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Insights into phyto pharmaceutical studies of the under-utilized mangrove species of *Lumnitzera racemosa* wild: A review

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Abstract
The traditional medical system has made extensive use of plants and naturally occurring compounds derived from plants. The plant has been discovered to be phyto chemically abundant in tannins, terpenes, terpenoids, phenolic compounds, phytosterols, and a variety of new metabolites that have displayed notable pharmacological effects. *Lumnitzera racemosa* wild is a non-viviparous evergreen shrub or small tree, an Indo-West Pacific mangrove. It is extensively used therapeutically and is becoming more well-known as a valuable medicinal plant. Its morphology, chemical components, and biological activity in connection to extracts and extracted secondary metabolites have all been extensively studied in several examinations of this medicinal plant. This plant is used as anti-inflammatory, anti-angiogenic, anti-cancer, anti-diabetic, anti-oxidant, anti-hypertensive, anti-bacterial, and Cytotoxic, Hepatoprotective and anti-leishmanial activity. This review summarises the present level of knowledge about morphology, important bioactive components, their chemistry, purported medicinal properties, pharmacological activity, and traditional applications.

Keywords: *Lumnitzera racemosa* wild, morphology, chemical constituents, pharmacological activities, traditional and medicinal uses

1. Introduction
Mangroves are salt-tolerant plants that develop in 123 tropical and subtropical areas where they establish distinctive, highly productive groups [1]. They provide significant ecological and economic advantages. They create numerous novels to combat their harsh environment; metabolites are reportedly used in folk treatments, according to treat a variety of illness [2]. Combretaceae is a plant-family which has 500 species and about 20 genera. A genus from this family that includes real mangroves is *Lumnitzera* wild species found scattered over East Africa's coastline up to the Indo-West pacific [3]. This genus's name has originating with is tvan (Stephan) lumnitzera, a Hungarian botanist [4]. There are two main species in this genus: *L. racemosa*, which has white flowers and *L. littorea* (having red flowers) [5]. A third *L. rosea* variety appearing mixed-level and intermediate characters (pink flowers) has only occasionally been reported from the Philippines, Australia, New Caledonia, new guinea and a species that is infertile is not regarded as a real species, but a hybrid found in the area of l that overlap in between L. r and L. l and represented as L.x rosea [6]. The species *L. racemosa*, which is more extensively distributed geographically, has been used by traditional healers to address a range of medical conditions. The species has been discovered pharmacologically significant new compounds, many of which to be present, like other mangroves. An effort has been made to gather current data regarding the study of phytochemicals and pharmaceuticals on this mangrove to demonstrate its healing possibilities given that no such review was discovered. The term "phyto pharmaceutial drug" is defined as a purified and standardised fraction with defined minimum four bio-active or phytochemical compounds (qualitatively and quantitatively assessed) from an extract of a medicinal plant or its part, for internal or external use by humans or animals for diagnosis, treatment, mitigation, or prevention of any disease or disorder [7]. Herbal medications known as phyto pharmaceuticals owe their effectiveness to one or more plant compounds or active components. Since the beginning of time, they have been employed to treat illnesses. Many medical remedies derived from plants or their parts still have this traditional knowledge as their foundation. Since many generations ago, Baden-Württemberg has developed herbal medications [8].

1.1 Plant introduction

An Indo-West Pacific mangrove genus called *Lumnitzera* belongs to the Combretaceae family. Black mangrove is known by this name in English [9]. The mangrove plant known as *Lumnitzera*, which bears the name of the German botanist Stephan *Lumnitzera* (1750-1806), is found in mangroves from Northern Australia to the Western Pacific (including Fiji and Tonga) and East Africa. Tonga's *Lumnitzera littorea* and Indonesian *Lumnitzera racemosa* [10]. The genus contains two species with different flower colours but similar vegetative appearances. *Lumnitzera racemosa* has white flowers, while *Lumnitzera littorea* has red blooms. The leaves of both species have emarginate tips and are flat and spoon-shaped (spathulate). In the western and eastern halves of the range, respectively, *L. Racemosa* and *L. littorea* are the dominant species [10]. Within the overlap zone, hybrids of *Lumnitzera rosea* are found. Mangroves have three genera of the tropical woody Combretaceae family - *Laguncularia*, *Conocarpus*, and *Lumnitzera*–but only *Lumnitzera* is present in the Indo-West Pacific mangroves, which include Australia [10].

In South Africa, *Lumnitzera racemosa* var. *racemosa* (also known as the Tongan mangrove, Tonga-wortelboom, or Isikhaha-esibomvu) is a tree that is protected [11].

Fig 1: *Lumnitzera racemosa* wild plant

1.2 Vernacular names [12].

Telugu: kadivi, podapa, tanduga
Bengali: kripa
Kannada: tandaara
Malayalam: katakkantal, kadakandal
Oriya: tunda
Tamil: tipparathai
Marathi: kripa
Chinese: lan li.

1.3 Botanical description.

Botanical name: *Lumnitzera racemosa* wild.
Synonyms [13, 14].

- *Bruguiera madagascariensis* DC.
- *Combretum alternifolium* Herb. Madr. Ex Wight & Arn.
- *Funckia karakandel* Dennst.
- *Laguncularia rosea* Gaud.
- *Lumnitzera japonicum* (Thunb.) Kurata
- *Lumnitzera rosea* (Gaud.) Presl
- *Petaloma Alba* Blanco
- *Petaloma albiflora* Zipp. Ex Span.
- *Petaloma alternifolia* Roxb.

Common name [15]

Black mangrove,
White-flowered mangrove,
White Teruntum, Teruntum Bunga putih.

Taxonomical classification [16]

- Kingdom: Plantae
- Subkingdom: Viridiplantae
- Phylum: Tracheophyta
- Subphylum: Spermatophytina
- Class: Magnoliopsida
- Subclass: Rosidae
- Order: Myrtales
- Family: Combretaceae
- Genus: *Lumnitzera*
- Species: *Lumnitzera racemosa* wild.

Distribution [17]

L racemosa is seen widely distributed along the tropical and subtropical coastal countries of Eastern Africa, Asia, and South China to Korea, Bangladesh, Thailand, Cambodia, Vietnam, Malaysia, Indonesia, Philippines, and New Guinea. Australia, the Pacific Islands, Eastern Africa to Southeast Asia (including Singapore).In south western region of Sri Lanka, along the coasts from Sunder bans downwards to Maharashtra in India, and in the tidal forests of the Andaman and Nicobar Islands.

Morphology [12, 15]

The black mangrove is an evergreen, medium-sized, erect, and heavily branching tree that can reach a height of 10 meters, but usually only reaches 4-6 meters.

Root

Normal root systems lack above-ground breathing roots, although in humid conditions, little looping lateral roots may form.

Leaves

Simple, small, succulent, ob ovate, and with a notch in the tip, alternately arranged and measure 3-7 cm long by 2-3 cm wide. Sub- sessile, oblong or oblanceolate, apex emarginated. Leaf margin has a small wave to it. A 2-3 cm long spike known as the inflorescence grows in the leaf axils.

Flower

Small, bisexual, sessile, regular, 7-8 mm long; upright with a calyx that looks like a tube and is separated into five sepals at the apex. Five white petals are placed alternately with the sepals. Stamens: All ten free stamens, arranged in two whorls, with five stamens at the base of each petal and the remaining five at the base of the calyx lobes. Ovary 4-5 capillary, stigma simple.

Fruit

it has a vase-like shape, yellowish green in colour, 1-2 cm long, shiny, corky, buoyant, and distributed by currents, blackish-brown in colour when ripe, oblong to egg-shaped, 10-12 by 3-8 mm, somewhat compressed on one side, two or three ridged.

Seeds

One oblong, ovoid seed is present in each fruit. Drupe, compressed, elliptic-oblong.

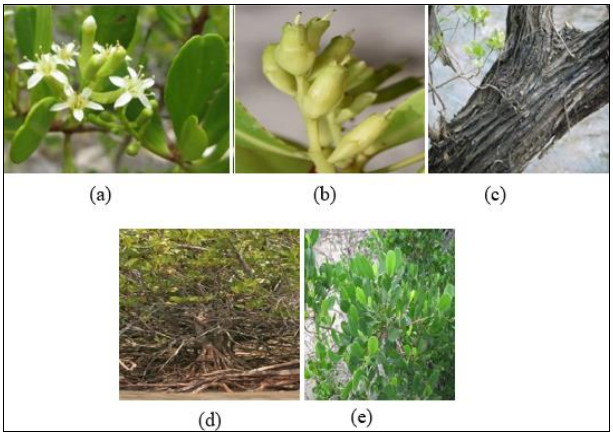


Fig 2 a) *Lumnitzera racemosa* wild flower b) fruit c) bark d) root e) leaf

2. Uses

2.1. Ayurvedic uses [17]:

- Pharmacological research on *L. racemosa* extracts revealed Cytotoxic, Antioxidant, Antihypertensive, Antibacterial, Antifungal properties, and others are:
- Anti-angiogenic
- Anti-inflammatory
- Anti-cancer
- Hepatoprotective
- Diabetes
- Anti-infertility
- Treatment of asthma
- Snakebite.

2.2 Traditional medicinal uses

1. Historically, thrush, herpes, cutaneous itch, and scabies have all been treated using this plant's sap [26].
2. This plant's fruits, juice from young twigs, and fluid old bark have all been discovered to be particularly effective in treating skin conditions [2, 19].
3. In addition to treating leprosy, asthma, and ulcer, tuberculosis, elephantiasis, malaria, dysentery, *L. Racemosa* preparations have also been utilised as antifertility medication to prevent conception [21-22].
4. Plant to treat snakebite cases and also as blood purifier [4, 20].

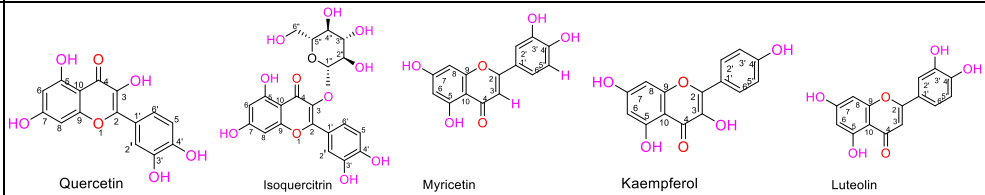
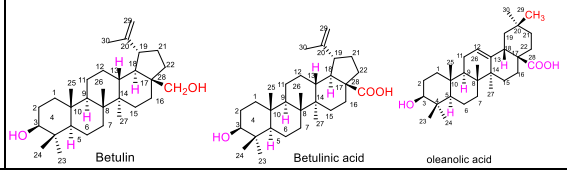
2.3. Other uses [23-25].

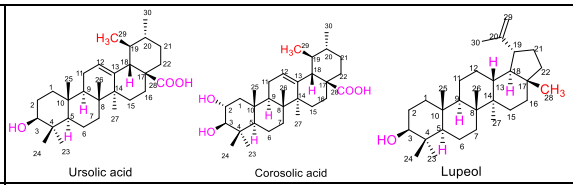
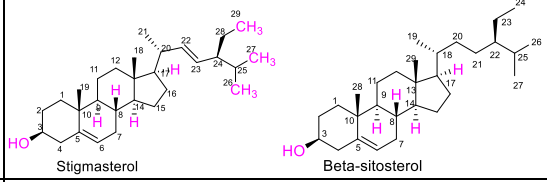
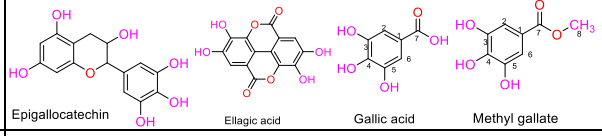
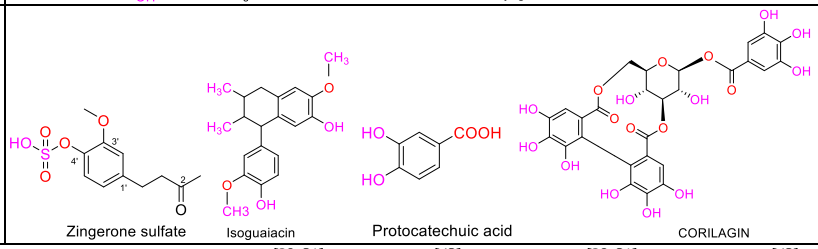
1. *L. racemosa's* wood is suitable for use as fuel, machinery, and building supplies.
2. African fishermen have been using its wood to make parts of boats (masts, paddles, oars, tie rod).
3. The leaves are edible and consumed by herbivores of Western Pacific islands in case of food scarcity.
4. The bark is preferred by the local inhabitants as firewood, for producing charcoal and for tanning leather.

3. Phytochemical properties

1. The isolated molecule was identified as 4a-methyl-5-(6-methylhept-5-en-1-yl) octahydro-1H-cyclopenta [a] pyridazine by HPLC and several spectroscopic investigations. This compound is a member of alkaloid class of secondary metabolites. In both *in vitro* and *in vivo* settings, the alkaloid extracted from *L. racemosa* leaves exhibits considerable anti-diabetic efficacy [26].
2. In addition to nine previously identified chemicals, a novel glycoside, 2-O-galloyl-alpha-L-rhamnopyranosyl-(3-4')-3'-O-galloyl-alpha-L-rhamnopyranose, were isolated from *Lumnitzera racemosa* wild. By analysing spectroscopic data and comparing it to those in the literature, their chemical structures were clarified [27].
3. The methanolic extract of the leaves and twigs of *Lumnitzera racemosa* yielded seven recognised chemicals and one neolignan, race lactone A. On the basis of the interpretation of the mass and NMR spectroscopic data, the structure of race lactone A was discovered [28].
4. A single novel macrolide, racemolide, was discovered in a MeOH extract of the 7 identified compounds, on *Lumnitzera racemosa* leaves. By different chromatographs, octadecylsilyl column chromatography and silica gel methods and high-performance liquid chromatography too. The New compound's structure been determined by combining spectroscopic and chemical methods analyses [29].
5. From chloroform and methanol extracts of leaves of *Lumnitzera racemosa* the compounds Lupeol and Betulin (triterpenoids) are obtained [30].
6. A methanol extract of leaves of *Lumnitzera racemosa*, further fractionated, yielded a total of 10 chemicals, including Kampferol and derivatives of Quercetin and Myricetin (avonoids), 3-O-methylellagic acid (hydrolysable tannin), Gallic acid (phenolic acid), and a new glycoside [31].

Table 1: (Chemical structures of *Lumnitzera racemosa* wild)

Compounds	Structures
Flavonoids	
Triterpenes	

	
Steroids	
Phenols	
Others	

[Table-1: chemical structures of Flavonoids- Quercetin [29, 31], Myricetin [43], kaempferol [28, 31], Isoquercetin [43], Luteolin [44]; Triterpenes- Betulin [29, 30], Betulinic acid [17], Oleanolic acid [44], Lupeol [30, 44], Ursolic acid [44], Corosolic acid [44]; Steroids- Stigmaterol [28, 17], beta-sitosterol [17]; Phenols- Gallic acid [17, 31] Epigallocatechin [43], Ellagic acid [17], Methyl gallate [28, 29]; Others- Isoguaiacin[17,28], Corilagin [17, 32], zingerone sulphate [42], Protocatechuic acid [17, 29]

4. Pharmacological properties

4.1 Anti-Diabetic activity [26].

The isolated substance inhibited alpha-amylase and alpha-glycosidase with IC_{50} values of 30.23 and 0.022 mg/ml, respectively, demonstrating strong anti-diabetic activity. In addition, STZ-induced diabetic rats administered an isolated chemical showed a considerable dose-dependent reduction in blood glucose levels (250 and 500 mg/ml BW). In addition, the isolated compounds haematological, biochemical, and histopathological results were comparable to those of conventional glibenclamide, indicating that it may act as a protective mechanism against kidney, liver, and pancreatic damage. The isolated molecule was identified as 4a-methyl-5-(6-methylhept-5-en-1-yl) octahydro-1H-cyclopenta[a] pyridazine by HPLC and several spectroscopic investigations. This compound is a member of alkaloid class of secondary metabolites. In both *in vitro* and *in vivo* settings, the alkaloid extracted from *L. racemosa* leaves exhibits considerable anti-diabetic efficacy.

4.2 Anti-Leishmanial activity [29].

At a dosage of 50 mM, racemolide extracted from leaves significantly inhibited the parasite leishmania major cells. Leishmanicidal potential of *L. racemosa* was revealed by the % values of inhibition for the isolated compound and the positive control of miltefosine, which were found to be 67.6 and 93.3, respectively.

4.3 Anti-Hypertensive activity

In rats with spontaneously elevated blood pressure above 180mmHg, corilagin, chebulinic acid, and castalagin showed potential action by reducing systemic blood pressure. The study discovered that chebulinic acid exhibited the most potential anti–hypertensive action [32].

4.4 Anti-Inflammatory activity [28].

The *L. racemosa* isolates race lactone A, methyl gallate, and myricitrin all significantly reduced the production of superoxide anion in human neutrophils, indicating that they have effective anti-inflammatory properties. This discovery might significantly contribute to the prevention and treatment of cancer.

4.5 Anti-Angiogenic activity [28].

According to Yu *et al*., component race lactone A obtained from *L. racemosa* extract inhibited the development of capillary tubes in human circulating endothelial progenitor cells (EPCs). It was found that tube length reduced as test compound concentration increased. The presence of lactic dehydrogenase in the treated cells further demonstrated the nontoxicity of this substance to EPCs. This data on anti-angiogenic action suggests that it is effective in preventing and treating late-stage cancers.

4.5 Anti- Coagulant activity [33].

A mild anticoagulant action of *L. racemosa* crude extract was indicated by a prolongation of the clotting time after treatment with the aqueous leaf extract.

4.6 Anti- Malarial activity [30].

The antimalarial potential of *L. racemosa* leaf extract was demonstrated by Ravikumar *et al*. Who found that it has an IC50 of 110g/ml against the chloroquine-sensitive plasmodium falciparum strain. The active ingredient separated from this crude extract might significantly increase the bioactivity, despite the fact that this value was relatively high compared to the control used. Recent research found that chloroquine-sensitive (MRC-2) and chloroquine-resistant

(RKL-9) plasmodium falciparum isolates were both significantly inhibited by leaf chloroform and methanol extract, with IC50 values of less than 2 g/ml.

4.7 Anti-Cancer activity [35].

The HepG2 cell line was used to test the anti-cancer properties of four different mangrove plants*: Bruguiera gymnorrhiza, Aegiceras corniculatum, Aegialitis rotundifolia,* and *Lumnitzera racemosa*. Using the soxhlet app, crude methanol extracts of specific mangrove plants were prepared for the current experiment. Mangrove plants extracts were tested for their *in vitro* anticancer properties against the selected cell line using the MTT assay (3-(4, 5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide). All four extract shown anticancer action. This indicates that *Bruguiera gymnorrhiza* methanolic extract has more potent anticancer properties because it has lower IC_{50} value than *Aegialitis rotundifolia*, *Lumnitzera racemosa*, and *Aegiceras corniculatum*, respectively. The result of the current investigation shown that the methanolic extracts of mangrove plants are effective against tumour cells and have anti-cancer properties. *In vitro* anti-cancer activity on MCF7 and HeLa cancer cells was demonstrated by methanol leaf extract from *Lumnitzera racemosa* by Gas Chromatography-Mass Spectrometry (GC-MS) testing.

4.8 Anti-Oxidant activity [37].

Antioxidants are essential compounds that can shield the body from a variety of harms brought on by oxidative stress brought on by free radicals. Numerous naturally occurring antioxidants that scavenge free radicals can be found in plants. The goal of the current study is to conduct *in vitro* antioxidant experiments to assess the antioxidant capacity of selected mangrove species, including *Aegiceras corniculatum*, *Excoecaria agallocha*, and *Lumnitzera racemosa*. In this work, *in vitro* antioxidant activity was measured using assay such the DPPH, reducing power, and total antioxidant activity techniques. The extract of *L racemosa* has the highest phenolic content, according to *in vitro* antioxidant experiments (38.80+/-0.19 mg GAE/100 mg) and greatest antioxidant potential. This is followed by *Aegiceras corniculatum* (24.06+/-0.79 mg GAE/100 mg) and *Excoecaria agallocha* (20.56+/-0.58 mg GAE/100 mg). The data from this work can serve as a foundation for additional research that will evaluate the compounds potential as medicines and concentrate on the bioassay-guided separation and isolation of active compounds from extracts [34].The leaf extract of *L. racemosa* shows *in vitro* antioxidant activity [36]. The methanolic leaf extract of *L. racemosa* shows *in vitro* antioxidant activity. Peroxyl radical-scavenging and reducing assays were used to conduct antioxidant experiments.

4.9 Anti- Microbial activity [38].

Lracemosa's methanolic extract and fractions were tested for their effectiveness against pathogenic bacteria, viruses, and fungi [27]. Significant action was shown by aqueous leaf extract against the fungus *Aspergillus Niger* and the bacteria *E. coli*.

4.10 Hepatoprotective activity [29, 39].

The leaf extract of *L racemosa* has significantly showed Hepatoprotective activity [36]**.** Using human HepG2 cells, *L racemosa* demonstrated Hepatoprotective efficacy against acetaminophen-induced hepatotoxicity. Racemolide isolated from leaves was also found to have moderate Hepatoprotective activity.

4.11 Cytotoxic activity [37].

The Cytotoxic action of *L. racemosa's* methanolic leaf extract has been considerably demonstrated. MTT tests were used to assess Cytotoxicity in HL-60 and Hel-299 cell lines.

4.12 Sperm Immobilization activity [36].

It was looked into if *L. racemosa* had the antifertility properties mentioned in traditional medicine. On samples of human sperm, a leaf methanol extract was utilized to assess the sperm immobilization activity in terms of time (15 to 240 sec) and concentration (0.15 to 50 g). At a concentration of 5 g, the extract showed a 90% suppression of sperm motility, while at a dosage of 10 g and 50 g, it showed a 100% inhibition. This activity was linked to sperm plasma membrane breakdown, suggesting that *L. racemosa* may one day be produced as an antifertility drug and used for birth control as is done in traditional medicine.

4.13 Anti-bacterial activity [41].

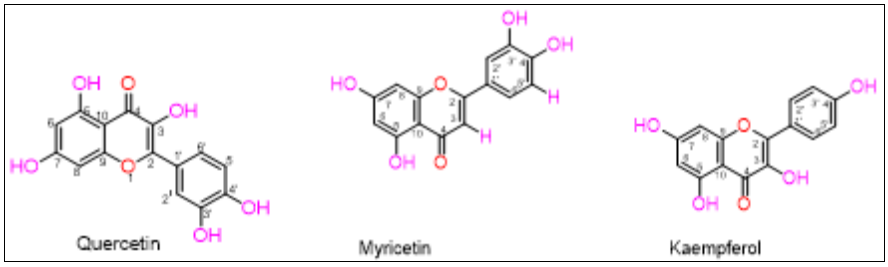
The antibacterial activity of aqueous and methanol extracts of leaves/shoots of mangroves was shown against *Staphylococcus aureus* [40]. Flavonoids (quercetin and myricetin) isolated from plant represented antibacterial activity against pathogenic bacteria [27]. Ethanol leaf extract showed antibacterial activity against gram positive and negative bacteria.

4.14 Anti-Infective [42].

Anti-bacterial potential was found in sample of *Lumnitzera littorea* from specific areas (Southern Nias Island and east java against Gram-negative bacteria, Halmahera and ternate Island against Gram-positive bacteria).

4.15 Other activities [42].

Lumnitzera roots from natural mangrove stands are a prospective source of sulphated ellagic acid derivatives as well as other sulphur-containing plant metabolites with potential human health benefits.



5. Conclusion

Based on various patterns of secondary metabolites, tannins, alkaloids, aldehyde, triterpenoids, flavonoids and phenolic compounds are the most prevalent ones in *Lumnitzera racemosa*, which provide a wide range of ethano botanical applications. Phenolic compounds, triterpenoids, flavonoids, tannins, alkaloids, aldehydes have been reported to contribution to the pharmacological properties of this *Lumnitzera racemosa*, including: anti-inflammatory, anti-diabetic, anticancer, antioxidant, antihypertensive, antimalarial (triterpenoids), antibacterial (flavonoids) as well as Hepatoprotective activity.

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