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Original Research Article

Study on use of Water Hyacinth (*Eichhornea crassipes*) for the Removal of Lead (II)) ions from Waste Water

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ABSTRACT

Water Hyacinth a monocotyledonous freshwater aquatic plant which is found in water gardens, rivers or canals. In the present study, leaves of Water Hyacinth (*Eichhornea crassipes*) has been used as adsorbent for the removal of heavy metals ions specially for Pb^{2+} and Cd^{2+} ions from waste water. The adsorption study was carried out under batch experiments including contact time, pH, concentration and temperature. The adsorbent was characterized by using FTIR and FESEM methods and the maximum adsorption of Pb^{2+} ions was observed at optimized contact time of 60 mins, pH 6, and dosage & at 60^0C. The percentage adsorption has been achieved as 67.8 %, 58.8%, 98.6% and 49.2% for Pb^{2+}. The equilibrium data of adsorption were tested with Langmuir & Freundlich isotherm models.

1. Introduction

Water Hyacinth is a monocotyledonous freshwater aquatic plant which is found in water gardens, aquariums or canals. It bears beautiful blue to lilac colored flowers along with their round to oblong curved leaves and waxy coated petioles. It gains from a few inches to around a meter in height the stem and leaves comprise air filled sacs, which support them to stay flooded in water. Water hyacinth has lignin content (10%) and covers high amounts of cellulose (20%) and hemicellulose (33%). biomass since land plants can have 30-50% cellulose, 20-40% hemicellulose and 15-30% lignins , which is also reported by Alia Badra et al in 2013[1]. In plants, lignin (composed of phenyl propanoid groups) performances as a polymer about the hemicellulose microfibrils, required the cellulose particles together and defensive them against chemical degradation. Lignin cannot be changed into sugars. Thus, it is not applied in biofuel production. Their degradation is a high-energy procedure. *Eichhornea crassipes* has low lignin, which means the cellulose and hemicellulose are more easily converted to fermentable sugar thus resulting in huge amount of working biomass for the biofuel industry A new method of pull out ethanol by saccharification with diluted sulfuric acid, and hurrying the procedure by using yeast. Cellulose present in water hyacinth in great percentage so we effort to harvest biodegradable packaging material from this palnt as well as it produce valuable product like, Biogas, Bioethanol, Bio fertilizer, Bio hydrogen, Fish feed and Water purification[2].

The exposure of heavy metals in water system has now become a major issue in the developing countries and even in the world. The presence of heavy metals in the water bodies is due to discharge of untreated metal contaminated effluent into water bodies. Heavy metals are non-biodegradable and harmful to all living organisms. In human, these metals are deposited in tissues of different organs through different food chains and contaminated waters[3].

The adsorption based removal of heavy metal ions from waste waters is a promising technique over the other conventional methods. Sorption of heavy metals utilizing waste biomasses have the certain characteristics such as high efficiency, low cost, minimization of chemicals/instrumentations and no harmful chemical sludge and metal recovery possible from metal loaded biomass. The mechanisms of adsorption onto a selected biomaterial are based on chemisorptions, complexation, diffusion and ion exchange[4].

Heavy metals such as chromium (Cr), lead (Pb), cadmium (Cd), nickel (Ni) and copper (Cu) may toxic among the other inorganic pollutants and cause a harmful effect to living forms and some of them are very toxic event at low concentrations. Cadmium (Cd) and lead (Pb) are generally present in the wastewaters that released from different industries and cause a variety of diseases to human health. Lead (Pb) is introduced in fresh, saline and waste waters from different sources such as batteries, petrol, cable wires, alloys, steel, plastic, and glass and paint industries[5]. Lead is metabolic poison and reduces the enzymatic activities in the human body. It is also a carcinogenic agent and its organic

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forms are more poisonous. The main sources of cadmium (Cd) in the aquatic bodies are ceramics, metal finishing, alloying, mining and other industries. It may cause hypertension, renal dysfunction, hepatic injury, lung damage etc[6]. The leaves, stem with roots of the plant were collected from Sahastradhara, Dehradun India.

2. Material and methods

All the chemicals used were of AR grade .Deionized water was used for the preparation of all necessary reagent solutions. The collected waste leaves were washed with tap water and then 2-3 times with distilled water. After that, the leaves have dried in tray dryer for 3 hours between the temperatures 60-70 ^{0}C. Now, the leaves grinded and sieved into particle size 0.075 mm and characterized by using FTIR and FESEM methods. Stock solutions containing 1000 mgl^{-1} of Pb^{2+} and Cd^{2+} ions was ere prepared by dissolving 1.8307 g $Pb(CH_3COOO)_2{\cdot}3H_2O$ in volumetric flask . The stock solutions containing 1000 mgl^{-1} of lead was diluted in different working solutions having different concentrations; pH of working solutions was adjusted 1-6 by using 0.1 M NaOH and 0.1 M HCl. A requisite amount of biomass (0.1 g to 1 g) was then treated with a necessary working solutions (10, 20, 30, 40 or 50 mgl^{-1}) and pH (1 to 6) at a constant rpm 150 and temperature. After a certain contact time (10-70 minutes), the contents of the reacting flask were filtered through a filter paper and the filtrate was analyzed by Atomic Absorption Spectroscopy (Thermo Scientific: iCE 3000 Series). The percentage adsorption of metal ions was calculated by following formula:

$$\text{\% Adsorption or adsorption efficiency} = \frac{C_1 - C_2}{C_1} \times 100$$

(C_1 and C_2 are the metal ion concentrations in waste water before and after adsorption)

3. Results and discussion

3.1 Characterizations of adsorbent

The FTIR (Perkin Elmer) spectrophotometer was used to scan the FTIR spectra in the range 4000-500 cm^{-1} (Fig: 1). FTIR spectroscopy is generally used to observe the type of bonds present on the surface of adsorbents. Broad peaks have been obtained at 3400 cm^{-1}, 2927 cm^{-1}, 1723 cm^{-1}, 1623 cm^{-1}, 1449 cm^{-1}, 1376 cm^{-1}, 1249 cm^{-1}, 766 cm^{-1} and 611 cm^{-1}. Such peaks indicated that the organic groups like hydroxyl(–OH), Amine (, –NH), –C-H (Aliphatic), carbonyi(C=O), end (C=C) alkyl linkage (,–CH_3), C–N etc are present on the surface of unloaded leaf powder and available for the interactions with Pb^{2+} + ions during the process of sorption[7]. The morphology of particles of leaf powder before adsorption is shown in figure 2.

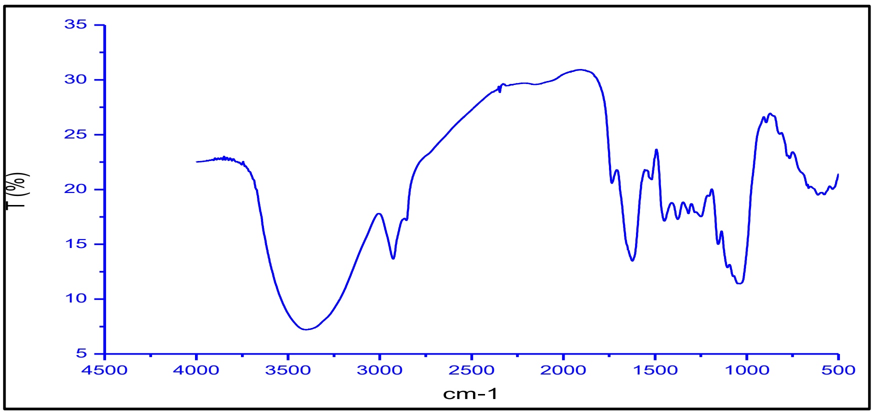

Figure No. 1: FTIR Characterizations of adsorbent

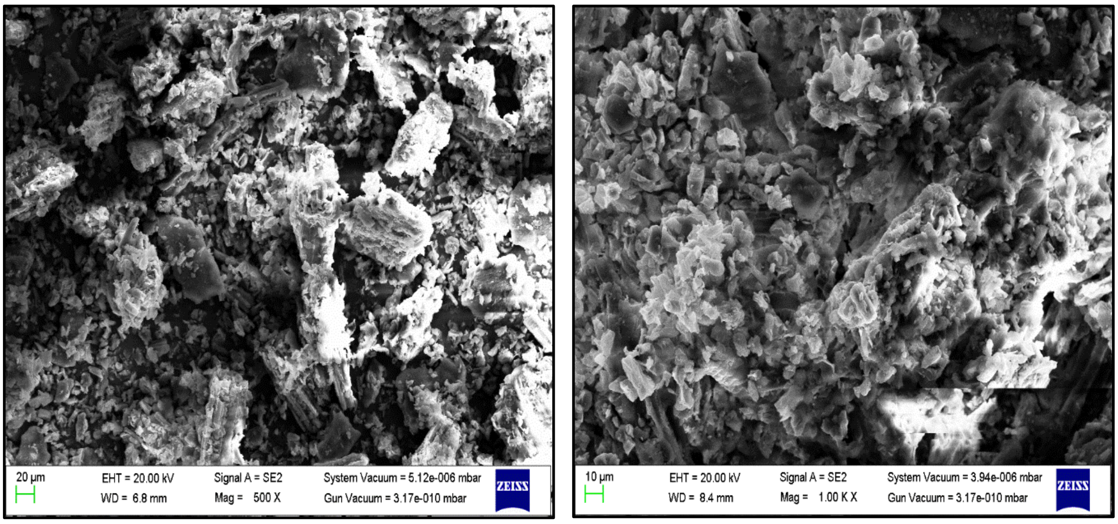

Figure No. 2: FESEM images of adsorbent

3.2 Effect of pH and contact time

The pH of aqueous solution is very important parameter in the removal of heavy metals and adsorption of Pb^{2+} ions increases with the increase in pH of working solutions[8]. At lower pH, the active sites on surface of adsorbent undergo protolysis and become positively charged. It results the repulsions between Pb^{2+} ions and active sites but at higher acidic pH, all the active sites are available for the interactions with Pb^{2+} ions. At initial pH 1, the removal efficiencies of Pb^{2+} ions have recorded 8.4 which rapidly increase to 93.2 % at pH 5. The maximum percentage adsorption is found for Pb^{2+} ions as 98.8 at pH 6 (Fig: 3A, B). The uptake of metal ions during sorption increases with the increase of applied contact time periods. It is due to the availability of more active sites for the metal ions but after certain time, the removal efficiency of metal ions become constant due to the occupation of about all organic groups by metal ions[9]

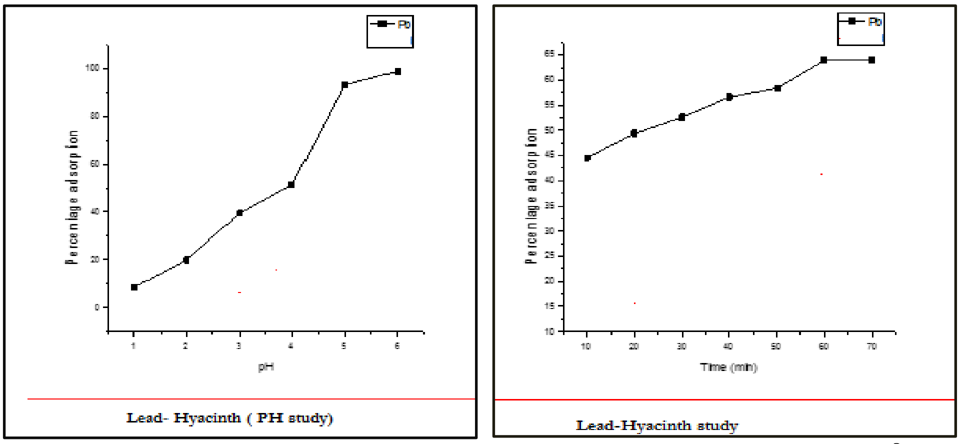

Figure No. 3: (A) Effect of pH and (B) Effect of contact time on the removal of Pb^{2+} Ions

3.3 Effects of dosage and temperature

The adsorption of metal ions increases with the surface area of adsorbents and a large surface area at similar particle size is available at the higher amounts of adsorbents. This can be explained by the fact that the active sites on adsorbent remain unsaturated during the sorption process and the number of sites available for adsorption by increasing the amount of sorbent[10]. About 9% removal of lead observed at the initial dose of adsorbent 0.1 g and increased to about 37% at o.5g dosage. The maximum removal of Pb is found about 59% at the highest dosage 1g (Fig: 4A). The percentage removals of Pb were recorded about 40% at 10^0C and that increased to about 47% at 40^0C. At 60^0C, the percentage removal of Pb was about 50%. (Fig: 4B).

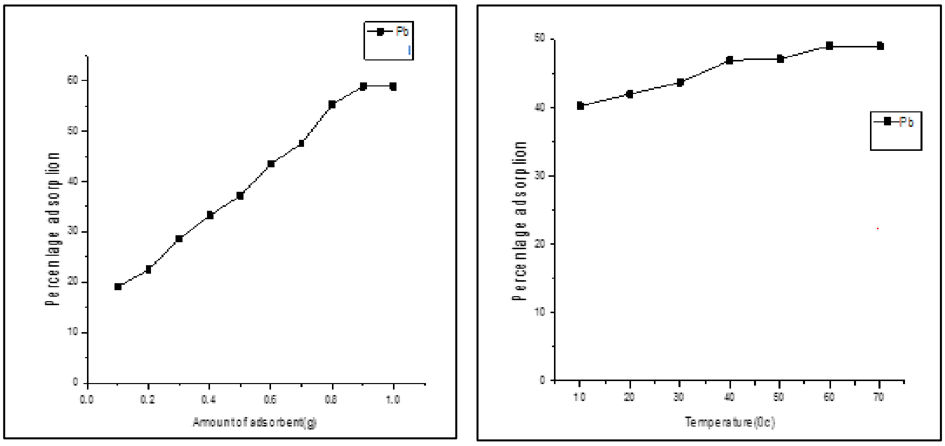

Figure No. 4A & 4B: Effect of dosage and Temperature

3.4 Effect of concentration

The percentage adsorptions of metal ions decrease with the increase in concentration of metals ions in working solutions whereas the amounts of adsorbate metal ions increased. This can be explained as the generation of a motive force of concentration gradient as the initial metal ion concentration. About 50% removal efficiency was recorded for an initial concentration of 10 mgl^{-1}. After that, it decreases to 17.6 for lead at 50 mgl^{-1} concentration, pH 4 and contact time 25 minutes (Fig: 5).

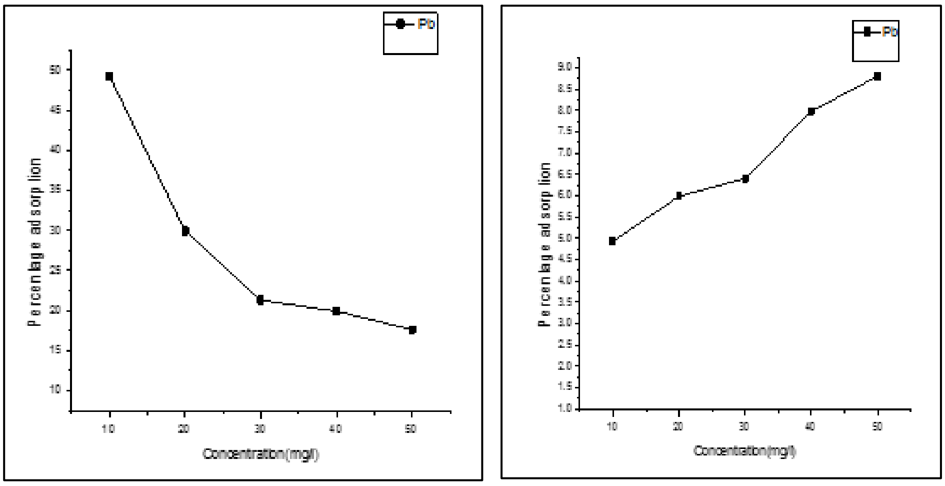

Figure No. 5: Effect of concentration on the removal of Pb^{2+} ions

3.5 Isotherm modeling

A suitable isotherm model is necessary for the explanation of adsorption behavior of adsorbents for the metal ions. Langmuir isotherm assumes that the formation of a single layer of metal ions on surface of adsorbents that containing an adequate number of binding sites which are arranged very regularly[11]. The Langmuir isotherm model is represented as below:

$$\frac{C_2}{Q_e} = \frac{1}{K_1 A} + \frac{C_2}{K_1}$$

Where, C_2 and Q_e are the equilibrium concentrations (mgl^{-1}) of ions and their amount adsorbed (mgg^{-1}) on the surface of leaf powder. The constant K_l and A are the adsorption capacity (mgg^{-1}) and adsorption equilibrium constant (Lmg^{-1}), respectively. When a graph is plotted between C_2 / Q_e vs C_2 (Fig: 7A); the values of K_l and A have been evaluated for Pb^{2+} ions as 10.101 mgg^{-1}. The values of regression (R^2) are indicating that the Langmuir isotherm model is best fitted to the removal of Pb^{2+} ions from contaminated waste waters (Table: 1).

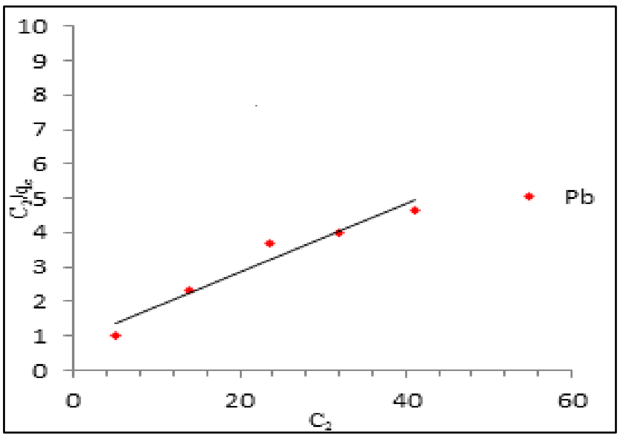

Figure No. 6: Langmuir isotherm model

Table No. 1: Isotherm parameters for lead

Isotherm model	Metal	Parameters	Values
Langmuir	**Pb**	K_l (mgg^{-1})	10.101
		A (Lmg^{-1})	1.001
		R^2	0.950

4. Conclusion

Water hyacinth waste leaves and roots have been found good adsorbent for the removal of lead from waste water. The adsorbent was characterized by using FTIR and FESEM methods. The maximum adsorption capacity was observed at higher contact time, higher acidic pH and moderate temperature. The data of adsorption have been correlated with isotherm.

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References

[1]. Alia Badra Pitaloka, Asep Handaya Saputra and Mohammad Nasikin, Water Hyacinth for Superabsorbent Polymer Material, World Applied Sciences Journal 2013;22(5):747-754.

[2]. Aziam R., Chiban M., Eddaoudi H., Shoudani A., Zerbet M., Sinan F., Kinetic modeling, equilibrium isotherm and thermodynamic studies on a batch adsorption of anionic dye onto eco-friendly dried Carpobrotus edulis plant, The European Phy J Special Topics 2017;226: 977.

[3]. Cao Y., Zhang S., Wang G., Xu X., Removal of Pb, Zn, and Cd from contaminated soil by new washing agent from plant material, Environ Sci and Poll Res 2017;24:8525.

[4]. Davis TA., Volesky B., Vieira RHSF., Sagassum seaweed as biosorbent for heavy metals, Water Research 2000;34:4270–4278.

[5]. Papegowda PK., Syed AA., Isotherm, Kinetic and Thermodynamic Studies on the Removal of Methylene Blue Dye from Aqueous Solution Using Saw Palmetto Spent. Intern J Environ Res 2017;11:91.

[6]. Demirbas A., Heavy metal adsorption onto agro-based waste materials: a review, J Hazard Mate 2008;157: 220-229.

[7]. Elangovam R., Philip L., Chandraraj K., Biosorption of chromium species by aquatic weeds: kinetics and mechanism studies, J Hazard Matel 2008;152:100-112.

[8]. Joshi NC., Singh A., Rajput H., Utilization of Waste Leaves Biomass of Myrica Esculenta for the Removal of Pb (II), Cd (II) and Zn (II) Ions from Waste Waters, Oriental J Chemi 2018;34:2548-2553.

[9]. Joshi NC., Bahuguna V., Biosorption of copper (II) on to the waste leaves of kafal (Myrica esculenta), Rasayan J Chem 2018;11:142-150.

[10]. Joshi NC., Rangar V., Sati R., Joshi E., Singh A., Adsorption Behavior of Waste Leaves of *Quercus Leucotrichophora* for the Removal of Ni^{2+} and Cd^{2+} Ions from Waste Water, Orient J Chemi 2019;35: 591-596.

[11]. Tang Q., Zhou T., Gu F., Wang Y., Chu JM., Removal of Cd(II) and Pb(II) from soil through desorption using citric acid: Kinetic and equilibrium studies, J Cent South Univ. 2017;24:1941.

[12]. Lu SG., Xu QF., Competitive adsorption of Cd, Cu, Pb and Zn by different soils of Eastern China, Environ Geol. 2009;57:685.

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