Article

Biomonitoring and speciation of road dust for heavy metals using *Calotropis procera* and *Delbergia sissoo*

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Abstract

The present study was conducted for identifying the important heavy metals present in the road dust and at the same time biomonitor them using *Calotropis procera* and *Delbergia sissoo* leaves. The study clearly indicated that both the plants can be used as biomonitor for As, Pb, Fe, V, Cd, Cr, Zn and Cu. The heavy metals were estimated using AAS-7000 (Shimadzu). Reason for selecting the plants were their abundance in the area and high air pollution indices. Presence of these heavy metals in the road dust can be attributed to the red soil and more importantly thermal power plants operating in the study area. Since plants are able to capture the road dust, they can also prevent the particulate pollution which is having adverse health impacts for humans.

Keywords biomonitor; road dust; speciation; heavy metals.

1 Introduction

Heavy metals are classified among the most dangerous groups of anthropogenic environmental pollutants due to their toxicity and persistence in the environment (Ackah et al., 2011; Sayadi et al., 2011; Sayyed and Wagh, 2011; Tiwari, 2011; Anim et al., 2012; Gyamfi et al., 2012; Prajapati et al., 2012; Zakaria et al., 2012). Presence of heavy metals in the road-side and particulate matter in the ambient air is serious and has adverse human health effect. Particulate matter has been widely studied in recent years due to its potential health impact and the need for its control. Links between asthma attacks and coughs to particulates have also been reported (Freer-Smith et al., 1997). Studies indicate that finer PM has the strongest health effects (Schwartz et al., 1996; Borja-Aburto et al., 1998). Vehicular traffic, industrial processes, and fossil fuel stations are primary sources of airborne particulate matter (Beckett et al., 1998), which is responsible for contamination of urban areas (Janssen et al., 1997; Monaci et al., 2000; Fernandez et al., 2001). In aerosols, magnetite is associated with other heavy metals, such as zinc, cadmium, and chrome (Georgeaud et al., 1997). There are references that plants capture trace elements and can be used as biomonitors (Rossini and Valdes, 2003; Rossini and Rautio, 2004; Madejón et al., 2006, 2006). Keane et al. (2001) compared the metal content (Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn) in dandelion leaves with the PM_{10} levels.

Higher plants function as biomonitors of aerial metal contamination due to their accumulation properties. Vehicle derived particulates were monitored using magnetic properties of leaf dust and it has been established that they are particularly dangerous to human health (Prajapati et al., 2006). Prajapati and Tripathi (2007) have biomonitored the trace metals present in PM_{10} using leaves of *Saraca indica* and *Lantana camara*. Present study was conducted in Bilaspur district (C.G.) of India which is facing nuisances of air problems.

2 Materials and Methods

Two plants *Calotropis procera* and *Delbergia sissoo* were taken for biomonitoring experiments because of their abundance in the area and also that they are having high air pollution tolerance index. *Calotropis procera* and *Delbergia sissoo* leaves were collected from the roadside and at the same time road dust was also collected. Dust were removed and collected from both plant leaves with the help of fine brushes in different boro-silicates vessels and marked for identification. Samples were digested in 15 mL of a mixture of concentrated acids HNO_3 : $HClO_4$ v/v (3 : 1). Sample solutions were transferred into sterile tubes after digestion and cooling. The metal concentration was measured with the help of atomic absorption spectrophotometer (AAS) model: AA 7000, SHIMADZU and the standard was prepared using standard metal solution of Inorganic Ventures.

3 Results

Heavy metal speciation of dust collected from road and dust present on *Calotropis procera* and *Delbergia sissoo* is given in table 1. It is evident from the table that the dust analysed is heavily contaminated with heavy metals. Out of eight metals for which analysis was performed arsenic (As) was not detected in any samples. Fe was present in maximum concentration followed by Zn>Cr>Cu>Cd>Pb>V. It can be observed from the table that *Calotropis procera* is good biomonitor for V, Cr, Zn and Cu than *Delbergia sissoo* while it is poor than *Delbergia sissoo* for metals Cd, Fe and Pb. Biomonitoring capacity of heavy metals are different for different plants which can be attributed to different leaf morphology and texture of plants.

Table 1 Heavy metal present in road-side dust and dust collected from the leaves of *Calotropis procera* and *Delbergia sissoo*(µg g^{-1} dust)

	As	V	Cd	Cr	Fe	Pb	Zn	Cu
Road-side dust	n.d.	1.43±0.85	6.2±0.56	23.34±1.45	547.65±4.55	5.65±0.92	97.46±1.45	12.42±0.95
Calotropis procera	n.d.	1.25±0.46	3.9±1.2	16.50±0.96	257.25±1.54	2.14±0.26	33.53±0.82	6.78±0.40
Delbergia sissoo	n.d.	1.16±0.54	4.26±0.48	12.55±1.45	294.55±2.19	3.45±0.78	16.22±0.45	6.35±0.68

n.d.: Not detectible (0.01 ppm)

4 Discussion

The metal analysis of road dust and dust present on the leaves clearly indicate that the metals present on plant leaves are derived from the re-suspended road dust. The present work demonstrates that plants are able to capture the re-suspended road dust containing various toxic heavy metals. They are capable of holding heavy metals present in the dust and thus can be used as biomonitor for heavy metals present in the particulates matter. The metals present in the dust may originates from the red soil being used for construction of roads, heavy duty diesel vehicles travelling and carrying coal as well as fly ash of thermal power plants. The high dust holding capacity of *Calotropis procera* and *Delbergia sissoo* is due to the morphology and texture of the leaves. The study also clearly indicates that plants can be used to prevent heavy metals pollution originating from road side dusts.

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