Pb and Cd accumulation in *Avicennia marina* from Qeshm Island, Persian Gulf

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Abstract

The accumulation of heavy metals Pb and Cd in the mangrove, *Avicennia marina*, was studied on the southern coast of Iran, particularly on and near Qeshm Island in the Persian Gulf**.** The samples were collected from 7 stations which they were analyzed by flame Atomic absorption spectrophotometer after chemical digestion. Maximum Pb and Cd in leaves are (34.50, 3.52 ppm) and minimum of them are in stems (2.00, 0.05 ppm) and the accumulation of metals in leaves is more than stems. The different between monitored stations and accumulation of metals in tissues ($P \geq 0.01$) was not significant and there was no significant relationship between the leaves and stems of metals concentration ($P \geq 0.05$) but it was significant relationship between concentration of Pb and Cd in leaf tissue and stem tissue alone. ($P<0.05$). After entering these metals to food chain, are accumulated in human body and this matter may cause some disease by receiving metals more than provisional tolerable weekly intake (PTWI) of lead and cadmium, in adults which in 0.025 and 0.007 mg/kg body weight with standards ENHIS.

Keywords: Heavy metal, *Avicennia marina*, Persian Gulf

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Introduction

Mangrove forests and adjacent mudflats are be threatened by the mass movement of people to coastal urban and industrial areas all over the world (Lin and Dushoff, 2004; Lindsey et al., 2006). Among the wide variety of pollutants released from human and industrial activities, heavy metals are one of the most serious pollutants within the natural environment due to their toxicity, persistence and bioaccumulation problems (Macfarlane and Burchett, 2002; Lindsey et al., 2006; Vane et al., 2009; Lal Shah, 2010). Concentrations of heavy metals in sediments usually exceed those of overlying water by 3-5 orders of magnitude (Zabetoglouet et al., 2002). High concentrations of heavy metals in contaminated soil and water affect plants as well as the animal organisms in their habitat (Doganlar and Atmaca, 2011). Qeshm Island in Hormuz Strait dominated by the cosmopolitan species *Avicennia marina*. Qeshm Island not only represents an important ecological resource in the region, but also is one of the main economic assets of the north coast of the Persian Gulf serving a variety of industrial activities. The ecological and physiological characteristics of *Avicennia marina* tree which were widely studied (Tomlinson, 1986; Hutchings and Saenger, 1987) make it susceptible to be a potential candidate for accumulation of heavy metals. In this regard, to assess the extent to which the health of Mangrove forests has declined due to the inputs of heavy metals (i.e. Pb, Cd), this study has been conducted

Materials and methods

This study was directed in Mangrove forests of Qeshm Island, North coast of the Persian Gulf (Fig. 1). Samples were taken from seven sites, the geographical positions of sites were shown in Table 1. Samples included the leaves and stems tissues of trees taller than one meter and apparently be in a similar health status. Samples were collected in three intervals during summer 2008 with 3 replicates in each sampling procedure from each of 7 selected sites. The sites were selected in a way to encompass the entire area of the forests. Subsamples were prepared from collected leaves and stems tissues and washed in distilled water. To assess the concentrations of Cadmium and Lead the washed subsamples were dried up and wet digested in nitric acid 65% and perchloric acid 75% (Nollet, 2004). The samples were analyzed by atomic absorption flame spectrophotometer (Varian A110). Data analyses were undertaken using SPPS version14. The hypothesis that the concentrations of the 2 measured elements were differed in leaf and stem tissues and also among the 7 selected sites were examined by measuring One-Way Anova test. The hypothesis that there were a relationship between the concentrations of measured elements and the monitored tissues were explored by calculating Pearson correlation.

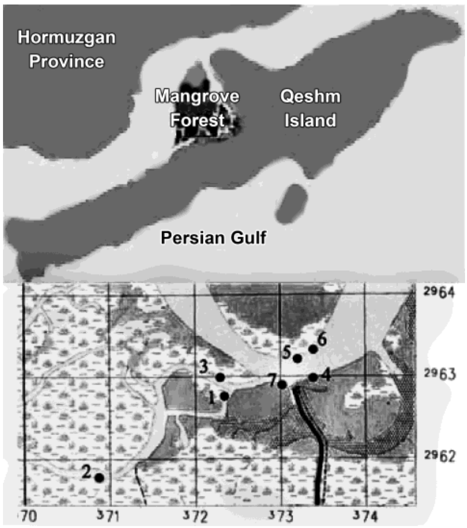

Figure1: The sampling stations in Qeshm Island

Table 1: Geographical Position of sampling stations

No. Station	N	E
1	26º46'45.98″	55º42'57.79″
2	26º46'42.21″	55º42'54.00″
3	26º46'53.33″	55º42'54.38″
4	26º47'6.45″	55º43'14.45″
5	26º47'6.97″	55º43'29.57″
6	26º46'58.64″	55º43'42.84″
7	26º46'53.63″	55º43'27.80″

Results

The concentration of Lead was measured in dried leaf and stem tissues ranged from 1.50 to 99.50 and 1.50 to 35.50 ppm, respectively. According to Table 2 the maximum concentration of Lead in leaf and tissue were recorded from sites 3 and 4, respectively. The minimum concentration of Lead in leaf tissue was found in site one although the minimum concentration in stem was recorded from site 5. The concentration of Cadmium was measured in dried leaf and stem tissues ranged from 0.00 to 10.45 and 0.00 to 2.65 ppm, respectively. As it shown in Table 2 the maximum concentration of Cadmium in leaf and tissue, as same as the Lead concentration, were recorded from sites 3 and 4, respectively. Furthermore the minimum concentration of Cadmium in leaf and tissue, as same as the Lead concentration, were recorded from sites 1 and 5, respectively (Table 2). The concentrations of Pb and Cd were not significantly differed among the 7 selected sites and also among the monitored tissues ($p \geq 0.01$). According to Tables 3 and 4 the highest amount of lead that accumulated in leaf and stem tissues it had low level of cadmium. It was also observed that the accumulation of Cd in tissues were in low level of lead. This comparison indicated that the quality of plant tissues absorption was difference in these two metals. Pearson correlations were calculated between the concentrations of measured elements and the monitored tissues (Table 5). In figure 2 Lead concentration was compared between Leaves and stems samples. In figure 3 Cadmium concentration was compared between Leaves and stems samples.

Table 2: The average of metals concentration (ppm) in the tissues of *Avicennia marina* in Qeshm Island

No. Station	Pb(leaf)	Pb(stem)	Cd(leaf)	Cd(stem)
1	3.30±0.289	2.50±0.147	0.15±0.005	0.06±0.009
2	8.00±0.708	5.50±0.433	0.25±0.026	0.22±0.033
3	34.50±5.629	3.50±0.132	3.52±0.060	0.10±0.013
4	17.70±1.848	15.50±0.174	2.07±0.358	1.08±0.136
5	5.20±0.472	2.00±0.050	0.43±0.054	0.05±0.000
6	3.90±0.1890	3.00±0.100	0.83±0.006	0.07±0.008
7	10.20±1.086	4.70±0.375	0.73±0.077	0.45±0.056

Table 3: Crosstab of metals level in the leaf tissue of *Avicennia marina* in Qeshm Island

		Range of cadmium						
		1	2	3	4	5	6	
Range of lead		0.00-0.15 (ppm)	0.16-0.35 (ppm)	0.36-0.60 (ppm)	0.61-2.00 (ppm)	2.01-6.50 (ppm)	6.51-10.50 (ppm)	Total
1:0.00-2.00(ppm)	٪within Pb	100	0	0	0	0	0	100
	٪within Cd	53.8	0	0	0	0	0	33.3
2:2.01-3.50(ppm)	٪within Pb	66.7	33.3	0	0	0	0	100
	٪within Cd	30.8	100	0	0	0	0	28.6
3:3.51-5.00(ppm)	٪within Pb	100	0	0	0	0	0	100
	٪within Cd	7.7	0	0	0	0	0	4.8
4:5.01-16.00(ppm)	٪within Pb	25	0	50	25	0	0	100
	٪within Cd	7.7	0	100	50	0	0	19
5:16.01-35.50(ppm)	٪within Pb	0	0	0	50	50	0	100
	٪within Cd	0	0	0	50	100	0	9.5
6:35.51-99.50(ppm)	٪within Pb	0	0	0	0	0	100	100
	٪within Cd	0	0	0	0	0	100	4.8
Total	٪within Pb	61.9	9.5	9.5	9.5	4.8	4.8	100
	٪within Cd	100	100	100	100	100	100	100

Table 4: Crosstab of metals level in the stem tissue of *Avicennia marina* in Qeshm Island

		Range of cadmium					
		1	2	3	4	5	
Range of lead		0.00-0.15 (ppm)	0.16-0.35 (ppm)	0.36-0.60 (ppm)	0.61-2.00 (ppm)	2.01-6.50 (ppm)	Total
1: 0.00-2.00 (ppm)	٪within Pb	100	0	0	0	0	100
	٪within Cd	26.7	0	0	0	0	19
2:2.01-3.50(ppm)	٪within Pb	90	0	0	10	0	100
	٪within Cd	60	0	0	100	0	47.6
3:3.51-5.00(ppm)	٪within Pb	33.3	66.7	0	0	0	100
	٪within Cd	6.7	66.7	0	0	0	14.3
4:5.01-16.00(ppm)	٪within Pb	33.3	33.3	33.3	0	0	100
	٪within Cd	6.7	33.3	100	0	0	14.3
5:16.01-35.50(ppm)	٪within Pb	0	0	0	0	100	100
	٪within Cd	0	0	0	0	100	4.8
Total	٪within Pb	71.4	14.3	4.8	4.8	4.8	100
	٪within Cd	100	100	100	100	100	100

Table 5: Pearson correlation in the tissues of *Avicennia marina* in Qeshm Island

		Pb leaf	Pb stem	Cd leaf	Cd stem
Pb leaf	r	1			
	P	.			
Pb stem	r	-.183	1		
	P	.427	.		
Cd leaf	r	.966*	-.175	1	
	P	.000	.448	.	
Cd stem	r	-.167	.914*	-.160	1
	P	.470	.000	.487	.

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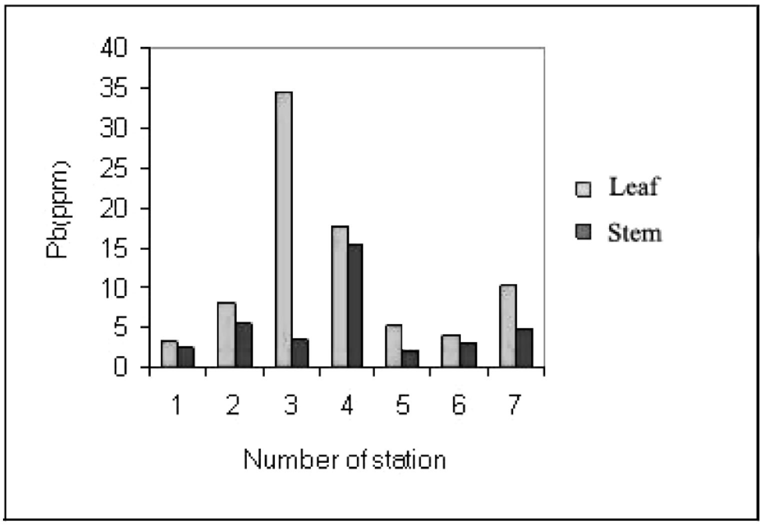

Figure 2: The average of Pb concentration (ppm) in tissues of *Avicennia marina* in Qeshm Island

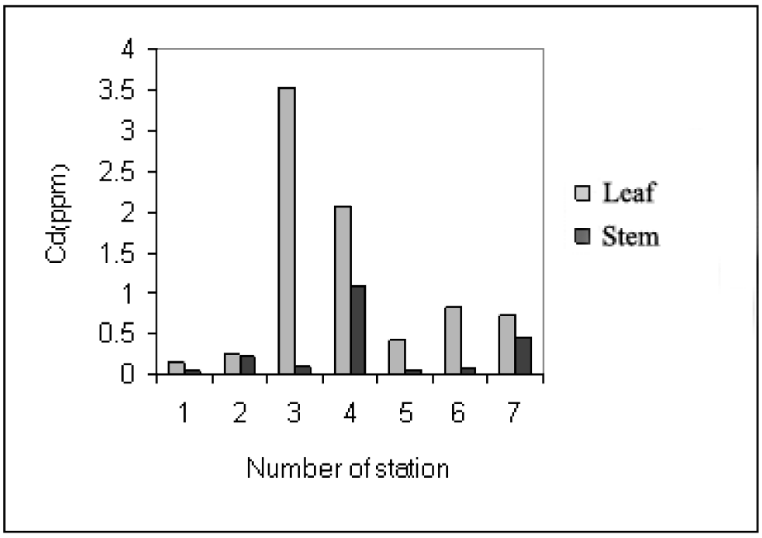

Figure 3: The average of Cd concentration (ppm) in tissues of *Avicennia marina* in Qeshm Island

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Discussion

Average cadmium measured in leaf tissue was found to be 1.03 ppm in dry weight and 0.29 ppm in stem tissue dry weight. Average lead found in leaf tissue was 10.95 ppm dry weight and in stem tissue was 5.24 ppm dry weight. According to The results of Table 5 shows that no significant relationship between leaf and stem about accumulation of heavy metals. observed It is attributed to the fact the absorption of metals in leaves and stems are different. While there is strong significant relationship between the amount of Pb and Cd in leaf tissue and stem tissue alone. It could be attributed to the same source of entering solvent used for these metals. According to the results of Davari et al. (2010), the amount of Pb and Cd exist in leaves of *Avicennia marina* at Bushehr Province are 39.01 ppm and 0.85 ppm, respectively. Hence, the amount of Pb in leaf tissue with 10.59 ppm is higher than the level at this research, then amount of Pb with 1.04 ppm was found less than it. This comparison indicates that Pb in Bushehr Province is higher in contrast to Qeshm Island but the value of Cd would be low. The comparison of these metals with other parts of the world showed Pb concentration was reported in the range of 1.7 and 3.7 ppm at Hawksbury and Jackson Ports (MacFarlane, 2002), 5.0 ppm at HomeBush Bay, Sydney (MacFarlane *et al*, 2003) and 6.13 ppm at Punta Mala Bay, Panama (Defew *et al*, 2005).Cd concentration in these areas were reported lower than detection limit of spectrophotometer. Results in Table 2 and 3 show that accumulation of metals in leaf tissue of *Avicennia marina* is more than stem, although Yim and Tam (1999) found that, in general, very small amounts of heavy metals were accumulated in leaf tissue as most absorbed heavy metals were accumulated in stem and root tissue. According to The results of Davari et al (2010), the concentration of metals in root of *Avicennia marina* in Bushehr Province is more than leaf.

The study of Ramos E Silva et al. (2006) in red mangrove forest of northern Brazil was reported the belowground roots represented the main mass budget of Pb and Cd in the branch. Considering that leaves and stems are used for animal feed and medicine, the level metals were compared with (CODEX, 2007) standard and was resulted that Pb and Cd in tissues was not significant different at ($P \geq 0.01$) levels. The metals entered into food chain are accumulated in human body cause to some diseases in adults of being exposed to metal concentrations for amount more than the provisional tolerable weekly intake (PTWI) of lead and cadmium which are in 0.025 and 0.007 mg/kg body weight (ENHIS, 2007). Daryagoosh Estuary and other estuaries in Qeshm Island are the protected areas, however, traffic of motor-boats and oil pollutants of the Persian Gulf are the factors to threaten this environment. Therefore, taking the better results on metal uptake, sampling should be extended to other areas to obtain a greater variety and reduce environmental contamination level.

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