Adsorption Study of Cadmium on Water Melon Seed Shell by Flam Atomic Absorption Spectroscopy (FAAS)

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Abstrac t- This study was conducted to found a new and cheep method to remove heavy metal such as cadmium from aqueous solutions by use the seed shell of water melon plant (*Citrullus lanatus*), four experiments were done to demonstrate the effectiveness of watermelon seed shell to remove cadmium analyzed by FAAS. The first experiment was done to determine the effects of time on the adsorption process the results show that increased the adsorption of cadmium with contact time. In the second experiment, the results show that the removal efficiency (R) increase from 42.83 at concentration 0.5mg/l of the adsorbent to 43.75 at concentration 2.5mg/l of the adsorbent. The third experiment was carried out to determine the effect of initial concentration of the cadmium on the adsorption process. The results show that at initial concentration of cadmium 10 mg/l the adsorbent was able to remove the adsorbate completely and at concentration 60 mg/l the removal efficiency was decrease to 40.9, for the last experiment the effect of pH on the adsorption process was studied, the results show that 47.37 at pH 3 and decrease to 43.01 at pH 11 respectively. Langmuir and freundlich adsorption isotherm models were analyzed and experimental results fit very well with freundlich model than Longmuir model

Index Terms - Cadmium, Adsorption, Biotreatment, Water pollution, FAAS.

1.Introduction

Heavy metals can raise a health alert in the environment, since that they are toxic affect in the organisms, and they can't be degraded biologically, therefore, a method to get rid of these metals must be established. So, treatment of aqueous wastes containing dissolved heavy metals must reduce the contaminants as possible [1]. Cadmium can enter the aquatic environment from smelting, metal plating, Cadmium-Nickel batteries, phosphate fertilizer, mining, pigments, stabilizers, alloy industries and sewage sludge. Cadmium can cause different acute and chronic disorders, such as "itai-itai" disease, renal damage, emphysema, hypertension, and testicular atrophy [2].

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Species belong to the family of Cucurbitaceae are important crops, usually planted for its sweet and juicy fruits in warm area of the world [3]. Watermelon (*Citrullus lanatus*) is sufficient source of antioxidant during normal metabolism and protects against cancer, Melon fruit contains large quantities of seeds, and these seeds can be used as dressing for bread, cake. [4].

The orthodox methods of treatment such as filtration, flocculation, reverse osmosis, ion exchange and electrochemical deposition cost a lot of many and labor work and can produce a large amount of wastes[5]. There is a new successful, economical and easy to use method of treatment for removing heavy metals in aqueous solutions which is adsorption [6]. Many studies were conducted to remove the cadmium and other pollutants from water, "[7],[8],[9], [10]" by low cost material [11].
The present study aimed to evaluated the adsorption activity to water melon seed shell of cadmium from aqueous solution and removal of this element from environment.

2. Materials and Methods

Cadmium nitrate ($Cd(No_3)_4.4H_2O$) (used as adsorpate) was used to prepare a stock solution (60 ppm) by dissolving an exact weight of the deionized water (in order to get rid of

interruption in the results), then series of dilution was done to obtain the needed concentration for this work.

Water melon seed shells (used as adsorbent) were dried after been activated by using phosphoric acid H_3Po_4 (10%) for one hour and then kept in the oven at temperature of 100C° until it fully dried, the seed shells were grind to a fine powder by using the electrical mortar [12].
A series of experiments were conducted to determine the ability of water melon seed shells to remove the cadmium from aqueous solutions, asfollow "[13],[12],[14],[11]".
For the effects of the contact time on the adsorption process an amount of 1.5 gm of the water melon seed shells to series of aqueous solution of 60 ml with the concentration of 60 ppm , then the flasks were kept in the shaker for different time (30, 60, 90, 120, 150 mints) then the concentration of the cadmium by using the atomic absorption spectrometric.

Various concentrations of water melon seed shells Powder (0.5, 1, 1.5, 2, and 2.5) were addedtofive aqueous solution of cadmium with concentration of 60 ppm and volume of 50 ml respectively, and then the flasks were kept in the shaker for 150 mints, after that the concentration of cadmium in the solution was measured by using flam atomic absorption spectroscopy (FAAS) type (SHIMADZO ,AA-7000, Japan).

For the third experiment, a series of concentration of cadmium were prepare (10, 20, 30, 40, 50, 60) ppm to determine the efficiency of the water melon seed shell to remove the cadmium from aqueous solutions, 1.5 gm of the water melon seed shell to each flask, then the flasks were kept in the shaker for 150 mints, then the concentration of the cadmium was determine by using atomic absorption spectrometric.

To investigate the effects of pH on the adsorption process, 1.5 gm of the watermelon seed shells was added to three samples with different pH value, the first sample with pH value 3 (acidity medium), the second sample with pH value of 7 (Neutral medium), the third sample with pH value 10 (alkaline medium), the three sample were kept in the shaker for 150 mints, then the concentration of cadmium was measured by using atomic absorption spectrometric.

For isotherm studies, Agitation was provided for (30,60,90,120,150) min , adsorbent dose 1.5 g/l of (water melon seeds shell) "[15],[16]".
The adsorption capacity of adsorbent was calculated using the equation below

$$qe = \frac{(ci-ce)v}{w} \quad \text{..... (1)}$$

Where:
qe: Adsorption capacity of the adsorbent (mg/g).
Ci: Initial concentration of adsorbate (mg/L).
Ce: Equilibrium concentration of adsorbate after adsorption has occurred (mg/L).
V: Volume of solution (L).
w: Weight of adsorbent (g).

The dye removal percentage was calculated using equation (2)

$$R\% = \frac{Ci-Ce}{Ci} * 100\%) \text{ ……..(2)}$$

Where:
R% : The metal removal percentage.
Ci : The initial concentration of metal (mg/L).
Ce: The residual concentration of metal after adsorption had taken place over a period of time **t** expressed as (mg/L).

3. Results and Discussions

The first experiment was done to determine the effects of the contact time on the adsorption process, as shown in Fig.1 the adsorption of cadmium from aqueous solution is increased with the increase of the contact time, the removal efficiency of cadmium was ranged from 80.57 to 81.403 as the time contact increase from 30 mints to 150 mints respectively. The results suggest the at the first 30 mints the adsorption process was fast and reach saturation and after that the adsorption increased in very slow manner [11],The results of this study was similar to the results of '[17],[18]"

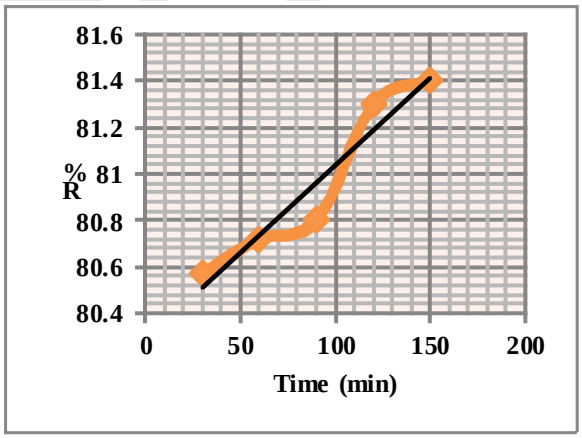

Fig. 1: The effects of the contact time on the adsorption of cadmium on the seed shell of water melon.

The second experiment was done to determine the effects of changing the adsorbent concentration on the adsorption process, the results shown in Fig. 2, the adsorption of cadmium was increased slightly with increase of the water melon seed shell concentration, the removal efficiency (R) was increased from 42.83 to 43.75 as the adsorbent concentration increased from 0.5 mg/L to 2.5 mg/l

respectively. and that's can be attributed to the fact that as the concentration of the adsorbent increased it will provide more surface area for adsorption [6], the results of this study were similar to the results found by [19].

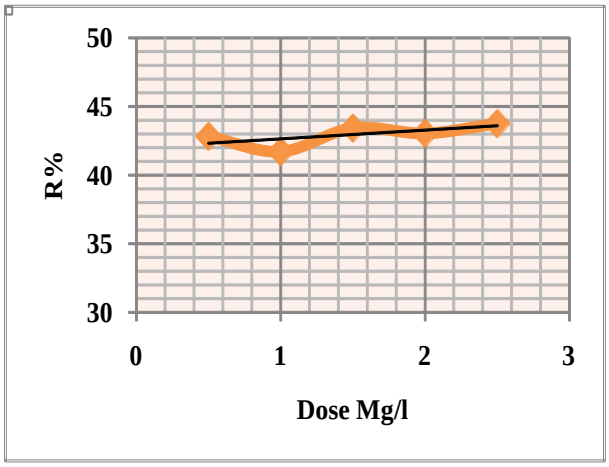

Fig. 2: The effects of adsorbent concentration on the removal of cadmium

The third experiment carried out to determine the effects of the initial concentration of the cadmium on the adsorption process, the results shown in Fig. 3 show that at initial concentration of cadmium 10 and 20 mg/L the cadmium concentration was not detected which means that the cadmium was adsorbed by the water melon seed shell and the R was decreased from 69.73 to 40.9 as the initial cadmium concentration increased from 30mg/L to 60mg/L, and that could be due to the fact that the access amount of the cadmium fill the pours of the adsorbent so the removal efficiency decrease. the results of this study was similar to the results of [20],[21].

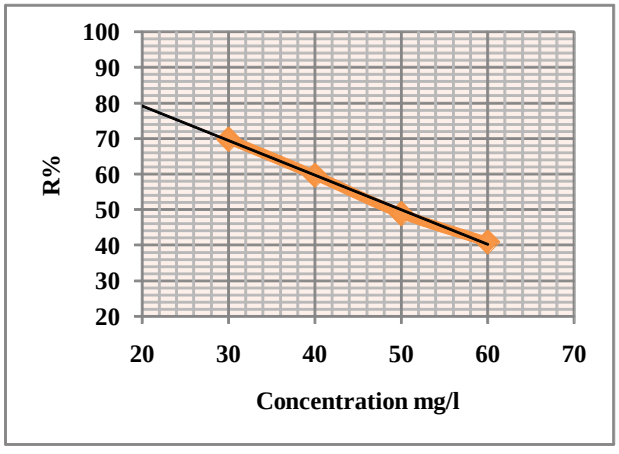

Fig. 3: The effects of the initial concentration of the adsorpate on the adsorption process

In the forth experiment the effects of the pH on the adsorption of the cadmium was studied, the results in table 4 show that R was ranged from 47.37 in the pH value of 3 and the removal efficiency decrease as the pH value increase (from acidity to alkaline) to reach R 43.01 at pH value 10 , and that can be explain according to the electrode potential at the point of zero charge at the adsorbent surface [22], and that's was similar to the results of [23].

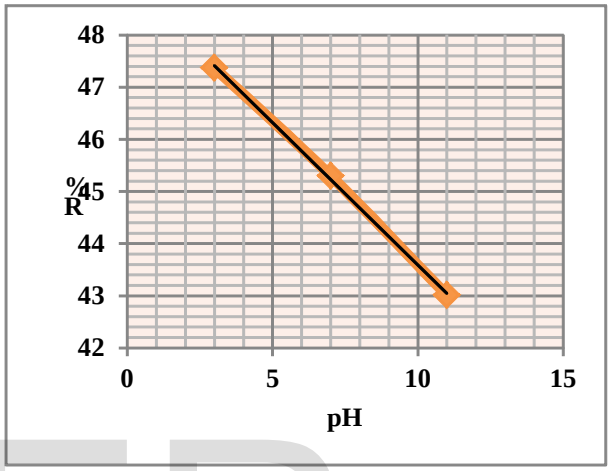

Fig. 4: The effect of the pH on the adsorption of cadmium

3.1 Adsorption isotherm

The adsorption isotherm for cadmium on water melon seeds shell is presented in Fig.7, These isotherm are Langmuir and freundlich, To qualify the adsorption capacity of melon shell in relation to cadmium the experimental data fitted to Langmuir linear equation…

$$qe= (q_o K_L C_e)/ (1+ K_L C_e)$$

And freundlich linear equations

$$qe=k_f C_e^{1/n}$$

$$\log q= \log K_F + 1/n \log C$$

whereqe : The quantity adsorbed at equilibrium in (mg/g) , Ce : The equilibrium concentration of adsorb ate in (mg /L), a and b: $q_o$is a Langmuir constant (mg/g) and $k_L$is also Langmuir constant in (L/mg), Kfand n: The Freundlich experimental constants, **K**Fand**n** are indicators of the adsorption capacity and adsorption intensity, respectively Where Fig.5 shows the straight line obtained from plotting ce against C_e/q_e, correlation coefficient is greater than 0.999, Langmuir's constants (q_o) and (k_L) can be evaluated from

	Langmuir			freudlish		
cadmium	q_o	kL	R^2	**Kf**	**1/n**	R^2
	1.587	**-0.48**	**0.9995**	**3.449**	**-0.2359**	**0.9935**

the slope ($1/q_o$) and intercept ($1/q_o k_L$) of the linear equation.

Fig.6 illustrate linear relationship of log C_e and log q_e, the parameter k_F and 1/n for cadmium have been calculated by least square method

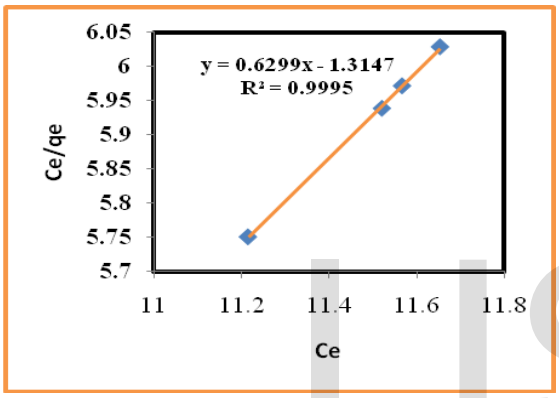

Fig. 5 Langmuir isotherm adsorption model

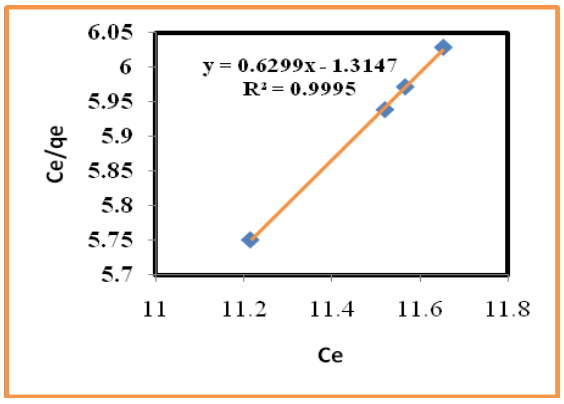

Fig. 6 freundlich isotherm adsorption model

From the values of correlation coefficient of the two models, freudlish isotherm fit very well with the experimental data as shown in Fig. 7

Characteristics, parameter and determination coefficient of experimental data for two isotherms are listed in table 5

Table 1 Characteristics, parameter and coefficient of experimental data

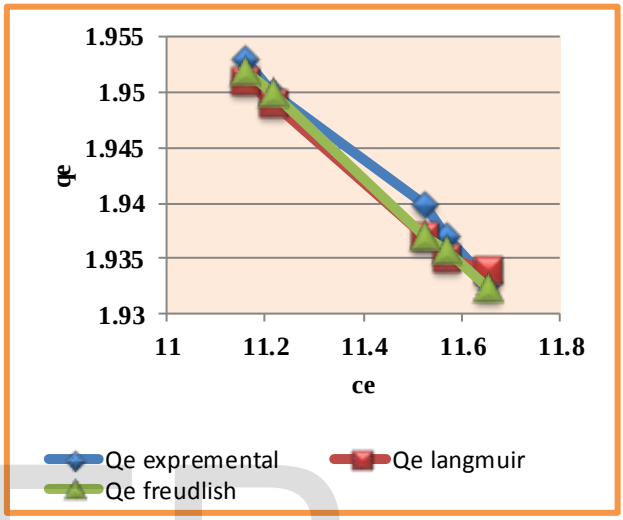

Fig.7: Isotherm of cadmium on water melon seeds shell

4. Conclusion

1. The present study deal with used a cheap materials to remove heavy metal from the environment.

2. The adsorption of cadmium from aqueous solution was increased with the increase of the contact time.

3. The results suggested the first 30 mints the adsorption process was fast and reach saturation and the adsorption increased in very slow manner.

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