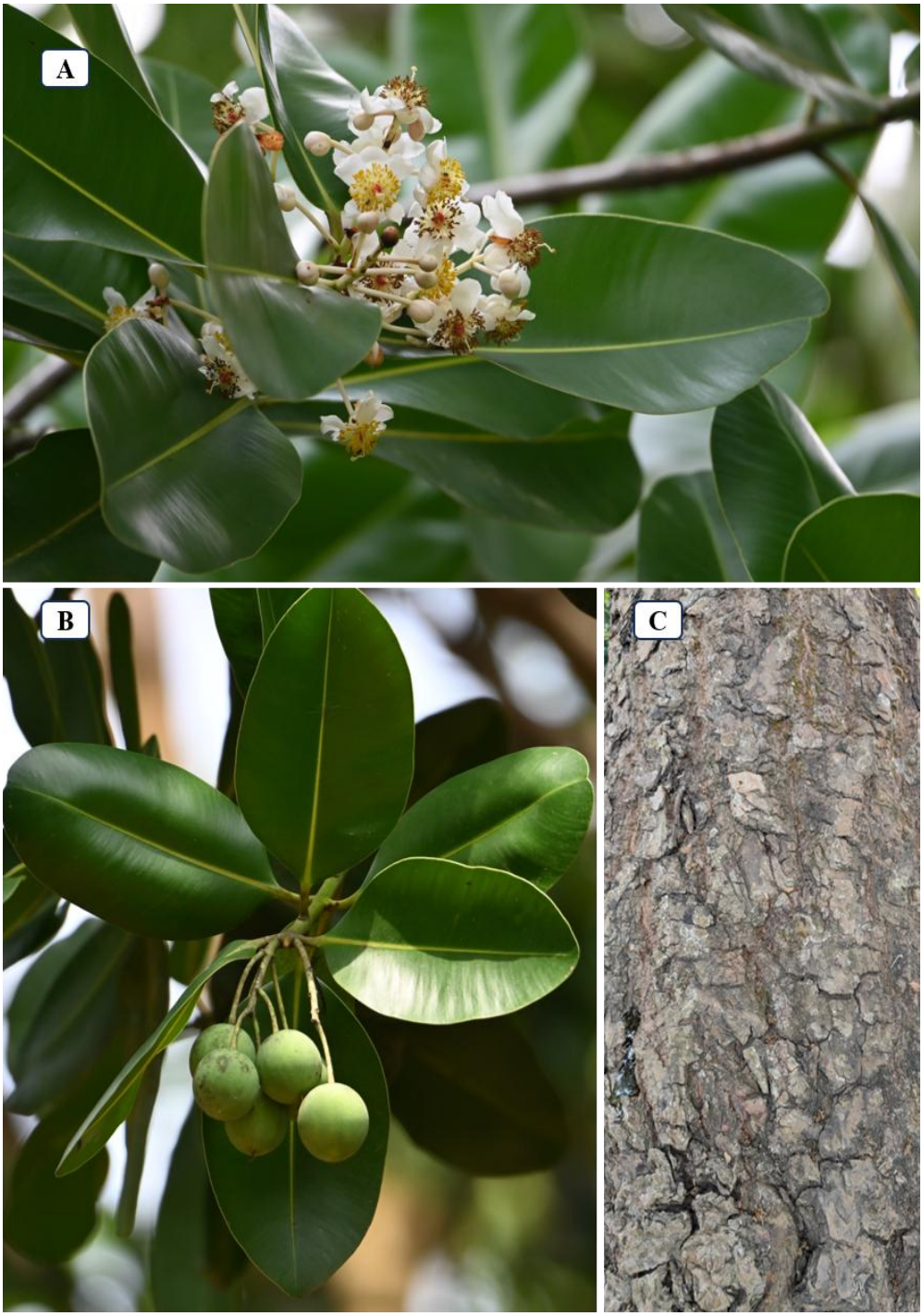


Figure 1: Vegetative parts of *C. inophyllum*; A) Flowers, B) Fruits with leaves, C) Bark

Leaf preparations, particularly decoctions, are widely used in the treatment of dermatoses and ocular ailments, whereas bark juice exhibits purgative activity. The oil extracted from seeds is extensively utilized as a natural antiseptic and anti-inflammatory agent, especially in the management of venous ulcers, wounds, and rheumatism (Cassien et al. 2021). In traditional practices of Taiwan, the entire plant is used for treating eye diseases, rheumatoid arthritis, contusions, sprains, and fractures. The resin is specifically applied for dental ailments such as odontalgia and gum bleeding (Liu et al. 2015). Similarly, leaf decoctions are used to relieve dermatosis, urticaria and eczema, while bark extracts act as purgatives (Dweck and Meadows 2002). Cold-pressed seed oil has gained importance for wound healing and in alleviating neuropathy associated with leprosy. It is also recommended for burns, post-surgical wounds, acne, psoriasis, herpes, rheumatism and gonorrhoea (Pidoux et al., 2012). Ethnomedicinal surveys in the Marquesas archipelago have reported the use of a traditional preparation known as “pani temanu” for treating itching, skin allergies, burns and minor wounds (Leguillier et al. 2015). It exhibits a wide range of medicinal properties such as antiseptic, astringent, expectorant, diuretic and purgative activities. The gum obtained from the bark is traditionally used as an emetic and for treating wounds and ulcers. In regions of India and Indochina, bark rich in tannins is used for managing vaginal discharge, postpartum bleeding and gonorrhoea. The bark also demonstrates antineuralgic, diuretic, antiseptic and disinfectant properties and is used internally as an expectorant in chronic bronchitis and phthisis. The resin is beneficial in persistent catarrh, while infusions of gum, bark, and leaves are used for treating sore eyes (Leguillier et al. 2015).

Ethnobotanical practices across different countries further highlight its importance. In Fiji and Linga, soaked leaves are applied to inflamed eyes, while in Cambodia, leaf infusions are used internally for heatstroke and as inhalation therapy for migraine and vertigo. In the Philippines, macerated leaves are applied as an astringent for haemorrhoids (Shanmugapriya et al. 2016). In Madagascar, Polynesia, and Malaysia, powdered bark is used in the treatment of orchitis, and the gum resin serves as an antiseptic and resolvent. The seed oil is particularly valued for its antirheumatic and anti-psoriatic properties. The kernel of the fruit yields a dark green, aromatic oil that is readily absorbed into the skin without residue, making it highly effective in treating various skin diseases (Shanmugapriya et al. 2016).

Table 1: Ethnomedicinal uses of *C. inophyllum*

Plant Part	Preparation	Traditional uses
Root	Decoction	Ulcers, boils, ophthalmia
Bark	Juice / Powder	Orchitis, purgative, vaginal discharge, postpartum bleeding, gonorrhoea
	Internal use	Expectorant (chronic bronchitis, phthisis), antineuralgic, antiseptic, disinfectant
Latex	Topical application	Rheumatism, psoriasis
Leaves	Decoction / Infusion	Eye infections, dermatosis, urticaria, eczema
	Soaked / Macerated	Inflamed eyes, haemorrhoids (piles)
	Internal / Inhalation	Heatstroke, migraine, vertigo
Resin (Gum)	Topical / Internal	Odontalgia, gum bleeding, catarrh, wounds, ulcers, antiseptic
Seeds/ Seed Oil	Oil (cold-pressed)	Wound healing, burns, ulcers, acne, psoriasis, herpes, rheumatism, gonorrhoea
	Topical	Antiseptic, anti-inflammatory, venous ulcers, neuropathy (leprosy), skin diseases
Whole Plant	Various preparations	Eye diseases, rheumatoid arthritis, sprains, fractures, contusions

PHARMACOLOGICAL POTENTIAL

C. inophyllum contains a variety of bioactive compounds such as coumarins, xanthones, flavonoids, triterpenoids and fatty acids. These phytochemicals contribute to the diverse pharmacological activities of the plant and make it an important species in traditional and modern medicine.

Anti-inflammatory activity

The plant possesses significant anti-inflammatory activity, mainly attributed to compounds such as calophyllolide and other coumarin derivatives. These compounds help reduce inflammation by inhibiting inflammatory mediators and are traditionally used for the treatment of inflammatory conditions such as arthritis, skin irritation and swelling. Tamanu oil extracted from the seeds is widely applied topically to relieve inflammation and promote healing of damaged tissues (Oo 2018).

Antimicrobial activity

C. inophyllum also demonstrates strong antimicrobial activity against a wide range of pathogenic microorganisms. Extracts obtained from the leaves, bark and seeds have shown inhibitory effects against several bacteria and fungi, including *Staphylococcus aureus*, *Escherichia coli* and certain species of *Candida*. The antimicrobial properties are mainly associated with the presence of xanthones, flavonoids and other phenolic compounds that interfere with microbial growth and metabolism (Ferdosh 2024).

Antioxidant activity

The presence of phenolic compounds and flavonoids enables the plant extracts to scavenge free radicals and reduce oxidative stress in biological systems. By neutralizing reactive oxygen species, the plant helps protect cells from oxidative damage, which is associated with aging and the development of chronic diseases such as cardiovascular disorders and cancer (Farida et al. 2024).

Antiviral activity

Certain coumarin derivatives isolated from *C. inophyllum*, particularly calanolides and inophyllums, have demonstrated antiviral effects by inhibiting the replication of viruses. Some studies have shown that these compounds exhibit activity against HIV-1 by acting as non-nucleoside reverse

transcriptase inhibitors, highlighting the plant's potential in antiviral drug development (Gupta and Gupta 2020)

Wound-healing properties

In addition, *C. inophyllum* is widely recognized for its wound-healing properties. The seed oil promotes faster healing of wounds by stimulating tissue regeneration, enhancing collagen production and preventing microbial infection. Due to these properties, Tamanu oil has been traditionally used for treating cuts, burns, ulcers and other skin injuries (Oo 2018).

Anticancer potential

Preliminary pharmacological studies also indicate that the plant may possess anticancer potential. Bioactive compounds such as xanthones and coumarins have shown cytotoxic effects against certain cancer cell lines, suggesting that these constituents may induce apoptosis and inhibit the proliferation of tumor cells. Although further research is needed, these findings indicate promising prospects for the development of anticancer agents from this plant (Sundur et al. 2014; Farida et al. 2024).

CONCLUSION

Calophyllum inophyllum represents a valuable medicinal plant with significant pharmacological potential due to the presence of diverse bioactive constituents. Scientific studies have validated many of its traditional uses, demonstrating activities such as anti-inflammatory, antimicrobial, antioxidant, antiviral, analgesic, wound-healing and anticancer effects. The seed oil and plant extracts have shown promising therapeutic applications, particularly in dermatology and in the management of infectious and inflammatory diseases. The presence of unique compounds such as calanolides and xanthones further highlights the plant's importance as a potential source of novel pharmaceutical agents. Although several pharmacological properties have been documented, further research including clinical trials and detailed pharmacological investigations is necessary to fully explore its therapeutic efficacy and safety. *Calophyllum inophyllum* holds considerable potential for the development of natural drugs and herbal formulations, making it an important plant for future pharmacological and medicinal research.

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