



REVIEW ARTICLE

# A review on the genus *Calophyllum* L. (Clusiaceae): a potential medicinal tree species

Chinthu R V<sup>1</sup>, Raveendran P B<sup>2</sup> & Raveendran M<sup>3\*</sup>

<sup>1</sup>PG and Research Dept. of Botany, M G College, Thiruvananthapuram, 695 004, India

<sup>2</sup>Dept. of Botany, NSS College, Cherthala, Alappuzha, 688 524, India

<sup>3</sup>Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram, 695 562, India

\*Email: raveemadhav@gmail.com



## ARTICLE HISTORY

Received: 11 April 2022

Accepted: 17 October 2022

Available online

Version 1.0 : 20 April 2023

Version 2.0 : 01 July 2023



## Additional information

**Peer review:** Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

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## CITE THIS ARTICLE

Chinthu R V, Raveendran P B, Raveendran M. A review on the genus *Calophyllum* L. (Clusiaceae): a potential medicinal tree species. Plant Science Today. 2023;10(3): 01-05. <https://doi.org/10.14719/pst.1818>

## Abstract

*Calophyllum* L. is the genus of evergreen tropical flowering plants in the Clusiaceae family. They are predominantly located in Asia with some of its genus distributed in the Pacific Islands, Americas, Australasia and Africa. Plants of the genus are well known for their chemical properties with lots of secondary metabolites such as triterpenes, flavonoids, coumarins and xanthonenes. Compounds from *Calophyllum* have been reported to have cytoprotective, anti-HIV, anti-secretory, cytotoxic, antinociceptive, molluscicidal and antimicrobial properties. Some of the plants in *Calophyllum* are used in folk medicine to treat conditions like peptic ulcers, tumours, inflammation, infections and pain. *Calophyllum* genus is important with respect to their ecological as well as their medicinal properties. But in India, some species located in Western Ghats are in vulnerable stage. So, for a sustainable environment, we should focus on the conservation, restoration and rehabilitation of the genus that makes significant differences in their population. This article reviews the genus *Calophyllum* of Western Ghats as a potential medicinal tree species.

## Keywords

Poon, oil, timber, xanthonenes, inflammation

## Introduction

The genus *Calophyllum* L. (Clusiaceae) includes about 187 species. Of these, 179 are present in the Old World (mainly in the Indo-Malaysian region) and about 8 are in the New World, from Mexico and the Caribbean to Argentina. Some species are ornamental and others yield timber, commercially classified as POON and oil (1). When the Old World taxa were revised, 14 species from India and Sri Lanka were accepted. The *Calophyllum* species which occur in India, especially in Western Ghats are *Calophyllum apetalum*, *C. inophyllum*, *C. polyanthum*, *C. austroindicum* and *C. pascalianum* (2).

## Materials and Methods

Available manuscripts like research articles, journals, review papers, books, e-papers, e-books, electronic thesis, dissertations and search engines like Google, Yahoo, Microsoft Bing were used for collecting data.

## Results

Plants of the World Online (POWO.org) shows 185 scientific names species rank under the genus *Calophyllum*. Of these, 179 are accepted names of species.

*Calophyllum apetalum* Willd ('Poonspar of Travancore')

### IUCN Red Data list category

Vulnerable

### Ecology

A medium-sized to large, straight and cylindrical stemmed, evergreen tree with a girth up to 2.1 m, distributed in the forests of Western Ghats, at an altitude up to 1350 m often found by the sides of rivers and water course. The tree is found along the foothills of Western Ghats from Maharashtra and Goa southward through the forests of Karnataka, Tamilnadu and Kerala. It is often found growing along the rivers which flow down the Western Ghats to the sea. The tree attains large size in Kerala, particularly in the interior of evergreen forests. The tree often grows away from streams; elsewhere it is medium-sized, mostly along the streams. Species are receptive to various viruses, fungi, an insect pest that affects the leaves, roots and the fruits

### Regeneration :

Natural regeneration is generally adequate under the parent tree. The seedlings thrive in the dense shade of the heavy undergrowth, found along the streams and continue to grow slowly until they emerge into the open. Afterwards the crown assumes a round shape. In Karnataka, transplanting of the species was successful in Dandeli and Telgeri-Kans division. The percentage of survival is reported to be 60–70 % (3).

### Uses

The timber is great for construction. It is employed for construction of boats, oil mills, bridges and for cabinet work. It is suitable for manufacture of matchboxes and poles. The timber is suitable for plywood. It is a good fuel. Besides timber, the tree yields edible fruits. They contain a cream-coloured kernel, which is eaten; it is enclosed in a hard shell. The fruits are collected and sold. The kernels contain apetalolide and  $\beta$ -sitosterol- $\beta$ -D-glucoside. The sun-dried kernels yield a greenish yellow fatty oil (45-56. %), having a characteristic odour and a bitter taste. The oil is used as an illuminant, lubricant and in soap making and leather-treating. The oil is used in sepsis, rheumatism, leprosy and skin infestations (3).

### Related works

Three new xanthonoids, apetalinones A-C, in which A was a novel xanthone were isolated from the roots of *C. apetalum*. The bark of *C. apetalum* has a new xanthonoid, apetalinone-D (4). *In vitro* multiplication of *C. apetalum* were carried out. Out of 345 plants restored to their native habitat in the forest at three locations 293 plants survived and showed uniform growth free of morphological defects (5). The acetone extract of leaves of *C. apetalum* records the isolation and structure determination of a dipyrano-coumarin  $\alpha$ -hydroxytomentolide-A along with known friedelin, triterpenoids, apetalolactone, calophyllol and

inophyllum C (6). Pollination biology and breeding systems of *C. apetalum* shows flowers are pollinated by both anemophily (through wind) and entomophily (through insects) gives effective pollination results and in successful fruit set. The manual cross and self-pollinations are significantly different which depicts the importance of naturally mediated cross-pollination by pollinators (7). Seed bank estimation and regeneration studies of *C. apetalum* results reports that, the seed densities are insignificant among the forest ranges and significant with the distances. The studies highly recommended that the *ex-situ* regeneration possibly give greater percentage of seed germination and so it as a best suitable method of conservation of this species (8).

*Calophyllum inophyllum* Linn. (Alexandrian Laurel)

### IUCN Red Data list category

Least concern

### Ecology

A medium to large sized, evergreen and spreading tree, height up to 20 m and girth 1.5 m distributed in the coastal regions of Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa and the Andamans. Often it grows wild but also reported to be naturalized in Arunachal Pradesh. The tree is a native of the 'Beach Forests' of the Arabian Sea, found all along the sea coasts above the high watermark, including coastal backwaters down to the edge of the sea from Bombay southward to Kerala on the west coast and from Cuttack to Madras through Andhra Pradesh on the east coast; it is also common in the Andaman and Nicobar Islands. The tree is reported to be growing in West Bengal.

### Regeneration

The tree reproduces fairly well in nature, as the seeds are dispersed by fruit-eating bats and birds. It can also be raised either by direct sowing or transplanting. In case of direct sowing, the seeds must be from ripe and fresh fruits. It can easily be raised in sandy soils. The germinative capacity of the seeds is fair, but the thick shell delays their germination. When sown during the warmer months, 48% seeds germinate and take 50-55 days. They germinate without any difficulty, if sown soon after ripening; the removal of shell is reported to be very effective in reducing the period of germination, and increasing the germination percentage as also the vigour potentials during initial stages of growth and development. The seeds are sown in the nursery for transplanting and these seedling have been raised on the coast of Orissa, either pure or mixed, under the shade of *Casuarina equisetifolia* Linn. (3).

### Uses

*C. inophyllum* is cultivated for its edible fruits, seed oil, timber and as an ornamental in various parts of India and rarely, as an avenue tree. The ripe fruits are red and sweet and are reported to be eaten. The ripe seeds yielded calophyllide, inophyllide and calophyllic acid which are reputed to be useful in the treatment of leprosy; whereas unripe seeds gave cinnamic, inophyllic and calophyllic acids and ponnalide. Presence of leucocyanidin is reported

in the seed coat. A considerable difference was found in the chemical constituents of the ripe and unripe seeds. The oil seed is used for burning and as a varnish for painting wood work since it contains considerable amount of resin (10–30%). It has recently recommended as a lubricant in place of castor oil. Sometimes it used for oiling up vegetable-tanned leather. The refined oil is excellent for soap making and is used in industries. It is, however unfit for human consumption. Combined with the resin of *Vateria indica* L (Dipterocarpaceae), the oil is applied for caulking boats. Heat polymerization of the oil with the fat of *Mallotus philippensis* (Lam.) Muell.Arg. (Euphorbiaceae) gives good stoving enamels. A paste of the kernels is applied to relieve painful joints. The oil is used as a stimulant embrocation in rheumatism and gout. It is antifungal and has a beneficial influence over the mucous membrane of the genito-urinary organs, therefore, used in the treatment of venereal diseases. The refined oil is intramuscularly injected to alleviate pain in leprosy. The oil cures scabies and other cutaneous diseases. The soap from the alcoholic extract of the oil also has strong bactericidal activity against the gram positive microorganisms and fungistatic properties. The camphor-mixed oil is used against ring worm. Graveyard tests on natural durability of wood showed that average life of the timber is about 67 months; preservative-treated wood is slightly more durable. The wood is used for posts, beams, furniture, railway carriages, cooperage, crane-shafts, yokes, tool handles and for cabinet-work. On the west coast and in the Andaman and Nicobar Islands, the wood is used for keels and pulley blocks of ships and for boats and dugout canoes. It is also used for railway sleepers. It peels satisfactorily and is good for commercial plywood. The tree can be used as a suitable support for pepper vine cultivation. If properly pruned, it is a useful wind break. As the flowers attract honey bees in large numbers, apiaries can be established near these trees (3).

#### Related works

*Calophyllum inophyllum* which have been widely used traditionally as a local medicine. According to the scientific literature on *C. inophyllum*, a broad spectrum of pharmacological properties has been shown by this tree as well as it is reported to be rich in several active bio-compounds (9). Different parts of *Calophyllum inophyllum* tree have some pharmacological effects: anti-inflammatory, wound healing, osteogenic, antidiabetic, anticancer, lipid-lowering, antioxidant, antifungal, neuro-pharmacological and antibacterial effects. The bioactive compounds have been observed, leading towards the development of novel potent drugs for ordinary diseases (10). Immature and mature ball nut seed meal were similar in chemical contents and could therefore serve as potential animal's feed resource due to its high energy level, amino acids profile as well as low fibre and other anti-nutritional factors present in the meals (11). *Calophyllum inophyllum* plant extracts consist compounds having antimicrobial properties that can serve as antimicrobial agents in new drugs for the therapy of infectious diseases (12). An effective protocol for *in vitro* micropropagation of *Calophyllum inophyllum*, is

through multiple shoot formation from seed explants was developed (13). From the *C. inophyllum* leaves beneficial phytochemicals were identified. It was found that all parts of *C. inophyllum* plant can be used for human needs. The information is limited to extraction and identification of mixture of phytochemical compounds that are obtained from plant extracts (14). Oil content in the seeds is higher in large and medium weight classes which can be used for oil extraction more economically (15). Genetic structure, genetic diversity and degree of gene flow were discovered for island populations of *C. inophyllum* - a plant that employs sea-drift for seed dispersal (16). *C. inophyllum* plant contains a few compounds that are capable of binding to and inhibiting the epidermal growth factor protein and thereby preventing cell proliferation in an uncontrolled manner (17). *In vitro* production of secondary metabolites from cultured cells/tissues and molecular characterization of *Calophyllum inophyllum* have promising results (18). Seeds are used as oil-seed and as biofuel (19). *In vitro* studies on the cytotoxicity and apoptosis induction by the methanol extract of the fruit of *Calophyllum inophyllum* in MCF - 7 human breast cancer cell line also showing promising results (20).

*Calophyllum polyanthum* Wall.ex.chois (Poonspar Tree)

#### IUCN Red Data list category

Not Evaluated

#### Ecology

A medium sized to large, straight, cylindrical stemmed, evergreen tree, 45 m in height and 4.5 m in girth, distributed on the western coast and ghats from Maharashtra to Kerala, in Tamil Nadu and in the hill forests of northern Bengal, Sikkim, Bhutan, Arunachal Pradesh, Assam, Meghalaya and Mizoram, up to an elevation of 1500 m. The tree inhabits the wet evergreen and semi-evergreen forests of Western Ghats and it is one of the tallest trees found there. The tree is a shade-bearer, especially in its early stages, overhead light being essential for the rapid development of the tree. It cannot tolerate relatively dry conditions as prevalent in a moist deciduous forest, but does well in the evergreen forest. It grows well near the streams. The best sizes are reached on the moist and fertile soils of sholas and foothills which are rich in organic debris and decomposing bacteria. The coppicing-power of the tree is poor; it is sensitive to fire and is encouraged by fire protection. Flowering in February- March and fruiting during April-August. The seeds weigh 140- 180 to a kg and can be stored in gunny bags without appreciable loss in fertility. In the seedbed, several seeds often germinate only in the second year (3).

#### Regeneration

Germinative capacity of fresh seed is generally low, though the recorded highest is 89%. Pre-soaking the seeds in cold or hot water are advantageous. The tree regenerates in nature under dense sunshade of the evergreen forests.

The seeds germinate early in the rains, soon after

falling. Clearing the weeds improves germination and growth. Opening of the top canopy, after obtaining adequate recruitment on the ground, encourages establishment and further development of the plants. Regeneration of these trees is adequate in the localities where its distribution is low, but it is inadequate in the areas where it occurs more frequently. The tree can be raised by direct sowing or by transplanting the nursery-raised seedlings. The seedlings are quite slow growing. The direct sowings under the tree may sometimes be disappointing owing, probably to the overhead drip. Stump-planting generally yields poor results. Planting or sowing in the prepared soil seems to be advantageous. The nursery-raised plants are generally better than natural forest-seedlings (3).

The best season for planting the species in Tamil Nadu is from mid-June to early July. In very heavy rainfall areas, such as those at the head of the Western Ghats, planting after the heavy monsoon, sometime in mid-August, is advantageous. Opening the top canopy and a light thinning are reported to be advantageous. The tree is generally removed in selection-fellings and the minimum exploitable girth varies: in Kerala, it is 1.2 m; in Karnataka, 1.8 – 2.3 m and in Tamil Nadu, 2.7 m.

#### Uses

Timber is ideal for construction purposes and is much used for house posts, beams, ceiling – boards, floorboards, for squash courts, rafters, planking, cheap furniture, poles, masts, spars, helms, dugouts and ferries, chests, stores, railway coaches, tent poles, mathematical instruments etc. and for construction of bridges. Carefully selected and graded wood is suitable for aircraft construction. The antiseptic treated wood may be utilized for sleepers; the diffusion process after incision is recommended in preference to other processes of treatment. For poles also this processes can be considered. The timber is reported to be suitable for paper –pulp and various grades of plywood. It may be used as a substitute for Oregon Pine (*Pseudotsuga menziesii* (pinaceae) (Mirbel) Franco) (3).

***Calophyllum austroindicum* Kosterm. ex P.F. Stevens** (Rhomb-leaved Poon)

#### IUCN Red Data list category

Not Evaluated

#### Ecology

It is a medium to large sized tree, usually 10 – 30 m in height and 3 m in girth, Canopy trees in medium and high elevation wet evergreen forests between 1100 and 1800 m. Flowering and fruiting: November-June.

***Calophyllum pascalianum* B.R. Ramesh, Ayyappan & De Franceschi**

#### IUCN Red Data list Category

Data Deficient

#### Ecology

Tree to 18 m tall. Bark yellowish, longitudinally fissured, blaze reddish, sap yellow. Young branchlets quadrangular, slightly puberulent when young, leaves opposite, fruits immature, drupaceous, one seeded. Distribution in India

at Agasthyamalai region of the Western Ghats, Tamil Nadu, in evergreen and semi-evergreen forests, along riverbanks on the Mundanthurai plateau. Flowering and fruiting: March to May (21).

#### Conservation status

Data Deficient (DD)

This species is named after Dr J.P. Pascal. As the species is ripi cole and found downstream of the Servalar dam, and considered that the species is endangered (22).

#### Conclusion

*Calophyllum* species are important for their timber, leaves, roots, fruits and also for the medicinal properties. Plants of the genus are also known for their chemistry, with a variety of secondary metabolites isolated, such as, triterpenes, coumarins, flavonoids, and xanthones. Compounds from the genus have been reported to have cytotoxic, anti- HIV, antisecretory, cytoprotective, antinociceptive, molluscicidal and antimicrobial properties. Many species are important for their seed oil. The regeneration rate of each species is very low. Among these species only three species were evaluated and other species even not evaluated and also data deficient. The approaches to these tree species should change because the genus consists of trees with recalcitrant type seeds also. Recalcitrant seeded plants can be conserved only through *ex situ* mode. The most studied species is *Calophyllum inophyllum* (23). Other species are poorly concerned. Based on the current environmental scenario the trees should be evaluated and make sure that the species are not prone to extinction. Most of the tree species can be propagated only through seeds. So there is an urgent need to study this genus and conserve, regenerate and restore the plants, thus make the environment sustainable.

#### Acknowledgements

I wish my deep sense of gratitude to Dr. Kamarudeenkunju M. (Late), Associate Professor, Dept. of Botany, University of Kerala, Kariavattom, Thiruvananthapuram for his valuable guidance during this endeavour.

#### Authors contributions

CRV has done the literature survey, RPB corrected the manuscript & RM contributed towards correction of the manuscript and finalization.

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