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Review Article

BIOLOGY, AGROFORESTRY AND MEDICINAL VALUE OF CALOPHYLLUM INOPHYLLUM L. (CLUSIACEA): A REVIEW

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Introduction

Calophyllum inophyllum L. (Kamani, Tamanu, Alexandrian Laurel, Pinnai (Tamil) is an evergreen tree with supports a dense canopy of glossy, elliptical leaves, fragrant white flowers and large round nuts. It grows along coastal areas and adjacent lowland forests; occasionally occurs inland at higher elevations. It has been widely planted throughout the tropics and is naturalized in the main Hawaiian Islands (Friday & Okano, 2004). The tree is valued for its hardiness and beauty as an ornamental tree. In Hawai'I it is traditionally used for food vessels and in Palau for storyboards (Little & Skolmen, 1989). Oil from the nuts has been traditionally used for medicine and cosmetics and is today being produced commercially in the South Pacific. The fragrant flowers have been prized as an adornment and as a perfume. The dense shade cast by the thick crowns provides shelter but does not favor under story plantings (Lamb, 1981). It withstands typhoons. The tree grows best in direct sunlight, but grows slowly. Although wildings occur, it can be moderately difficult to propagate. Its slow growth and large seeds make it unlikely that the tree will become an invasive weed if introduced into new areas (Mueller-Dombois & Fosberg, 1998).

Distribution

The tree is native to east Africa, through India and Southeast asia to the Philippines, Taiwan, and the Marianas. Southward its range extends through Melanesia to Australia and through southern and eastern Polynesia. The habitat is primarily coastal and adjacent to lowland forests (Friday & Okano, 2004).

Taxonomy

Trees grow to heights of 8-20m (25-65ft), sometimes reaching up to 35m (115ft). Canopy width is often greater than the tree's height when the tree is grown in open locations. It has a broad spreading crown often with large, gnarled, horizontal branches. The light gray bark shows deep fissures alternating with flat ridges.

Sap is milky white. It bears clusters of 4-15 fragrant white flowers about 2.5cm across and 8-14mm long on long stout stalks in leaf axils. There are 4-8 oblong petals. The opposite leaves are dark green, shiny, and hairless with broadly elliptical blades 10-20cm long and 6-9 cm wide. Both the tip and base of the leaves are rounded. Leaf veins run parallel to each other and perpendicular to the midrib. The ball-shaped light green fruits grow in clusters. Fruits are 2-5 cm in diameter. The skin, which turns yellow and then brown and wrinkled when fruits are ripe, covers the thin pulp, the shell, a corky inner layer, and a single seed kernel. Fruits are usually borne twice a year. One large brown seed 2-4 cm in diameter is found in each fruit. Seeds are prepared by cleaning off the skin and husk from the shell of the seed; there are 100-200 seeds/kg (45-90 seeds/Ib), with shells intact but husks removed.

Genetics

Calophyllum is a genus of about 190species. *Calophyllum inophyllum* is common to locally abundant. It has been identified as a priority species for further genetic research by the South Pacific Regional Initiative on Forest Genetic Resources (SPRIG). Named varieties include *Calophyllum inophyllum* var. *inoophyllum,* C. *inophyllum*

var. *takamaka,* and C. *inophyllum* var. *wakamatsui.*

Associated Plant Species

In its native range C. *Inophyllum* grows along with fish-poison tree (Barringtonia asiatica), ironwood (*Casuarina equisetifolia,* beach she-oak), kou (C*ordia subcordata)*, beach hibiscus (*Hibiscus tiliaceus)*, screwpine (*Pandanus tectorius)*, trolpical almond (*Terminalia catappa,* sea almond), tropical almond (*Terminalia catappa,* sea almond), and milo (*Thespesia populnea).* Associated shrubs often include naupaka (*Scaevola sericea)* and tree helioppe (*Tournefortia argentea)*. Native herbaceous plants commonly include Canavalia spp., beach morning glory (*Ipomea pes-caprae*), and beach pea (*Vigna marina)* Mueller-Dombois and Fosberg 1998).

Environmental References and Tolerances

C.inophyllum grows in warm temperatures in wet or moderate conditions. It is not suited to high elevations, cool areas, or very dry conditions. **Elevation range:** 0-200m (660ft) in Hawai'I; up to 800m (660 ft) in Hawai'I; up to 800m (2,000 ft) at the equator. **Soils:** The tree tolerates a wide range of soils. It grows best in sandy well-drained soils in coastal areas, but will tolerate clays, calcareous soils, and rocky soils. **Soil texture:** Tree population tolerates light to medium soils (Sands, sandy loams, loams and sandy clay loams). **Soil drainage:** It is that of freely draining as well as soils with impeded drainage or seasonal waterlogging. **Soil acidity:** is of neutral to acid soils (pH 7.4-4.0). **Special soil tolerances:** are shallow and saline soils. **Tolerances:** It is a hardytree of tropical coastal areas that tolerates wind, salt spray, drought, and brief periods of waterlogged soils. It does not tolerate much shade nor cold weather. **Drought:** It can tolerate 4-5 months of drought in its natural littoral and riparian environments. **Salt spray and wind:** Tree grows in areas subject to sea breezes and salt spray.

Abilities:

The trees drop large amounts of fruit and wildings, which may often be found under mother trees, though growth is slow relative to many weed species. It regrows dependably but slowly after pruning. The branches can be pruned back every 2-3 years and they will regrow.

Growth and Development

The seedlings start out growing erect and with few branches. Growth slows after the first few years and the trees branch out, often developing multiple stems. (Ng, 1992). **Growth rate:** Young trees may grow up to 1 m (3.3 ft) in height per year for the first few years, but after that the growth rate slows. In Malaysia it is reported onje stand of trees attained a diameter of 50cm (20in) at breast height in 70 years (Soerlanegara and Lemmens, 1994). **Flowering and fruiting:** The tree flowers twice a year in the northern hemisphere, in the late spring/early summer and late fall. In northern Australia, it flowers in January and June. Young trees begin flowering after 7 or 8 years (Neal, 1965) in peninsular India. **Rooting habit:** The tree has a non-aggressive root system. **Reaction to competition:** The tree is only slightly share tolerant and will not grow under dense forest canopies. It grows slowly in height and may be overwhelmed by weeds in young plantations.

Propagation

It is moderately easy to propagate by seed and local seed sources are easily found. Germination and initial growth is slow and seedlings should be started six months before they are required. Once out planted, seedlings are hardy but slow growing. They prefer full sun and tolerate wind, salt spray, and drought (Salim et al., 2002). **Seed collection:** Ripe fruits are most easily collected from the ground under trees. Fruits fall twice a year in most location. **Seed storage:** Seed storage is intermediate. In other words, fresh seeds may keep for a few months stored cool and dry. Usually with the husk removed. **Pre-planting treatments:** Seed germination is slow if the entire fruit is planted. Ripe fruits (Skin is yellow or brown and wrinkled) may be soaked overnight to remove skin. Just prior to plantijng it is best to crack shells or shell seeds entirely using a mallet, pliers, or hammer, No additional tlreatments are required (Elevitch & Wilkinson, 200). **Growing area:** Plants may be started in containers at least 6 cm (2.4in) in diameter, of sufficient size to accommodate the fairly large seeds. Hot areas. Seedlings should be grown in full sun after 1-2 months. **Germination:** Seeds germinate gradually and shelled seeds germinate faster than seeds in their shells. One study found average germination items of 22 days for seeds fully shelled, 38 days for seeds in cracked shells, and 57 days for seeds still in their shells (Parras undated). Germination rates for fresh seed are greater than 90%.

Agroforestry/Environmental Practices

Its thick, waxy leaves decay slowly and form a thick layer of litter. It is a good tree for soil stabilization in coastal areas. It is being planted for firebreaks as it shades out fire-prone grasses, is moderately tolerant to fire itself, and is resistant to typhoons. The tree casts a dense shade and usually does not transmit enough light to allow understory crops to thrive in a multi-story system. It is grown as part of the mixed garden agroforestry systems in many Pacific islands. In the Solomons, it has been traditionally retained or planted along with other trees such as *Terminalia, Burckella, Pometia*, and *Canarium* in fallow yam and sweet potato fields (Ten, 1976).

Uses and Products

The mature fruit may be burned for mosquito repellent. Oil derived from the seeds was used as an alternative to candlenut oil in lamps by some Polynesians. It may also be used for massage or hair oil, particularly when scented. The oil was also used to finish wooden bowls

(Uphof, 1968) and for cosmetic and topical applications for healing of burns and skin diseases. The latex or a decoction of the bark is also sometimes used medicinally (Friday & Okano, 2004).

Flowers are used in leis (Garlands), scent hair, and to scent bark cloth. The beautiful wood has a fine lustrous texture that shows a distinctive interlocked grain. It is white and red when fresh cut and ages to a reddish brown. Because of this interlocked grain, sawn surfaces tend to be woolly. The wood is moderately dense, specific gravity 0.6-0.8 and is somewhat difficult to work due to the interlocked grain. In Hawai'I the tree provides one of the most valuable woods on the market, although timber is often unavailable. It has been used for paneling and furniture. Elsewhere the wood is used for general cabinetry, construction, and boat building. It has, however, been variously described as vulnerable or resistant to termite attack (Grace and Tome, 1995; Little and Skolmen, 1989).

The wood is particularly useful for food platters and calabashes, as it imparts no taste to the food. It is also prized for handicrafts because of its beauty. In Palau it is a favorite wood for carving traditional storyboards. The tree has traditionally been used in boat building. The bark is used as shingles for house walls in Yap. Latex from the cut bark has been made into a poison to kill rodents and stun fish. The nuts are hollowed out and the shells are used in making leis. In ancient times whistles were made from the hollowed-out shells.

Other Uses

In ancient Hawai'I, a brownish mauve dye for tapa or bark cloth (*Kapa*) was made from the fruit husks. The bark contains tannins which have been used to toughen fish nets. The flowers and the sap were used to scent bark cloth (*Kapa*) in old Hawai'i. The seed oil is used as a wood finish.

Ceremonial /Religious importance

It is a sacred tree in some Pacific Island traditions and has been planted alongside temples and is mentioned in old Hawaiian chants and they were planted around altars in ancient times (Abbot, 1992).

Ornamental

The tree is a favorite ornamental in the Pacific. The tree's tolerance of poor soil conditions, salt spray, and poor air quality make it hardy in urban conditions. The large size makes the tree impressive along wide avenues, but it is not suited to confined spaces (Neal, 1965).

External Application of the plant

The application of the Gum

The gum extracted from the plant (From the wounded bark) is emetic and purgative but also has use for the treatment of wounds and ulcers. It can also be mixed with strips of bark and leaves are infused in water, and the oil that rises to the surface is another application for sore eyes (Nadkarni and Nadkarni, 1999; Drury, 1873). The resin is said to be responsible for the colour and the odour of the oil and may be poisonous; it is also said to contain benzoic acide (Quisumbing, 1951). The gum resin is said to be good for old sores and wounds (Ibid 1951). The resin may be useful for chronic caterrh.

The application of the Bark

The bark is astringent (contains 11-10% tannin) and its juice is purgative (Ibid.1951). It is considered medicinal in asia, being used in India (according to some this is Indo-China) for orchitis (Ibid. 1951). In Indonesia, It is used after childbirth for vaginal discharge, the passing of blood and also for vaginal discharge, the passing of blood and also for use in gonorrhoea (Burkil, 1964). It is used in decoction for internal haemorrhages and as a wash for indolent ulcers (Nadkarni and Nadkarni, 1999).

The bark acts as an antiseptic and disinfectant. Rubbed with water lime juice, it makes a useful application on armpits, groins and feet in bromidrosis. The bark taken internally acts as an expectorant and is useful in chronic bronchitis and phthisis. The resin is mixed with strips of bark and leaves, steeped in water and the oil which rises to the surface is a household application for sore eyes. The astringent juice of the bark is a purgative and given in the form of a decoction for internal haemorrhages.

The application of the Leaves

The leaves soaked in water yield a bluish colour and natural scent is applied to inflamed eyes (Nadkarni and Nadkarni, 1999) also used for this purpose in Linga and Fiji. The leaf infusion is also taken internally for heatstroke and used in combination with an extermal application of the root decoction. A reverse treatment is used for a stitch where the hot poultice of eaves is applied externally and the root decoction taken internally (Quisumbing, 1951).

In Cambodia, the leaves are prescribed as an inhalation for migraine and vertigo and the oil forscables. In Madagascar, Polynesia and Malaysia the leaves are applied to sore eyes and other eye oilments, the pounded bark for orchitis; the gum resin is a vulnerary, resolvent and anodyne; oil from seeds is used against psoriasis and is antirheumatic. In java, the tree is supposed to posses diuretic properties, while in Samoa the plant is considered a virulent poison and the sap from the bark is used for the preparation of an arrow poson (Jayaweera, 1981). The leaves impart a pleasant odour when soaked in water, which is used in the phillippines as an astringent for haemorrhoids (piles) (Quisumbing, 1951 and Baurkil, 1994) and is used in Indonesia as an eye lotion (Ibid. 1951, 1994).

The plant has a rich history of use; Primitive tribes of native blacks throughout Papua New Guinea utilize the

leaves frequently for different kinds of skin problems. On Manus, the leaves are heated over a fire until soft and then applied to skin ulcers, boils, cuts, sores, and pimples, while on Dobu Island, leaves are boiled and a skin rash is washed periodically with the solution. The natives in New Caledonia and in Samoa also utilize these leaves for treating skin inflammations, leg ulcers and wounds. Water in which the macerated leaves have been soaked for some time has been used by them and other tribes for haemorrhoids (Quisumbing, 1951).

The application of the Fruits

The fruits according to some authors are more or less poisonous and only the endosperm of the still immature fruit is sufficiently poisonous to be ground and used as a rat bait (Burkill, 1994). An infusion of the fruit is said to be pectoral and stimulates the fruit is said to be pectoral and stimulates the mucous membrancfe of the lungs (Quisumbing, 1951).

The application of the Plant Sap and Seed

The balsam (oleoresin) from the bark is used for its cicatrizing properties. The Negritos of the Phiullippines mix the plant sap with suphur as an ointment to apply on boils, open sores and wounds (Ibid. 1951). Native blacks of Jamaica used another species Catophyllum Cataba for healing wounds and sores in the 18th century. The resin was melted and poured into gangrenous and incised would requiring only a couple of changes in dressing and producing recovery (Grime, 1979). A material (calophyllolide) isolated from the seeds reduced histamine inflammation and carrageenan-induced tissue swelling in rats (Oliver-Bever, 1986).

The oil from the seeds is used for soap making and is a rubefacient and irritant, but on the mucous membranes of the genito urinary organs it is specific. It is only employed externally and can be used as a stimulating application in cases of rheumaticm (Nadkarni and Nadkarni, 1999). In southern India, the oil of the seeds of the plant is used specifically for treating skin diseases. It is also applied topically in cases of rheumatism (Oliver – Bever, 1986). The root bark contains and antibacterial principle (Muller, 1993). The root bark contains and antibacterial principle (Muller, 1993). The plant is also reported to have novel inhibitors of HIV-I reverse transcriptase (Patil et al. 1993).

Pharmacology

The xanthones of *Calophyllum inophyllum* and *Mesua ferrea* namely, dehydrocycloguanandin (DCG), Calophyllin-B (CPB), jacareubin (JR), 6-desoxy jacareubin (DJR), mesuaxanthone (EX) were screened for various pharmacological effects in experimental animals. All the xanthones produced varying degrees of C.N.Session characterized by ptosis, sedation, decreased spontaneous motor activity, loss of muscle tone, potentiation of pentobarbitone sleeping time and ether anaerthesia in mice and rats. None of the xanthones had any analgesic, antipyretic and anticonvulsant activities. The xanthones did not produce any pharmacological effect in the cardiovascular system of frogs and dogs. All the xanthones exhibited anti-inflammatory activity both by intraperitoneal and oral routes in rats as tested by carrageenin induced hind paw oedema, cotton pellet granuloma and granuloma pouch techniques, in normal and adrenalectomised rats. The xanthones did not have any mast cell membrane stabilizing effect, and the degranulating effect of compound 48/80, diazoxide and Won-X-100 on rat peritoneal mjast cells in vitro war not prevented. JR and DJR exhibited antiulcer activity in rats. The xanthones did not alter the prothrombin time in rats (Gopalakrishnan *et al.,* 1980).

Calophyllolide was isolated from the nuts (Rastogi and Mehrotra, 1998) also in Indian J.Med. res 1980), 72, 762). ED_{50} of 140mg. Kg^{-1} when used orally, showed anti-inflammatopry and antiarthritic activity in formaldehyde-inflammatopry and antiarthritic activity in formaldehyde-induced arthritis and adjuvant arthritis in rats. LD_{50} was 2.5 gkg^{-1} orally. It was devoid of ulcerogenic activity up to twice the ED_{50} dose.

Dehydrocycloguanandin, calophyllin-B, Jacareubin and 6-deoxyjacareubin produced varying degrees of CNS depression, characterized by ptosis, sedation, decreased spontaneous motor activity, loss of muscle tone, potentiation of phenobarbitone sleeping time and ether anaesthesia in mice and rats. All the xanthones exhibited anti-inflammatory activity by both intraperitoneal and oral r5outes in rats. Jacareubin and 6-dexylacareubin also showed antiulcer activity iin rats (Gopalakrishnan et al. 1980).

Calophyllolide, iolated from the seeds (Oliver – Bever, 1986) reduced histamine inflammation and carrageenan induced tissue swelling in rats. Together with inophyllide, it reduced oedema by 60.7 and 29.8%, respectively (compared to hydrocortisone, which reduced inflammation by about 44%). The safety margin of calophyllolide is very similar to that of oxyphenbutazone (21.4 and 25 $mgkg^{-1}$, respectively) (Rastogi and Mehrotra, 1998). Inophyllumbs B and P inhibited HIVreverse transcriptase (IC_{50}38 and 130 nm. respectively).

A search for anti-tumor-promoting agents was carried out by a primary screening of ten 4-phenylcoumarins by examining their possible inhibitory effects on Epstein—Barr virus early antigen (EBV-EA) activation induced by 12-O-tetradecanoylphorbol-13-acetate in Raji cells. All of the compounds tested in this study showed inhibitory activity against EBV, without showing any cytotoxicity. Calocoumarin-A(5) showed more potent activity than any of the other compounds tested. Furthermore, calocoumarin-A(5) exhibited a marked inhibitory effect on mouse skin tumor promotion in an in vivo two-stage carcinogenesis test.

The results of the present investigation indicate that some of these 4-phenylcoumarins might be valuable as potential cancer chemopreventive agents (anti-tumor-promoters). (Itoigawa et al.,)

Chemical Constituents

Steam volatile oil from flowers was examined by the GCMS technique. Twenty-five checmial components were detected, 17 of which, accounting for approximately 75% of the oil, were identified 1,2,3,4,4 –hexahydro 1,6-4-(I-methylethyl) napathalene was found to be the most abundant component (24.5%). Other major constituents were: cubenene, bourbonene, selinene, calarene, farnesene, fernesene, cadinene, sesquiphellandrene, octadecanal, hexadecane and farnesol (Samsudin et al., 1998).

Studies on the chemical composition of the heartwood showed the presence of several xanthones, jacareubin, 6-deoxyjacareubin, 1,7-dihydroxyxanthone, 1,5-6-trihydroxyxanthone, 6(3-methylbut-2-enyl)- 1,5-di-hydroxyxanthone, 2-(3-methylbut-2-enyl)-1,3,5-tri-hydr-oxyxanthone,2-(3-hydroxy-3-methylbutul)-1,3,5,6-tetra-hydroxyxanthone (Al-Jebory and Locksley, 1971; Goh and Ibrahim, 1969).

Systematic extraction of the dried and groundnuts of led to the isolation of six substances. Four of them can be identified according to their physical properties, chemical reactions and spectral data. Calophyllolide was found in both the hexane and dichloromethane extracts. Inophyllolide (cis and trans) was found in the hexane extract. Stigmasterol and a mixture of stigmasteryl-3-0-D-glucopyranoside,-stigmasteryl-3-0—D-glucopyranoside were found in the dicholoromethane extract, Investigation of two unknown compounds, one from the dicholoromethane extract and one from hexane, is in progress. In addition, the saponifiable matter of the crude hexane exact was methylated. The GC-MS of the methyl ester shows four fatty acids: Palmitic acid, stearic acid, oleice acid and linoleic acid (Bushan et al., 1975).

Dried flowers were extracted with hexane, dichloromethane and methanol, respectively. The curde hexane and methanolic extracts showed antibacterial activity against *Staphylococcus aureus, Salmonella derby* and *Bacillus cereus.* Fractionation of these two crude extracts by column chromatography led to the isolation of sevens substances. Five substances were characterized by mean of physical properties. TLC with authentic samples and spectral data, five substances were a mixture of long chain esters and a mixture of long chain alcohols (C28, C30, C33), which found in the hexane extract and a mixture of sterioids (Stigmasterol, -sitosterol), quercetin and myricetin were found in methanolic extract (Sundaram et al., 1986).

The biossay results indicated that myricetin and aromatic compound (T7) showed antibacterial activity against *Bacillus cereus* and *Staphylococcus aureus* at dose level 300 microgram/dis. Besides, myricetin also showed activity against Escherichia coli (Potti &Kurup, 1970).

Lederer et al (1953) identified two main actives in seed oil and succeeded in isolating two essential components of the oil. He found a totally new fatty acid, Calophyllic acid and a lactone endowed with antibiotic properties to be at the origin of the oil's amazing clcatrizing power. The dark yellow oil extracted from the seeds contains a poisonous resin, which has a parsley-like odour. The resin is similar to myrrh and is alcohol soluble.

The bark contains tannin (Burkill, 1994) and exudes an oleoresin, which contains benzoic acide (Jeyaweera 1981). The oleoresin is officinal in the Mexican and Spanish Pharmacopoelas (Quisumbing, 1951). The leaves contain friedelin and triterpenes of the friendlin group, namely calophyllal, calophyllol and clopyllic acid (Govindachari et. Al.1967) and from the heartwood xanthones sucha s mesuraxanthone B and calophyllin B are obtained (Govindachari, 1968). Interestingly, many of these substances, i.e. canophyllal and friedelin, are also found in syzigium species (Mercfk 1996).

Tamilnadu oil contains terpenic esse4nces, benzoic and oxi-benzoic acids. Small amounts of vitamin F and phospho-aminolipids come along with glycerides and saturated fatty acids. The plant contains 4-phenylcoumerins that have antitumour activity (Itoigawa, 2001).

The following active principles have been found in the oil: calophyllolide ($C_{25}H_{22}O_5$) the molecule of which contains a lactonic and a methoxyl group, calophuyllic acid ($C_{25}H_{24}O_6$), which results from the saponification of the calophyliollide. These active principles are coumarine derivatives (Muller, 1993).

Composition of the oil :
Free fatty acids, glycerides, sterols.
Terpenoids and steroids (Canophyllal, canophyllol, canoophyllic acid).

Coumarinic dervities :

P-catophyllolids (natural neo-flavonoids with antibacterial, anti-inflammatory an dantiblood coagulation properties). Inophyllolids (natural neo-flavonoids with antiviral properties), calophyllic acid (natural neo-flavonoid with antimolluscidal and healing activities).

Medicinal value of seed Oil:

The oil from C.inophyllum is also known as Tamanu oil. Many remedies sold today in the markets of developed nations contain ingredients that have a long history of use by indigenous peroples in their countries of origin. Such is the case with tamanu oil. A traditional remeduy with a history of native use in Polynesia and Southeast asia (Cox and Banack,

1991; Pectard, 1972;Pillai et al. 1974; Whistler, 1992). Only within the past few years has tamanu oil begun to penetrate the European and U.S. markets, primarily in the cosmetic sectors. Since the 1930s the effectiveness of tamanu oil has been studied inhospitals and by researchers in Europe, asia, and the Pacific islands (Petard, 1972; Jeanson, 1938). This research has revealed that tamanu oil is a significant topical healing agent with skin healing (Petard, 1972; Jeanson, 1938), anti-inflammatory (Petard, 1972; Arora et al. 1962; Bhalla et al. 1980; Bhushan et al. 1980; Saxena, 1991), antimicrobial (Petard, 1972; Goh et al. 1991; Mahmud Et. Al. 1998; Sundaram et al. 1986), and antioxidant (Mahmud et al., 1998) properties.

Oil in Nuts

When the fruits of the tree are collected and cracked open, the blonde nut kernel inside contains little evident oil upon pressing or grinding. But when the kernel is dried on a rack for a month or so, it turns a deep, chocolate brown, and becomes sticky with rich oil. Once this transformation has taken place, the oil can be easily extracted from the dark kernels using only mechanical pressing. The resulting oil has rich texture and greenish-amber color. The means by which the tamanu kernel becomes oily remains unknown. At present, no studies explain this process (Kilham, 2004).

Oil and Cicatrization

Tamanu oil applied to wounds possesses the capacity to promote the formation of new tissue, thereby accelerating healing and the growth of healthy skin. This process of forming new tissue is known as cicatrisation (Petard, 1972; Chevalier, 1951). Tamanu oil is a widely used traditional topical aid. In pacific island folk medicine, tamanu oil is applied liberally to cuts, scrapes, burns, insect bites and stings abrasions, acne and acne scars, psoriasis, diabetic sores, anal fissures, sunburn, dry or scaly skin, blisters, eczema, and herpes sores, and to relieves sore throat when it is applied topically to the neck. The oil also demonstrates pain-relieving properties and has been used traditionally to relieve neuralgin, rheumatism, and sciatica. Polynesian women apply tamanu oil topically to promote healthy, clear, blemish-free skin, and massage it onto babies to prevent diaper rash and skin eruptions (Petard, 1972: Chevalier, 1951: Sidi, 1955).

Anti-Neuralgic and Skin healing Activity

Traditionally tamanu oil has a history of topical use for relieving the pain of sciatica, shingles, neuralgia, rheumatism, and leprous neuritis (Jeanson, 1938). In the late 1920s, Sister Marie-Suzanne, a nun in the Society of Mary stationed in fiji, became aware of a local topical aid for neuritis known locally as *dolno,* i.e., tamanu oil. The nun began to administer tamanu oil topically to leprosy victims for the relief of neuritis associated with that disease, with apparent positive results; her reports of success with this treatment attracted the interest of scientists in France (Petard, 1972; Jeanson, 1938). In other cases, tamanu oil has been reportedly employed successfully to heal severe burns caused by boiling water, chem. Cals, and X-rays (Petard, 1972: Picidalo and Chaslot, 1955).

Lipid Composition

The oil of tamanu contains basic classes of lipids (fats), enumerated below.

General lipid composition: neutral lipids: 92%.
Neutral lipids: Monoacylglycerols: 1.8%, sn-1,3-Dia-glycerides: 2.4%, sn-1-2(2,3)-diaglycerides:2.6%, Free fatty acids: 7.4%, Triacylglycerols:82.3%, Sterols, sterolesters and hydrocarbons:3.5%. Glycolipids: Monogalactosyldiacyl glycerol: 11.4%, Acylated sterolglucoside: 13.1%, Nono-galacto-Sylmonoacylglycerol: 22.2%, Acylmono-galactosyl-diacylg-lycerol: 53.3%
Phospholipids: Phosphatidyl-ethanolamine: 46.3%, Phosphatidylcholine: 33.8%, Phosphatidic acid: 8.1%, Phospha-tidylserine: 6.1%, Lysophosphati-dylcholine: 5.7%, (Petard, 1972; Hemavathy and Prabakar, 1990; Lederer et al., 1953).

Anti-Inflammatory Activity

Anti-inflammatory activity is due partly to the 4-phenylcoumarin calophyllolide (Bhalla et al., 1980; Saxena et al., 1982; Duke, 2003) and to a group of xanthones in the oil, including dehydro cycloguanandin, calophyllin-B, jacareubin, mesuaxanthone-A, mesuaxanthone-B, and euxanthone. All the xanthones in tamanu oil show anti-inflammatory activity (Gopalakrishnan et al., 1980), which explains reductions of rashes, sores, swelling, and abrasions with topical application of the oil (Petard, 1972).

Antibacterial and Ant fungal activity

Tamanu oil demonstrates significant antimicrobial activity, as demonstrated in antibacterial and antifungal tests (Petard, 1972; Mahmud et al. 1998; Sundaram, 1986). The oil contains several powerful bactericide/fungicide agents, which demonstrate efficacy against various human and animal pathogens. These antimicrobial phytochemical agents include friedelin, canophyllol, canophyllic acid, and inophynone (Mahmud et al., 1998).

In anti bacterial studies conducted in Karachi, Pakistan, esearchers discovered the following:

Canophyllic acid demonstrated moderate antibacterial activity, compared with ampicillin and amoxicillin, against Proteus mirabilis (a cause of bladder infections, wound infections, septicemia, and pneumonias, mostly in hospitalized patients) (MMID, 2003).

Canophyllol demonstracted good activity, compared with ampicillin and amoxicillin, against Staphylococcus aureus (a cause of inflammation, suppuration, abscesses, boils, infected wounds, septicemia, and conjunctivitis), cornebacterium

diptheriae (the cause of diphtheria), Klebsiella pneumonia (a cause of septicemia, infected wounds, and infected burns), and Proteus mirabilis (a cause of urinary tract infection, septicemia, and infected wounds).

Friedelin demonstrated good activity, compared with ampicillin and amoxicillin,m against S. aureus. In antifungal tests, the same researchers discovered the following: Friedelin exhibited good antifungal activity against Pseudallescheria boydii, (a cause of fungal keratitis and Madura Foot, a disease in which the foot swells and suppurates, with multiple open sinuses).

Friedelin exhibited moderate activity against Trichophyton schoenleinii (cutaneous fungus occurring in hair, skin and nails, and associated with multiple open sinuses).

Friedelin exhibited moderate activity against Trichophyton schoenleinii (cutaneous fungus occurring in hair, skin and nails, and associated with "Jock itch," ringworm, athlete's foot, and dermaphytosis of the scalp and beard). The n-butanol fraction of tamanu oil was examined against various fungal cultures, showing significant activity against *Trichophyton* semi and T. metagrophyte(both cutaneous fungi occurring in hair, skin and nails, and associated with "jock itch," ringworm, athlete's foot, and dermaphytosis, a fungal disease usually transmitted from animals to humans in the scalp and beard).

Researcbers concluded that the antimicrobial agents in tamanu oil could be used effectively to treat a range of infections fo the skin and eyes and to treat ringworm (Mahmud et al., 1998).

Antioxidant Activity

Xanthones and coumarins in tamanu oil demonstrate antioxidant properties, specifically inhibiting lipid peroxidation, Cell membranes are made of lipids. Lipids are organic compounds that are oily to the touch and are insoluble in water but are soluble in nonpolar organic solvents (e.g. chloroform, ether). Lipids include fats, oils, waxes, sterols, and triglycerides. The antioxidant activity of tamanu oil helps to protect skin cells from damage by reactive oxygen species (ROS) and other oxidative antagonists (Mahmud et al., 1998).

Oils as Topical First Aid

Due to its cicatrizing, anti-inflammatory, and antimicrobial activities, oil of tamanu is a versatile topical aid suitable for use in a broad range of skin conditions. Oil of tamanu can be applied undiluted directly to skin. There are no reports of adverse effects due to such application of tamanu.

Oil for Cosmetics

Tamanu oil is suitable for general skin and cosmetic purposes. The oil's mild and pleasant aroma and luxurious feel make it ideal for use in lotions, creams, ointments, and other cosmetic products. Oil of tamanu absorbs readily, leaving the skin, without any residual greasiness or oiliness. Tamanu oil has the potential to be a significant ingredient for companies wanting to develop beneficial natural products.

Conclusion

Tamanu oil is an excellent example of a traditional remedy that has percolated to broader attention due to a combination of effective use in traditional settings and scientific research supporting its traditional uses. Tamanu oil offers relief for common skin problems and has demonstrated significant benefit in hospital settings as a first aid treatment in cases of serious burns.

Tamanu oil fulfills three significant ideals: a healing benefit to users; the collection of the nuts and manufacture of the oil cause no damage to the environment; and the collection and processing of the nuts provides income to indigenous people by enhancing the local economies of small communities.

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