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Research Article

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A comparison of performance of *Acalypha indica* and *Abutilon indicum* in the removal of heavy metals from contaminated soils

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ABSTRACT

Environmental pollution from hazardous metals and minerals can arise from natural as well as anthropogenic sources. As a result of human activities such as mining and smelting of metalliferous ores, electroplating, gas exhaust, energy and fuel production, fertilizer and pesticide application, etc., metal pollution has become one of the most serious environmental problems today. Phytoremediation is a novel, less expensive, efficient, environment and eco-friendly remediation strategy with good public acceptance. In the present study experiments was conducted using Acalypha indica and Abutilon indicum herb plant species for heavy metals absorption (lead, nickel, zinc, cadmium and chromium). The absorption of metals lead, nickel, zinc, cadmium and chromium was compared in leaves, stem and roots. The leaves of Acalypha indica showed highest concentration of zinc followed by lead, chromium, cadmium and nickel in that order. The results showed that Acalypha indica was good accumulator of lead, nickel, zinc and chromium. The species can be recommended for Phytoextraction of lead, nickel, zinc and chromium contaminated soils. Abutilon indicum was good accumulator of zinc and chromium. The species can be recommended for the phytoextraction of zinc and chromium contaminated soils.

Keywords: *Acalypha indica, Phytoremediation, Nickel, Zinc, Cadmium and Chromium.*

INTRODUCTION

Environmental pollution with xenobiotics is a global problem. As a result of human activities such as mining and smelting of metalliferous ores, electroplating, gas exhaust, energy and fuel production, fertilizer and pesticide application, etc., metal pollution has become one of the most serious environmental problems today. The increasing demand for agricultural products has led to extensive cultivation in agricultural lands. Applying fertilizers, pesticides and herbicides is necessary to protect the quality and quantities of these products. However, the excessive use of these agro-chemicals creates environmental problems, such as accumulation of these chemical substances in the soil and plant uptake [1]. For example the application of phosphate fertilizers to the agricultural soil has led to increase in Cd, Cu, Zn and As [2]. At higher concentrations, they interfere with metabolic processes and inhibit growth, sometimes leading to plant death [3]. Cadmium affects lungs, kidneys, liver and skeletal system. The techniques in Bioremediation/Phytoremediation include the application of appropriate plants for in-situ risk reduction through contaminant removal, detoxification or containment in contaminated soil, sediments, and ground water. Phytoremediation is an emerging technology that employs the use of higher plants for the cleanup of contaminated soils, water and atmospheric pollutants. Phytoextraction is gaining great attention as alternative technique

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for remediation of heavy metal contaminated soils. Approximately 400 plant species from at least 45 plant families have been so far, reported to hyperaccumulate metals [4]. Some of the families are *Brassicaceae, Fabaceae, Euphorbiaceae, Asterraceae, Lamiaceae* and *Scrophulariaceae.* Crops like alpine pennycress (*Thlaspi caerulescens*), *Ipomea alpine, Haumaniastrum robertii, Astragalus racemosus, Sebertia acuminate* have very high bioaccumulation potential for Cd, Zn, Cu, Co, Se and Ni, respectively [5][6]. Willow (*Salix viminalis* L.), maize (*Zea mays* L.), Indian mustard (*Brassica juncea* L.), and sunflower (*Helianthus annuus* L.) have reportedly shown high uptake and tolerance to heavy metals. The success of Phytoremediation depends mainly on the choice of plant, which must obviously possess the ability to accumulate large amounts of heavy metals [7].

MATERIALS AND METHODS

A brief description of the plant selected for the present study *Acalypha indica* and *Abutilon indicum:*

Acalypha indica L. occurs widely throughout the tropics. It occurs in India, South East Asia, and Oceania. A small erect herb grows up to 60 cm tall or a little more, with a few ascending branches, angled and pubescent; leaves broadly ovate, subdeltoid, rather coarsely toothed, on petioles as long as or longer than the 3-5 cm long blades [8]. *Abutilon indicum*, G. (Indian Abutilon, Indian mallow) is a small shrub, native to tropic and subtropical regions and sometimes cultivated as an ornamental plant. [9]. This plant is often used as a medicinal plant and is considered invasive on certain tropical islands. The plant tends to have a weedy character, found growing in disturbed sites [10]. The garden soil was obtained from nursery. Seedlings were placed in each pot. The plant species were grown in pots and were irrigated with known heavy metal solutions (Pb, Ni, Zn, Cd and Cr) were added to the pots alternate days for 60 days. A watering schedule was prepared and maintained throughout the study. Uptake of heavy metals by plants in a metal contaminated and normal soil was studied in pot culture experiment. In controls normal water was used. The plants were grown for a period of two months (60days). The initial soil heavy metal concentration was analyzed. Every 20 days the plant samples from each pot were collected and washed thoroughly under running tap water and distilled water so that no soil particles remained. The samples were then cut to separate the roots, stems and leaves. The different parts were air dried and then placed in a dehydrator for 2-3 days and then dried in an oven at 100^0C. The dried samples of the plant were powdered and stored in polyethylene bags. The powdered samples were subjected to acid digestion. Samples (1gm) of each part (leaves, stems and roots) of the plant was weighed in digestion flasks and treated with 5 ml of concentrated HNO_3. 1gm of the powdered plant material were weighed in separate digestion flasks and digested with HNO_3 and HCl in the ratio of 3:1. The digestion on hot plate at 110ºc for 3-4 hours or continued till a clean solution was obtained. After cooling, the solution was filtered, the filtrate was analyzed for metal content using AAS.

Bioconcentration Factor (BCF) and Translocation Factor (TF):

Metal concentrations in plants vary with plant species. The concentration, transfer and accumulation of metals from soil to roots and shoots was evaluated in terms of Biological Concentration Factor (BCF), Translocation Factor (TF). Biological Concentration Factor (BCF) was calculated as metal concentration ratio of plant roots to soil. The Bioconcentration Factor (BCF) of metals was used to determine the quantity of heavy metal absorbed by the plant from the soil. [11,12]. Translocation Factor (TF) was used to evaluate the potential of this species for Phytoextraction, the Translocation Factor (TF) was calculated. This ratio is an indication of the ability of the plant to translocate metals from the roots to the aerial parts of the plant. Metals that are accumulated by plants and largely stored in the roots of plants are indicated by TF values <1, with values greater indicating translocation to the aerial part of the plant [11]. The most common species of the region are selected. The criteria followed for selection of species their biomass, commonness, tolerance to adverse climatic conditions. The

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accumulations in leaves, stem and roots were estimated at 20 day intervals. The accumulation of heavy metals in different parts of the plant such as roots, stem and leaves for the experimental plants and the total accumulation was also estimated. For each metal and plant species a set of 'control' was maintained to record the background soil concentrations. The initial concentration of each heavy metal in the soil was estimated on the first day i.e. the starting day of the experiment.

Objectives of the study:

1. To test the ability of these two experimental plant species to absorb the five heavy metals namely Lead, Nickel, Zinc, Cadmium and Chromium.
2. To estimate the absorption capacity of the heavy metals *Acalypha indica,* and *Abutilon indicum.*
3. To calculate the Translocation Factor (TF) and Bio-Concentration Factors (BCF) for different heavy metals in the selected plant species.

RESULTS AND DISCUSSION

Acalypha indica: The absorption of metals lead, nickel, zinc, cadmium and chromium was compared in leaves, stem and roots. The leaves of *Acalypha indica* showed highest concentration of zinc followed by lead, chromium, cadmium and nickel in that order. The total accumulation of metals in leaves also showed the same trend. The total concentrations varied from a lowest 3.27 (Cd) to highest of 118.06 (Zn) mg/kg concentration. The order of total concentration accumulated in the stem was nickel followed by chromium, lead, zinc and cadmium. Nickel accumulated in highest (19.15 mg/kg) in stem and cadmium accumulated in lowest (0.91 mg/kg) concentration in the stem in 60 days of experimental period in *Acalypha indica.* The roots showed an initial concentration of metals in varied quantities. The total accumulation of metals in roots of *Acalypha indica* followed a different way. In cases like zinc and cadmium accumulation appears to be very high in roots. The initial accumulation was high and translocation was also high and by 40th day the accumulation in stem and leaves saturated and then onwards all the absorbed metals remained in the roots without being translocated. A particular plant cannot act as good accumulator for all the metals hence the plant which acts as good accumulator for a particular metal is recommended for use as phytoextractor or phytostabilizer for that metal.

Table 1: Accumulation of lead, nickel, zinc, cadmium and chromium (mg/kg) in *Acalypha indica*

Heavy metal	leaf	stem	root	Total accumulation	Bioconcentration factor	Translocation factor
Lead	22.63	10.68	19.98	53.29	5.62	1.67
Nickel	7.57	19.15	17.35	44. 07	5.23	1.54
Zinc	20.15	4.96	92.95	118.06	9.02	0.27
Cadmium	3.27	0.91	15.65	19.83	54.2	0.27
Chromium	21.13	17.33	44.1	82.56	6..08	0.87

Abutilon indicum: The quantities of metals absorbed by *Abutilon indicum* are moderate with respect to different parts and total accumulations. Cadmium and chromium were accumulated in substantially high quantities in roots (14.08 mg/kg, 33.18 mg/kg respectively). This revealed that the cadmium and chromium remained in the roots with being translocated to the above ground plant parts. A completely inverse picture was witnessed in case of zinc, nickel and lead. Highest accumulation of zinc was observed followed by lead in stem. In cases of lead, nickel, cadmium and chromium the total accumulation was more or less uniform in leaves and stem where as the leaves of *Abutilon indicum* showed greatest absorption of zinc. Moreover, no other metal except zinc showed a tendency to accumulate in such a (140.82 mg/kg) high concentrations in leaves. In other words, only zinc was translocated by roots very effectively to leaves when compared to other metals. Zinc accumulation was very high in all the plant parts viz. leaves, stem and roots. The concentrations were nearly five times higher than other metals. Cadmium concentrations were lowest (5.75mg/kg in leaves and 5.49 mg/kg in stem). These differences of accumulations are attributed to the plant requirement. Zinc is required for plant for strength and to withstand environmental stress. Whereas cadmium and chromium enter the plant body along with the nutrients though they do not have any defined metabolic activity.

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Table 2: Accumulation of lead, nickel, zinc, cadmium and chromium(mg/kg)in *Abutilon indicum*

Heavy metal	Leaf	Stem	Root	Total accumulation	Bioconcentration factor	Translocation factor
Lead	12.07	17.21	1.25	30.53	3.22	23.44
Nickel	11.57	11.97	6.9	30.44	3.61	3.41
Zinc	140.82	73.71	63.55	278.08	21.25	3.37
Cadmium	5.75	5.49	14.08	25.32	69.52	0.79
chromium	8.8	10.09	33.18	52.07	3.83	0.57

The metal concentration, transfer and accumulation of metals from soil to roots and shoots was evaluated in terms of Biological Concentration factor (BCF) or Bioconcentration Factor (BCF) and Translocation Factor (TF). Phytoextraction ensure elimination of the metal from the soil, as the plant absorbs the metals and store them in the roots, stem and leaves. Phyto stabilisation ensures adsorption metals on roots, concentration or agglomiration or precipitation of metals in rhyzosphere. The plant which fails to translocate the metals can be used for phytostabilization. In the present study the plants have shown varied BCF and TF for each metal. The Bioconcentration factor and translocation factor was calculated. *Acalypha indica* was good accumulator of lead, nickel, zinc and chromium. The species can be recommended for Phytoextraction of lead, nickel, zinc and chromium contaminated soils. *Abutilon indicum* was good accumulator of zinc and chromium.The species can be recommended for the phytoextraction of zinc and chromium contaminated soils.

SUMMARY AND CONCLUSIONS

In order to maintain good quality of soils and waters and keep them free from contamination, continuous efforts have been made to develop technologies that are easy to use, sustainable and economically feasible. Physicochemical approaches have been widely used for remedying polluted soil and water, especially at a small scale. Phytoremediation is a promising green technology that can be used to remediate heavy metal contaminated soils. Plants exhibit different affinity to different metals. Numerous plant species have been identified and tested for their traits in the uptake and accumulation of different heavy metals. In the present study *Acalypha indica,* L. and *Abutilon indicum*, G was used for Phytoremediation of heavy metal contaminated soils. *Acalypha indica* was good accumulator of lead, nickel, zinc and chromium. The species can be recommended for Phytoextraction of lead, nickel, zinc and chromium contaminated soils. *Abutilon indicum* was good accumulator of zinc and chromium. The species can be recommended for the phytoextraction of zinc and chromium contaminated soils.

REFERENCES

1. Sahibin AR, Zulfahmi AR, Lai KM, Errol P, Talib ML. Heavy metals content of soil under vegetables cultivation in Cameron highland In: Proceedings of the regional symposium on environment and natural resources 10-11th April **2002,** Kuala Lumpur, Malaysia 1: 660-667.
2. Zarcinas BA, Ishak CF, McLaughlin MJ, Cozens G. Heavy metals in soils and crops in Southeast Asia. Environ. Geochem. Health, **2004,** 26(3): 343-357.
3. Schaller A, Diez T., Plant specific aspects of heavy metal uptake and comparison with quality standards for food and forage crops in German. In:Sauerbeck D, Lubben S (eds) Der Einflu von festen Abfa llen auf Boden, Pflanzen. KFA, Julich, Germany, **1991,** 92-125.
4. Lasat MM., Phytoextraction of toxic metals: A review of biological mechanisms. J. Environ. Qual, **2000,** 31: 109–120.
5. Salt DE, Smith RD, Raskin I. Phytoremediation. Annu. Rev. Plant Physiol. Plant Mol. Biol., **1998,** 49: 643–668.
6. Dushenkov,S,. Trends in Phytoremediation of Radionucleides. Plant Soil, **2003,** 249: 167-75.
7. Schmidt U..Enhancing Phytoextraction: The effects of chemical soil manipulation on mobility, plant accumulation, and leaching of heavy metals. J. Environ. Qual., **2003,** 32: 1939-1954
8. Gamble, J. S., Flora of the presidency of Madras. Bishen Singh Mahendra Pal Singh Publishers. 23-A, New Cannaught Place, Dehra Dun – 248001 (India). **2008a,** II. 1330.
9. Matlwaska., Flavonoid compounds in the flowers of *Abutilon indicum* (Linn.) Sweet.

Copyright © 2015, IJRB

Acia Poloniac Pharmaceutic - Drug Research. **2002,** 59 (3): 227–229.

10. Gamble, J. S., Flora of the presidency of Madras. Bishen Singh Mahendra Pal Singh Publishers. 23-A, New Cannaught Place, Dehra Dun – 248001 (India). **2008b,** I. 91.
11. Yoon J, CaoX, Zhou Q, Ma LQ., Accumulation of Pb, Cu, and Zn in native plants growing on a contaminated Florida site. Sci. Total Environ, **2006,** 368 (2-3): 456-464.
12. Ghosh, M. and S. P. Singh., A review on Phytoremediation of heavy metals and utilization of its byproducts. Applied Ecology and Environmental Research, **2005,** 3(1): 1-18.

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