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Phytoremediation of Copper and Lead by Using Sunflower, Indian Mustard and Water Hyacinth Plants

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Abstract: ***Environmental pollution is a major cause of concern. Because of the over-mining and industrial effluents, soil and water are being extensively contaminated. One of the methods of overcoming this problem is the use of plants, and the method is called Phytoremediation. Present work is focused on the removal of heavy metal contaminants like lead and copper from soil and water using three different plants, Water Hyacinth(Eichhornia crassipes), Sunflower(Helianthus annus), and Indian Mustard(Brassica juncea). The plants were grown in presence of heavy metals like lead and copper and digested with mixture of acids and metal concentrations were monitored using Atomic Absorption Spectroscopy(AAS) and results showed that copper absorption by plants was more compared to lead. Sunflower plants showed high absorption compared to other two and it was much higher with the use of enhancer like EDTA. Different parts of water hyacinth like leaves, petioles and roots were analyzed for their absorption capacity and among these roots absorbed more amount of metal. The cost effectiveness and user efficiency makes this method useful in pollution monitoring and control.***

Keywords: Heavy metals, absorption, Sunflower, Water Hyacinth, phytoremediation

1. Introduction

The rapid development and industrialization are the main factors responsible for pollution problem. Among the different pollutants, heavy metals pollution is very serious as they are toxic in very less concentrations. Potentially contaminated soils may occur at old land fill sites, particularly which take industrial wastes, old orchards due to use of excessive pesticides, fields that had past application of sludge or municipal waste, industries where chemicals have been dumped, or in areas downwind of industries. Their pollution in water and soil is causing a threat to the humans, plants and livestock. The pollutants finally enter into the food chains of humans and livestock and get accumulated, which is called bio-accumulation. There is another process called bio-magnification, it is the increase of concentration of a particular heavy metal through the food chains. Thus, these high concentrations have effect on the functioning of body organs, hormone system, and growth of body. They can have acute or chronic effect and can also be transferred to next generations [1].

Traditional methods of remediation are very difficult and not feasible. The high cost and difficulties involved in such treatments has made the development of in situ alternatives. Hence, there is a great need to promote effective soil treatment technologies that attempts to remove the metals from the soils. Bioremediation and phytoremediation are the alternatives found [2].

Phytoremediation is a general term for the use of plants to clean up the environment. It includes use of plants and rhizosphere microflora to remove, degrade, or stabilize the complex environmental contaminants. Various types of vegetation including trees, grasses, aquatic plants, are used for phytoremediation [3].

The most studied phytoremediation technology is phytoextraction, a plant-based cleanup method involving the use of metal accumulating plants to extract metal contaminants from soil. Over the past decade, researchers have sought to perfect this remediation technology. The majority of phytoextraction research has focused on finding the ideal metal-accumulating plant and the means by which metals can be liberated from the soil for root uptake. The present study involves the use of plants like sunflower, water hyacinth and Indian mustard for phytoremediation of copper and lead.

2. Materials and Methods

Soil was obtained from the horticulture department, Davanagere. Water hyacinth plants were obtained from a pond near Bathi. Sunflower and mustard seeds were brought from local market of Davangere.

Soil properties were analyzed like cation exchange capacity [4], total nitrogen [5], soil moisture, pH , electric conductivity, phosphorus and potassium content [6].

2.1 Biosorption Study

Sunflower and Mustard seeds were sown in tested soil. After germination metal solutions of different concentrations - lead 0, 100, 200, 300mg/kg of soil and copper 0, 75, 150, 225mg/kg soil copper were added to separate plants. The plants were allowed to grow under suitable conditions like sunlight and moisture. The plants were watered twice a day with distilled water. After 20 days of incubation with metals, plants were removed and subjected to digestion.

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Water hyacinth plants were grown hydroponically in containers containing water with one plant in one container. The metal solutions of concentrations 40mg/l, 60mg/l, 80mg/l were prepared and 10ml of these metal solutions were put in separate containers. Then the plants are allowed to grow under sunlight for a week. After a week of incubation with the metals, plants were removed from water and dried under sunlight. The parts of these plants (roots, petioles, leaves) were separated and were subjected to digestion [7].

2.2 Digestion of plants

The plants (Sunflower, Mustard, and Water hyacinth) were ashed using Hot air oven at 80ºc overnight. The ashed plant parts are taken in separate test tubes. To these test tubes 5ml of Concentrated Nitric acid and 3ml of Concentrated Perchloric acid was put. These test tubes were kept in Hot Air Oven for 5 minutes at 60ºc. After heating, the samples were diluted using Diluted Nitric acid and filtered to get clear solution. After filtering the volume of the solution was made up to 25ml using Diluted Nitric acid tested for metals using AAS [8].

2.3 Biosorption using Enhancers

Using EDTA : The plants were grown with metals according to the procedure above. Along with metals, EDTA (0.5mg/l) was put to the growth media and the plants were allowed to grow under sunlight. After 20 days sunflower and mustard and after a week water hyacinth were digested and tested for metals using AAS.

Using Ammonium sulphate: The plants were grown with metals according to the procedure above. Along with metals, Ammonium sulphate (0.5mg/l) was put to the growth media and the plants were allowed to grow under sunlight. After 20 days sunflower and mustard and after a week water hyacinth were digested and tested for metals using AAS. With pH elevation for Water hyacinth: The water hyacinth was grown hydroponically in 300ml of 0.02N NaOH solution of pH 12. After a week the plants were removed and digested and tested for metals using AAS [9].

3. Results and Discussion

Phytoremediation is an effective process in the removal of heavy metal contaminant from soil and water. The project is mainly focused on Phytoextraction and Rhizofiltration and plants like sunflower, water hyacinth and Indian mustard were used. Before the seeds were sown, essential parameters of soil were tested (Table1).

Table 1: Soil properties analysis

Soil properties	Amount in kg	Inference
pH	7.12	Neutral
CEC	0.8mol/kg	High
Moisture	97%	Good
Electrical Conductivity	0.20	Normal
Nitrogen	110	Low
Phosphorus	7.602	Low
Potassium	98.0	Moderate

Plants were grown in presence of different concentrations of metals and digested and subjected to AAS study. Highest absorption readings are represented in the tables.

Table 2: Amount of lead and copper present in leaves, petioles and roots of water hyacinth plant

Sample	Lead mg/l	Sample	Copper mg/l
Control	0.181	Control	0.181
Leaves	0.168	Leaves	0.178
Petiole	0.388	Petiole	0.468
Roots	0.513	Roots	0.842

From table 2 we can confer that, in Water hyacinth plants, roots were found with high absorbing capacity compared to leaves and petioles and copper extraction was high than lead. Water hyacinth are so prolific, that harvesting them for industrial use serves also as a means of environmental use. They are extremely tolerant of and have a high capacity for the uptake of heavy metals like Pb, Ni, Co, Cr, Cd. They are also suitable for biocleaning of industrial waste water. [7].

Table 3: Amount of lead and copper absorbed by mustard and sunflower plants

Sample	Lead mg/l	Sample	Copper mg/l
Control	0.100	Control	0.105
Mustard plant	0.623	Mustard	0.290
Sunflower plant	2.369	Sunflower (digested)	4.136

Table 3 shows biosorption of lead higher than copper. The metal accumulating ability of this plant coupled with the potential to rapidly produce large quantities of shoot mass make this plant ideal for phytoextraction [10]. Copper extraction by sunflower plants was higher than lead. With the addition of enhancers like EDTA, increase in pH and Ammonium sulphate to contaminated sources, the absorption can be increased. But among these EDTA can increase the absorption of heavy metals considerably more than Ammonium sulphate and pH increase. Table 4 shows the biosorption by parts of water hyacinth using enhancers.

Table 4: Amount of lead and copper absorbed by water hyacinth plants with enhancers

	Leaves		*Petioles*		*Roots*	
	Lead mg/l	*Copper mg/l*	*Lead mg/l*	*Copper mg/l*	*Lead mg/l*	*Copper mg/l*
pH(12)	0.031	0.109	0.035	0.013	0.165	0.105
$(NH_4)_2SO_4$	0.040	0.267	0.179	0.115	0.513	1.187
EDTA	0.020	0.178	0.231	0.468	0.623	2.369

Tests were carried out with the enhancer EDTA on sunflower and absorption of heavy metals was tested. Sunflower plant showed copper extraction (5.063mg/l) high compared to lead (7.109mg/l).

Plants are better for biosorption and roots of plants have very high absorption capacity. Plants are very beneficial in in-situ bioremediation of contaminated soils, it acts as a biofilter to adsorb and biodegrade contaminants in air and water and also in buffer zones for control and treatment of leachate and surface waters.

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Plants that take up metals can be smelted for recovery of the metals. Some plants metabolize contaminants so the material is no longer a biohazard and the plants can continue to grow or be composted. Some can be burned so the contaminant is left in the much smaller volume of ash residue. This ash can be handled as a biohazard.

4. Conclusion

Phytoremediation can be considered as suitable method for remediation of heavy metals that pollute environment. The level of contamination the plant can withstand, depends on the accumulation capacity of it. Phytoremediation can be limited by the depth, to which the plant roots penetrate, and solubility and availability of the contaminant. Moreover, phytoremediation by water hyacinth has been proved useful in remediating the tannery effluent, dairy effluent, textile effluent, dye effluent also. Much research is need to be done in these areas and assure that the plants used for phytoremediation don't have adverse effects on environment It is also needed to find efficient phytoaccumulators, hyperaccumulators that produce more biomass.

References

[1] Shao-weiliao and Wen-lianchang, "Heavy Metal Phytoremediation by Water Hyacinth at Constructed Wetlands in Taiwan"J. Aquat. Plant Manage Vol 2(42), 2004, pp 60-68.
[2] Shilpi Sharma, Bioremediation: Features, Strategies and applications, Asian Journal of Pharmacy and Life Science Vol. 2 (2), April-June,2012, pp 2231 – 4423.
[3] Chandra Shekar K, Kamala C T, Chary N Sand Anjaneyulu Y, Removal of heavy metals using a plant biomass with reference to environmental control. Int. Journal. Mineral Processing. 68:Vol 1-4,2003, pp37-45.
[4] Fabio Aprile, Reinaldo Lorandi "Determination of soil CEC using methylene blue", Journal of Agricultural Science; Vol. 4, No. 6; 2012,pp 278-289.
[5] Protein (Crude) Determination in Animal Feed: Copper Catalyst Kjeldahl Method. (984.13) Official Methods of Analysis. 1990. Association of Official Analytical Chemists. 15th Edition.
[6] Reynolds, S.G, The Alafua Penetrometer for the Measuring soil Crust Strength. Tropical Agriculture Vol 48(4),1971, pp 365-366.
[7] Pramod C. Mane, Arjun B. Bhosle&Pandurang A. Kulkarni, "Biosorption and Biochemical Study on Water hyacinth (Eichhorniacrassipes) With Reference to Selenium" Arch. Appl. Sci. Res., Vol 3 (1), 2011, pp222-229.
[8] Rafi Ullah, JehanBakht, Mohammad Shafi, MadihaIqbal, Ayub Khan and Muhammad Saeed,African, Phyto-accumulation of heavy metals by sunflower (Helianthus annuus L.) grown on contaminated soil. Journal of Biotechnology Vol. 10 (75), 28 November, 2011, pp. 17192-17198.
[9] Thirunavukkarasu E and Palanivelu K, Biosorption of Cr(VI) from plating effluent using marine algal mass . India Indian Journal of Biotechnology Vol 6, July 2007, pp 359-364.
[10] Zhuang Ping, Shu Wensheng, Li Zhian, Liao Bin, Li Jintian, Shao Jingsong, "Removal of metals by sorghum plants from contaminated land", Journal of Environmental Sciences 21, 2009, pp1432–1437.

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