ANUSANDHAN- AISECT University Journal
Vol. 06, Issue No. 12, September-2017, P-ISSN 2278-4187

Phytoremediation of Water and Soil, Heavy Metal and Other Contaminants in Excess Uptake by Plants, Effect and Plant Biologically Active Compounds or Active Chemical Constituents in Maintaining Human Health

Pragya Shah*

Ph.D. (Botany) AISECT University, Bhopal (M.P.) India

Abstract – Phytoremediation a green technology consists of process phytoextraction, rhizofiltration, phytostabilization, phytovolatifization, phytodegradation with increasing industrialization mining pesticides sewage disposal, heavy metal deposition and other contaminants are added in water and soil through human activities. These interfere with the metabolic functions of plants, inhibition phytosynthesis, respiration, crop yield, sometimes intracellular compartments of cell. Mining include crushing, grinding, washing, smelting. There are biologically active chemical constituents in plants. Catachins, Isoflavones, Isothiocyanate, Indoles, Caffeic acid, Apigenin, Lignins, Reveratrol etc which are helpful in certain diseases like arthritis, cancer, cardiovascular problems, acute respiratory damages etc.

Keywords: Phytoremediation, Rhizofiltration, Phytodegradation, Isoflavones, Arthritis, Green technology

----------♦----------

I. INTRODUCTION

Phytoremediation is a group of technologies that use plants to reduce, degrade or immobilize environmental toxins. Phytoextraction is also known as phytoaccumulation, phytoabsorption and phytosequestration. This process reduces soil metal concentration by cultivating plants with a high capacity for metal accumulation in shoots. Plants extract large concentrations of heavy metals into their roots, translocate the heavy metals to above ground shoots or leaves and produce large quantity of plant biomass that can be easily harvested.

Rhizofiltration technique is used in cleaning contaminated waste water or acid mine drainage by absorption or precipitation. Phytostabilization is phytoimmobilization, holding of contaminated soil and sediments in place of vegetation and to immobilize toxic contaminants in soils. It occurs through the sorption, precipitation, complexation or metal valance reduction. For example, grasses, sedges, forage and reeds. Phytovolatization involves the use of plants to take up contaminants from the soil transforming them into volatile form and transpiring them into the atmosphere. Eg. Selenium.

Phytodegradation, also known as phytotransformation, involves uptake, metabolization, degradation of contaminants within the plant or the degradation of contaminants in the soil sediments, sludges, groundwater or surface water by enzymes produced and released by the plant.

II. BRIEF DESCRIPTION

Phytoremedition is a new "green technology" by IJAAER (2017) Dumping of raw industrial waste and by sludge application to agricultural soils have contributed significantly to deterioration of land and water resources as is clear from changes in ecosystem processes (Jan et al 2017)

(**Hyperaccumulator or Hypertolerance** Some plants which grow on metalliferous soils have developed the ability to accumulate massive amount of indigenous metals in their tissues without exhibiting symptoms of toxicity are hyper accumulator or hypertolerance.)

(a) **Active chemical constitution and application:** Alkaloid Lignins,Indoles, Cafficacid, Catechine, Apigenin,Reveratrol Rosmaric acid flavanoide etc. helpful

tohuman health in treating arthritis, cancer and cardiovascular diseases etc.

(b) **Phytoremediation Plants :** Helianthus annus (Sunflower), Hibiscus moscheutos, spinach, Rye plant lycopersicum esculentum, Hydrilla, Cabbage plant, vetiver grass, Mustard etc.Water hyacinth(Eicchornia crassipes)

(c) **Application of Phytoremediation :** Helpful in cleaning water and soil and environment. Mining activities such as crushing, grinding, washing, smelting and all other processes used to extract and concentrate metals generate a large amount of waste rocks and tailings are often very unstable and make elements environmentally labile through normal biogeochemical pathways, to sink such as sediments, soils or biomass. The direct effect will be loss of cultivatd land, forest or grazing land and the overall loss of production. Establishment of vegetation cover can fulfill the objectives of stabilization pollution control, visual improvement and removal of threats to human beings. However adverse factors such as acidity nutrient deficiencies, toxic heavy metal ions and poor physical structure and their interaction with most mine tailings inhibit plant establishment and growth on the tailings. Evaluation of metal concentration in plants growing in contaminated sites can be used to get information about specific plant behavior in that environment, metal dispersion and mobility with reference to their biomass. Metal concentration in plants is a function not only of the total soil concentrations but depend also on the chemical speciation of metals in soil solutions and on the involvement of the metal in biological functions. Plant species found in metal polluted/contaminated soils are expected to take up metals and eventually accumulate them. Some plants phytostabilize heavy metals in the rhizosphere through root exudates immobilization whilst other species incorporate them into root tissues. Some plants also transfer metals to their above ground tissues, potentially allowing the oil to be decontaminated by harvesting the above ground parts. Therefore plant community established on mine waste could be useful to minimize the impact of mining, thus considering the diversity of plant responses in contaminated sites with different metals and toxicity levels, it is important to study the composition of plant community established on mine waste, which serve as a basic tool of mine remediation. More information about plant community that can grow on metal enriched soil is essential to determine their potential for mine reclamation/remediation and for biological exploration.

Heavy metals such as cd, cu, PB, Hg+, cr are major environmental pollutants particularly in areas with high anthropogenic pressure. Heavy metal accumulation in soils is of concern in agricultural production due to adverse effect on food safety and marketability, crop growth plant toxicity and environmental health of soil organisms. The influence of plants and their metabolic activities affects the geological and biological redistribution of heavy metals through pollution of air water and soil. Metal contamination has high impact and relevance to plants and consequently it affects the ecosystem, where the plants form an integral component. Plants growing in metal polluted sites exhibit altered metabolism and growth reduction, lower biomass production and metal accumulation. The current worldwide mine production of cu, cd, Pb, Hg+ is considerable (Pinto et all 2004.) Anthropogenic sources that contaminate soil and fly ash produced due to coal burning and corrosion of commercial waste products, which adds cr, cu, Pb, and galvanized metals primarily Zn into the environment. Oil burning contributes Fe Pb, Ni to the environment. Metal emission during transport of vehicles includes Ni and Zn from tires, Al from catalyst, cd and cu primarily from diesel engines and Ni and Zn from aerosol emissions. Lubricants which are anti-wear protestants for vehicles emit cd, cr, Hg+, Ni Pb and Zn particularly in case of inefficient engines. Hydrilla verticillata is a submerged rooted aquatic plant. Eicchornia crassipes (Water hyacinth)is also a aquatic macrophyte. Tomato, Mustard are soil and rooted plant.

III. RESEARCH OBJECTIVE

Research Objective of Phytoremediation technology is the use of plants to remediate selected contaminants in the contaminated soils, sludge ground water and waste water It has a number of different methods that can lead to contaminant degradation, removal of metals through accumulation dissipation and immobilization. A variety of plants have been identified which are capable of accumulating high concentrations of metals in their aerial parts and roots or stabilizing the metals in soils and thus restricting their translocation to the shoots and removing the metals from the soil through synthesis of volatile compound

Biologically active naturally occurring chemical compounds found in plants provide health benefits for human. They protect plant cells from environmental hazards such as pollution, stress, drought, UV exposure and pathogenic effect. Helps in protection of human health, when their dietary intake is significant.

Research Objective is to study the processes of Phytoremediation technique, to elucidate the physical, chemical, physiological and metabolic mechanisms of contaminated uptake, translocation, sequestration/ detoxification, partitioning and bioaccumulation in

phytoremediation plants, to demonstrate the plant based cleanup systems for heavy metals.

IV. RESEARCH APPROACH

Research Objective is the cleanup technology advancement and Phytoremediation processes along with the study of biologically active compounds of plants. Phytoremediation concept is based on well-known ability of plants and their associated rhizosphere to concentrate and/or degrade highly dilute contaminants. Critical components of rhizosphere, in addition to a variety of free living microorganisms include root exudates. These complex root secretions which feed the microorganisms by providing carbohydrates, also contained by providing carbohydrates also contain natural chelating agents (citric acid and other organic acids) that make the ions of both nutrients and contaminants more mobile in the soil. Root exudates may also include enzymes such as nitroreductase, dehallogenase and laccases. These enzymes have imp natural functions, but they may also degrade organic contaminants that contain nitro groups (eg., chlorinated hydrocarbons ,many pesticides). Plant roots and rhizsosphere microorganisms "sense" the immediate soil environment in which they are growing and have complex feedback mechanisms that permit them to adapt to changing conditions as they grow. In some plants growing in phosphorus-deficient soil the root exudates contain large amounts of citric acid, in an attempt to mobilize and make available for uptake any phosphorus compounds present. Some rhizosphere microorganism secretes plant hormones that 7increase root growth and thereby the secretion of root exudates that contain metabolites they use as an energy source. Large green plants have the capability of moving large amount of soil solution into the plant body through roots and evaporate by transpiration. Plants transpire water to move nutrients from soil solution to leaves and stems, where photosynthesis occurs and to cool the plant. During this process contaminants present in soil water are also taken up and sequestered metabolized or vaporized out of the leaves along with the transpired water. However, some plants are poor at water conservation usually because they normally grow in moist environments.

When we grow selected adapted plants in contaminated substrates, the root system is highly dispersed, fibrous uptake system. Contaminants over a large range of concentrations are taken up along with the water and degraded metabolized and/sequestered in the plant body, while evapotranspiration from aerial parts maximizes the movement of soil solution or wastewater through the plant. Through the process of bioaccumulation, contaminants can be concentrated thousands of times higher in plant than in the soil or wastewater. The contaminated plant biomass can be digested or ashed to reduce its volume 95%and the resulting small volume of material can be processed as an "ore" to recover the contaminant (eg., valuable heavy metals, radionuclides).

The present study deals with the phytoremediation processes, phytoremediator plants, hyperaccumulators and various processes of phytoremediation including transpiration by plants, here roots play an important part in passive uptake via micropores in the root cell walls where sequestration and degradation takes place. Study includes contaminant uptake mechanisms, study of root physiology, morphology, uptake kinetics, translocation in root stem leaves, total contaminant removal. For this plant leaves and branches are collected from different heavy metal polluted sites, statistical analysis is done. Further research plan includes the use of more and more plants taken for phytoremediation processes and study of more and more active chemical constituents of plants.

V. RESEARCH GAP

Phytoremediation and Plant Biologically active compounds are very vast topics of unlimited resources of study Phytoremediation technology very much closed the research gap. Present study shows the processes of phytoremediation for cleaning the environment and Active chemical constituents of plants eg., lignin caffeic acid , alkaloids, tannins, spooning for maintaining human health. For this the collection of plant and its study is very important. It is the study of heavy metal uptake and translocation by plants and the contamination which creates pollution problem at different sites.

The present research aim is to clean the environment by this technique and study plant active chemical constituents for fighting of various diseases eg., cancer, arthritis, cardiovascular problems etc.

This technique is limited to surface area and depth occupied by roots. Slow growth and low biomass require a long time commitment. It is not possible to completely leaching of contaminants into the groundwater. Survival of plants is affected by contaminants. Slow pace, it requires long time. Data collection problem because it has unlimited resources. Besides this the present study has very large amount of benefits, it is cost effective low cost, ecofriiendly environmental friendly technique. The present research gives fruitful and useful results in future. Latest technologies in this research shows advancement in near future. Furthur researches along with applied aspects will show benefits to the whole world.

VI. MATERIAL AND METHOD

Collection of plants from different sites. Comparison with the control plant stock solution of Cr, Cd is prepared by K2Cr2O3 and CdCl2+H2O. Solution was prepared in 1000 ml of water. After 11 days on keeping in this solution wiped out with 0.01NHCl and washed with water, then statistical analysis is done Mean + SD. **For soil**: For this metal mine, contamination soil, leaves and twigs taken. For digestion acid oxidizing agent, HNO3, HClO4, Cu, Zn, Cd, and Pb are used.

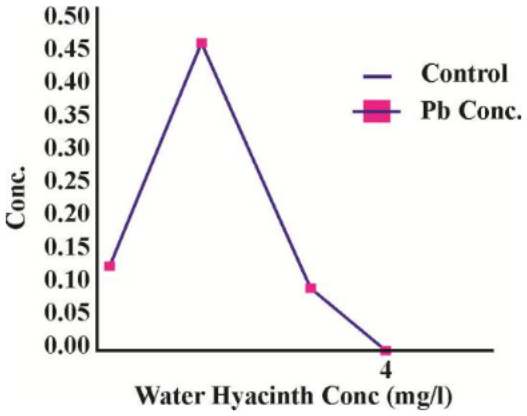
(a) Test for Alkaloids

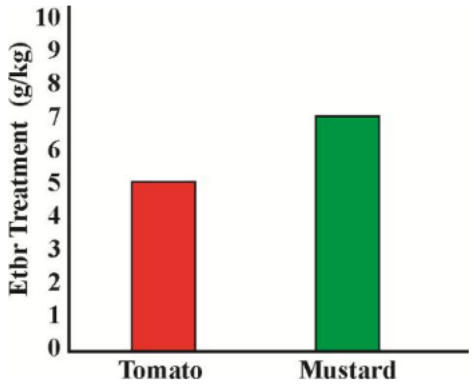
(i) Mayer's Test: Take few ml of plant sample extract, add mayer's reagent, white ppt occurs.

(ii) Saponin Test: Extract (50mg) is diluted with water and made upto 20ml. Suspension is shaken. The 2cm layer of foam indicates the presence of spooning.

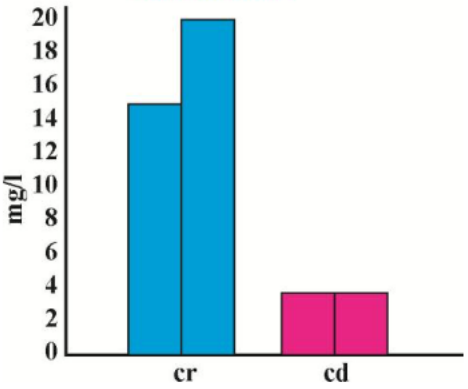
VII. RESULTS AND DISCUSSION

Heavy metals and contaminants present in water, soil due to industrialization, sewage disposal, and mining are hazardous and when plants collected from different sites shows uptake of contaminants at different conc. in roots, shoots and whole plant. In water plants shows removal of Cr, Cd, and in soil shows uptake and acts as phytoremediator. Different test shows the presence of biologically active chemical constituents of plants. **Tomato and Mustard: On treatment with etBr g/kg, mustard shows more uptake of etBr than tomato. (p< 0.05)**





Hydrilla plant



VIII. CONCLUSION

High contaminants and metal concentration increases water and soil acidity. Fast growing high biomass with improved metal uptake are effective for phytomediation. Cu, Zn, Ni, Pb, Cr, As, Cd shows toxicity.

IX. ACKNOWLEDGEMENT

Work supported internationally and nationally.

REFERENCES

Afi,NE.,FBrhada,M.Dary,A.F.Maltouf and E.Pajuelo (2012). Rhizostabilization of metals in soils using lupinus luteus inoculated with the metal resistant rhizobacterium Serratia spMSMC 541. Int.J.Phytorem.,14: pp. 261-274.

Ali H. E. Khan and M. A. Sajad (2013). Phytoremediation of heavy metals-concepts and applications chemosphere, 91: pp. 869-881.

American Journal of Climate Change, 2013, 2, pp. 71-86.

Atmani D, Nassima C. Dina A. Meriem B. Nadjet D. Hania B. (2009). Flavonoides in human health:From structure to Biological Activity.Current nutrition and Food Science, 5: pp. 225-237.

Babu A.G. andS.Reddy (2011). Dual inoculation of Arbuscular mycorrhizal and phosphate solubilizing fungi contributes in sustainable maintenance of plant health in fly ash ponds.Water Air Soil Poll., 219: pp. 3-10

Biotechnology Advances 29 (2011) pp. 248-258.

Bluskov, S. J. Arocena., O. Omotoso and J. Young. 2005. Uptake distribution and speciation of chromium in Brassica Juncea. Int.J.Phytoremediation, 7: pp. 153-165.

Cheraghi, M., B. Lorestani., N. Khorasani., N. Yousefi and M. Karami (2011). Findings on the phytoextraction and phytostabilization of soils contaminated with heavy metals.BiologicTraceElem.Res.,144: pp. 1133-1141.

Elekes, C. C. (2014). Eco-Technological Solutions for the remediation of polluted soil and heavy metal recovery.In:Hernandaz-Soriano,MC., Ed. Environment Risk assessment of soil contaminants.Intech.Rijeka.,309-335 http://dx.doi.org/10.5772/57314.

Felix, A, Oluwole, F. and Eki. T. (2010). Journal on phytoremediation of heavy metals in aqueous solution, pp. 49-60.

Glick B. R. (2010). Using soil bacteria to facilitate phytoremediation.Biotechnol.Adv.,28: pp. 367-374.

Global Journal of Environmental Research 2010.

International Journal of Advance Research in Chemical Science April 2015, pp. 25-32.

International Journal of Agriculture and Environmental Research (2017); 31: pp. 1-18.

International Journal of Science and Research 2012.

IOSR Journal.

Kramer U. (2010). Metal hyper accumulation in plants Annu.Rev.PlantBiol.,61: pp. 517-534.

Malik,NandA.Biswas.2012.Role of higher plants in remediation of metal contaminated sites.Sci.Rev.Chem.Commun.,2:1, pp. 141-146.

McIntyre T. (2003). Phytoremediation of heavy metals from soils, Phytoremediation. Springer, pp. 97-123.

Mendez M. O. and R. M. Maier (2008). Phytostabilization of mine tailings in arid and semiarid environments, an emerging remediation technology, Environ, Health perspect., pp. 116:278.

Osakwe S.A. (2012). Chemical partitioning of Iron, Cadmium Nickel and Chromium in contaminated soils of South Eastern Nigeria ,Res.J.Chem.Sci.,2(5), pp. 1-9.

Pazferreiro, J. H Lu., S. Fu., A. Mendez and G.Gasco.2014.Use of phytoremediation and Biochar to Remediate Heavy Metal Polluted Soils: A Review Solid Earth.,5: pp. 65-75.http//dx.doi.org/10.5194/se-5-65-2014.

Rascio,N.,F.Navari-Izzo (2011). Heavy metal hyperaccumulating plants:How and Why do they do it.And what makes them so interesting.Plant Sci.,180: pp. 169-181.

Subhashini V. and A.V.V.S. Swamy (2013). Phytoremediation of Pb andNi contaminated Soils using Catharanthus roseus (L.).Universal. J. Enviro. Res and Technol.,3: pp. 465-472.

BIBLIOGRAPHY

Phytoremediation 2017 international journal NCBI.

American Journal of Climate change, 2013, 2. pp. 71-86

Ayub K, Van Hallebusch EDcassir M,Bermond A.Application of advanced oxidation processes for TNT removal: a review .J Hazard Mater;2010 178(1-3): pp. 10-28.

Rechenauer T. G. Germida J. J. Phytoremediation of organic contaminants in soil and groundwater, Chem Sus Chem 2008;1: pp. 708-17.

Sukumran D. (2013). Phytoremediation of heavy metals from industrial effluent using constructed wetland technology.Appl Ecol Environ Sci;(5): pp. 92-7.

Whole internet source.

http://www.sciencedirect.com/

http://www.springerlink.com/

Int. Res. environment Sci Vol. 4(3), pp. 35-40 March (2015)

IJAAER (2017); 3 (1) : pp. 1-18

Phytoremediation OSP's Phytoremediation, 15 Feb. 2017

Phytoremediation of cadmium by mustard on March 23, 2017

Corresponding Author

Pragya Shah*

Ph.D. (Botany) AISECT University, Bhopal (M.P.) India

E-Mail – shahpragya76@yahoo.in