Green Revolution-Removal of Lead from Battery Industrial Effluent by Phytoremediation using Eichhornia Crassipes

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Abstract— Lead (Pb) being very high poisonous heavy metal, non-biodegradable affects the food chain and are hazardous to all living beings. This paper investigates about the removal of lead from lead acid battery effluent by phytoremediation technique using Eichhornia Crassipes (Water Hyacinth). Synthetic Chelator (EDTA) is induced to increase the mobility and uptake of lead by the plant from the effluent. Removal of lead from the contaminated effluent is varied by concentrations of 5 ppm, 10 ppm, 15 ppm and it is tested with the time interval of 15 days. The parameters like concentration of lead in the effluent, concentration of root and shoot uptake by the plant, degradation of lead by the plant, proline, chlorophyll, carotenoid characteristics of the plant is considered. The factors such as Bioconcentration Factor (BCF), Metal accumulation in plant and water, Enrichment Factor (EF), and Translocation Ability (TA) are calculated. The uptake of lead by the plant has been transferred from root to various other parts of the plant. Accumulation of lead in various parts of the plant, soil and water sample is analyzed by using Atomic Absorption Spectroscopy.

Key words: Phytoremediation, Eichhornia Crassipes

I. INTRODUCTION

Water is a vital natural resource and forms basis of all life. Heavy metals (Pb, Hg, As, Cd, Cr) present in many industrial effluent mix with other natural resources and causes environmental problems. Lead contamination in the environment affects the food chain and is hazardous to all living beings. Several conventional methods like precipitation, solvent extraction, reverse osmosis, ion exchange, adsorption, electrodialysis used for removing heavy metals from the industrial effluents are expensive and also cause negative impact on ecosystem. The innovative method of using plants to reduce the contaminant levels in the effluent from industries seems to be more effective [1]. Phytoremediation is a green revolution composed of various involving phytoaccumulation, phytostabilization, rhizofiltration, phytodegradation, phytovolatilization using metal accumulating plants to remove heavy metals. Phytoremediation is innovative, economical and environment friendly for the treatment of environmental problems through the use of plants. Hyper-accumulation of heavy metals by the plants is of effective potential. The selective uptake of lead by the root system, translocation of lead from root to shoot system, bioaccumulation, lead degradation are all the Eichhornia Crassipes [2] abilities for the removal of lead from the battery manufacturing industry. Eichhornia Crassipes is an aquatic floating macrophytic plant occurring in meso and eutropic water reservoirs having the advantages of high growth rate, fibrous root system and to tolerate the metal concentration. The uptake mechanism of phytoremediation of the process of rhizofiltration [3] describes the take up of lead in the roots surrounding zone by adsorption, precipitation, absorption process of the plant. Phytoextraction [5] is the process where the plant can absorb and accumulate the heavy metals in the root and shoot tissue. Phytostabilization [4, 23] is the process of certain plant species to immobilize contaminants in the soil and ground water through absorption and accumulation by roots, adsorption onto roots, or precipitation [6] within the root zone of plants. This process reduces the mobility of the contaminant and prevents migration to the ground water and it reduces bio-availability of metal into the food chain. Phytostabilization can occur through the sorption, precipitation, complexation, [7, 20] or metal valence reduction. It is useful for the treatment of lead as well as arsenic, cadmium, chromium, copper and zinc [8,25]. Phytovolatilization [9] involves contaminants being taken up into the body of the plant, but then the contaminant, a volatile form thereof, or a volatile degradation product is transpired with water vapour from leaves. Phytovolatilization can occur with contaminants present in soil, sediment, or water. One major factor limiting the potential of lead phytoremediation is low lead bioavailability for the plant uptake. Addition of synthetic chelating agents like Ethylene diamine tetraacetic acid (EDTA) [10, 21, 24] to lead contaminated wastewater increases the amount of bio-available lead in water and a greater accumulation in plants. The presence of a ligand affects the biouptake of lead through the formation of metal-ligand complexes and changes the potential to bind the lead below the root zone.

II. METHODOLOGY

Eichhornia Crassipes from the nearby lake were collected and washed with distilled water. The effluent contaminated with lead was varied with the concentrations of 5ppm, 10ppm, 15ppm. One plant was grown in a normal condition without effluent and compared with those plants growing under the conditions of lead contaminated wastewater and induced synthetic chelator. EDTA was added to the effluent to induce the uptake of lead by the plant. The initial concentration of the effluent was analyzed by Atomic Absorption Spectroscopy. The plants were tested with the time interval of 15 days. The growth and weight of the plants before and after testing the effluent were measured. The uptake of lead in root, shoot, soil and effluent were analyzed by using acid digestion method. The characteristics of plant like proline, chlorophyll and carotenoids were analyzed by using UV Vis Spectrophotometer.

From the figure 1 and 2, the growth and weight has been increased by inducing synthetic chelating agent to the effluent. The measurements were done with the time period of 15 days. At higher concentration of the lead there showed a slower growth rate of the plant in effluent alone as well as in the induced EDTA.
bioconcentration factor [13]. To evaluate the potential of Eichhornia Crassipes for phytoextraction, the Translocation Factor is defined as the ratio of metal concentration in aerial parts to that of the metal concentration in roots [14]. The Translocation factor for 5ppm after 15 and 30 days were 1.33 and 1 respectively. The Translocation factor for 10ppm after 15 and 30 days were 0.15 and 0.34 respectively. The Translocation factor for 15ppm after 15 and 30 days were 0.29 and 0.45 respectively.

C. Translocation Factor

Phytoremediation being a sustainable and inexpensive process is fast emerging as a viable alternative to conventional remediation methods. [17, 18, 19] and will be most suitable for a developing country like India. 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 [15]. Several factors must be considered in order to accomplish a high performance of remediation result. The most important factor is a suitable plant species which can be used to uptake the contaminant. Eichhornia crassipes used in ‘Eco-technology’ [16] for phytoextraction and phytofiltration are the best-developed subsets for removal of toxic metal from environment.

REFERENCES