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Removal of toxic lead metal from wastewater by using bio-absorbent

J. Ahamed Sulthan[1*], M. Mohamed Sihabudeen[2], J. Sirajudeen[2] and A. Asrar Ahamed[2]

[1] PG Department of chemistry, DR. R.K.Shanmugam College of Arts and Science, Kallakurichi, Tamil Nadu, India.

[2] PG and Research Department of chemistry, Jamal Mohamed College, Trichy, Tamil Nadu, India.

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Abstract

Heavy metal contaminations are becoming growing common issues in developing countries like India and elsewhere. Rapid urbanization, industrialization and excessive population growth are the most leading causes of environmental degradation. Heavy metals such as Pb, Zn, Cd and As etc., are the major toxic pollutants which show harmful effects on living system. Lead is one of such contaminants, which disrupts the food chain and it is poisonous even at very low concentration. The existing purification technologies used for removal of contaminants from wastewater are not only expensive but causes harmful impact on ecosystem subsequently. Bioremediation is an ecofriendly technique which is both ecologically sound and economically feasible. It is an attractive and alternative choice to the existing cleanup methods and is less expensive. Here different parts of Amla tree are used as Bio adsorbent such as stem, external bark, rachis and leaves were taken in the form of charcoal to remove, detoxify or immobilize heavy metals. Removal concentration of lead was analyzed by using Atomic Absorption Spectrophotometer (AAS). The objectiveof this study is to evaluate the current condition of Bioremediation as an innovative technique and to discuss its usefulness and prospective in the remediation of lead tainted water.

Keywords: Heavy Metals, Lead, Wastewater, Bioremediation, Amla, Bio adsorbent.

INTRODUCTION

Wastewater from various industries such as pigments, paints and glass productions, mining operation, metal plating, and battery manufacturing processes are known for the production of heavy metal contaminants. Heavy metals such as Pb, Cd, Cr, Ni, Zn, Cu and Fe are frequently found in industrial wastes, and these heavy metals in wastewater are non-ecofriendly and their existence in receiving lakes and streams causes bioaccumulation in living organisms, which leads to several physical issues in human beings such as cancer, kidney failure, metabolic acidosis, oral ulcer and renal failure. As a result most of the problems are caused by heavy metal contamination. Removal of heavy metals from wastewater is important task in the present condition. Investigation of novel and low priced methods of metal ions removal has been an increasing issue (Sharma *et al*., 2004; Bernard *et al.,* 2013).

Lead is one of the extremely toxic heavy metals that not only accumulates but also have the capability to affect the entire food chain and disturbs the healthiness of human being, animals and plant kingdoms. Hence, suitable healing of lead from soil and industrial wastewater is very essential (Hatice Daghan *et al.,* 2004). There are a few conventional methods are used for the removal of lead from wastewater which include chemical precipitation, ion exchange and reverse osmosis. But major drawbacks with such treatments are production of large amount of sludge, expensive and ineffective processes. So, that the investigation of a new simple effective and eco affable technology concerning the removal of toxic heavy metal from wastewater has directed the attention towards bioremediation. Most of the plants have the potentiality to remove heavy metals.

Phytoremediation

Plant based bioremediation technologies that have been collectively termed as phytoremediation. This refers to the use of the green plants to clean up contaminated soil and groundwater. The idea of using metal accumulating plants to remove heavy metals and other compounds were first introduced in1983, but the concept has actually received the attention only in the recent year, though it has been practiced since a long time (Nagajyoti *et al.,* 2010). The generic term "Phytoremediation" consists of the Greek prefix phyto (plant), attached to the Latin word remedial to correct or remove an evil. Phytoremediation has also been called green remediation, botanoremediation, agro remediation and vegetative remediation. It is a less destructive to the environment, cost effective, aesthetically environmental pollutants removal

*Corresponding Author :
email: *drahamedsulthan@gmail.com*

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approach. There are several ways by which plants cleanup or remediate contaminated sites.

Potential of different Bio adsorbent in improving water quality

When using different forms of phytoremediation there are many positive and negative aspects to consider, Phytoremediation is an attractive alternative or complementary technology that can be used along with or, in some cases in place of mechanical conventional cleanup treatments that often require high capital inputs, more labour and energy). Phytoremediation involves the use of plants (root) to remove, transfer, stabilizer degrade contaminants in soil, sediment and water. Aquatic plants are known for accumulating and concentrating heavy metals. Bio adsorbent of heavy metals from aqueous solutions is a relatively new process that has been confirmed a very promising process in the removal of heavy metal contaminants. The major advantages of bio adsorption are its high effectiveness in reducing the heavy metal ions and the use of inexpensive bio adsorbents. Bio adsorption processes are particularly suitable to treat dilute heavy metal wastewater (Fenglian Fu and Qi Wang, 2011).

MATERIALS AND METHODS

Bio adsorbents can be derived from three sources as follows (1) non-living biomass such as bark, lignin, shrimp, krill, squid, crab shell, etc., (2) algal biomass.(3) microbial biomass, e.g. bacteria, fungi and yeast. Different forms of inexpensive, non-living plant material such as potato peels sawdust, black gram husk , eggshell , seed shells, coffee husks, sugar-beet pectin gels and citrus peels have been widely investigated as potential bio adsorbents for heavy metals (Ana-Irina Smical *et al*., 2008; Divya Singh *et al*., 2010)

Preparation of Bio Adsorbent

In the present study various parts of 'Amla' *Phyllanthus emblica*) tree such as leaf, nerve, steam, external skin (bark) were taken as adsorbent for this experimental work. They were washed with distilled water several times to remove dirt particles and kept under shade for some time, dried for three hours in an oven at 150 ^{o}C and then allowed to cool at room temperature, the dried components were roasted and converted to charcoal (Bio adsorbent) with the help of China dish, subsequently they were crushed, and the ground charcoal were stored in an air-tight container, without adding chemicals.

Preparation of Lead Nitrate Solution (Ppm)

This is a way of expressing very dilute concentrations of substances. Just as per cent means out of a hundred, so parts per million or ppm means out of a million. Usually describes the concentration of something in water or soil. One ppm is equivalent to 1 milligram of something per liter of water (mg/l) or 1 milligram of something per kilogram soil (mg/kg).The metal solutions used in this study were prepared as the stock solutions containing 1000mg/L of each metal. 100ml of adsorbate solution with known concentration was taken in the 250 ml conical flask and 1g of each adsorbent was added separately and then reactant was stirred by magnetic stirrer without any pH modification at room temperature. For a wide range contact time 30-180 mints. After that the solution was filtered by Whatmann 42 filter paper and concentration of the filtered solution was determined by atomic absorption spectrophotometer (Zahir Hussain and. Mohamed Sheriff, 2014).The percentage removal was determined by the following expression.

The amount of adsorption efficiency was calculated by,

$$\text{Adsorption percentage} = \frac{(Co - Ce)}{Co} \times 100$$

Where, Co = initial concentration of metal ion in the solution (mg/lit) Ce = final concentration of metal ion in the solution (mg/lit).

RESULTS AND DISCUSSION

Bioremediation is one of the new cleanup concepts, which involves the use of plant charcoal to clean contaminated environments. In the present investigation different vegetative parts of *Phyllanthus emblica* were used for the phytoremediation. Lead is a serious cumulative body poison. Natural water usually contains up to 20 ppb of lead, maximum concentration of lead in drinking water is 0.10mg/L prescribed by ISI10500-91. That is why very small concentration i.e. 7 ppm of lead solution was prepared for the present investigation. It was found that the carbon dose played an important role in the adsorption of heavy metal lead (Pb) from waste water. Phytoremediation is compensated by bio adsorbent. Materials such as potato peels, sawdust, black gram husk, egg shell, seed shell, coffee husk and sugar-beet and), etc., have been widely investigated as potential bio adsorbents of heavy metals (Divya Singh *et a*l., 2010). In the present study with Amla (*Phyllanthus emblica)* it was found that the observed concentration with percentage of lead ((Table 1, Fig. 1) and the adsorption percentage of lead in ppm by using batch adsorption technique (Table 2 and Fig. 2) were maximum in the presence of Amla leaves which were 27.42%.and 0.725 respectively. Other parts were also found to adsorb the heavy metal but the proportionate adsorption of lead was comparatively high in leaves, which could be due to variations in the presence of number of active sites, the particle size and dose of carbon in different parts of the plants. These adsorbents appear to be technically feasible, user

Table 1.

S. No.	Components	Observed Concentration (Ppm)	Percentage (%)
1	Steam	1.101	15.72
2	External skin	1.446	20.65
3	Leaf	1.920	27.42
4	Nerve	0.864	12.34

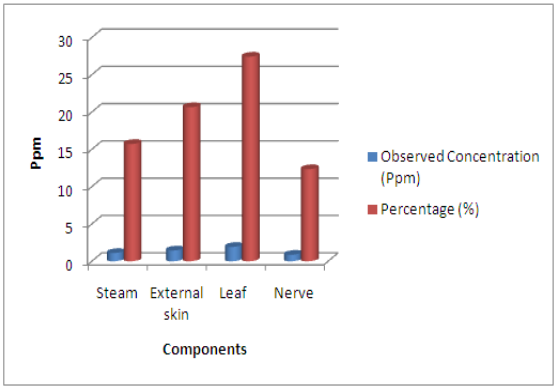

Fig. 1. Observed Concentration with percentage

Table 2.

S. No.	Components	Adsorption percentage (Ppm)(Batch adsorption studies)
1	Steam	0.842
2	External skin	0.793
3	Leaf	0.725
4	Nerve	0.876

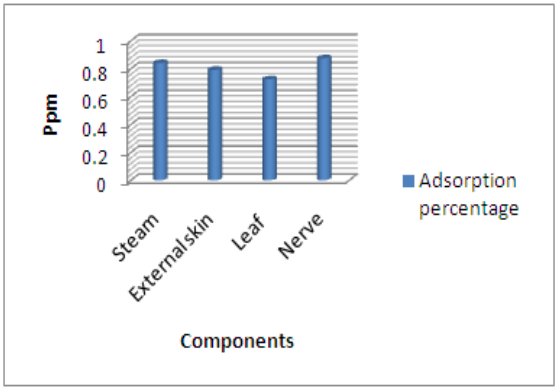

Fig. 2. Batch adsorption studies

friendly and ecofriendly and economical process. This work suggests that various such potential adsorbents are to be screened and used as good adsorbent material for to remove heavy metals from the environment including lead.

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