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Syzygium travancoricum: A short review

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Abstract
A comprehensive literature review was conducted to identify and analyse existing studies, reports, and reviews related to the aspects of ethnobotanical, phytochemical and pharmacological reviews of *Syzygium travancoricum.* The following databases were searched: PubMed, Google Scholar, Web of Science, Willey Online Library, Science Direct and Research Gate. The literature search used the terms *'Syzygium'* '*Syzygium travancoricum Ethanobotany' 'Syzygium travancoricum morphology',* '*Syzygium travancoricum essential oil', 'Bioactivities of Syzygium species' and Phytoconstituents and chemistry of Syzygium species'.*

Keywords: *Syzygium travancoricum*, ethnobotany, phytochemicals, pharmacology, medicinal plants

Introduction
The study of ethnobotanical resources bridges the gap between traditional knowledge and modern scientific exploration, offering insights into the therapeutic, ecological, and cultural significance of plant species. Among these, *Syzygium travancoricum*, a vulnerable tree species native to the Western Ghats of India, occupies a unique place in the biodiversity of the region. This species, belonging to the Myrtaceae family, is not only an essential component of the ecosystem but also holds traditional medicinal value, making it a subject of interest for conservationists and researchers alike.

Endemic to India, *Syzygium travancoricum* thrives in semi-evergreen and mangrove forests, demonstrating adaptability to specific ecological conditions. However, habitat destruction and limited geographical distribution have pushed it to the brink of extinction, earning it a place on the International Union for Conservation of Nature (IUCN) Red List as a vulnerable species [1]. The plant's bark, leaves, and other parts have been traditionally used for treating various ailments, reflecting the rich ethnobotanical knowledge of local communities. Yet, scientific documentation and validation of these uses remain scarce.

The genus *Syzygium* is renowned for its diverse phytochemical profile, encompassing essential oils, phenolic compounds, flavonoids, and triterpenoids, many of which exhibit significant pharmacological activities. While closely related species like *Syzygium cumini* and *Syzygium aromaticum* have been extensively studied, S. travancoricum has largely been overlooked in scientific literature. This gap presents an opportunity to explore its chemical composition, pharmacological potential, and ecological significance.'

This review consolidates existing information on the taxonomy, distribution, morphological features, traditional uses, and pharmacological properties of *Syzygium travancoricum*. By highlighting the plant's potential and the pressing need for its conservation, this study aims to foster a better understanding of its role in biodiversity and its prospects in medicinal research. Additionally, it underscores the importance of integrating traditional knowledge with scientific methods to unlock the full potential of this vulnerable species.

Ethnobotanical Review [2]
Plant Profile
Botanical name: *Syzygium travancoricum* Gamble
Synonym: *Syzygium stocksii* [3], *Eugenia stocksii* Duthie
Family: Myrtaceae
Parts used: Bark
Common name: Poriyal, Vatham Kolli Maram, Kulavetti, Vallamanchi

Taxonomical Classification
Kingdom: Plantae
Phylum: Tracheophyta
Class: Magnoliopsida
Order: Myrtales
Family: Myrtaceae
Genus: *Syzygium*
Species: *Travancoricum Gamble*

Distribution
Syzygium travancoricum have been seen in few locations in Kerala and are endemic to India. It is threatened by habitat loss. Endemic distribution has been seen in southern Western Ghats region of India

Kerala: Thrissur district, Ernakulam district, Alappuzha district, Pathanamthitta district,
Kollam district, Thiruvananthapuram district

Tamil Nadu: Nilgiris district
Karnataka: Siddapura taluk

Description of Plant
Syzygium stocksii occupies in the hillocks and low land swamps of evergreen and semi evergreen forest which is under pressure due to the deposition of silt and waste as a result of anthropogenic interventions. Intense soil erosion, habitat fragmentation and changes in land use patterns due to monoculture plantations, industries and urbanisation were considered as the major threats to their population and regeneration.[4]
Habitat: Terrestrial; Semi evergreen and mangrove forest
Natural history - Cyclicity: Flowering and fruiting: April-June
Habit-Growth cycle: Tree (Fig: 1.1 & 1.2)

Morphological Review [1]
General: Evergreen trees, growing up to 25-30 meters high.

- **Bark:** Greyish-brown surface, longitudinally fissured.
- Peels off in thin, irregular flakes.
- Inner bark is grey
- Branchlets are tetragonous. (Fig: 1.3)
- **Leaves:** Simple, opposite, and estipulate.

1. **Petiole:** 10-20 mm long, stout, grooved above, glabrous.
2. **Lamina:** 8-16.5 x 5-8.5 cm, ovate or ovate-oblong.
3. **Base:** narrowed and decurrent on petiole.
4. **Apex:** acuminate, acumen folded, obtuse.
5. **Margin:** entire, thin, filmy glabrous.
6. **Lateral nerves:** 10-15 pairs, parallel but very irregular, distant, prominent, and looped near the margin forming an indistinct intramarginal nerve.
7. **Intercostal reticulation:** faint. (Fig: 1.4)

- **Flowers:** Bisexual, white, mostly in axillary lax cymose corymbs.

1. **Peduncle:** 4.5-5 cm long, can extend up to 8 cm.
2. **Petals:** white, calyptrate.
3. Stamens: numerous, free, bent inwards at the middle when in bud.
4. **Ovary:** inferior, 2-celled, many ovules.
5. **Style:** 1
6. **Stigma:** simple. (Fig: 1.5)

- **Branches:** Long, ascending.

1. **Calyx tube:** short, 1 mm across.
2. **Calyx lobes:** 4, very short.
3. No thickened staminal disc.

- **Fruit:** Berry, unilocular oblong-obtuse on both sides, 1 x 0.5 cm.

1. Deep violet colour.
2. Juicy pericarp.
3. **Seed:** one. (Fig: 1.6)

Fig 1.1: *Syzygium travancoricum* tree

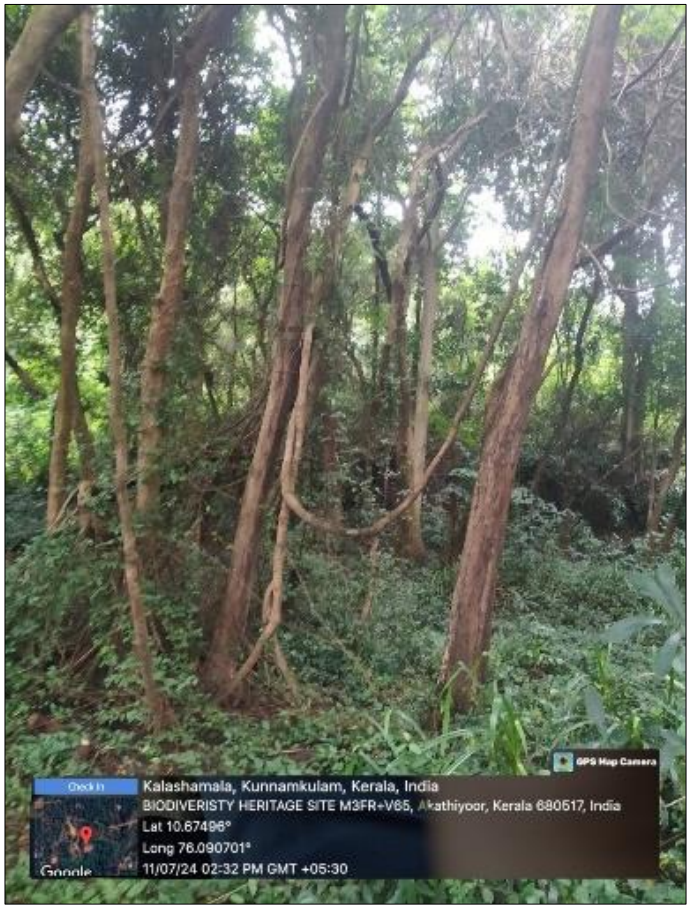

Fig 1.2: *S. travancoricum* tree

Fig 1.3: *S. travancoricum* Bark

Fig 1.4: *S. travancoricum* leaves

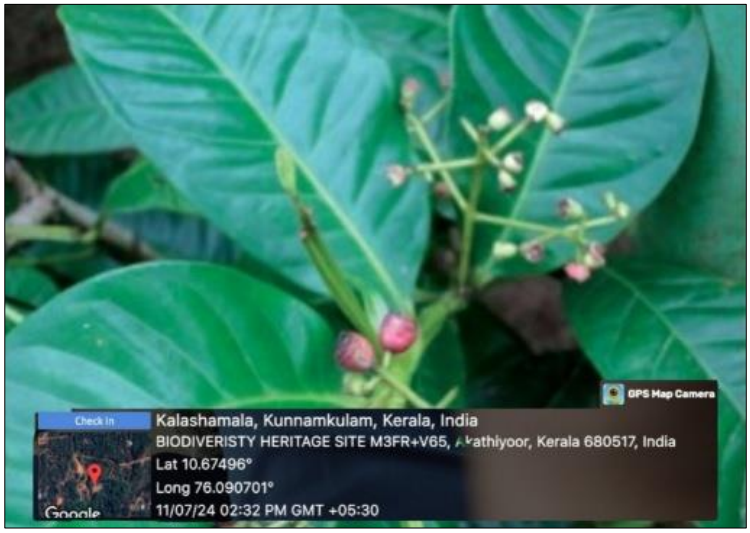

Fig 1.5: *S. travancoricum* flower

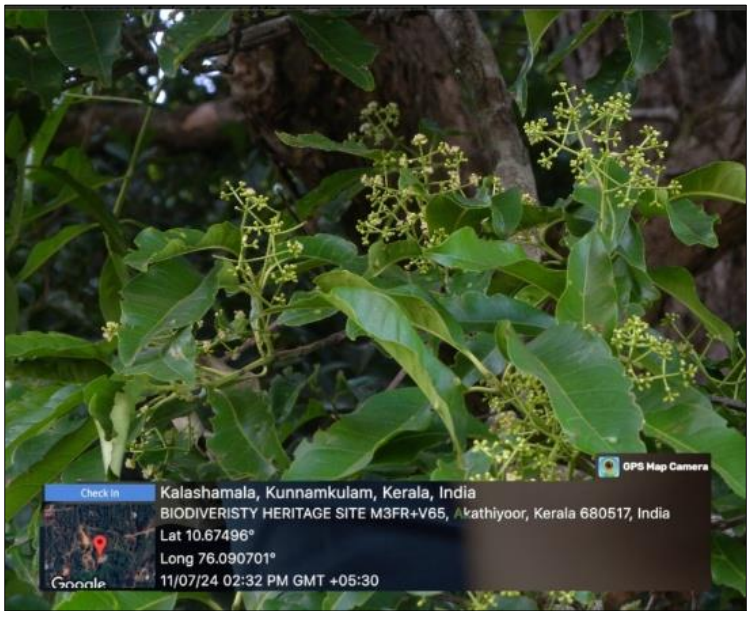

Fig 1.6: *S. travancoricum* fruit

Chemical Constituents

S. travancoricum is a plant species native to the Western Ghats of India. While detailed chemical studies on this specific species are somewhat limited compared to more extensively researched plants, general information on the chemical constituents of the genus *Syzygium* can provide some insights. Here are some typical chemical constituents found in *Syzygium* species, which may also be relevant to *Syzygium travancoricum*:

1. **Essential Oils:** Many species of *Syzygium* are known to contain essential oils in their leaves, fruits, or other parts. These oils often contain compounds such as terpenes (like α-pinene, β-pinene), sesquiterpenes, and aromatic compounds [5].
2. **Phenolic Compounds:** *Syzygium* species are rich in phenolic compounds such as flavonoids (quercetin, kaempferol, myricetin derivatives), phenolic acids (Gallic acid, ellagic acid), and tannins. These compounds contribute to antioxidant properties and potential health benefits.
3. **Triterpenoids:** Some species may contain triterpenoids compounds, which can have various biological activities including anti-inflammatory and antimicrobial effects.[37]
4. **Volatile Compounds:** Besides from essential oils, volatile compounds like aldehydes, ketones, and alcohols may also be present, contributing to the aroma and flavour of the plant parts [5].
5. **Fatty Acids:** This is especially true concerning the seeds and other lipid-rich parts of *Syzygium* species may contain fatty acids, which are important for their nutritional value.
6. **Alkaloids:** Although not frequently found, some *Syzygium* species have been reported to contain alkaloids, which can have diverse pharmacological activities.

Traditional Medicinal Uses

Traditional medicinal uses of *Syzygium travancoricum* are not extensively documented in scientific literature compared to more widely studied species within the *Syzygium* genus. However, based on general knowledge and regional ethnobotanical practices, here are some traditional medicinal uses attributed to *Syzygium travancoricum*:

1. Digestive Disorders: In traditional medicine, various parts of *Syzygium* species are used to treat digestive issues such as diarrhoea, dysentery, and stomach-aches. This use likely extends to *Syzygium travancoricum*, given the general application of similar species.

2. Anti-inflammatory and Antioxidant: The bark and leaves of *Syzygium* species are often used for their anti-inflammatory and antioxidant properties. These properties may be utilized in treating inflammatory conditions and promoting overall health. [5]

3. Wound Healing: Poultices or extracts from *Syzygium* species are sometimes applied externally to wounds and cuts for their purported wound-healing properties. This use could extend to *Syzygium travancoricum.*

4. Antimicrobial Activity: Many *Syzygium* species are known for their antimicrobial properties. Traditional uses may include treating infections, especially those of the gastrointestinal tract or skin. [5]

5. Diabetes Management: Some *Syzygium* species are reputed to have hypoglycaemic effects. While specific to *S. travancoricum* is not well-documented, but used by the local peoples for curing diabetes. Similar uses may exist based on the genus's reputation in traditional medicine [6].

Pharmacological Review

Various parts of *Syzygium* species, including leaves, seeds, fruits, barks, stem barks, and flower buds, are reported to have diverse pharmacological activities due to the presence of secondary metabolites such as terpenoids, chalcones, flavonoids, lignans, alkyl phloroglucinols, hydrolysable tannins, and chromone derivatives (Srivastava *et al*., 2005; Ayyanar *et al*., 2013; Cock & Cheesman, 2018) [7, 8, 9]. Despite the rich diversity within the genus, only *S. aromaticum* and *S. cumini* have been extensively studied due to their widespread use in traditional medicine systems like Iranian, Ayurveda, and Unani.

Antioxidant Activity

S. cumini: - Eshwarappa *et al*. (2014) [10] reported higher antioxidant potential in methanolic leaf gall aqueous and methanol extracts compared to reference standard ascorbic acid, utilizing DPPH, nitric oxide-scavenging, hydroxyl scavenging, and FRAP methods.

Ahmed *et al*. (2019) [11] evaluated leaves, finding a high average phenolic content (369.75 mg GAE/100g) and significant antioxidant activity (IC50 133.07 µg/ml).

S. samarangense: - Banadka *et al*. (2022) [12] reported antioxidant activity of fruit extract using ABTS, DPPH, and FRAP methods. The IC50 values for DPPH and ABTS scavenging activity were 175 µg/ml and 250 µg/ml, respectively when compared to the standard L-ascorbic acid which having the IC50 value 140 µg/ml.

Antimicrobial Activity

S. cumini and S. travancoricum: Shafi *et al*. (2002) [13] reported antibacterial activity of essential oils from leaves against *Bacillus sphaericus, B. subtilis, S. aureus, E. coli, P. aeruginosa, and Salmonella typhimurium*, with significant activity against *S. typhimurium.*

S. cumini: Amin *et al* (2012) [14] demonstrated antifungal activity of methanolic leaf extracts against *Alternaria alternata* that was isolated from the die-back trees of *E. globulus* and *E. citriodora*. The varying concentration of methanolic extract shown reduction with the range of 82-88% in the fungal biomass.

Gupta & Bhadauria (2015) [15] was founded that aqueous fruit and bark extracts inhibited the growth of *F. oxysporum and Alternaria alternata* respectively.

Kumar and Singh (2021) [16] found antimicrobial activity of various leaf extracts such as aqueous, methanolic, hexane and ethyl acetate against dental caries-causing strains like *S. viridans, S. mutans, E. coli, P. aeruginosa, S. aureus, and B. subtilis.*

Anti-inflammatory Activity

S. jambos: Sharma *et al*. (2013) [17] found ethanol leaf extract reduced release of inflammatory cytokine IL-8 and TNF-α by 74-99%, indicating anti-acne effects.

S. cumini: Machado *et al*. (2013) [18] detected anti-inflammatory and apoptotic activity of essential oil in mice models, reducing granulomatous area and altering granuloma patterns that were formed in the hepatic parenchyma.

Siani *et al*. (2013) [19] found that essential oil from leaves and terpene-enriched fractions that were obtained by vacuum

distillation inhibited eosinophil migration by 63-67%, correlating with presence of α-pinene and β-caryophyllene.
Latief *et al*. (2015) [20] investigated anti-inflammatory effect in carrageenan-induced hind paw oedema and antioxidant effects in CLP-induced sepsis in mice using trimeric myricetin rhamnoside (TMR), also flavonoid glucoside from the leaves of *S. cumini* concludes it had potential anti-inflammatory benefits.

Anticancer Activity

S. travancoricum: Smitha P.S (2023) [5] finds anticancer potential of Syzygium travancoricum essential oil has been explored through various *in vitro* studies. Using the MTT assay, the essential oil demonstrated significant anti-proliferative activity against the B16 melanoma cell line. Further investigations into the underlying mechanisms revealed its ability to induce cell apoptosis and alter reactive oxygen species (ROS) activity. Additionally, the essential oil was found to disrupt mitochondrial membrane potential, influence the cell cycle, and affect DNA content, collectively contributing to its anticancer efficacy.

S. aromaticum: Prashar *et al*. (2006) [21] reported that the essential oil can helps to relieve pain and promote healing. The *In-vitro* studies finds that cytotoxic properties of oil and eugenol toward human fibroblasts and endothelial cells.
Dwivedi *et al*. (2011) [22] found essential oil inhibited proliferation of HeLa, MCF-7, MDA-MB-231, DU-145 cell lines and Te-13 cell lines, with apoptosis as the primary mechanism. Natural essential oil and extracts were not significantly toxic to normal human peripheral blood lymphocytes.

Antidiabetic Activity

S. travancoricum: Smitha P. S. (2023) [5] conducted a study on the antidiabetic activity of *Syzygium travancoricum*, focusing on the effects of water and ethanol leaf extracts on various digestive enzymes. The research revealed that these extracts effectively suppressed the activity of lipases, α-amylase, and α-glucosidase in a dose-dependent manner. Among the different extracts tested, the leaf essential oil of *S. travancoricum* demonstrated moderate inhibitory properties against lipase (26.8%), α-amylase (63.22%), and α-glucosidase (53.55%). The moderate antidiabetic effects of *S. travancoricum* essential oil were attributed to the presence of oxygenated terpenoids, specifically monoterpenes and sesquiterpenes. These terpenoids are believed to bind to the amino and sulfhydryl groups of enzymes, inducing a conformational change that results in the loss of enzyme activity. This binding mechanism suggests that the moderate antidiabetic effects observed are due to the inhibition of these enzymes by the volatile components of the essential oil.

S. samarangense: Shen *et al*. (2012) [23] found fruit extract inhibited inflammatory response and reduced insulin resistance in TNF-α treated FL83B cells.
Huang *et al*. (2016) [24] found vescalagin reduced insulin resistance in hyperglycemic rats by a high-fructose diet.

S. cumini: Sanches *et al*. (2016) [25] found hydroethanolic leaf extract reduced hyperinsulinemia and insulin resistance in obese rat models that was induced by MSG by modifying beta-cell insulin release.

Other species: Zulcafli *et al*. (2020) [26] reviewed anti-diabetic potential of eight Syzygium species, highlighting inhibition of carbohydrate metabolism enzymes as the most researched mechanism.
Mahmoud *et al*. (2021) [27] reported *S. aqueum* leaf extract decreased glucose levels and increased insulin secretion in STZ-induced diabetic rats.
Konda *et al*. (2021) [28] found *S. paniculatum* fruit extract improved insulin receptor function and reduced hepatic insulin resistance in HFD-induced diabetic rats.
The Syzygium genus exhibits significant pharmacological potential, particularly in antioxidant, antimicrobial, anti-inflammatory, anticancer, and antidiabetic activities. While S. aromaticum and S. cumini are well-studied, there is a need for further research on other species to explore their potential benefits and applications in medicine.

Phytochemical Review

The family Myrtaceae is characterized by an abundance of tannins and flavonols, with myricetin derivatives being frequently reported as significant chemical constituents (Amaral *et al*., 2001[29] Various studies on the genus *Syzygium* have identified numerous compounds, including triterpenes (Djoukeng *et al*., 2005; Kuiate *et al*., 2007) [30, 31], tannins, flavonoids (Kuo *et al*., 2004) [32], chromone derivatives (Tanaka *et al*., 1993) [33], phenylpropanoids (Miyazawa & Hisama, 2003; Tanaka *et al*., 1993) [34, 35], and phloroglucinols derivatives (Zou *et al*., 2006) [32].
A notable compound identified in *Syzygium grijsii* is a monolignan, which demonstrated chemotaxonomic significance (Miyazawa & Hisama, 2003) [34]. Additionally, phenylpropanoids isolated from *S. aromaticum* were found to be precursors to those isolated from *S. grijsii*, indicating a close relationship between the two species.
Previous chemical investigations have further confirmed the presence of triterpenes, hydrolysable tannins, anthocyanin's, flavonoids, chromone derivatives, phenylpropanoids, and phloroglucinol derivatives within the genus *Syzygium* (Reynerston *et al*., 2008; Ayyanar & Subash-Babu, 2012) [36, 37].
Yao *et al*. (2013) [38] identified various tetralin-type lignans, 8, 40-oxyneolignane, and monolignans in *S. grijsii*, proposing that these compounds could serve as taxonomic markers.
Recent studies have continued to uncover new compounds in *Syzygium* species.
Hu *et al*. (2020) [39] isolated two new oleanane triterpenoids and one known analogue from the leaves of *S. samarangense* collected in Xishuang Banna Prefecture, Yunnan Province, China. This discovery not only highlighted the chemical diversity of *Syzygium* plants but also suggested potential chemotaxonomic markers for the species.
Moreover, Zhang *et al*. (2020) [40] isolated a new monocyclic diterpenoid along with three known diterpenoids and five sesquiterpenoids from the twigs and leaves of *S. fluviatile*, proposing these compounds as chemotaxonomic markers for *S. fluviatile*.
Smitha P S (2023) [5], an analysis of the leaf water extracts of *Syzygium travancoricum* revealed a higher concentration of phenolic compounds and flavonoids compared to ethanol extracts. Furthermore, the leaf extracts exhibited a diverse range of phytochemical constituents, including tannins, terpenoids, steroids, alkaloids, carbohydrates, reducing sugars, and proteins. In addition to the findings on leaf extracts, it was noted that the fruits of *S. travancoricum*, at various stages of maturity, possess high nutritional value.

These fruits are rich in vitamins, minerals, and dietary fibre's, highlighting their potential as a significant nutritional resource.

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