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Corn cobs Efficiency in Adsorption of Cadmium Ions (Cd^{+2}) from its Aquatic Solutions

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Abstract: Corn cobs efficiency in adsorption of cadmium from its aquatic solutions was studied in the laboratories of Department of Fisheries and Marine Resources, College of Agriculture and Department of Marine Chemistry, Marine Science Centre during the period from January until June, 2018. Three parameters (time, pH and temperature) were tested for determine the removal ratio of cadmium by corn cobs. Its observed that the maximum removal ratios of cadmium ions 81%, 95.01% and 86.75% were 60 min., pH=6 and 25°C respectively.

Keywords: Corn cobs, Adsorption, Cadmium ion (Cd).

Introduction

The increase in human populations and industrial progress has led to an increase in the effluents of industrial wastes into the aquatic environment. In developing countries, waste management pollution ratio in marine and rivers (Danh *et al*., 2009; Mihajlovic *et al*., 2015).

Heavy metals are considered the most dangerous pollutants in the environment (El-Said *et al*, 2010; Sheba & Nandini, 2016) which are natural components of the earth's crust within the natural levels (Badmus, 2007; Hossain *et al.*, 2014). These elements are necessary for metabolism of organisms such as copper, iron and zinc. But increases their ratio due to human activities, they become poisonous. Others elements are unnecessary more dangerous when their concentrations in the environment become higher than normal levels such as mercury, lead and cadmium (Abdullah & Ali, 2001; Abdullah *et al*., 2016).

There are several ways to remove heavy elements from its water solutions such as precipitation, fermentation, ion exchange, filtration and adsorption (Muthusamy *et al*., 2012; Mbugua *et al.*, 2014). The adsorption method was used due to its simplicity, more efficient and relatively less expensive than other methods (Nasim *et al*., 2004; Sheba & Nandini, 2016), which is known as the transition of ions between two different concentration surfaces. Corn cobs was used as a maize material, being widely available after harvest and may cause environmental pollution (Mwangangi, 2015; Shafiq *et al.*, 2018).

The aim of the study is to determine the efficiency of corn cobs in removing the cadmium ions in the appropriate conditions (time, pH and temperature) for removing the highest percentage of the adsorbent element.

Materials & Methods

Corn cobs were brought from the grain mills in the Qurna city, Basrah governorate to the laboratory. It was cleaned from impurities and dried in the oven at 100°C for 20 min. (Hossain *et al.*, 2012), then grinded and sieved with a sieve size 1 mm. The standard solution of $Cd(NO_3)_2$ for the cadmium material at a concentration of 10 ppm was prepared. It take 20 ml from it and put in a flask, then add 0.1 g of the corn cobs material and placed in a vibrating incubator at 120 rpm at 20° C and pH 7. Series of times (0, 5, 10, 15, 20, 30, 40, 50, 60, 75, 90,105, 120, 240 and 360) minutes. were used to determinate the best time to remove. A series of pH (4, 6, 8 and 9) were also used to determine the highest percentage of time effectiveness, temperature and vibration speed. There are three degrees of temperature (25, 37 and 50)°C were used to determine the best removal percentage after fixing the rest conditions (time, pH and vibration speed). Samples were filtered for each group and placed in special containers then measured with the atomic absorption device (F.A.A.S type Shimad Zu, Japanese origin in the Department of Marine Chemistry, Marine Science Centre (Mohammadi *et al.*, 2017). Standard curve was used to measure the remaining cadmium concentrations in the solution then the percentage of removal has calculated using following equation (Khan *et al.*, 2009):

Removal ratio % = $[(C_0\text{-}Ce)/ C_0]*100$

Where:

C_0 concentration of the element before the adsorption.

C_e concentration of the element after the adsorption.

Results

Table (1) explained the percentage of cadmium removal at different times (20 °C, pH (7), granule size (1 mm) and weight

Table (1): **Percentage of Cd^{2}+ removal by adsorbent at different time intervals.**

Time (min.)	Concentration of cadmium after adsorption (ppm)	Removal (%)
0	5.29	47.10
5	3.07	69.30
10	2.83	71.70
15	2.55	74.50
20	2.4	76
30	2.23	77.70
40	2.02	79.80
50	2.37	76.30
60	1.9	81
75	2.1	79
90	2.06	79.40
105	2.11	78.90
120	2.02	79.80
240	1.96	80.40
360	2.17	78.30

(0.1 g). It was noticed that the highest removal rate (81%) was at time 60 minutes and the lowest removal rate (30.76%) at time (360) minutes. The results showed that there was an inverse correlation (- 0.494) between time (minutes) and adsorption percentage.

Table (2) indicated the effect of pH values on the cadmium removal percentage. It is observed that the highest removal percentage (95.010% was in pH 6 and the lowest removal percentage (89.64)% was in pH 4. The results explained that there was a weak positive correlation (0.27988) between pH values used and removal percentage.

Table (2). Percentage removal of Cd^{2+} at equilibrium at different pH values.

pH	Concentration of cadmium after adsorption (ppm)	Removal (%)
4	1.04	89.64
6	0.5	95.01
8	0.84	91.58
9	0.78	92.19

Table (3) showed the effect of temperature on the cadmium removal percentage. It was observed that the highest removal rate was 86.75% at 25°C and the lowest removal rate was 71.27% at 37°C. The results indicated that there was a weak negatively correlation (-0.32392) between temperature and removal percentage.

Table (3).The percentage of cadmium removal at different temperatures

Temperature (°C)	Concentration of cadmium after adsorption (ppm)	Removal (%)
25	1.33	86.75
37	2.87	71.27
50	1.87	81.32

Discussion

The current study show the percentage of removal at different times. It is gradually increases with increase time until it reaches the highest percentage at a certain time and then decreased. This finding agreed with some previous studies (Mureithi *et al*., 2012; Satya *et al*., 2012; Thijar *et al*., 2014; Hasson, 2015). They indicated that the percentage of removal varies according to time, depending on the difference of the element,and the type of material used. This happens as a result of the formation of a thin layer of the element after adsorption on the surface of the adsorbent material until the completion of this layer, after that adsorptive materials will discontinue to absorb more elements without including the calculating time as a factor (Horsfall & Spiff, 2005). However Han *et al*. (2000) explained that the difference in the removal percentage during different times may be due to more than one mechanical process such as adsorption and absorption. pH plays crucial role in the adsorption process. The current study recorded the highest removal percentage (95.01)% in pH 6. The present study agreed with Ghorbani *et al*. (2012) and Mbugua *et al*. (2014). They recorded the highest adsorption of the cadmium ions at pH values (6-9), and explained that increasing in pH values led to increase polarization and charged sites of adsorptive material increasing the competition of adsorptive surface and adsorptive material and solvent on (H^+) (OH^-) ions. This is not has positive or negative effects on adsorption process. On other hands Al-Hassani (2006) noted that the acidic medium increased the tendency of heavy elements to bind with the molecules adsorbed surface than to the solvent.

Temperature plays an important and effective role in the adsorption process. Adsorption increase when temperature rise but at limited level (Nasim *et al*., 2004). The current study recorded the highest removal percentage of cadmium at 25°C, which is consistent with Al-Haidary *et al*. (2011) and Mbugua *et al*. (2014); but it reach saturation at 25°C. They explained that the high temperature of the solution increase the kinetic energy of the ions that are absorbed on the surface, leading to their separation from the surface and its return to the solution (Israa, 2010).

Conclusions

It was observed that the best time, pH and temperature to have maximum removal ratios of cadmium ions(80.9%,at 60 min 95.01% in pH 6and 86.75% on 25°C) with using corn cobs.

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