Removal of Cadmium(II) ion from aqueous solutions by the outer layer of Onion

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Abstract

Cadmium element is one of the group IIB and classified as heavy metal and effects on human health and environment. The present work concerns with the biosorption of Cd(II) ions from aqueous solution using the outer layer of onions. Adsorption of the used ions was found to be pH dependent and maximum removal of the ions by outer layer of onions and was found to be 99.7%.

Keywords: Cadmium, aqueous solution, adsorbent, adsorption, outer layer of Onions.

1. Introduction

Cadmium is a heavy metal with high toxicity and has a devastating effect on mast body systems.¹ Health hazards of cadmium environmental contamination have caused concern worldwide since the emergence of Itai-Itai disease caused by chronic cadmium poisoning in Japan in the 1950s, and cadmium has been classified as toxic sub-substances of high risk to human health.² At the same time, this element was the focus of the study on environmental pollution in the United Nations Environment(UNE) Program and the International Commission(IC) on Occupational Health. It was also prioritized for the study on food contaminants in the World Health Organization(WHO).³ Many natural biomaterials were studied using innovative techniques and at the lowest economic cost. The efficiency of removing the heavy gloss was high. These materials include roots, stems, husks and seeds of plants.⁴ The adsorption process has many advantages when compared to other conventional methods currently used so that it is less cost, less time and high efficiency in removing metals from liquids.⁵ In this study, the outer layer of Onions(Allium cepa L.) was used to remove cadmium (II) ion from an aqueous solution, due to the presence of effective sites to bind or adsorb heavy metals with the onion's outer layer.
Experimental

2. Material and Methods

Chemicals:
All chemicals used in this study were AR grade. Cadmium metal, HCl (98%), buffer solution, distilled water was used in all preparations.

Adsorbent: *Allium cepa* L. (onion) was selected from the local market, and then washed with distilled water several times to remove dust and other contaminants. Then they were herded in small sizes, left to dry for 5 days and then were kept in a plastic box.\(^{(6)}\)

Preparation of adsorbate:
A stock solution of 1000 ppm for Cd(II) ion was prepared by dissolve 1g cadmium metal in minimum volume of conc. HCl and completed the volume to 1000 mL of distilled water in volumetric flask (ASTM), then diluted the stock solution several times to obtain concentration of 1 ppm.\(^{(7,8)}\)

\[
C \times V = C_{-} \times V_{-} ; \quad 1000\text{PPM} \times V_1 = 100\text{PPM} \times 1000\text{ML}; \quad V_1 = 100\text{ML}
\]

\[
100\text{PPM} \times V_2 = 10\text{PPM} \times 1000\text{ML}; \quad V_2 = 100\text{ML}; \quad 10\text{PPM} \times V_3 = 1\text{PPM} \times 1000\text{ML}
\]

V3 = 100ML

Study of adsorption of cadmium(II) ion on outer layer for Onions:
The general method used for this study is described as below:

Three different acidic, neutral and alkaline solutions were taken for the water solution, where the solution was added to the buffer solutions pH( 4,7,9). For pH 4 add 35 ml from buffer solution 4, for pH 7 add 35 ml from buffer solution 7, for pH 9 add 85 ml from buffer solution 9. In 1ppm from Cd(II) ion solution, the weight of adsorbent 0.5 orange peel was taken and left at different temperatures 30, 60 and 90 °C. The sample is placed in 50 ml of solution in different contact times; 4, 8, 12, 30 and 60 minutes. The suspension of the adsorbent was separated from solution by filtration using Whatman No.1 filter paper. The concentration of heavy metal ion remaining in solution was measured by FAAS (Flame Atomic Absorption Spectrometer). The effect of several parameters, such as pH, temperature, contact time and adsorbent dose on the adsorption were studied. The results of these studies were used to obtain the optimum conditions for maximum heavy metals removal from aqueous solution\(^{(8)}\). The percentage of heavy metal removal was calculated as follows. \(^{(9)}\)

\[
\text{Metal ion removal (\%)} = [(\text{Co} – \text{Ce})/\text{Co}] \times 100
\]

Where \(\text{Co}\) = Initial metal ion concentration of test solution mg/l.

\(\text{Ce}\) = Final equilibrium concentration of test solution mg/l.
3. Results and Discussion

The results after the treatment process by using the outer layer of onions in the process of extracting a standard solution of cadmium concentration of 1 mg/L adsorption technique has been shown that the rate of removal of cadmium ion differ depending on the material used and also factors affecting adsorption, such as Temperature, pH and exposure time.

Fig-1 shows the results obtained after treatment, the highest percentage of removal of ion Cd(II) at a time of exposure of 60 minutes and a temperature of 90 °C is 96.4%, where the best ratio of removal of cadmium(II) ion from the solution in pH(4)

![Figure-1](image1.png)

**Figure-1:** Effects of temperature and contact time on the % removal of Cd(II) ions from aqueous solution. (initial concentration 1ppm), pH(4).

In Fig-2, the result was convergent at pH = 7 and using the onion outer layer in the adsorption process is 99.70%; achieved at 30 °C and equilibrium at 60 min

![Figure-2](image2.png)

**Figure-2:** Effects of temperature and contact time on the % removal of Cd(II) ions from aqueous solution. (initial concentration 1ppm), pH(7).

From previous studies, it was found that the removal of heavy metal ions using the adsorption process by peeling fruits and vegetables is located in the acidic medium which
helps them to bind to the active groups on the surface of the crusts, but in Figure-3 a change was made in the medium where pH = 9 was used in the medium (10).

![Figure-3: Effects of temperature and contact time on the % removal of Cd(II) ions from aqueous solution. (initial concentration 1 ppm), pH (9).](image)

The results were positive in removing cadmium(II) ion by the outer layer of onions which is 99% at 30 °C and 60 °C at 60 min exposure time

4. Conclusion:

In this study the results obtained by adsorption technique by the onion outer layer to remove the Cd(II) ion are very high with the highest adsorption rate of Cd(II) 99.7% at 30 °C and 60 minutes at pH range 7, thus using this technique reduces the risk of water pollution and makes water safe for consumption.

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5. References

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