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Asiatic Mangrove *(Rhizophora mucronata)* – An overview

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Abstract:

Mangroves are highly dynamic ecological entities which supply energy to aquatic as well as terrestrial habitats through their production and decomposition of plant debris. Rhizophora mucronata belongs to family Rhizophoraceae. It is commonly known as the loop root mangrove, red mangrove and Asiatic mangrove. The natural habitat of Rhizophora mucronata is estuaries, tidal creeks and flat coastal areas subject to daily tidal flooding. Mangroves that need no introduction in today's world with a variety of bioactive metabolites have been the interest of marine researchers all over the world. Apart from the resources those flourishes in the dense tangle of roots, mud and tidal water, mangroves are known for its medicinal wealth that have been successfully employed for treating a variety of diseases over hundreds of years. The specific medicinal properties of Rhizophora mucronata depend on the part employed and finds its use to treat human ailments like angina, dysentery, hematuria and many more. However in Pakistan forests are located in the Indus delta, lack of fresh water has resulted in their stunted growth. Avecennia marina is

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the main species. Ceriops and Rhizophoras are the other tree species but are gradually disappearing due to increasing salinity and biotic pressures. In Red list of IUCN placed Rhizophora mucronata in least concern category but in Indus delta due number of reason Rhizophora mucronata facing extinction. In this review cover all aspect of Rhizophora mucronata.

Key words: Rhizophora, Hepatoprotective, Asiatic mangrove, phytoremadiation

General introduction:

Rhizophora mucronata belongs to family Rhizophoraceae (Schwarzbach and Ricklefs, 2000) and commonly known as the looproot mangrove, red mangrove and Asiatic mangrove (Grin, 2006). *Rhizophora mucronata* is found in the IndoPacific region on the banks of rivers and on the edge of the sea. It is the only mangrove species to be found in East Africa (Gillikin and Verheyden , 2005). In Asia *R. mucronata* found in Cambodia, India, Indonesia, Malaysia Pakistan, Sri Lanka, Thailand and Vietnam. *Rhizophora mucronata species* also found in South Pacific Solomon Islands, Vanuatu and Australia northern territory (Grin, 2006). In Pakistan its few small populations are located in Miani estuary, Baluchistan and the Indus delta (Saifullah, 1982; Atkinson, 1967).

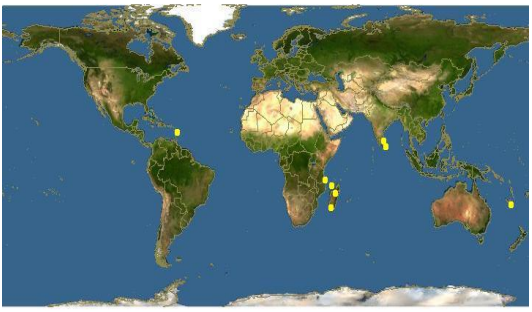

Fig. 2. Encyclopaedia of Life: yellow dots shows *Rhizophora mucronata distribution*

Occurrence:

The natural habitat of Rhizophora mucronata is estuaries, tidal creeks and flat coastal areas subject to daily tidal flooding. It seems to be more tolerant of inundation than other mangrove species and often forms an evergreen fringe to mangrove areas.

Morphological description of *Rhizophora mucronata*:

Rhizophora mucronata is a small to medium size evergreen tree growing to a height of about 20 to 25 metres on the banks of rivers. On the fringes of the sea 10 or 15 metres is a more typical height. The tallest trees are closest to the water and shorter trees are further inland. The tree has a large number of aerial stilt roots buttressing the trunk. The leaves are elliptical and usually about 12 cm long and 6 cm wide. They have elongated tips but these often break off. There are corky warts on the pale undersides of the leaves. The flowers develop in axillary clusters on the twigs. Each has a hard cream-coloured calyx with four sepals and four white, hairy petals. The seeds are viviparous and start to develop whilst still attached to the tree (Gillikin and Verheyden , 2005).

Physiological Distinction:

Rhizophora mucronata is classified as C3 plants since CO2 is fixated by the use of intermediates which contain 3 carbon atoms. These 3 carbon atoms are converted into glucose (C6H12O6) using light that at most 10% of the salinity of sea water will be found in the sap of the tree. Due to the presence of salt glands on the leaves, the excess of salt can be secreted (Parida and Jha, 2010)

Fig. 2. Rhizophora mucronataa: a. Plant showing roots b. fruit c. flower

Ecological and economic Benefits of Rhizophora mucronata:

There are a number of benefits provided by Rhizophora mucronata to living communities. As far as ecological benefits are concerned, Rhizophora mucronata act as protection barrier against storms, hurricanes and tsunamis (Tri et al., 1998; Alongi, 2008; Alongi and Dixon, 2000; Alongi, 2005). It also plays a role in avoidance of coast erosion (Alongi, 2008; Alongi *et al*., 2005). Its roots trap suspended solids assuring filtering of the upland runoff, protecting the coral reefs and sea grass beds for the negative effect of suspended particles. Helps in reducing global warming by Counteracting global heating by its high amount of carbon sequestration (Giri et al., 2011). It provides protection to natural fish diversity in oceanic water. The extensive root systems provide the breeding place for fish and prawns, as well as the shelter for the juveniles. (Nagelkerken et al., 2000) Economically, Mangroves are considered as a supplier of natural products such as charcoal, wild honey, timber, food and medicinal element (Dahdouh-Guebas et al., 2000).

Ethnobotanical Attributes:

R. mucronata has long been traditionally used for the treatment of elephantiasis, haematoma, hepatitis, ulcers and

febrifuge (Bandaranayake, 2002; Ravikumar et al., 2005). Its leaf is being used in the folk medicine for treating diarrhea or gastric motility disorder. *R. mucronata* leaf extract is used as diarrhea therapy. In ethno medicine, the *R. mucronata* bark is also mentioned for its anti diarrheal properties (Harrison, 2005). It is also been scientifically proved to have antiviral activities (Padmakumar and Ayyakkannu, 1997),R. mucronata extract of leaves exhibited strong inhibitory action against Bacillus subtilis, Staphylococcus aureus, Candida albicans, Aspergillus fumigatus and Aspergillus niger and moderate inhibitory action against Pseudomonas aeruginosa and Proteus vulgaris.

The barks of *Rhizophora mucronata* have long been used for tanning and dyeing and the leaves are the source of a black or chestnut dye (Burkill, 1966). Only the leaves which have diverse phytochemical compounds, even though, the present of tannin and saponin is weak positive. The parts of *R. mucronata* showed some antibacterial activity against *S. aureus and E. coli*. It is interesting to note that just about all parts showed broad spectrum antibacterial activity . Its antibacterial (Chandrasekaran *et al*., 2009), antiviral (Premanathan *et al.,*1999), Antifungal (Bose and Bose, 2008), mosquito larvicidal (Thangam and Kathiresan, 1989)and antioxidant activity (Babu *et al*., 2001).

Table 1.Traditional uses and chemical constituents and activities of R. Mucronata

Botanical name	Traditional use/properties	Tested for	Chemical compounds
R. mucronata	Treatment of elephantiasis, haematoma, hepatitis, ulcers and a febrifuge(B, FL, FR, L, R)	Antiviral, anti-HIV, growth hormones test on plants, biotoxicity on fingerlings of fish(B, FL, FR, L, R)	Alkaloids, Anthocyanidins, Carbohydrates, carotenoids, chlorophylla, b, a & b, condensed and hydrolysable flavonoids, minerals and riterpenes(B, L, R, S).

B=bark, L=leaves, Fr=fruits, R=roots, Fl=Flower, S=Seed

Phytoremadiation potential of *Rhizophora mucronata:*

In terms of environmental restoration and management mangrove communities may provide to effective trap to immobilize water borne metal (Wong *et al*., 1997; Tam and Wong, 1996; Wing, 1997; Wong, 1998). Many mangrove species contained very high concentration of certain metal such as Fe and Mn (Untawale *et al*., 1980; Untawale *et al*., 1987). Most of the studies have proved that phenomenon regarding accumulation of Fe and Mn by R. mucronata in roots. Phytoremediation capcity of R. mucronata varies from metal to metal (pahalawattaarachchi *et al*., 2009).

Table 2. Metal concentration factor of R. mucronata given by pahalawattaarachchi *et al*., 2009.

Plant part	Cu	Cd	Ni	Mn	Cr	Zn	Fe	Pb
Leaves	0.030	0.187	0.027	0.109	0.030	0.059	0.010	0.191
S. leaves	0.041	0.178	0.022	0.242	0.018	0.078	0.010	0.350
Bark	0.061	0.250	0.012	0.295	0.020	0.081	0.01	0.369
Root	0.091	0.107	0.021	0.055	0.015	0.047	0.044	0.265
Whole plant	0.056	0.180	0.021	0.175	0.021	0.066	0.018	0.294

Table 3.Translocation ranges of detected metals to leaves, senescent leaves and bark of *R. mucronata* (Pahalawattaarachchi et al., 2009)

Plant parts	Cu	Cd	Ni	Mn	Cr	Zn	Fe	Pb
Leaves	1.53-0.7	1.19-1.84	0.84-1.49	0.12-0.20	0.67-1.66	0.78-2.41	0.24-1.00	0.48-0.50
Senescent leaves	0.37	1.06-1.99	0.82-1.22	0.15-0.45	0.94-2.37	0.90-0.98	0.3-0.8	0.98-1.18
Bark	0.42-0.83	1.85-2.53	0.37-0.39	0.29-0.66	0.96-1.27	0.93-1.11	0.31-0.89	0.97-1.30

Hepatoprotective and Antioxidant Properties of *Rhizophora mucronata*:

Liver is understood to be a major organ in the metabolism, detoxification and excretion of various xenobiotics from the body. The synthetic drugs used for the treatment of liver diseases are inadequate and can have serious side effects. Traditionally, many of the folk remedies of plant origin have long been used for the treatment of liver diseases. Marine halophytes, such as mangroves and related species, are known to have many and various metabolites possessing antibacterial and antifungal, antiviral, antidiarrhoeal, hepatoprotective, antifeedant, insecticidal, cytotoxicity and antiplasmodial properties. There number of studies on hepatoprotective and antioxidant activity of parts of the Rhizophora mucronata against CCL4-induced hepatotoxicity. R. mucronata different parts extract- effect check on hepatotoxicity of rats (Ravikumar and Murugesan, 2012).

Table 4. Hepatoprotective effect of *R. mucronata* on the histopathological sores of treated rats

	Fatty changes	Hydrophobic changes	Focal necrosis	Congestion in central vein	Congestion in sinusoidal spaces	Hepatocytes Deformation
Control	O	0	0	0	0	0
Hepatotoxin group	3	0	3	3	2	0
Silymarin	1	2	0	0	0	1
Bark	3	0	1	1	2	0
Collar	1	0	1	2	0	0
Hypocotyl	2	0	1	2	1	0
Stilt root	1	0	0	0	0	0

Figure 3. I. Liver section of normal control rats showing normal architecture. II. Liver section of CCl4 treated rats showing: massive fatty changes, necrosis, ballooning degeneration, and severe infiltration of the lymphocytes and the loss of cellular boundaries. III. Liver section of rats treated CCl4 and 100 mg/kg of silymarin showing: signs of inflammatory cascade around central vein indicating a mild degree of fatty change, and necrosis and focal necrosis (Singhal and Gupta, 2012).

Chemical characterization of *Rhizophora mucronata* parts:

R. mucronata has highest amount and most diverse phytochemical i.e. alkaloid, tannin, saponin, phenolic, flavonoid, triterpenoid and glycosides.

Table 5. Phytochemical content in *Rhizophora Murcatana*

Phytochemical screening	Parts of mangrove (*R. mucronata*)				
	Leaves	Root	Bark	Fruit	Flower
Alkaloid	++++	++++	++++	+++	++++
Tannin	+	+	++++	++	+++
Saponin	+	+	+++	++	+++
Phenolic	++++	-	++++	++	++
Flavonoid	++++	-	++++	+	++
Terpenoid	++++	-	++++	+	+
Steroid	++	+	-	-	-
Glycosides	++++	+	+++	++	+++

(-) negative; (+) weak positive; (++) positive; (+++) strong positive

Conservation status:

R. mucronata is in least concern category of IUCN red list ver 3.1(2010). Mangrove species are more at risk from coastal development and extraction at the extremes of their

distribution, and are likely to be contracting in these areas more than in other areas. It is also likely that changes in climate due to global warming will further affect these parts of the range. There has been an estimated 20% decline in mangrove areas within it range due to habitat loss or extraction, but not enough to reach any of the threatened category thresholds. This species is listed as Least Concern.

Threats:

The mangrove ecosystem as a whole is under severe threat, and the need for immediate efforts to conserve the flora, fauna and structural integrity of the ecosystem has been widely emphasised. In India, the genus Rhizophora has already been reported to be at the verge of extinction (Blasco, 1977), with sterile hybrids being the most vulnerable. In the present study area, Pichavaram Mangrove Forest, Tamil Nadu, India, Rhizophora is represented by Rhizophora apiculata Blume, R. mucronata Lamk. and a co-occurring sterile hybrid. The hybrid blooms profusely but rarely produces viviparous propagules. Production of synthetic hybrids by sexual hybridisation between the parental species and introduction into the original habitats is one strategy for conservation. However, reports on parentage based on morphological features for this hybrid are contradictory (Kathiresan, 1995; Kathiresan, 1997; Kathiresan, 2003). Over grazing and deforestation in all terrestrial biomes of the country is major threat to the loss of biodiversity. The main driving forces are high population growth rate, increasing poverty and wide gap between the supply and demand of the natural resources. The population pressure has increased on the marginal lands for subsistence agriculture. Faulty agricultural practices result in loss of soil due to wind erosion and water erosion. When the land loses fertility, new lands are broken for agriculture and so the process continues unabated. All mangrove ecosystems occur within mean sea level and high

tidal elevations, and have distinct species zonations that are controlled by the elevation of the substrate relative to mean sea level. This is because of associated variation in frequency of elevation, salinity and wave action (Duke *et al*. 1997). With rise in sea-level, the habitat requirements of each species will be disrupted, and species zones will suffer mortality at their present locations and re-establish at higher elevations in areas that were previously landward zones (Ellison *et al*., 2005). If sea-level rise is a continued trend over this century, then there will be continued mortality and re-establishment of species zones. However, species that are easily dispersed and fast growing/fast producing will cope better than those which are slower growing and slower to reproduce.

Conservation strategies:

Extensive and intensive surveys are required to prepare a comprehensive inventory of fodder resources of Indus delta. A mass awareness campaign should be launched on both governmental and community level in order to promote awareness among the people about the importance of plants and conservation of the flora. Cultivation of medicinal plants on scientific lines will be useful to reduce pressure on natural flora. *R. mucronata* protect from excessive siltation and induation. *R. mucronata* species should be introduced in botanical gardens. Public participation in conservation program and awareness through training or mass media should be ensured. Permanent monitoring programmes should be developed.

Conclusion:

The paper gives comprehensive information about the status of, chemical activity and major threats to *R. mucronata*. Scientific outputs of this plant also supports and validate knowledge of

this patrimony and revealed scope for isolation of novel compounds for modern therapeutic value for hepatoprotective drug from *R. mucronata.* There is need to updating of IUCN red list and proper conservation measure should b taken.

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