Eichhornia Crassipes as a Potential Sorbent for Lead from Battery Industrial Effluent

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ABSTRACT

Lead present in many industrial effluents are non-biodegradable and toxic pollutant. Lead is a highly poisonous metal which affect the food chain and are hazardous to all living beings. This work presents the removal of lead from wastewater of battery manufacturing industry using Phytoremediation technique. Present study is to investigate the removal of lead from the lead contaminated effluent by varying concentrations of 5, 10, 15ppm. Eichhornia crassipies an aquatic floating macrophytic plant occurring in meso and eutrophic water reservoirs can be used for the phytoremediation of lead from industrial effluent. At regular interval of 15 days the samples were collected and analyzed for 60 days. The uptake of lead by Eichhornia Crassipies is increased by inducing synthetic chelating agent (EDTA). Various parameters such as pH of the effluent, Plant Relative Growth (PRG), Bioconcentration Factor (BF), Metal accumulation in plant and water, Enrichment Factor (EF), and Translocation Ability (TA) are taken into account. Accumulation of lead in plant and water sample was analyzed using Atomic Absorption Spectroscopy. The uptake of lead by the plant has been transferred from root to various other parts of the plant. The maximum Bioconcentration factor and Translocation ability are obtained at maximum concentration of 15ppm and gradually decreases at lower concentration of 5ppm. This is due to the availability of contaminant in the effluent and accumulation potential of aquatic plant. Translocation ability shows that the accumulation of metal were found more in the root system because binding of lead ions gets saturated due to the fulfillment of lead for the growth of the plant. The concentration in the effluent, before and after the interval period is analyzed. Higher concentration of lead in Eichhornia Crassipies shows higher removal of lead in the effluent.

Keywords: *Phytoremediation, Eichhornia Crassipies, Atomic Absorption Spectroscopy*

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1. INTRODUCTION

Water is the vital resource of the Earth and forms the basis of our life and this is related to the quality of the environment. Contamination of heavy metals in the environment is a worldwide problem [1, 3, 4]. Today the environment has very limited abundance because of the contaminated sites all around [2, 5]. The problems associated with contaminated sites now assume increasing prominence in many countries throughout the globe. Among the various environmental resources water is one of the most important commodities which require special attention [6]. Heavy metals like Pb, Hg, As, Cd, Cr, and Zn are among the most important sorts of contaminant in the industrial effluents that affect the environment are non-biodegradable and toxic [7, 8]. Heavy metals are highly poisonous and affect our food chain which alternatively affects the living beings. Lead one of the toxic heavy metals found in wastewater has to be treated [9]. Removal of lead by traditional methods is expensive and also sometimes produces hazardous effluent. Several conventional methods are used for the removal of lead from wastewater includes chemical precipitation, ion exchange and reverse osmosis, adsorption and various other process but major drawbacks with such treatments are produces large amount of sludge and may be ineffective.

A new, simple, effective and ecofriendly technology involving the removal of toxic heavy metal from wastewater has directed attention towards phytoremediaton. The plants can be used to reduce the heavy metals from the industry and this process of uptaking the heavy metals by plants is called as Phytoremediation. It is relatively easy to implement, and can reduce remedial costs while restoring the habitat. However, the plant species being used must grow well in toxic levels of heavy metal conditions and can produce high biomass [10]. The success of phytoremediation is greatly de- pendent upon the choice of plant species to be used. The use of plants to reduce contaminant levels in waste water from industries is a cost effective method of reducing the risk to human and ecosystem health posed by contaminated water sources [11, 13]. Plants having natural ability of bio accumulate or metal-accumulating capacity is known as hyperaccumulator plants.

Eichhornia Crassipes(Water Hyacinth), an aquatic floating macrophyte occurring in meso and eutropic water reservoirs have a high growth-rate, fibrous root system and broad leaves along with tendency to tolerate high metal of lead concentration, and so it is considered as an important species to be used in phytoremediation technique [12,14]. Eichhornia Crassipes possesses the qualities that favour its potential use in wastewater treatment. Eichhornia Crassipes reduces the levels of heavy metals from the effluent with its toxicity. The plant is ideal in hydroponic studies because of its rapid growth rate and extensive root system. Hydroponic experiments were done for accumulating the heavy metals by hyper accumulator plants. Adding chelating agent like EDTA increases the accumulation of heavy metals in the plant. EDTA makes the strong affinity towards the lead and it is adsorbed into the Eichhornia Crassipes. Chelating agents are capable of solubilising and complexing heavy metals in to the aquatic system and also promote the translocation of lead from root to the other parts of the plant.

2. Materials and Methods

2.1 Cultivation of Plants

Eichhornia Crassipes of uniform size plants were collected from the lake and were washed with distilled water to remove the dust particles on it. These plants were made to grow in a hydroponic system and pots were arranged for its growth. The pots were half filled with lead-free soil. These pots were separated for normal growth and with the effluent of varying concentrations. The biological characteristics of the plants like Proline, Chlorophyll, Carotenoid were analyzed by UV Vis Spectrophotometer.

2.2 Standardization of Effluent

The characteristics like pH, turbidity, total dissolved solids, odour and other heavy metals present in the Battery industrial effluent were analyzed. The lead contaminated effluent collected from battery industry was standardized using Atomic Absorption Spectroscopy. The concentration of the effluent was varied for 5, 10 and 15 ppm. Some plants were allowed to grow in a normal condition in order to compare with the other plants growing in effluent and with EDTA solution.

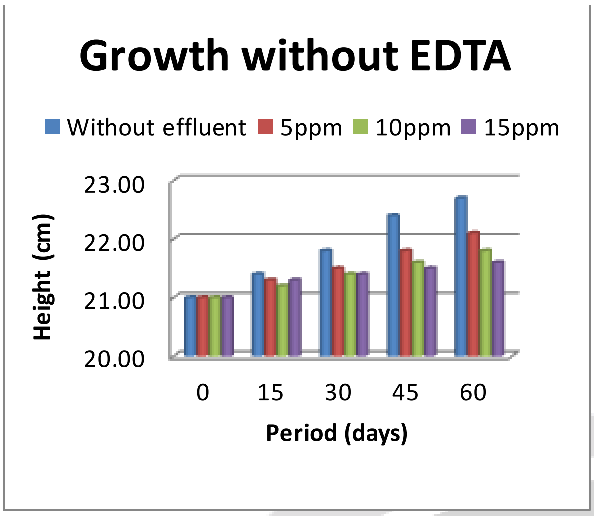
2.3 Analysis of Sample

At the interval of 15 days the plants were taken and analyzed. The wet and dry weight of the plants after exposing it to the effluent and EDTA solution were taken and calculated. The roots and shoots were separated and dried in oven for $500^{o}C$ and were made into powder by using pestle and mortar. The concentration of lead in root and shoots of the plants, soil and effluent were analyzed by acid digestion followed by Atomic Absorption Spectroscopy.

3. Results and Discussion

3.1 Growth Rate of Plant

The growth of the plants were measured for the plants growing in normal condition and with effluent of 5, 10, 15ppm, and effluent with EDTA. Plant growth rate was tested and compared with the growth of plant with effluent alone and with EDTA. The growth was higher without effluent and EDTA induced plant was higher than with effluent alone. The below fig 1 and 2 shows that as days increases the growth was higher with EDTA for higher concentration. The wet and dry weight of the plant was also calculated.



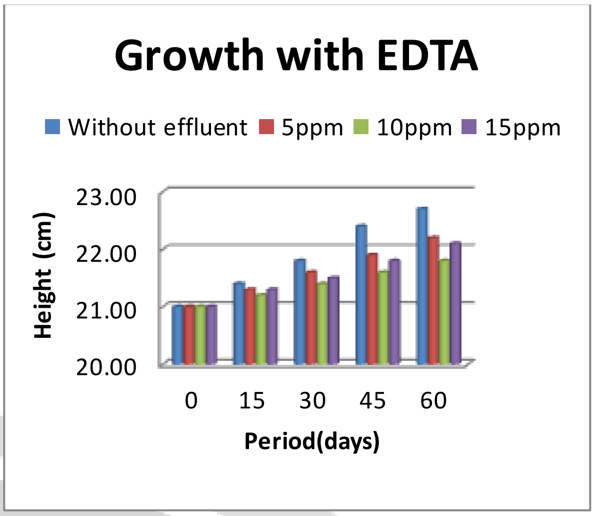
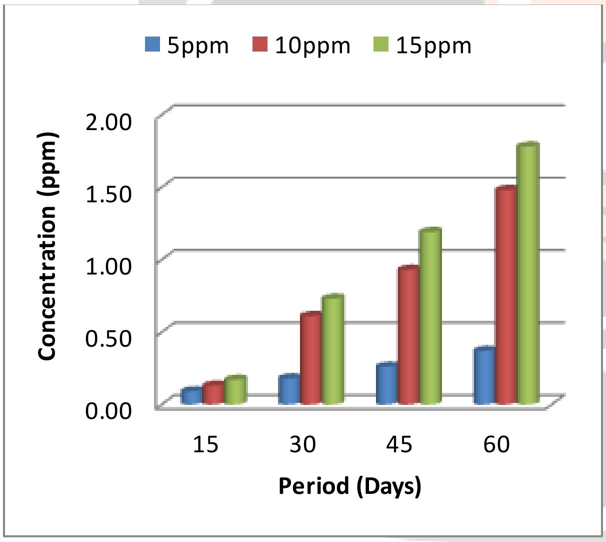


Fig.1 Growth of the plant without EDTA

Fig.2 Growth of the plant with EDTA

3.2 Concentration of lead in root

Concentration of lead in Eichhornia Crassipes root was analyzed by Atomic Absorption Spectroscopy. The accumulation of lead in root was more than in other parts of the plants. The figure 3 and 4 shows that there is increase of lead concentration in root as the days increases.



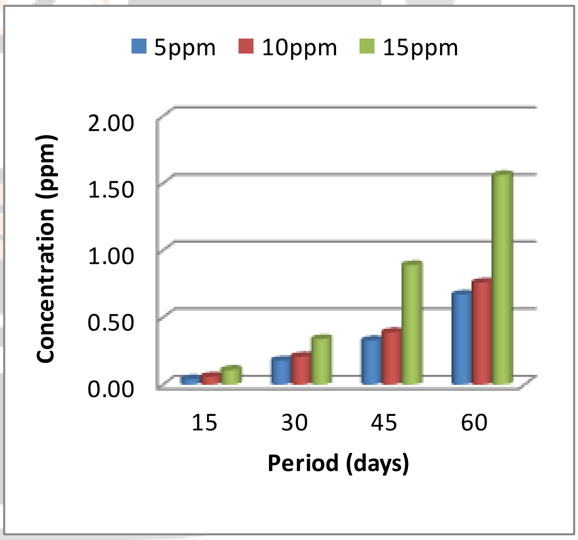


Fig.3 Concentration in root without EDTA

Fig.4 Concentration in root with EDTA

3.3 Concentration of lead in shoot

The concentration in root is translocated to shoot and was analyzed by acid digestion method followed by atomic absorption spectroscopy. Translocation ability of plant was not much impact on with EDTA. 15ppm shows better translocation ability with EDTA than compared to other plants.

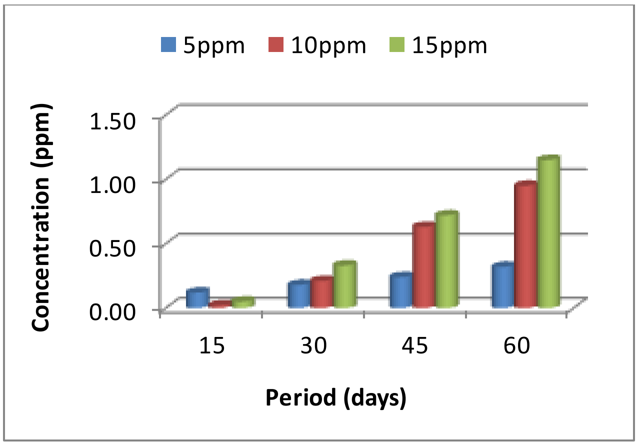


Fig. 5 Concentration of lead in shoot without EDTA

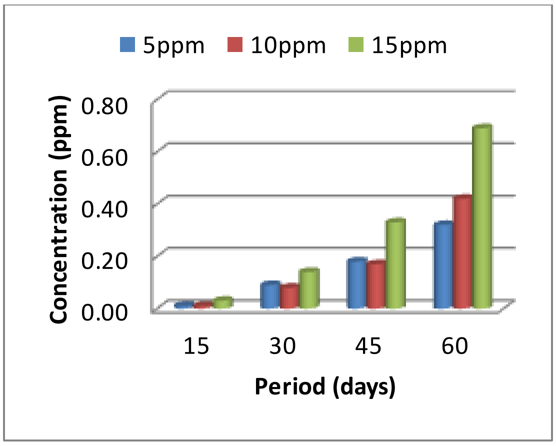


Fig.6 Concentration of lead in shoot with EDTA

3.4. Degradation Rate

From fig 7 and 8, degradation rate was highly influenced by using EDTA. Without EDTA 5ppm was started degraded only on 35th day compared to 20th day of experiment in with EDTA. At the same time degradation rate for 10ppm was higher in without EDTA than the other one. For 15ppm the degradation was less than 10ppm in the case for without EDTA and higher than the 5 and 10ppm in using EDTA.

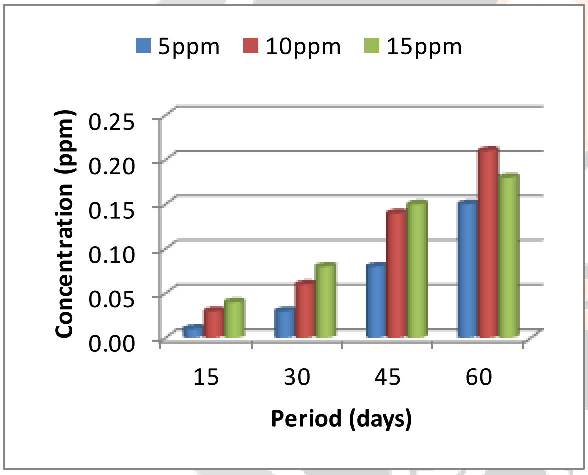


Fig.7 Degradation rate without EDTA

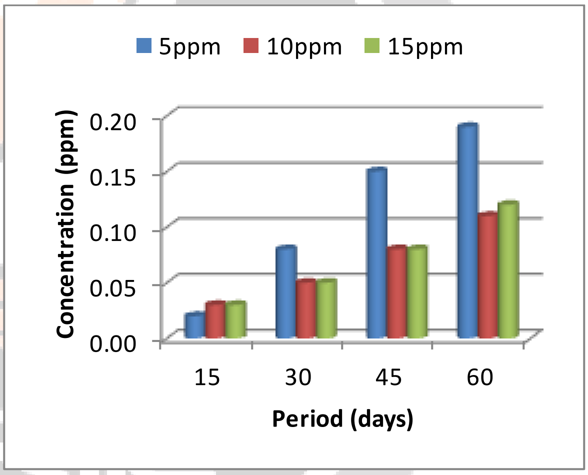


Fig.8 Degradation rate with EDTA

4. Conclusions

In 5ppm, accumulation of Pb concentration in root was more in without EDTA. This is due to the reason that free Pb ions in the effluent starts bind to the EDTA and translocate to the root and shoot. But the number of free Pb ions is less compared to the 10ppm and 15ppm. Due to this reason Pb ions in EDTA induced plant was not translocate as high as without EDTA. The same phenomenon applies for the concentration of shoot and the amount of Pb contaminant settled in soil. The heavy metal concentration in roots showed higher accumulation values than shoots this imply relevant availability in the sediments. The Heavy metal accumulation and degradation was done by using with and without EDTA. Using EDTA as chelating agent for the treatment of Pb contaminant for the uptake of heavy metal is higher than without EDTA. Also the degradation rate was higher in for the case of EDTA. In both cases the growth of the plant was mostly affected by the effluent not much by the chelating agents. EDTA agent was more favorable to the higher concentration than the lower concentration. Eichhornia Crassipes shows good tolerance and remediation towards lead contamination because of its long roots and capability of uptake of heavy metals by its roots.

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