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Bioaccumulation of Zn and Pb in *Avicennia marina* (Forsk.) Vierh. and *Sonneratia apetala* Buch. Ham. from Urban Areas of Mumbai (Bombay), India

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ABSTRACT: Accumulation of heavy metals (Zn, Pb) was studied in two mangrove species *Avicennia marina* (Forsk.)Vierh. and *Sonneratia apetala* Buch.Ham. under field conditions. Variation in concentration of metals was found in leaf, root and sediment samples of these two species from different localities. Both the species of mangroves from different locations had high concentration of zinc when compared to lead. Lead showed less mobility towards the leaf tissue. In comparison to *Sonneratia apetala*, roots of *Avicennia marina* showed higher accumulation of the metals. @JASEM

Despite of the many efforts of ecologists and researchers to create awareness about mangroves ecosystem, this unique ecotone is still to gather the necessary attention. In spite of its ecological and economical values, mangrove ecosystems still in many parts of the world have been considered as wasteland. Land reclamation activities including increasing industrialization, urban runoff leading to high risk of effluent discharges along the coastal areas have resulted into depletion of mangroves. These ecosystems have capacity to act as a sink or buffer and remove or immobilize heavy metals before reaching nearby aquatic ecosystems. Due to large proportion of high organic content and low pH, mangrove mud effectively sequesters heavy metals, often immobilized as sulphides in anaerobic sediments (Peters et. al. 1997). Accumulation of pollutants especially heavy metals occurs in the roots but restricts its transport to aerial portions of the plant (Silva et.al, 1990; Chiu and Chou, 1991.) Generally mangrove shows ratio less than one for metal concentrations between tissues and sediments (Saenger et.al, 1990; Rao et.al, 1991; Tam and Wong 1995; Thomas and Fernandez, 1997; Ong Che 1999).

Avicennia marina is widely distributed species and reported from Papau New Guinea to southern Australia and New Zealand (Macfarlane et.al 2003.) It is a shrub or small tree having yellowish brown. Leaves are elliptic ovate/oblong pale green in colour. Flowers of Indian varieties are pale yellow. Capsule is viviparous1.2-2cm long. *Avicennia marina*, a facultative halophyte has various adaptations for hypersaline environments (Hutchings and Saenger, 1987; Waisel et.al, 1986.). *Sonneratia apetala* Buch.Ham is most distinctive genus and is restricted to southern India and Burma. It is small to medium sized tree, with narrow leaves gradually tapering towards the apex. The flowers are smaller than those of other species and usually 4 calyx lobes are twice as long as tube (Tomlinson, 1986).

Within leaf tissue, *A. marina* possesses numerous excretory glandular trichomes on both the surfaces, which actively excrete salts rich in sodium and potassium in order to maintain favourable osmotic gradients under saline environment (Thompson, 1975, Drennan and Pammenter 1982). The increased accumulation of metals to plant tissues of *Avicennia* species is supposed to be through the translocation of air absorbed through lenticels in pneumatophores from underground roots. This creates oxidized rhizospheres within the anaerobic soil environment, a reduction in complexing sulphides, a lowered stability of iron plaques, and a consequent higher trace metal concentration in the exchangeable form (De Lacerda et.al, 1993). The present study gives comparative account of accumulation of Zn and Pb in *Avicennia marina* and *Sonneratia apetala* in the above localities and hypothesizes their promising use for remedial activities.

MATERIALS AND METHODS

The collection site Koparkhairane and Ghatkopar are situated along the Thane creek industrial region while Elephanta Island is located at 9km distance from Mumbai city and is not disturbed (Map1). Mumbai (formerly Bombay) is one of the major metropolitan, located on the western coast of India. The area being along the creek and urban region has undergone rapid changes due to reclamation and discharge of waste resulting into depletion of mangroves. *Avicennia marina* species shows dominance. Samples of leaves and roots of *Avicennia marina* and *Sonneratia apetala* were collected along with sediment samples from above three sites. These samples were dried, crushed and weighed. Sediment samples were digested in 4ml of HNO_3 and 2ml of HF. These were heated and brought near to dryness then filtered and made up to 25ml stock solution using 25% HNO_3. Zn was determined using AAS (Atomic Absorption Spectroscopy, GBC Avanta Version 2.02). Pb was determined using DPASV (Differential Pulse Anodic Stripping Voltametry; 663 VA Stand Metrohm). Leaf

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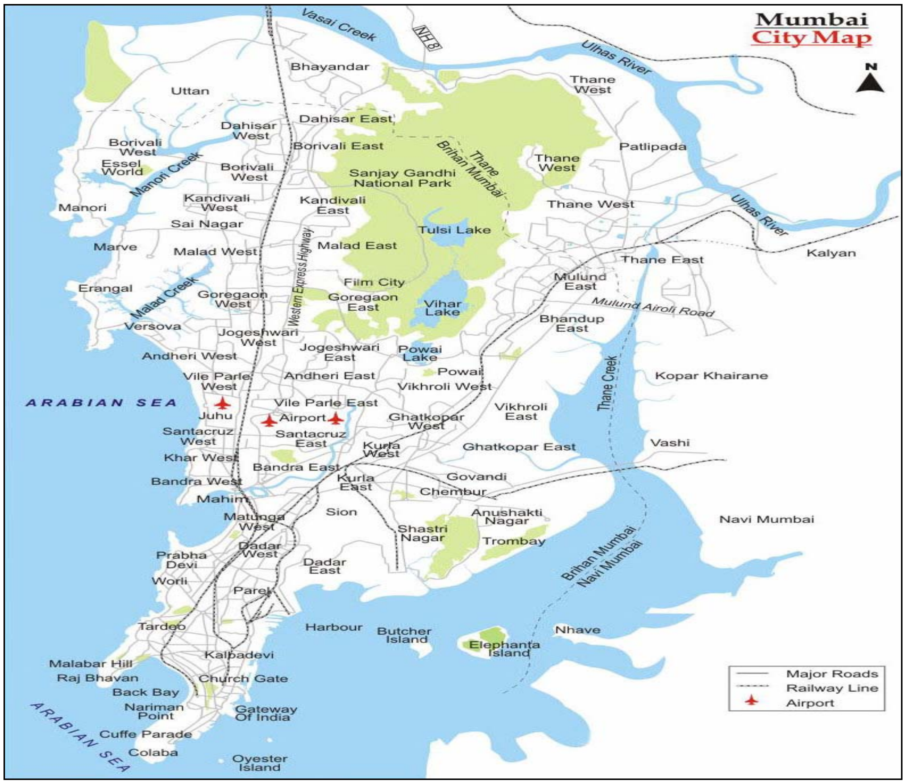
and root samples were then ashed using muffle furnace at 435°F and digested using 1 ml of HNO_3 and ½ ml of $HClO_3$. These were filtered and made up to volume 25ml using 25% HNO_3 and analysed.



Map1. Location of Mumbai and sampling stations

RESULTS AND DISCUSSION

The main aim is to know the bioaccumulation of heavy metals in mangroves. It is generally considered that mangroves show ability to accumulate metals and possess a certain tolerance to relatively high levels of heavy metal pollution (Thomas and Eong 1984). The tolerance appears to be the result of metals in sediment being in a form, which is not bio-available, in conjunction with biological mechanisms including exclusion and sequestering processes in root tissue (Chiu and Chou, 1991). The present study gives the quantified results of accumulation of zinc and lead. Also, the plant tissue to sediment ratio was studied and found to be less than one. The study also shows the comparison with respect to the plant part (leaf, root), location and species *(Avicennia marina* and *Sonneratia apetala)*. The trend of bioaccumulation was Sediments>Roots>Leaves. It was found that concentration of metals was higher in the samples collected from Koparkhairane and Ghatkopar which are having chemical and electrical industries, which discharge the effluents. Elephanta Island, which is undisturbed from industrial wastes show low concentrations of metals. Zinc, is an essential plant micronutrient, mobile and tends to be accumulated in mangrove tissue. As a nutrient, its uptake and allocation to plant organs such as photosynthetic leaf tissue is high and active (Baker A.J., Walker P.L., 1990) High concentration of zinc is found in both the mangrove species. Zinc was found to accumulate 207.605µg/g in sediment sample of Ghatkopar region. Also concentration of zinc was found to be 97.643µg/g in root sample of *Sonneratia apetala* near Ghatkopar. The other two sites show accumulation of zinc is more in case of *Avicennia marina.* (Table.1).

Table.1. Accumulation of Zinc (µg/g) in samples of Mangrove Species

		Zinc µg/g			
Location	Mangrove Species	Leaf Sample	Root Sample	Sediment Sample	LR/S ratio
Koparkhairane				158.1634	
	Avicennia marina	47.6791	65.4701		0.7153
	Sonneratia apetala	46.2314	65.3171		0.7052
Elephanta Island				76.4603	
	Avicennia marina	13.233	16.846		0.3933
	Sonneratia apetala	8.844	9.7249		0.2428
Ghatkopar				207.605	
	Avicennia marina	45.7259	53.9085		0.4799
	Sonneratia apetala	53.0395	97.6437		0.7258

Lead is non-essential and higher concentrations may be toxic to some species (Wozny A., Krzeslowska M., 1993.) High concentration was found to be in sediment sample (51.651µg/g) from Ghatkopar. Lead was with minimum concentration and showed less mobility towards the leaf tissue. Lead was absent in leaf sample of Elephanta Island. Elephanta Island is an Island with comparatively cleaner and undisturbed mangrove environment. (Table.2). The present study also indicated that roots of *Avicennia marina* were able to bioaccumulate and survives despite of the heavy metal contamination. The luxuriant growth of *Avicennia marina* in comparison to other mangrove species is evident of its adaptability even under polluted conditions.

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Table.2. Accumulation of Lead (µg/g) in samples of Mangrove Species

		Lead µg/g			
Location	Species	Leaf Sample	Root Sample	Sediment Sample	LR/S ratio
Koparkhairane				16.6977	
	Avicennia marina	2.3578	2.37775		0.2836
	Sonneratia apetala	8.7903	1.2491		0.6012
Elephanta Island				3.8004	
	Avicennia marina	nd	0.6182		0.1626
	Sonneratia apetala	nd	0.55835		0.1469
Ghatkopar				51.651	
	Avicennia marina	7.39295	5.58685	12.9798	0.2512
	Sonneratia apetala	3.8154	2.23795	6.05335	0.1171

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