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Impact of Low Cost Biosorbent Potatoes Peels for Biosorption of Lead on Two Important Pulses

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Abstract

Lead pollution is a key ecological problem facing the modern world especially Lead stress is the adverse hazard for all living organism. There are several conventional techniques for detoxification of heavy metal. Remediation of Lead stress using the vegetables peels is an emerging environmental cleaning method. Application of metal-accumulating plants to neutralize the Lead contagion from soil is the most emergent, environmentally friendly and inexpensive technology. The main objective of this research is to determine the remediation of Lead toxicity by utilizing the biosorbent potato peels. Previous investigation showed that concentration of Lead 200 - 250 ppm was exerted adverse effect on plant growth. Results reveal that adapting this green strategy for detoxification of Lead is very significant. Growth rate in both species Phaseolus mungo and Lens culinaris under this dynamic technology considerably enthused. Present data shows that potato peels have the biosorption capability for Lead ion and act as good adsorbent and have low-cost, it is abundantly present, requires little processing and is a byproduct of waste material. Results illustrate that morphological biochemical and physiological attributes enhanced in both pulses for using this technique. Current research also demonstrates that photosynthetic pigments are necessary component of plant life which was adversely influenced by Lead stress. But adapting this developing strategy water content and chlorophyll concentration increased so the growth rate automatically improved. Results revealed that potato peels are regarded as potential remediator of Lead stress that can be neutralize the toxic effect of Lead on plants and reduced the soil Lead contamination rate.

Keywords: Lead, potatoes Peels, *Phaseolus mungo, Lens culinaris*, remediation.

Introduction

Lead is one of the most ubiquitous toxic materials encountered in everyday life. The movement and allocation of Lead from major emission sources, both immovable and movable are mainly through air[1]. The main reason of edaphic pollution is the presence of xenobiotic (human-made) chemicals or other variation in the natural soil attributes. It is generally increased by innovation in industries and agricultural activities or improper disposal of waste products. The main elements involved are petroleum, lead, and other heavy metals. Lead-contaminated soil poses a threat when plants are grown here so Lead enters into the plant and affect the vegetative parts as well as floral parts, fruits. Through this producer Lead enter into ecosystem ultimately affect the whole cycle of ecosystem.

Higher dose of Lead is more detrimental for plants life. It inhibits the growth rate with the disturbance of cell division, obstruction in ascent of sap, and reduction of photosynthetic rate[2]. Photosynthetic products are useful in promoting growth and provide sustenance for all consumers of ecosystem. Thus the inhibition in photosynthetic rate becomes a major source which drastically affects the all trophic level of food chain. Recently several researchers have proposed many techniques for treating or cleaning up heavy metal toxicity from soils. Several remediation technologies are use for overcome the heavy metal toxicity from contaminated sites by excavation (physical removal of the contaminated material), stabilization of the metals in the soil on site, and the use of growing plants to stop the spread of contamination or to extract the metals from the soil.

Phytoremediation is best technology to overcome and reduces the Lead stress from the environment. Naturally some plants have the capability to neutralize the harmful effect of heavy metal from atmosphere. Aquatic plants including Algae and single-cell plankton in aquatic systems seem to be fairly resistant to toxic effects of Lead. The resistance may be due to presence of cellulose, is usually vital biomolecule and posses several functional groups such as hydroxyl groups and carboxyl group.

Generally Hydroxyl group have binding capability and form chelation with heavy metal[3]. Similarly there are some higher plants also serves as a detoxifier of heavy metal toxicity. According to previous investigation *Brasssica juncea* and some solanaceae family members are the best plant species which are act as phytoremediator of heavy metal stress[4]

Hyperaccumulation of heavy metal is remarkable phenomenon in plants.

In angiospermic plants groups more than 400 species and 45 Angiospermic families have the ability of hyperaccumulation of metals[5], among these Brassicaceae, Fabaceae, solanaceae and Poaceae families' members are very common[6, 7]. Solanaceae members are recently use as remediator of heavy metals toxicity. This technique is effortless, low cost and environmentally friendly strategy for detoxicification of heavy metal anxiety. *Solanum tuberosum* one of the best specie use as a hyperaccumulator of cadmium and other heavy metals. Similarly, *Solanum nigrum* also belongs to solanaceae family act as best hyperaccumulator and detoxifier of heavy metal toxification[8].

Potatoes tuber are the higher accumulator of heavy metals[9] by sowing and harvesting *Solanum nigrum* or by using potatoes tuber powered or extract to reduce the heavy metals toxicity from the soil. Several investigations showed that some plants are best heavy metal hyperaccumulator such as *Thlaspi caerluescens*[10], *Solanum nigrum L*[11], *Sedum alferedii.*[12], *Brassica junceae*[13]. Accumulating capability is the natural phenomenon of plants to accumulate metals in their above and underground parts. All plant species have the potential to uptake metals; although, particular plants species have particular capability to accumulate the heavy metal some can accumulate greater amounts of metals (100 times more than the average plant in the same condition without showing any adverse effect). The woody or herbaceous plants that accumulate and tolerate heavy metals in an amount greater than the toxic levels in their tissue are known as hyperaccumulators[6,8,14].

In recent years, the use of hyperaccumulators for remediation of contaminated sites due to their ability to take up heavy metals from polluted soil and accumulate them in their shoots has been receiving a great deal of attention from researchers[12,15].

The main criteria for hyper-accumulators are; i. accumulating potential, ii. restraint capability, iii. prohibiting efficiency (PE) based on plant biomass, iv. bio-concentration factor (BCF) and v. transfer factor (TF). Whole *Solanum tuberosum*, their tubers and peels are the best hyperaccumulator of heavy metal. Similarly many vegetables like ginger, tomato, cauliflower, bitter gourd and brinjal are also heavy metal accumulator.

Material and Methods

Potatoes peels congregate from different snacks restaurants of Karachi after collection potatoes peels were thoroughly washed out with tap water and then distilled water for removing the dust particles. They were dried at room temperature and then powered by using rotary mill.

The biosorbent (potatoes peels) was supplied with different dose 0, 3, 5, 7, 9gm in powder form in different pots containing one kg soil, thoroughly mixed with soil by hand and also added the Hoagland based 250 ppm Lead chloride solution then retained the soil for one week. Seed of *Phaseolus mungo* and *Lens culinaris* were sterilized with tween 20 solution then soaked for 2-3 hours in distilled water. Forty seeds were sown in each pot. Experiment was performed in growth chamber of Botany department. First pot is mentioned as control experimental units and other pots are as treated unites. Seed germination was recorded after 4th day. After passing 15 days plants were harvested. Different agronomic parameter were recorded such as Root length, shoot length and leave length of both leguminous species.

Determine the photosynthetic pigments concentration (chlorophyll a & b) by spectrophotometer. Pigments in the leaves were extracted with 80% acetone and absorbances were recorded at 645 nm, and 663 nm. The concentrations of chlorophyll, a, b, were calculated by the using equation of Maclachlan & Zalik with specific absorption co-efficient of Mackinny. Statistically all reported data are the mean of three replicates and standard error determined by using SPSS Version 16.0.

Results and Discussion

Heavy metals become a chronic problem globally. Industrialization and urbanization chiefly increasing Lead pollution drastically which adversely affected all living organism. Soil contamination also elevated due to increasing concentration of Lead in environment. Soil is main reservoir of plant so ultimately plants are influence by Lead contaminated soil as well as whole ecosystem was distressed by deleterious changes in the environment. Hence there is crucial need to overcome the toxic effects to safe our earth by protecting our environment from hazards pollution. There are various conventional methods for removing Lead stress. Present study used the green technology for Lead remediation, potatoes peels are best Lead accumulator which helped to remove the Lead toxicity and not only saved the other important food crops but also increased their yield. Results showed that under this defensive strategy plant growth have been improved in *Phaseolus mungo* and *Lens culinaris* although they are grown in two harsh concentrations of Lead 200 ppm and 250ppm. 200ppm and 250 ppm of Lead concentration are severely destructive for this important food crops productivity.

Previous investigation also revealed that higher doses of Lead are adversely affected the plants growth[1]. Haider *et al*., (2006) was demonstrated under the exposure of 200ppm and 250 ppm of Lead plant growth was significantly inhibited in *Phaseolus mungo* and *Lens culinaris*. Data illustrate that potato peels of different concentration 3gm, 5gm, 7gm and 9 gm are used as a bioremediator in response to Lead exposure in both pulses. Investigation also revealed that banana peels were used for removal of heavy metals[16]. Similarly under the potatoes peels treatment germination % significantly increased in both pulses

which were grown in Lead contaminated soil (table 1). Adapting the green technology biophysical parameters was showed amazing results. Root is the main important and first contact part from soil contamination[1]. Root maturation, elongation and branching pattern were the first visible symptom by using this method in both leguminous plants.

Table-1
Effect of Phytoremediation of Lead on germination of *Phaseolus mungo* and *Lens culinaris* by using biosorbent potatoes peels

Treatment with 250 ppm lead dose(gm)	% Germination in *Phaseolus mungo*	% Germination in *Lens culinaris*
0	20 ±0 .577	15±2.30
3	77± 1.154	69±2.88
5	86±1.154	82±1.154
7	92±.577	98±1.732
9	81±1.154	74±2.309

Tables 2 - 3 demonstrated that root attributes were improved by applying this remediation technique, root length significantly increased in *Phaseolus mungo* as well as *Lens culinaris.* The root characteristics improvement leads to enhance the water and minerals absorption and conduction system. If the absorption process was work properly then all physiological phenomenon capability were enhanced. Consequently other vegetative part such shoot and leaves length were also increased in both pulse. This defensive strategy provides the obstruction in the transportation of Lead from soil to root.

Table-2
Impact of Phytoremediation of Lead on physical characteristic of *Phaseolus mungo* by using biosorbent potatoes peels

Treatment with 250ppm lead dose (gm)	Root Length (cm)	Shoot Length (cm)	Leaf Length (cm)
0	2.45 ± 0.275	6.92 ± 0.501	2.34± 0.803
3	6.2 ± 0.346	12.78± 0.400	2.54± 0.805
5	7.53 ± 0.297	17.35± 0.330	3.93±0.950
7	8.2 5 ± 0.43	19.46 ± 0.965	4.04±0.558

Other remarkable parameter is photosynthesis. Photosynthesis is main process on which other physiological phenomenons were based. If the photosynthesis is affected than the all physiological processes of plant species ultimately are disturbed. Photosynthetic pigments are very key element for conducting the photosynthesis process properly. Under the exposure of Lead chlorophyll a and b both are adversely affected [2]. Using this protective technique data showed that chlorophyll a and b concentration considerably elevated in *Phaseolus mungo* and *Lens culinaris* (table 4 and 5). In L*ens culinaris* chlorophyll concentration more increased as compared to *Phaseolus mungo* (table 5). Present research also revealed that 7gm potatoes peels give the better results as compared to their other relevant dose in both *Phaseolus mungo* and *Lens culinaris*. Potatoes tuber peels contain large amount of carbohydrate constituent, phenolic compound[17], phosphorus, potassium and other important nutrients. Cellulose has the binding capability with metals due to presence of carboxyl and hydroxyl functional group as well as phenolic compound are also have chelation ability and form metal complex. Phosphorus also very important nutrients for plant growth, application of phosphorus also reduce the uptake of Lead in the plants in response to metal precipitation as pyromorphite and chloro-pyromorphite[18]. All these attributes are very helpful to overcome the metal toxicity in soil and retained the Lead in complex form so inhibition in solubility and bioavailability of Lead to growing plants in Lead contaminated habitat revealed that potatoes peels is the potential remediator of Lead stress therefore both *Phaseolus mungo* and *Lens culinaris* showed the better growth index in Lead polluted soil.

Table-3
Impact of Phytoremediation of Lead on physical characteristic of *Lens culinaris* by using biosorbent potatoes peels

Treatment 250ppm Lead dose (gm)	Root Length (cm)	Shoot Length (cm)	Leaf Length (cm)
0	2.26 ± 0.2942	5.16 ± 0.092	0.90± 0.230
3	5.82 ± 0.0577	12.98 ± 0.230	0.99± 0.0577
5	6.92 ± 0.173	15.35± 0.577	2.07±0.577
7	7.08 ± 0.046	17.46 ± 0.577	2.19±0.023
9	6.11 ± 0.0635	14.99 ± 0.577	1.89± .0519

Table-4
Impact of Phytoremediation of Lead on concentration (mg/gm) of Photosynthetic Pigments of *Phaseolus mungo* in response to green technology

Treatment with 250ppm Lead dose (gm)	Chlorophyll (a)	Chlorophyll (b)
0	0.056± 0.00173	0.046± 0.00231
3	0.715± 0.00173	0.613± 0.0023
5	1.25± 0.0288	0.956± 0.00115
7	1.542± 0.0803	1.252± 0.0081
9	0.853± 0168	0.724± 0.00173

Table-5
Impact of Phytoremediation of Lead on concentration (mg/gm) of Photosynthetic Pigments of *Lens culinaris* in response to green technology

Treatment 250 ppm Lead dose (gm)	Chlorophyll (a)	Chlorophyll (b)
0	0.057± 0.0040	0.048± 0.0011
3	0.625± 0.00289	0.519± 0.0040
5	0.821± 0.0057	0.711± 0.0040
7	1.324± 0.381	0.954± 0.0011
9	0.734± 0.0040	0.684± 0.00231

Conclusion

Remediation of Lead toxicity by green technology is one new emergent strategy that involves the use of waste product of plants to clean the contaminated environments. Despite all of today's present technology, it seems that Angiospermic species may be the best source to remove the Lead from contaminated soil.

This review showed that terrestrial plants such as potato peels can have remediatory effects on Lead removal from polluted soil. Therefore, higher plants accumulate the heavy metals are varied based on species to species as well as metal to metal. Current investigations proved that *Solanum tuberosum* peels are the best substitute and have been recommended to neutralize the Lead toxicity from contaminated soil, because it is the best hyperaccumulator of Lead. This study revealed that under this treatment plants showed better growth and other biophysical and physiological parameters are also improved in *Phaseolus mungo* and *Lens culinaris*. In addition to this, it is easy to implement and maintain, does not require the use of expensive equipment or highly specialized personnel and is environmentally friendly and aesthetically pleasing to the public.

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References

1. Azmat, R., Haider, S. and Askari, S., Phyotoxicity of Pb:IEffect of Pb on germination, growth, morphology and histomorphology of *Phaseolus mungo* and *Lens culinaris*, *Pak. J. Biol. Sci.,* **9,** 979-984 **(2006)**

2. Haider, S., Kanwal, S., Uddin, F. and Azmat, R., Phytotoxicity of Pb: II. Changes in chlorophyll absorption spectrum due to toxic metal Pb stress on *Phaseolus mungo*and *Lens culinaris*, *Pak. J. Biol. Sci.,* **9,** 2062-2068 (**2006)**

3. Shukla,S.R. and Pai, R.S., Removal of Pb (II) from solution using cellulose containing materials, *J. Chem. Tech. Biotech.***, 80,** 176-183 **(2005)**

4. Ilya, R., Robert, D., Smith, D.E. and Salt, Phytoremediation of metals: using plants to remove pollutants from the environment, *Pt. Biotech.,* **8,** 221-226 (**1997)**

5. Salt, D.E., Smith, R.D. and Raskin, I., Phytoremediation, *Annu Rev Plant Physiol Plant Mol Biol.*, **49,** 643-668 **(1998)**

6. Baker, A.J.M., McGrath, S.P., Reeves, R.D. and Smith, J.A.C., Metal hyperaccumulator plants: a review of the ecology and physiology of a biochemical resource for phytoremediation of metal-polluted soils, *Phytoremed cont soil & water.,* 85–107 **(2000)**

7. Prasad, M.N.V. D. and Oliveira-Freitas, H.M., Metal hyperaccumulation in plants—Biodiversity prospecting for Phytoremediation technology, *Electr. J. Biotech.,* **6,** 285–321**(2003)**

8. Zhou, Q.X. and Song, Y.F., Principles, Methods of Contaminated Soil Remediation, Beijing: *Science Press* (**2004)**

9. Dunbar, K.R., McLaughlin, M.J. and Reid, R.J., The uptake and partitioning of cadmium in two cultivars of potato (Solanum tuberosum L.), *J. Exp. Bot.*, **54. (381),** 349-54**(2003)**

10. Banasova, V., Horak, O., Nadubinska, M., Ciamporova, M. and Lichtscheidl, I., Heavy metal content in *Thlaspi caerulescens* J. et C. Presl growing on metalliferous and non-metalliferous soils in Central Slovakia, *Intern J. Env. & Pollut.,* **33**,133–145 **(2008)**

11. Sun, Y.B., Zhou, Q.X. and Diao, C.Y., Effects of cadmium and arsenic on growth and metal accumulation of Cd-hyperaccumulator *Solanum nigrum* L., *Biores Techn.,* **99(5),** 1103–1110 **(2008)**

12. Sun, Q., Ye, Z.H., Wang, X.R., and Wong, M.H., Cadmium hyperaccumulation leads to an increase of glutathione rather than phytochelatins in the cadmium hyperaccumulator Sedum alfredii, *J. Pt Physiol.,* **164,** 1489–1498 (**2007)**

13. Saraswat, S. and Rai, J.P.N., Phytoextraction potential of six plant species grown in multimetal contaminated soil, *Chem.Eco.,* **25,** 1-11 **(2009)**

14. Barcelo´ J. and Poschenrieder C., Phytoremediation: principles and perspectives, *Contributions to Sci.,* **2,** 333–344 **(2003)**

15. Sun Y, Zhou Q, Wang L. and Liu W., Cadmium tolerance and accumulation characteristics of *Bidens pilosa* L. as a potential Cd-hyperaccumulator, *J. Hazard. Mater.,* **161(2-3),** 808-814 **(2009)**

16. Muhammad, A.A., Abdul, W., Karamat, M., Mohd. J.M. and Ismail, Y., Low cost biosorbent banana peel (*Musa sapientum)* for the removal of heavy metals. Scientific Research and Essays, **6(19),** 4055-4064 **(2011)**

17. Azadeh, M.S., Hashem, P., Nima, H. and Amirhosein E., Phenolics in Potato Peels: Extraction and Utilization as Natural Antioxidants, *World Appli. Sci. J.,* **18 (2),** 191-195 **(2012)**

18. Chaney, R.L., Brown, S.L., Li, Y.M., Angle, J.S., Stuczynski, T.I., Daniels, W.L., Henry, C.L., Siebelec, G., Malik,,M. and Ryan, J.A., Compton H. "Progress in risk assessment for soil metals, and *in-situ* remediation and phytoextraction of metals from hazardous contaminated soils. *U.S-EPA Phytoremediation: State of Science, Boston, MA***. (2000)**