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RESEARCH ARTICLE

The Transfer of Heavy Metals from Contaminated Soils in *Polyalthia longifolia* in Allahabad Industrial Region

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Abstract

This work addresses the issue of Lead, Cadmium, Nickel, Copper, Zinc and Iron heavy metals accumulation in naturally growing plant *Polyalthia longifolia* in the context of its possible use for the pollution monitoring of these metals. This plant was collected from the industrial areas of Allahabad near the polluted effluent discharge by the industries. Six heavy metals Pb, Cd, Ni, Cu, Zn and Fe were evaluated in *Polyalthia longifolia* at the site. The concentration of these metals were found in the soil below *Polyalthia longifolia* at the site is as following order: Fe> Cu> Zn> Pb> Ni> Cd. *Polyalthia longifolia* was representing high metal accumulation properties and also a high level of metal transportation from the root to the shoot appear to be useful for giving higher possible heavy metal removal from the soil. To evaluate the potential of plant species for phytoremediation, bioconcentration factor was calculated.

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INTRODUCTION

Polyalthia longifolia belongs to Annonaceae family and is a lofty evergreen tree, native to India. The plant is generally planted due to its capacity to alleviate noise pollution. Plant species vary in their capacity to remove and accumulate heavy metals [1].

According to Zurayk the plant act as diffuse samplers, accumulating pollutants to a higher concentration than their surroundings due to the continuous absorption of minerals over time [1].

Heavy metal pollution affects biosphere in many places around the world [2-3]. Heavy metals make a significant contribution to environmental pollution as a result of human activities such as smelting, mining, electroplating, energy and fuel production, intensive agriculture, power transmission, sludge dumping and other industrial activities [4]. These metals present a risk for primary and secondary consumers and ultimately humans [5]. Therefore it required a green technology to face these types of problems and sustainable development. This technology is said to be Phytoremediation. Phytoremediation of heavy metal-contaminated soil is an emerging technology that aims to extract or inactivate metals in soils [6]. Bioconcentration factor is the factor to evaluate phytoremediation potential of metals by the plants.

The objective of the study was to evaluate the species ability to accumulate Pb, Cd, Ni, Cu, Zn and Fe in different parts of the plant –*viz.* leaf, stem and root. It will help in the phytoremediation potential of the metals Pb, Cd, Ni, Cu, Zn and Fe by *Polyalthia longifolia*.

MATERIALS AND METHODS

Sampling sites and locations

Present work has been conducted in industrial area of Allahabad district. This site contain a large amount of polluted effluent from different localities especially the vicinity of the effluent discharge of the industries of Allahabad. This site contains several types of effluent containing large amount of the metals from the various indusrial activities *viz.* manufacturing, metal plating, refining other activities. The work was conducted during a period of the one year, *i.e.* from March 2011 to March 2012. Sampling has been done each month. Plant samples were collected in triplicate. Soil material were sampled at an average soil depth of 1-20 cm.

Sample preparation

The dried young plants and soil samples were ground manually with ceramic mortar and pestle to pass through a 1 mm non-metal sieve. Samples were re-dried to constant weight using an oven. To 1 g of each dry sample, was ground and wet-digested in a Nitric-perchloric acid (4:1 v/v) solution. The mixture was then diluted to 50 mL with double distilled water and filtered through filter paper No.42.

Heavy Metal analysis

Concentrations of different heavy metals viz; Pb, Cd, Ni, Cu and Zn were determined by atomic absorption spectrometer (AAS).

Data of various parameters of *Polyalthia longifolia* and data of different variables of soil samples was statistically analyzed by ANOVA SPSS version 16.0.

Determination of Bioconcentation Factor

Bioconcentation Factor was calculated as follows: the ratio of concentration of heavy metal in plant roots to that of soil [7] and is represent in equation 1.

BCF = Metal in root / Metal in soil **……..**Eq. 1

RESULTS AND DISCUSSIONS

Heavy metal concentration in plants parts

Plants parts/metals	Pb	Cd	Ni	Cu	Zn	Fe
Root	56.75	9.25	218.25	158.25	201.53	464.00
Stem	72.75	7.25	110.54	367.75	148.23	959.50
Leaf	73.25	7.43	205.75	194.25	248.75	509.70

Table 1. Heavy metal conc. in root, stem and leaves of *Polyalthia longifolia* (all values in mg/kg)

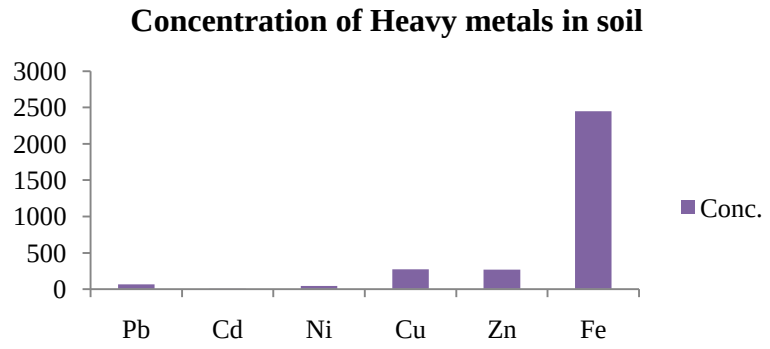

Figure 1. Concentration of different heavy metals in soil near the plant (all values in mg/kg).

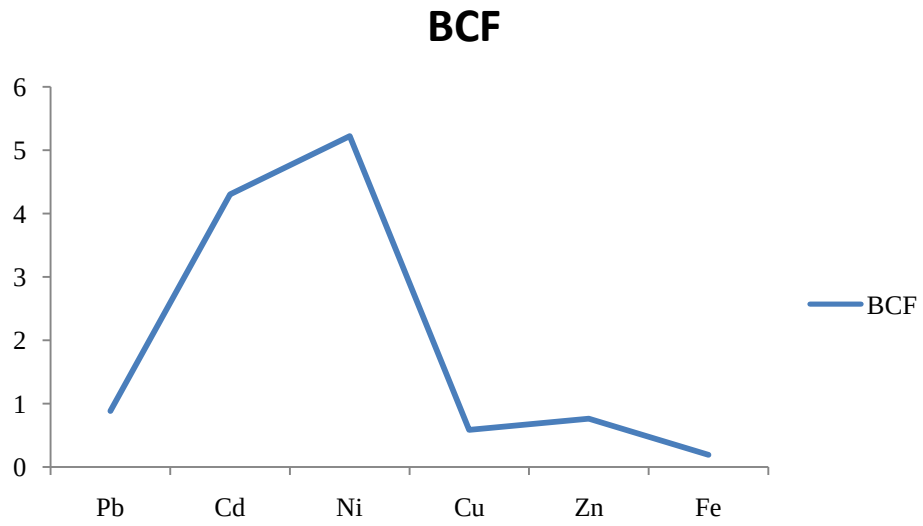

Figure 2. BCF of *Polyalthia longifolia*

Metal Concentrations in Plant Tissues

The data obtained in the study showed that the concentration of Pb, Cd, Ni, Cu, Zn and Fe were considerably higher in plant tissues than soil concentrations. It may indicate that the plant is capable of removing the metals from the soil. It would also show that removed metal were translocated from the root to the shoots and leaves in a similar fashion as hyper-accumulator species. Six heavy metals Pb, Cd, Ni, Cu, Zn and Fe were determined in *Polyalthia longifolia* at the site was as follows: Fe (stem> leaf> root), Zn (leaf> root> stem), Cu (stem> leaf> root), Ni (root> leaf> stem), Cd (root> leaf> stem) and Pb (leaf> stem> root). The plant species showed variable trend of heavy metals concentration in root, shoot as well as in leaf.

The concentrations of Six heavy metals Pb, Cd, Ni, Cu, Zn and Fe were determined in the soil below *Polyalthia longifolia* at the site is as following sequence: Fe> Cu> Zn> Pb> Ni> Cd.

According to Siuta "For the phytoremediation of contaminated soils with heavy metals, plants representing high metal accumulation properties, high biomass production, and also a high level of metal transportation from the root to the shoot appear to be useful for giving the highest possible heavy metal removal from the soil. Knowledge regarding the potential ability of plant mineral element uptake and their accumulation in the biomass is not sufficient, despite many studies on heavy metal content in different plants" [8].

Kabata-Pendias and Pendias [9] reported the some toxic metal cadmium, chromium, copper, nickel, lead and zinc contents in the foliage of plants of moderate tolerances to their surplus amounts.

The bioconcentration factor of the plant species was more than one for Nickel and Cadmium metals. This showed that the plant can accumulate nickel and cadmium more than the other heavy metals based on this study.

CONCLUSIONS

Ecosystem clean up is the purpose of this study, which shows that bioremediation is a cheap option to wipe pollution. There were varying trends in heavy metal accumulation in different plant parts root, shoot and leaf of the plant. These show the heavy metal accumulation capacity of the plant.

Finally the results that we also suggest the need to understand processes that affect metal availability, metal uptake and translocation in *Polyalthia longifolia*. Several conventional methods *e.g.* chemical precipitation, lime coagulation, ion exchange, reverse osmosis solvent extraction, aeration, chemical oxidation, electrolysis, ultra filtration and chlorination are used to control and remove the heavy metal. But the cheapest method is phytoremediation. This process uses plants to remove the heavy metals by the process called bioaccumulation.

It was also observed in the present study that plants affected by Heavy Metal at different concentrations as compared to root and shoot. Further studies are required to evaluate heavy metal accumulation in plants.

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