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Ethno-medicinal uses of a mangrove species *Rhizophora apiculata* Blume: Mini Review

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Abstract:
People have used mangrove plants for a very long time. It is generally believed that these mangroves still offer a number of undiscovered advantages. Rhizophora apiculata, a key mangrove species found throughout tropical and sub-tropical coastal regions, has long been utilized in traditional medicine. This review explores the ethno-medicinal applications of R. apiculata, emphasizing its significance in folk remedies for various ailments. The prospective applications of R. apiculata as an anticancer, antitumor, anti-inflammatory, antifungal, antibacterial, antiviral, and antidiabetic agent are the focus of many of these studies. Research has demonstrated that, the species do offer a plethora of advantages and unrealized potential in the medical domain. Existing pharmacological studies are also discussed to highlight the plants therapeutic potential. This piece will also examine the current status and importance of R. apiculata worldwide.
Keywords: *Rhizophora, mangrove, folk medicine, antitumor, antifungal, antidiabetic etc.*

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I. Introduction:

Mangrove forests are among one of the world's most productive tropical ecosystems and are highly potential, because the ecosystem is always under stress which leads to the production of certain compounds for their survival. Mangroves are used in traditional and medicine for the treatment of many diseases. A real mangrove, *Rhizophora apiculata* Blume (family: Rhizophoraceae) is commonly found in mangrove ecosystems of south and Southest Asia, including India, Malaysia and Phillippines. Its use in indigenous medicine systems underscores the therapeutic value, warranting a comprehensive evaluation (Bandaranayake, 2002). The compounds found in this plant have antibacterial, anticancer, antidiabetic, antidiarrhea, antiemetic, and hemostatic qualities (Bandaranayake, 1998; Seepana *et al.,* 2016; Satyawan and Ulumuddin, 2012). The leaves bark and roots of *R. apiculata* have therapeutic qualities. After drying, the tree's roots, leaves, and bark are ground to extract these chemicals. Crude extracts are prepared using organic solvents such as methanol, ethanol, hexane, and aqueous solvents, which are then, concentrated using a rotor evaporator. Finally, fractionation is accomplished using HPLC and column chromatography. *R. apiculata* methanol extracts are high in tannins. While the hexane fraction has a mild effect on the same fungus, methanol and ethanol extracts significantly inhibit *Aspergillus niger* (Seepana *et al.*, 2016). Additionally, one of the most prevalent fungi that cause skin infections, *Candida albicans*, can be inhibited by ethanol extract (Jadhav and Jadhav, 2012). Thus, the species *Rhizophora* is rich in tannins, which have the ability to suppress some infamous fungi. These compounds isolation from *Rhizophora* may be useful in suppressing them. Numerous ethno-medical applications exist for the mangrove species *Rhizophora apiculata*. In conventional medicine, it is used to treat amoebiasis, typhoid, hepatitis, diarrhea, nausea, vomiting, and as an antiseptic and pesticide. Extracts from the plant have also showed promise in the treatment of diabetes, cancer, and skin diseases.

Since, plant-derived medications have significantly improved human health and well-being; plants have historically served as a source of inspiration for new therapeutic molecules. A plentiful supply of antibacterial compounds can be found in medicinal plants. Many researchers have recently focused on extracts and physiologically active chemicals obtained from plant species used in herbal medicine because of the negative effects and the resistance that pathogenic germs develop against antibiotics. Medicinal plants are a valuable natural resource and play a significant role in health care initiatives in underdeveloped nations. They are crucial in providing rural residents with primary healthcare facilities and services. Additionally, they are essential raw materials for the production of both conventional and modern medicine and significant healing agents. They are regarded as a source of innovative natural compounds due to their biochemical uniqueness. Mangroves typically contain high levels of tannins and polyphenols. Flavonoids and phenols, which act as ultraviolet (UV) screen chemicals, are found in mangrove leaves. Folk medicines have historically utilized substances found in mangroves to heal illnesses. Several mangrove plant components have strong antiviral properties against human, animal, and plant viruses, including the human immunodeficiency virus. Strong proof

of the therapeutic power of mangrove plant species is provided by their extensive use in human suffering, which calls for more research.

II. Methodology

An extensive literature survey of the *Rhizophora apiculata* belongs to family Rhizophoraceae, *R. apiculata* bioactivities, traditional uses, phytochemical constituents and antibacterial was conducted in scientific databases, including PubMed, Elsevier, ResearchGate, Scopus, and Google Scholar. All selected articles were thoroughly evaluated and focused on potential therapeutics; chemical components and bioactivity of *R. apiculata* Blume were used.

Botany:

Rhizophora apiculata is medium to large sized tree growing upto 30 m occurs on deep, soft and muddy soils that are flooded by normal high tides, permanent fresh water input is preferred. Trunk is about 50cm in diameter, bark is dark grey. Arching stilt roots extending upto 5 m up the stem and also has aerial roots from the branches. Leaves are dark green, smooth, leathery, elliptic with entire leaf margin and reddish leaf stalks. Long, red stipules emerge from the leaf bases. Flowers are composed of cream-coloured, linear petals arranged in cross shaped pattern. Flower buds are broadly elliptic and finely fissured. Brown, pear-shaped fruit hang with the smaller and pointed down. A long, cylindrical seedling emerges from the smaller end, while the fruit is still attached to the parent plant. This condition is known as vivipary.

Study of Review:

Here's a more detailed look at the ethno-medicinal uses of *Rhizophora apiculata*:

Ethno-medicinal Applications:

- **Diarrhea, Nausea, Vomiting:** The plant is used as an astringent to help stop diarrhea and relieve nausea and vomiting. Traditionally, decoctions made from the bark or leaves are administered orally to treat diarrhea and dysentery. The high tannin content contributes to its astringent action, which helps to reduce gastrointestinal inflammation and fluid loss (Kathiresan & Bingham, 2001). Razanah *et al.,* 2023 reported *Rhizophora apiculata* is employed by Malay for treating skin diseases, diarrhea, vomiting, and nausea, as an antiseptic, for tanning, and also as fuelwood and fodder. Its large-scale use can be attributed to its high-quality timber, availability as well and the presence of a chemical named tannin that is employed for reinforcing fishing lines, nets, and ropes. The tannin content of *R. apiculata's* roots, bark, and leaves is regarded to be a natural inhibitor of fungal infections. This study is focused on determining the different kinds of functional groups, as well as individual phenolic compounds present in *R. apiculata* for identifying new bioactive compounds via decoding of the traditional values of Malay remedies.

Antiseptic: The plant is used as an antiseptic for treating infections and wounds. The bark of *R. apiculata* is widely applied in poultices or decoctions for treating wounds, sores and ulcers. The astringent and antiseptic properties aid in rapid healing and infection prevention (Sivakumar *et al.,* 2012).

Skin Diseases: Extracts of the plant are used for treating various skin conditions. The plant is used to manage various skin ailments such as eczema, fungal infections and rashes. Topical application of bark extract is believed to alleviate symptoms due to its antimicrobial effects (Sivakumar *et al.,* 2012).

Antimicrobial, antioxidant and anticancer Activity: *Rhizophora apiculata* has shown antimicrobial activity against various pathogens, including bacteria and fungi. Tannins are a major component of *Rhizophora apiculata* and are responsible for many of its medicinal properties, including astringency and antimicrobial activity. The plant extracts contain strong antioxidants, which can help protect against damage from free radicals. V. Ramlingam and R. Rajaram (2018) reported enhanced antimicrobial, antioxidant and anticancer activity of *R. apiculata* in their experimental report. Antimicrobial and minimal inhibitory activities of different solvent extracts were assessed against human clinical pathogenic bacteria, and the results showed that butanol and methanol extract has potential antimicrobial activity. FTIR analysis of solvent extracts showed the presence of phenolic compounds at 3409–3430 cm^{-1} that actively involved in various applications including antioxidant and anticancer activities. The *in vitro* antioxidant activity of solvent extracts showed excellent antioxidant potential, about 84% of DPPH free-radical scavenging, 76% of hydrogen peroxide, 82% of hydroxyl radical scavenging, and 80% of reducing power. Two-way ANOVA analysis showed that the highly significant effect of antioxidant activity depends on the concentration of extracts. The DNA protection efficiency of extracts against oxidative damage was confirmed by DNA nicking assay using bacterial DNA. The methanol extract effectively inhibited the growth and induces the apoptosis through ROS generation and sensitizes the mitochondrial membrane potential of A549 lung cancer cells. Taken together, the results showed that the solvent extracts of *R. apiculata* could be potential antioxidant and anticancer agents.

Anti-Inflammatory / Anti-tumor activity: The plant has demonstrated anti-inflammatory effects, which can be beneficial in managing pain and swelling. In some regions, preparations of bark are used to reduce inflammation and relieve pain, particularly in rheumatism and joint pain (Dahdouh-Guebas *et al.,* 2005).

Study evaluated the anti-inflammatory and anti-tumor activity of methanolic extract of *R. apiculata* against B16F10 melanoma cells in BALB/c mice. Results showed inhibition of solid tumor development in mice. Treatment significantly reduced tumor cell glutathione (GSH) levels as well as serum γ-glutamyl transpeptidase (GGT) and nitric oxide (NO) levels in tumor-bearing animals. Total WBC and Hb were also significantly increased. It also substantially reduced acute inflammation (paw edema) induced by carrageenan and reduced inflammation edema induced by formalin. The ME revealed high content of 4-pyrrolidinyl, pyrazole, and ketone derivatives. Results suggest potential as a natural anti-inflammatory and anti-tumor agent. (V Vinod Prabhu, 2012).

Antibacterial activity: Study evaluated the antibacterial activity of methanol, ethyl acetate, and n-hexane extracts of *R. apiculata* against several pathogenic bacteria *viz.,* gram positive *Bacillus cereus* and Gram negative *E. coli*, *S. typhi*, and *S. aureus*. An ethyl acetate extract showed highest antibacterial activity with average inhibition zone of 18.64 mm, followed by methanol extract 15.02 and n-hexane extract 8.48mm. The most susceptible to the three extracts was *Salmonella typhi* with inhibition zone of 18.02. (R B D Sormin *et al.,* 2021).

Antidiabetic and antihyperlipidemic activity: Studies have shown that extracts from *Rhizophora apiculata* can help regulate blood sugar levels in diabetic individuals. Study evaluated the antidiabetic and antihyperlipidemic activities of ethanolic extract of leaves of *R. apiculata* and its dichloromethane and aqueous fractions in experimental diabetic rats. Rats treated with DCM fraction showed significant reduction in blood glucose ($p<0.01$), serum cholesterol ($p<0.05$)(, and triglycerides ($p<0.05$), and increased HDL-C ($p<0.05$) (Annie Mande *et al.,* 2022).

Hemostatic properties: The bark is applied to minor cuts and wounds to stop bleeding, demonstrating its hemostatic capalibities (Bandaranayake, 2002).

Phytochemical and Pharmacological Evidence: Several studies have validated the ethno-medicinal claims associated with *R. apiculata*. Phytochemical screening reveals the presence of tannins, Flavonoids, saponins, alkaloids and phenolic compounds. These phytochemicals are also present in the plant and contribute to its diverse range of medicinal effects. These constituents are linked to antimicrobial, antioxidant, anti-inflammatory and cytotoxic activities. Methanolic extracts of the bark have shown antibacterial activity against *Staphylococcus aureus* and *E. coli* (Sivakumar *et al.,* 2012). Other studies report significant free radical scavanging ability, supporting its use in oxidative stress-related conditions (Bandaranayake, 2002).

Silver Nanoparticles / Cytotoxic activity: Study reports on the green synthesis of silver nanoparticles using *R. apiculata* as reducing agent. Extract yielded flavonoids and phenolic contents of 44.18 mg/g quercetin and 53.24 mg/g gallic acid, respectively. Cytotoxicity cell viability assay showed the AgNPs were less toxic (IC50 1.05.5 µg/mL) compared to the extract (IC50 47.47 µg/mL) against noncancerous fibroblast L929 cell line. The AgNPs inhibited protein denaturation by 71.65%, compared to diclofenac 94.24%. The AgNPs showed considerable cytotoxic effect, with % of cell viability against skin cancer, lung cancer, and oral cancer cell lines of 31.48, 56.09, and 22.59%, respectively. The AgNPs demonstrated stronger cell migration and percentage wound closure (82.79%) compared to plant extract (75.23%) (Henni Syawal *et al.,* 2020).

Other Uses:

Timber & Products: Wood used for foundation piles, beams, outriggers of canoes, furniture, firewood and making of charcoal.

Forestry: Sometimes planted along fish ponds to protect dikes and bunds.

Others: This species' extensive set of prop roots help to disperse the destructive energy carried by strong tidal waves, helping to protect the shoreline and surrounding areas.

III. Conclusion:

Rhizophora apiculata represent a diverse and ecologically significant genus with a wide range of potential benefits. The species holds immense ethno-medicinal importance, particularly in coastal communities where it is readily available and widely used. Scientific study in relation to the phytochemical composition, biological activities, and ecological roles of *R. apiculata* is proved crucial for realizing their full potential and ensuring their sustainable use. While traditional uses are well documented, further pharmacological and clinical studies are essential to validate its efficacy and safety. This could pave the way for the development of novel therapeutic agents derived from this mangrove species.

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Conflicts of Interest:

The authors declare no conflict of interest.

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