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LEVEL OF HEAVY METALS IN THE FOLIAGE OF NATURALLY GROWING PLANTS COLLECTED FROM KORANGI AND LANDHI INDUSTRIAL AREAS OF KARACHI CITY, PAKISTAN

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Abstract

The accumulation of heavy metals of Fe, Pb, Cu, Cr and Zn was determined in the foliage of naturally growing plants of *Prosopis juliflora* Swartz, *Abutilon indicum* (L.) Sweet and *Senna holosericea* (Fresen.) Greuter, which were collected from various factories in the vicinity of Korangi and Landhi industrial areas of Karachi. High concentration of ferric and lead was observed in the foliage of *A. indicum* which were collected from Tanveer Garment factory as compared to foliage collected from a control area of Karachi University Campus. The level of copper and chromium was highest in the foliage of *S. holosericea* at Khan Towel factory than control site. Khan Towel factory also caused considerably high amount of lead in the foliage of *P. juliflora* as related to control site. The excessive copper was recorded in foliage of *A. indicum* at One Tech Ply Board factory as compared to control site. The foliage of *S. holosericea* showed highest concentration of zinc at One Tech Rubber factory as compared to control area.

The research demonstrated that accumulation of different metals was generally higher in the foliage of naturally growing plants collected from the industrial areas.

Introduction

Industrial pollution due to heavy metals in Karachi is a major issue. Botanical materials have been used to detect the deposition, accumulation and distribution of metal pollution (Aksoy *et al.*, 2000). Accumulation of heavy metals in tree rings (Kennedy & Bergeron, 1991), leaves of higher plants (Romero *et al.*, 1987; Kaneez *et al.*, 2000; Ahmed *et al.*, 2003) and forest (Nikonov *et al.*, 2001) from the industrial areas have also been investigated. Heavy metals produce detrimental effect on plants by reducing plant growth (Shafiq & Iqbal 2005; Atiq-ur-Rehman & Iqbal 2006). Different industries are present in the industrial areas of Karachi. In view of the destructive and hazardous role of industries in Karachi, it was necessary to investigate the accumulation of heavy metals of Fe, Pb, Cu, Cr and Zn in foliage of naturally growing plants of *P. juliflora*, *A. indicum* and *S. holosericea* collected from industrial areas of Korangi and Landhi of Karachi. Similar studies conducted at roadside areas of Karachi by Ara *et al.*, (1996), indicated highest concentration of Cu, Fe, Ni, Pb, Zn, Cd and Cr in *Eucalyptus* sp., and *Ficus religiosa* leaves. *Prosopis juliflora* Swartz, *Abutilon indium* (L.) Sweet and *Senna holosericea* (Fresen.) Greuter are plants which are distributed world-wide. *P. juliflora* (Family Mimosaceae), *A. indicum* (Family Malvaceae) and *S. holosericea* (Family Caesalpinaceae) were found as dominant species in the vicinity of Korangi and Landhi industrial areas of Karachi (Atiq-ur-Rehman, 2006). *S. holosericea* was also found at the Karachi University Campus where *P. juliflora* was most dominant species. *P. juliflora* is distributed in Karachi along Lyari, common in sandy areas.

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The aim of this study was to determine the accumulation of heavy metals of ferric, lead, copper, chromium and zinc in the foliage of naturally growing plants of these three species collected from the industrial areas of Korangi and Landhi and compared with the less polluted plants growing in Karachi University Campus.

Materials and Methods

To determine the accumulation of heavy metals in leaves samples were collected from naturally growing plants of *Prosopis juliflora* Swartz, *Abutilon indium* (L.) Sweet and *Senna holosericea* (Fresen.) Greuter from the vicinity of industrial areas of Korangi and Landhi. The leaves of *P. juliflora* were collected from Khan Towel, Tanveer Garment, One Tech Rubber and One Tech Ply Board factories whereas, leaves of *A. indicum* were obtained from Khan Towel, Tanveer Garment and One Tech Ply Board factories. The leaves of *S. holosericea* were collected from Khan Towel, One Tech Rubber and One Tech Ply Board factories. The leaves of same three species were also collected from the Karachi University Campus, a control area as less polluted leaves. The leaves were air dried followed by oven drying at 80°C for 24 hours. The dried leaves were powdered, passed through 1 mm sieve and stored in labeled polythene bags till wet digestion. For wet digestion, 0.5 gram powdered leaves were digested with 5 ml concentrated Nitric acid (HNO_3) + 5 ml concentrated Perchloric acid ($HClO_4$), heated at 90 °C for 2½ hours. Thereafter, little amount of distilled water was added in the digested residue, filtered through Whatman filter paper No. 42 and the volume was made up to 50 ml using distilled water and the solution was diluted 10 times for ferric (Fe), lead (Pb), copper (Cu), chromium (Cr) and zinc (Zn) analyses. Heavy-metal analyses of plant leaves were carried by atomic absorption spectrophotometer (Perkin Elmer Model No. 3100).

Data were statistically analyzed by analysis of variance (ANOVA) (Steel & Torrie, 1984) and Duncan's Multiple Range Test (DMRT) (Duncan, 1955) ($p<0.05$) using a personal computer software package Costat version 3.0.

Percentage reduction of heavy metals in leaves collected from factories sites was determined in comparison with leaves of control site using the following formula:

$$\text{Percentage reduction (\%)} = \frac{\text{Mean value for foliage of control area plant (Karachi University) – Mean value for foliage of factory area plant}}{\text{Mean value for foliage of control area plant (Karachi University)}} \text{ X } 100$$

Results and Discussion

Heavy metals accumulation was generally higher in plants samples collected from Korangi and Landhi industrial areas as compared to a control area of Karachi University Campus (Tables 1-2). Higher ferric and lead (Tables 1-2) concentrations were recorded in all the samples collected from factories sites than control site. Ara *et al.* (1996) reported greater ferric, copper, nickel, cadmium and chromium accumulation in leaves of *Eucalyptus* sp., and *F. religiosa* at roadsides of Gurumander, M.A. Jinnah Road, Shaheed-e-Millat Road at Karachi. Thus, these results showed that the accumulation of ferric in leaves of various plants growing at both polluted areas like Korangi and Landhi industrial areas and roadside areas of Karachi was higher as compared to a control site. Iron comes from corrosion of pipes, containers and wear and tear of vehicles (Ara *et al.*, 1996). Aksoy *et al.*, (2000) had also demonstrated that the effects of Zn, Cu, Pb and Cd on vegetation were varied and could involve in the disappearance of some species of *Robinia pseudo-acacia* at industrial, road side, urban, suburban and rural areas of Kayseri at Turkey.

Table 1. Level of ferric, lead, copper, chromium and zinc (μg^{-g}) in foliage of some plants collected from different sites.

Heavy metals	Sites	*Prosopis juliflora*	*Abutilon indicum*	*Senna holosericea*
Fe	A	0.635 ± 0.007 d	1.191 ± 0.057 b	1.365 ± 0.119 b
	B	1.184 ± 0.038 b	1.438 ± 0.004 a	1.632 ± 0.012 ab
	C	1.348 ± 0.016 a	1.440 ± 0.016 a	-
	D	1.233 ± 0.033 b	-	1.481 ± 0.051 ab
	E	1.062 ± 0.026 c	1.356 ± 0.028 a	1.718 ± 0.068 a
	L.S.D.	0.096	0.129	0.288
Pb	A	0.001 ± 0.001 c	0.001 ± 0.001 c	0.017 ± 0.001 b
	B	0.010 ± 0.002 a	0.013 ± 0.001 a	0.025 ± 0.002 b
	C	0.008 ± 0.002 ab	0.015 ± 0.001 a	-
	D	0.002 ± 0.000 c	-	0.021 ± 0.001 b
	E	0.003 ± 0.001 bc	0.009 ± 0.001 b	0.088 ± 0.012 a
	L.S.D.	0.005	0.004	0.024
Cu	A	0.007 ± 0.001 bc	0.002 ± 0.000 c	0.040 ± 0.004 b
	B	0.012 ± 0.002 ab	0.021 ± 0.001 b	0.083 ± 0.019 a
	C	0.017 ± 0.003 a	0.019 ± 0.001 b	-
	D	0.003 ± 0.001 c	-	0.010 ± 0.002 b
	E	0.008 ± 0.002 bc	0.081 ± 0.007 a	0.016 ± 0.002 b
	L.S.D.	0.007	0.014	0.039
Cr	A	0.041 ± 0.021 a	0.108 ± 0.004 b	1.106 ± 0.896 b
	B	0.071 ± 0.019 a	0.212 ± 0.010 a	9.893 ± 0.111 a
	C	0.036 ± 0.008 a	0.203 ± 0.001 a	-
	D	0.039 ± 0.003 a	-	2.567 ± 0.515 b
	E	0.080 ± 0.004 a	0.187 ± 0.009 a	7.743 ± 1.341 a
	L.S.D.	0.049	0.028	3.331
Zn	A	0.013 ± 0.001 a	0.002 ± 0.000 b	0.020 ± 0.016 b
	B	0.003 ± 0.001 b	0.018 ± 0.002 a	0.000 ± 0.000 b
	C	0.005 ± 0.001 b	0.009 ± 0.001 ab	-
	D	0.005 ± 0.003 b	-	0.084 ± 0.022 a
	E	0.003 ± 0.001 b	0.017 ± 0.005 a	0.002 ± 0.000 b
	L.S.D.	0.006	0.011	0.053

A = Karachi University; B = Khan Towel factory; C = Tanveer Garment factory; D = One Tech Rubber factory; E = One Tech Ply Board factory.
Statistical significance determined by analysis of variance. Number followed by the same letters in the same column is not significantly different, according to Duncan's Multiple Range Test. Least significance difference (L.S.D.) values at $p < 0.05$ level, ± Standard error.

In the present investigations, copper and chromium (Tables 1-2) accumulation was higher in the leaves of *P. juliflora, A. indicum* and *S. holosericea* collected at Khan Towel factory site. Copper concentration was higher in leaves of *P. juliflora* at Tanveer Garment factory and chromium accumulation was high in foliage of *P. juliflora* at One Tech Ply Board factory. In Scots pine (*Pinus sylvestris*) needles, sulphur and copper was increased from smelters of industrial centre in north-western Russia (Roitto *et al.*, 1999). High levels of Cu discharge into the environment through mining, smelting, manufacturing, agriculture and waste disposal technologies (Yruela, 2005). Copper and ferric treatments greatly reduced the germination of *A. lebbeck* seeds, particularly at the higher concentrations (Iqbal

& Atiq-ur-Rehman, 2005). Ara *et al.,* (1996) found that chromium was not detected in the foliage of *Eucalyptus* sp., and *F. religiosa* at roadsides areas of Gurumander, M.A. Jinnah and Shaheed-e-Millat roads and at Karachi University Campus. Thus, industrial areas showed the presence of chromium at factories sites. The industrial effluents released from tanneries, plastic and chrome plating had considerably elevated levels of chromium in plants (Rai *et al*., 1992). The increase in concentration of Cr suppressed the dry weight of *Leucaena leucocephala* (Iqbal & Atiq-ur-Rehman 2002).

Zinc accumulation was higher in foliage of *A. indicum* at all of the factories (Tables 1-2). Aksoy & Sahin (1999) found high levels of Pb, Cd and Zn in *Elaeagnus angustifolia* in the industrial, road side and urban areas of Kayseri in Turkey. Kartal *et al.,* (1993) reported that Pb, Cd and Zn pollution was high, which originated from the zinc ore used in the factory (Cinkur plant) in Kayseri, Turkey.

Our investigations showed that accumulation of metals of Fe, Pb, Cu, Cr and Zn were mostly higher in foliage of plants collected from different industries investigated. Despite of higher metal accumulation in the leaves, *Abutilon indium* was found in the industrial areas of Karachi. Atiq-ur-Rehman (2006) described that *A. indicum* was most dominant species in the vicinity of Korangi and Landhi industrial areas as compared to other species studied.

The findings of this research could be helpful in monitoring the heavy metals in naturally growing plants in the vicinity of industrial areas. Furthermore, such information could also be useful for landscaping and urban planning.

Table 2. Percentage reduction in levels of Fe, Pb, Cu, Cr and Zn in the foliage of naturally growing plants collected from different factories in comparison with plants collected from Karachi University.

Heavy metal	Sites	*Prosopis juliflora*	*Abutilon indicum*	*Senna holosericea*
Fe	A	86.5+	20.7+	19.6+
	B	112.3+	20.9+	-
	C	94.2+	-	8.5+
	D	67.2+	13.9+	25.9+
Pb	A	900.0+	1200.0+	47.1+
	B	700.0+	1400.0+	-
	C	100.0+	-	23.5+
	D	200.0+	800.0+	417.6+
Cu	A	71.4+	950.0+	107.5+
	B	142.9+	850.0+	-
	C	57.1	-	75.0
	D	14.3+	3950.0+	60.0
Cr	A	73.2+	96.3+	794.5+
	B	12.2	88.0+	-
	C	4.9	-	132.1+
	D	95.1+	73.1+	600.1+
Zn	A	76.9	800.0+	100
	B	61.5	350.0+	-
	C	61.5	-	320.0+
	D	76.9	750.0+	90.0

A = Khan Towel factory; B = Tanveer Garment factory; C = One Tech Rubber factory; D = One Tech Ply Board factory, + Percentage increase.

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