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THE REMOVAL OF CADMIUM FROM AQUEOUS SOLUTIONS BY USING *ALBIZIA LEBBECK* SEEDS

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ABSTRACT

One of the major environmental problems is a polluted of water by toxic heavy metals. Using the biological treatment an effective way to remove heavy metals because it is environmental friendly, economic, easy to implement and do not require the expertise. The aim of the current study is estimate the efficiency of low cost adsorbents for Cadmium removal , these adsorbents consist of *Albizzia lebbeck* seeds in treatment of aqueous solution that contains heavy metals (Cd) with other pollutants by adsorption technique, and study the effect of a number of parameters(Cd concentration, contact time and pH values). The sample of plant waste *(Albizzia lebbeck* seeds) was tested to determine its activity which gives the best performance in heavy metals removal and other pollutants (TSS, TDS). Adsorption tests showed the seed adsorbents had significant heavy metal removal efficiency. Higher removal efficiency for Cd was 95% occurred at 2ppm and pH 5 after 2hr.

KEYWORDS: *Albizzia lebbeck, Adsorption, Cadmium, aqueous solution.*

INTRODUCTION

Water pollution is the major problem in the global environment which refers to the any change in chemical, physical and biological quality of water which lead to diseases and deaths to any living things that drinks or uses or life.[1-3]The aquatic environment exposed to many pollutants, including agricultural fertilizers, petroleum hydrocarbons, heavy metals, pesticides, thermal pollution, radiation and other types of pollutants, heavy metals are most important pollutants of aquatic environment as large quantities released into the environment from industrial waste and waste water, causing many environmental problems.[4,5] Large quantities of various pollutants, such as toxic pollutants or heavy metals. Danger lies in its entry within the food chain and accumulates in the tissues of living organisms through the bio-concentration processes, as well as, their effects on the human health. Therefore, heavy metals water pollution has received considerable attention worldwide including identifying, classifying these metals, controlling, assessing their environmental impacts, treating their effects and monitoring and searching for scientific mechanisms to reduce and prevent any possible influences may occur due to such contamination.[6,7] Various techniques for treatment stages like; ion-exchange, chemical precipitation, electro dialysis, reverse osmosis (RO) and membrane separations.[8] All of these techniques are already being used to clean up the environment from those kinds of contaminants, but most of them are costly and not enough effective to allow the recovery of very dilute heavy metals present in the effluent, and not suitable for small-scale industries.[9] it would be necessary to find other methods through the use of biological efficient systems, For at least 300 years, the ability of plants to remove contaminants from the environment has been recognized and taken advantage of in applications such as land farming of waste. Over time, this use of plants has evolved to the construction of treatment wetlands or the planting of trees to counteract air, soil and water pollution. Many species of plants have been successful in absorbing contaminants such as lead, cadmium, chromium, arsenic, and various radionuclides from soils and water. Among the existing pollutants,[10] *Albizzia lebbek* may have significant adsorption capacity for bio removal heavy metal ions from aqueous solution as adsorbents. So, this study was designed to examine the use of *Albizzia lebbeck* parts in the bio removal of lead, cadmium and cobalt from aqueous water.

MATERIAL AND METHODS

Seeds and pods of *Abizzia lebbeck* were collected locally from the gardens of College of Science, Baghdad University, during October 2015. Plant was classification scientifically in Herbarium of Department of Biology, College of Science, University of Baghdad, Iraq.

1-Preparation of Adsorbents

The pods of *Albizzia lebbeck* plant were collected from the tree. The choosing of these adsorbents for two reasons, their cost effectiveness and ready availability. Which prepared by washing pods and seeds in de-ionized water until apparent excess material were removed from the samples, then drying in incubator at temperature range (50 ±1°C). After that, clean plant wastes adsorbents were used of adsorbent on process inthe experiment.

2- Preparation ofstandard aqueous solutions

Preparation of standards aqueous solutions with, Cdwas prepared depending on the atomic and molecular weights of these heavy metals and estimated and recorded by atomic absorption spectroscopy in laboratory.[11,12]

3-Adsorption experimental studies

a. The adsorption studies were carried out in transparent glass column, the column had 2cm internal diameter and 30cm in height, The high of plant adsorbents in the column was(21cm).In this experiment, the entire glass column washed with de-ionized water before all adsorption experiments. The column filled with individually prepared plants wastes adsorbents samples in order to estimate the efficiency of adsorbent was determined according to certain parameters such as: pH value and contact time.

b. Factors affecting heavy metals removal and other pollutants. The adsorption tests were carried out for the examination of possible effects of different levels of pH(4-6) and contact time(6-120min).

3. Removal efficiency (R.E) Calculation

The removal efficiency calculated according to the following equation:[13]:

$$\text{Removal Efficiency (Re)\%} = \frac{C_0 - C_f}{C_0} \times 100$$

❖ *Where:*

C_0 = the initial metal concentration (mg/l).

C_f = the final concentration (mg/l).

Statistical analysis

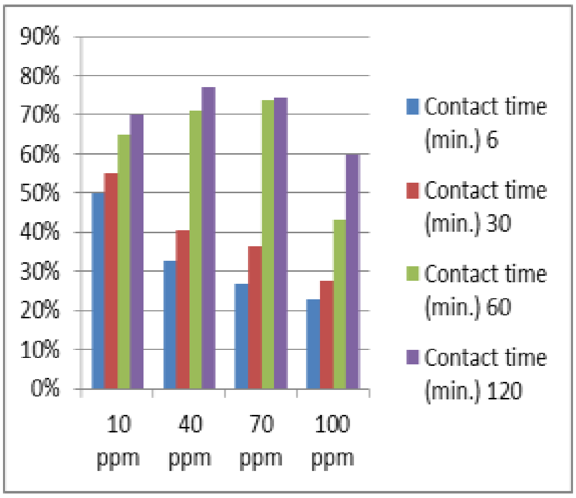
The Statistical Analysis System- SAS (2012) program was used for estimation effect of different factors (metal concentration and contact time) in study parameters. Least significant difference –LSD test was used to significant compare between meansin this study.

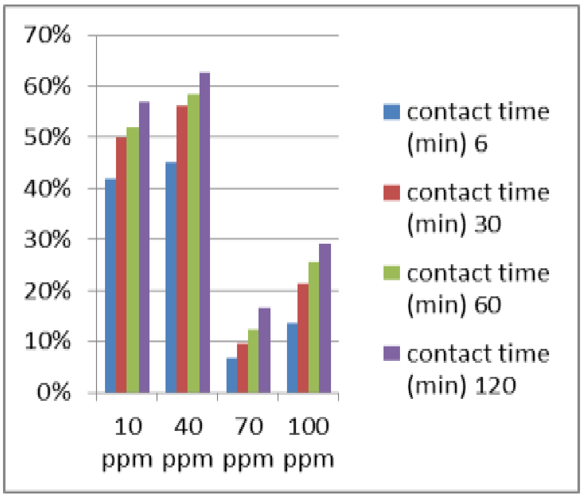
RESULTS AND DISCUSSION

Factors effecting on adsorption efficiency of heavy metals solution from the aqueous solutions by Albizzia lebbeck seeds.

pH values andcontact time

Result of Cd removal efficiency by *Albizzia lebbek*as seeds that were achieved under three values of pH 4,5,6 and four different contact time (6,30,60 and 120min) are displayed in figure(3.1), (3.3)and (3.5) while the residual concentrations were displayed in figures (3.2),(3.4) and (3.6). Figure (3-1) showed the removal efficiency of Cd ions by seeds at pH4.It is obviously, the highest removal efficiency at concentration 20ppm was 94.3% after 120min, while the lowest removal efficiency at concentration 2ppm was 50% after 6min.while in figure (3.2) Generally, the highest removal efficiency at the concentraion 2ppm was 95% after 120min, while the lowest removal efficiency at the concentraion10ppmwas 48% after 6min. The statistical analysis showed a significant differences ($P<0.05$) in all concentrations. The current study is agreement with published that finding by.[14] They report the optimum value of pH for cadmium and zinc removal were lied between 4 and 5 in case of using banana peels. Also this data revealed significant differences between the ability of adsorbent materials for sufficient removing of heavy metal ions from the aqueous solution depending on the heavy metals types and complete saturation of Cd binding sites on *Abizzia lebbeck* seeds.[15] Figure (3-3) had been shown Cd adsorbate by *Albizzia lebbek*as seeds at pH6. Generally, higher adsorption efficiency for removing of Cd exhibited at concentration 2ppm was 90% after 120min, while the lowest adsorption efficiency at concentration was42% after 6min.Increasing of the concentration with increasing time can be attributed to the reduced surface mass transfer, as result of decrease in metal concentration gradient between the solution and adsorbents.[16] While[17] reported that the pH 6.5 gave 85.10% of removal efficiency for Cd.





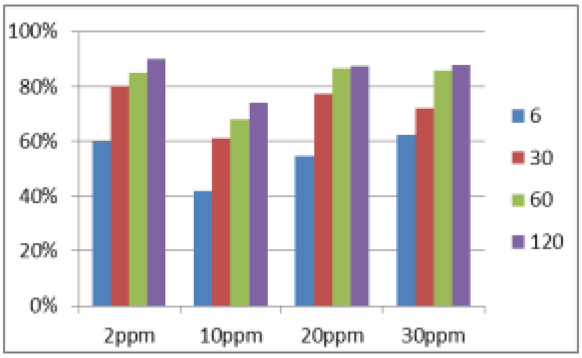
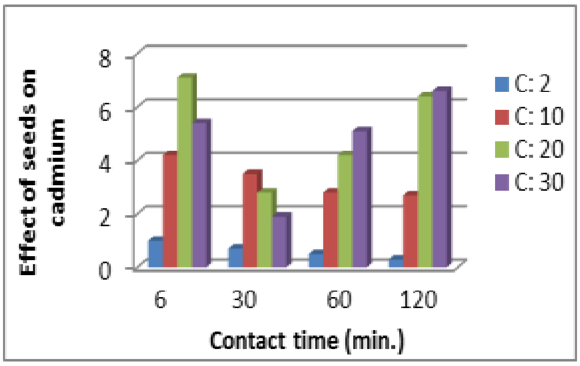


Figure 3-1: Removal efficiency of cadmium(Cd)by *Albizzia lebbekas* seeds at 4 different metal concentrations with different contact times at PH 4,5,6

Figures (3-4), (3-5) and (3-6) shows the residuals concentrations of Cd in aqueous solution after treatment by seeds at pH4, pH5 and pH6 with different contact time (6, 30, 60 and 120min). Figure (3-4) had been the residual at pH4. Clearly, the lowest residual was 0.3ppm at 2ppm concentration, while the highest residual concentration 30ppm was 6.6ppm after 120min. The statistical analysis showed a significant differences ($P<0.05$) in all concentrations. Figure (3-5)showed the residual concentration of Cd ions in aqueous solution after treatment by seeds at pH5 after adsorption Process. Clearly, lowest residual concentration at 2ppm concentration was 0.1pm after 120min, while the highest concentration of residual at concentration 30ppm was6.9ppm after6min. The statistical analysis showed a significant differences ($P<0.05$) at 10, 20 and 30ppm while Not-significant in 2ppm.

Figure (3-6) showed the residuals concentration of Cd in aqueous solution after treatment by seeds at pH6.Clearly,the lowest residual concentration at 2ppm concentration was 0.2ppm after 120min, while the highestresidualconcentrationat30ppm was11.3 after 6min. The statistical analysis showed a significant impact($P<0.05$)for10,20 and 30ppm while Not-significant at 2ppm.



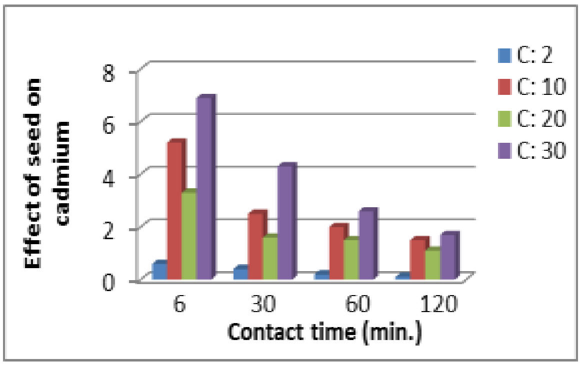


Figure 3.4: The residual Cd (ppm) in the	**Figure 3.5: The residual Cd (ppm) in the**

aqueous solution after adsorption Process by Albizzia lebbeck seeds at 4 different concentrations of cadmium at pH4	**aqueous solution after adsorption Process by Albizzia lebbeck seeds at 4 different concentrations of cadmium at pH5**

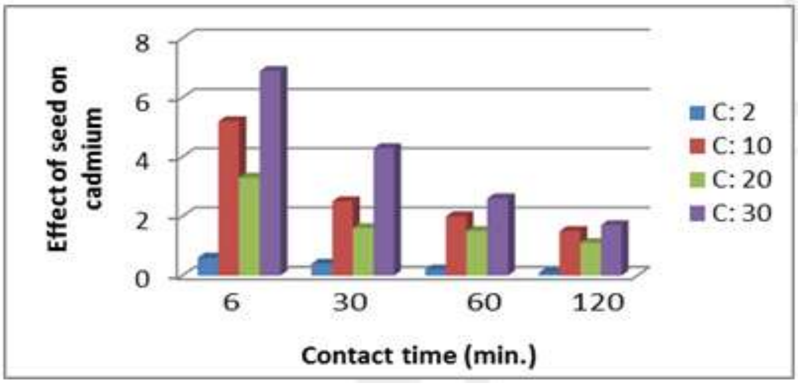


Figure 3.6: The residual Cd (ppm) in the aqueous solution after adsorption Process by Albizzia lebbeck seeds at 4 different concentrations of cadmium at pH6

It seem that the pH values of the aqueous solution is one of an important controlling factor that effects on heavy metals adsorption process and adsorption capability of all adsorbent materials for the removal of Cd.[18] However, according to the type of adsorbent materials and heavy metals in the present study, a higher adsorption capacities was 95% occurred at pH5 for 2ppm of cadmium after 120min by *Albizzia lebbeck* seed. It was noticed that the ability of removing of ions depends on the pH values of the solution that depends on the ion state and nature of material. Therefore, heavy metals may precipitate as a salt in solution over pH6. Lower metal uptake was observed at highly acidic pH could be attributed to competition of metal binding sites between metal ions and hydrogen ion (H+) and hydronium (H_3O^+) ions.[19] This means, the higher H^+ ion concentration up to 6.5, the adsorbent surface becomes more positively charged and the attraction between adsorbents and metal cations is reduced[4], and becomes available to facilitate greater metal removal.[20] Also at alkaline pH the effects may arise that alter the process, such as the predominant presence of hydrated species of heavy metals that leading to changes in the surface charge or the precipitation of the appropriate salts.[21] Various studies have examined the possible effects of pH on adsorption of heavy metals using different adsorbent materials and reported that the repulsion occurs between the metal cation and the adsorbent. When the pH value increase, the binding sites are start de-protonating and makes different available functional groups for binding of metal. In general, binding of cation increases with increasing of pH.[22,23] Also, due to the complete saturation of Cd on binding sites of*Abizzia lebbeck* seeds. Additionally, Plant wastes have many properties such as physicochemical characteristics including: Chemical composition, Functional groups (chemical groups), Surface texture, Surface area, Porosity and porous structure and Nature of charges. Generally, in a given contact time for adsorption of materials from solution by plant wastes there are three primary rate steps:

1. Transporting of the adsorbate through a surface layer to the exterior of the adsorbent (film diffusion).
2. The adsorbate diffusion within the pores of the adsorbent (pore diffusion).
3. The solute adsorption on the interior surfaces bounding pore and capillary spaces.

For most operating conditions, transport of adsorbate through the 'surface layer' or boundary layer is rate-limiting, if sufficient turbulence is provided, transport of the adsorbate within the porous adsorbents may control the rate of uptake.[24]

Chemical and physical measurements of samples after treatment by adsorbents

According to the data that resulted from adsorption experimental studies, the best empirical conditions were selected to conduct optimal conditions for industrial waste water samples treatment at contact time 120min, and it was found that the results of chemical and physical analyses were varied among the adsorbents(concentration, E.C. , T.D.S).

Table (3-1): Chemical and physical measurements (E.C and T.D.S) for treatment of cadmium by Albizzia lebbekas seeds at pH4 with different metals concentrations and contact time.

Initial concentration	Physical and chemical properties									
	E.C. µs/cm 0	E.C. µs/cm 6min	E.C. µs/cm 30min	E.C. µs/cm 60min	E.C. µs/cm 120min	T.D.S 0	T.D.S 6min	T.D.S 30min	T.D.S 60min	T.D.S 120min
2ppm	57	627	703	1691	1976	30	330	370	890	1040
10ppm	152	608	1140	3629	4902	80	320	600	1910	2580
20ppm	114	760	1349	2147	4617	60	400	710	1130	2430
30ppm	154	855	969	1748	2033	82	450	510	920	1070

Table (3-2): Chemical and physical measurements(E.C. and T.D.S) for treatment of cadmium by *Albizzia lebbeck seeds* seeds at pH5 with different metals concentrationss and and contact time.

Initial concentration	Physical and chemical properties									
	E.C. µs/cm 0	E.C. µs/cm 6min	E.C. µs/cm 30min	E.C. µs/cm 60min	E.C. µs/cm 120min	T.D.S 0	T.D.S 6min	T.D.S 30min	T.D.S 60min	T.D.S 120min
2ppm	119	665	684	1159	1178	60	350	360	610	620
10ppm	76	570	684	969	1539	40	300	360	510	810

20ppm	133	513	817	1349	2584	70	270	430	710	1360
30ppm	171	546	836	1387	1349	90	340	440	730	710

Table (3-3): Chemical and physical measurements(E.C. and T.D.S) for treatment of cadmium by *Albizzia lebbeck* see seeds at pH6 with different metals concentrations and contact time.

Initial concentration	**Physical and chemical properties**									
	E.C. µs/cm 0	**E.C. µs/cm 6min**	**E.C. µs/cm 30min**	**E.C. µs/cm 60min**	**E.C. µs/cm 120min**	**T.D.S 0**	**T.D.S 6min**	**T.D.S 30min**	**T.D.S 60min**	**T.D.S 120min**
2ppm	57	1026	1273	4427	3135	30	540	670	2320	1650
10ppm	95	494	589	1558	1561	50	260	310	820	822
20ppm	133	665	703	855	2033	3070	350	370	450	1070
30ppm	209	705	722	1425	1482	110	375	380	750	780

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