

Some notable bioactivities of *Rhizophora apiculata* and *Sonneratia alba*

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Background

Rhizophora apiculata Blume (Rhizophoraceae) is a large-sized tree that grows up to 30 m tall with 50 cm trunk diameter. The tree has prop or stilt roots, looping from the base of the trunk (Figure 1). Occasionally, aerial roots emerge from the lower branches that lend additional support when they reach the ground. The bark is grey with longitudinally fissures. Leaves are simple, opposite and elliptic with fine black dots on the underside. Inflorescences are axillary and typically two-flowered (Figure 1). The peduncle is stout and the calyx is four-lobed, greenish-yellow inside and reddish-green outside. Petals are four and white. Hypocotyls are 25–30 cm long, greenish-brown and relatively smooth. Propagules producing a red collar are mature and can be planted. Botanical descriptions of *R. apiculata* are from Giesen *et al.* (2007), Selvam (2007), and Chan & Baba (2009).



Figure 1 Flower buds (left) and stilt roots (right) of *Rhizophora apiculata*.

Sonneratia alba Sm. (Sonneratiaceae) is a tree that grows up to 20 m tall. The bark is cream to brown colored and smooth with fine longitudinal fissures. Arising from underground cable roots are stout conical pneumatophores (Figure 2). Leaves are simple, opposite, leathery, ovate and bear vestigial glands at the base of leaf stalks. Bisexual flowers occur either solitarily or in groups of three. The 6–7 persistent sepals are stellate-shaped, green outside and red inside (Figure 2). Flowers have numerous attractive long and white stamens that shed following anthesis. Flowering occurs all year round. The fruit is a flattened round berry with persistent sepals at its base and contains many seeds. The species is a pioneer found in seaward habitats of consolidating mud and sand. It also occurs on rocky shores and on coral islands. Botanical descriptions of *S. alba* are from Giesen *et al.* (2007), Selvam (2007), and Chan & Baba (2009).



Figure 2 Opened flowers (left) and conical pneumatophores (right) of *Sonneratia alba*.

Bioactivities

Antioxidant: The total phenolic content and antioxidant capacity of *R. apiculata* were stronger than those of *S. alba* (Chan *et al.*, 2017). Values of roots were generally higher than those of stems and leaves. Higher values were obtained from acetone and methanol extracts (Lim *et al.*, 2021a). Vinegar produced from *R. apiculata* wood during charcoal production had stronger properties before distillation than after distillation (Chan *et al.*, 2012a). Antioxidant properties of the wood vinegar based on total phenolic content, antioxidant capacity and ferric reducing power were stronger or comparable to black *Camellia sinensis* tea. Antioxidant activities of *R. apiculata* bark have been attributed to the high tannin content (Rahim *et al.*, 2008; Sulaiman *et al.*, 2011). Antioxidant properties based on total phenolic content and antioxidant capacity of *S. alba* bark were stronger than those of the leaf (Haq *et al.*, 2014). Ranking of phenolic contents and radical scavenging activities of *S. alba* was stem > leaf > root (Suh *et al.*, 2014).

Antibacterial: The antibacterial activity of condensed tannins extracted from *R. apiculata* bark has been reported by Sulaiman *et al.* (2011). Most susceptible was *Bacillus cereus* with 14 mm diameter zone of inhibition. Against Gram-positive bacteria, antibacterial activity of non-distilled and distilled wood vinegar from *R. apiculata* was comparable (Chan *et al.*, 2012b). Antibacterial activity of non-distilled wood vinegar was slightly stronger than distilled wood vinegar against Gram-negative bacteria. It is notable that *R. apiculata* wood vinegar inhibits both Gram-positive and Gram-negative bacteria. Gram-negative bacteria have an outer membrane consisting of lipoprotein and lipopolysaccharide, which can regulate access of chemical compounds into the underlying structures. This renders the Gram-negative bacteria less susceptible to plant extracts than the Gram-positive bacteria (Chan *et al.*, 2007). The ethanol leaf extract of *S. alba* inhibited the multidrug-resistant *Salmonella typhi* (Sahoo *et al.*, 2012), and the flavonoid extract of *S. alba* fruit inhibited *Vibrio alginolyticus*, a Gram-negative marine bacteria (Sulistijowati & Karim, 2020). The antibacterial activity of the bark of *S. alba* was attributed to lupane-type of triterpenoids (Harizon *et al.*, 2015). Studies have also reported on the antibacterial activities of *S. alba* leaf (Saad *et al.*, 2012), and *S. alba* leaf, bark and fruit (Haq *et al.*, 2014).

Anti-tyrosinase: Out of four mangrove species studied, *R. apiculata* and *S. alba* displayed anti-tyrosinase activity (Chan *et al.*, 2017). Strongest inhibition was in the leaves (70%) and stems (70%) of *R. apiculata*, and in the roots (62%) of *S. alba*. The methanol extract of *R. apiculata* leaves and the acetone extract of *S. alba* leaves displayed the strongest tyrosinase inhibitory activity with IC₅₀ values of 0.28 and 0.55 mg/mL, respectively (Lim *et al.*, 2021a). Tyrosinase inhibitory activity of different plant parts of *S. alba* showed that the bark (82%) exhibited the strongest activity (Suh *et al.*, 2014).

Anti-quorum sensing: Stems and roots of *R. apiculata*, and roots of *S. alba* possess anti-quorum sensing (anti-QS) activity against *Chromobacterium violaceum* (Chan *et al.*, 2017). The methanol leaf extract of *R. apiculata* also possessed anti-QS activity against *Pseudomonas aeruginosa* (Annapoorani *et al.*, 2013).

Polyphenol oxidase inhibition: Recently, the inhibitory effects of leaves of coastal plants on polyphenol oxidase (PPO) activity in banana, sweet potato and ginger were studied based on oxidation of pyrocatechol (Lim *et al.*, 2021b). Banana PPO was strongly inhibited by *R. apiculata* (71%) and sweet potato PPO was strongly inhibited by *S. alba* (82%).

Other bioactivities: A recent study by Thao *et al.* (2022) reported that leaves of *R. apiculata* possess anti-cancer properties. Among the compounds isolated, 2,6-dimethoxy-1,4-benzoquinone exhibited cytotoxic effects towards MCF-7 breast, SK-LU-1 lung and HepG2 liver cancer cells, with IC₅₀ values of 8.3, 13 and 15 µM, respectively.

Other bioactivities of *R. apiculata* include antiviral properties of leaves against human immunodeficiency virus (Premanathan *et al.*, 1999), and anti-inflammatory and anti-tumor activity of aerial parts (Prabhu & Guruvayoorappan, 2012). The methanol leaf extract of *S. alba* had hypoglycemic and anti-diabetic effects in mice (Morada *et al.*, 2011, 2016), and analgesic, anti-inflammatory and central nervous system depressant activities in mice (Asad *et al.*, 2017).

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