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Moringa oleifera legumes husk as a powerful adsorbent in determining the Cr (VI) heavy metal spectrophotometrically

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Abstract

The study and identification of toxic metals in various samples is important from the point of view of the health concern of humans and aquatic life. In the present work the effective and powerful adsorbent properties of husk of waste legumes of Moringa oleifera after its use were thoroughly studied. In this work the determination of Chromium (Cr) heavy metals from the solutions of its salt were studied. The efficiency of removal of Cr(VI) was found to be 79.9 % at the optimum pH 2.0 and the contact time was 80 min for the toxic metal Chromium (VI). This adsorbent is the ecofriendly cost effective and easily available and will become the better substitute adsorbent for the removal of heavy metal Cr (VI). The different parameters such as contact time, effect of pH, initial concentration of metal ions and amount of adsorbent on the adsorption capacity were studied by using the double beam UV-Visible Spectrophotometer.

Key words: Toxic Metals, aquatic life, Moringa oleifera, low cost adsorbent, Chromium (Cr)

1. Introduction

Heavy metal pollution is the very dangerous kind of pollution from the health concerns of humans [1,2]. Heavy metals are not the different kind of metals it is like of usual elements found in nature it has a properties of metal materials at room temperature. Unlike the usual metallic these are toxic not only to humans but also to the marine animals, different Microorganisms and plants. Heavy metals are generally having the high densities, atomic weights, or atomic numbers.

Some of the heavy metals are beneficial to living organisms in trace amounts some of them are cobalt, copper, manganese, molybdenum, vanadium, strontium, and zinc. If the concentration of such metals increases it becomes fatal to organisms [3]. The heavy metals such as mercury, lead, Chromium and cadmium in excess accumulation in the bodies of animals can leads to the carcinogenic can cause serious illness. Chromium (VI) was found to be the most toxic [4] heavy metals. The general hazards due to chromium includes irritation of throats nose, and lungs. Due to carcinogenic properties of Cr (VI) continues exposer may leads to risk of bone prostate cancer [5] and bladder cancer.

Considering the all above risks of heavy metals from the health concern of human being its proper study, detection and isolation became the prime importance. The traditional methods for detection and isolation required the tedious and lengthy process. These processes are not economic and further leads to the environmental hazards due to use of chemicals.

To avoid the environmental adverse effect the use of low cost potential adsorbent is still in demand. In the present study the ecofriendly, economical and easily available low cost adsorbent was used to remove the heavy metals by adsorption. Adsorption is a process employed in these days for the removal of heavy metals from water and wastewater due to cost effective and environmentally compatible this process is universally accepted.

2. Materials and Method

All chemicals and reagents used in the process were of AR grade. The waste thrown parts of legumes after its use as vegetable were collected and washed thoroughly first with running water and then with distilled water. After dried in the sunlight then powdered with the help of mortared and pistol. Powder is sieved into different fine particle and particle size nearly of 0.6 mm was used for characterization. In the present study double beam UV-VIS spectrophotometer was used for entire study.

In the present study the standard methods for spectrophotometric determination of chromium suggested by APHA and Stewart were employed [6, 7].

In 125 ml Erlenmeyer flask 0.1 gm powdered husk of legumes adsorbent and 50 ml Chromium solution were taken. Tightly Sealed the flask with rubber tubing sealed and were shaken for 4 to 5 hours at 160 rpm in a mechanical shaker. After the shaking the equilibrium established between the Cr (VI) adsorbed and unabsorbed on the powdered husk of legumes. Filtered of the sample through the whatman filter paper and filtrate was use to investigate the Cr (VI) concentration. As per the standard methods the unadsorbed Cr(VI) were determined at 540 nm spectrophotometrically by adding the Diphenyl Carbazide as complexing reagent.

3. Results and Discussion

To study the effect of various factors on the process of adsorption such as such as pH of the solution, contact time, quantity of the adsorbent and the initial concentration of Cr (Via batch study were performed for accurate results by following the standard procedure.

EFFECT OF PH

The important factor for the process of adsorption is the pH of solution. pH of the solution played important role in the process of adsorption of metals on the adsorbent. To investigate the optimum pH we were perform the batch experiment by keeping all other factor same and change in pH from 1 to 10. It was observed that at pH 2.0 the adsorption is highest 79.5 %. As shown in the graph.

EFFECT OF CONTACT TIME FOR REMOVAL OF Cr (VI)

Contact time is nothing but the time required for process of adsorption to attain the equilibrium between the adsorbed and unabsorbed material on the adsorbent. It is more important to check the efficiency of adsorbent to adsorb the material in less time. From the following table it was observed that as the time goes on increasing the adsorption also increases at certain limit.

At 80.4 min the adsorption is highest 82.4% then the process reach to equilibrium and adsorption remains same as the time passes.

EFFECT OF ADORBENT DOSAGE

To study the concentration of the adsorbent dose the batch study is the perfect. For this we performed the doses of adsorbent from 1 mg/ml to 10mg/ml. keeping the concentration of Cr(VI) is constant. from the table and graph a it was observed that the at 4mg/ml concentration of adsorbent can attain the 78.5% of Chromium (VI). As we go on increasing the concentration of adsorbent the adsorption or removal of Cr(VI) goes on decreasing. It may be due to the number of ions are adsorbed are decseases with respect to the space available for the ions to adsorbed.

EFFECT OF INITIAL CHROMIUM (VI) CONCENTRATION

To study the effect of concentration of metal the batch study were performed by taking the amount of initial concentration from 5mg/ml to 300mg/ml at 2.0 pH of solution and 4gm/ml of adsorbent and the contact time is 80 min. it was observed that the at initial concentration of metal in mg/ml the adsorption is more and after gradual increase in concentration the curve down steadily. The % removal of Cr(VI) decreases as we go on increase in the concentration of metal in mg/ml. it was due to the total area of for occupying the metal is fixed but the number of ions goes on increasing this why the % removal decreases.

Table:1 showing the variation of % of adsorption with respect to pH of solution

pH	1	2	3	4	5	6	7	8	9	10
% removal of Cr(VI)	60.02	79.5	75.0	72.1	50.3	48.2	51.6	45.1	30.9	25.7

Table: 2 showing the variation of % of adsorption with respect to Contact Time

Contact Time in min	10	20	30	40	50	60	70	80	90	100
% removal of Cr(VI)	20.3	31.5	43.0	52.1	59.3	68.2	75.6	82.4	82.4	82.4

Table: 3 showing the variation of % of adsorption with respect to Adsorbent dose

Adsorbent dosage in mg	1	2	3	4	5	6	7	8	9	10
% removal of Cr(VI)	8.5	20.2	38.0	78.5	70.6	60.02	45.3	46..2	48.3	39.9

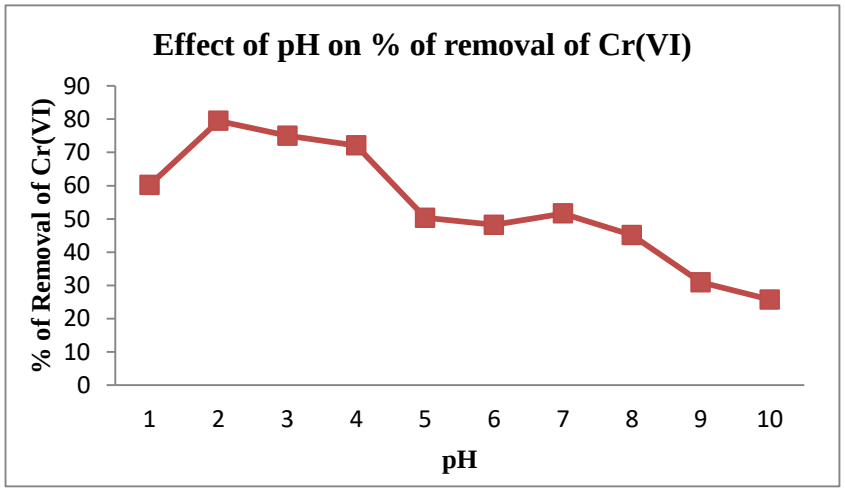

Figure:1 Effect of pH on % of removal of Cr(VI)

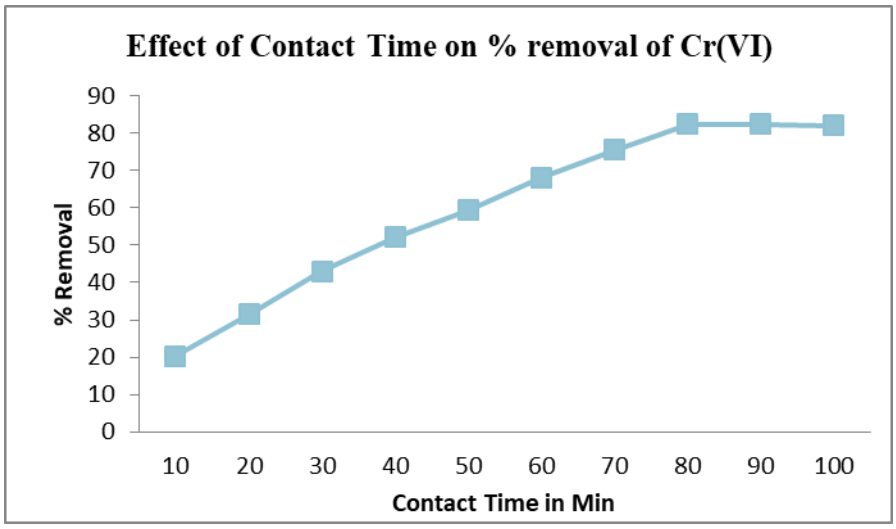

Figure:2 Effect of Contact time on % of removal of Cr(VI)

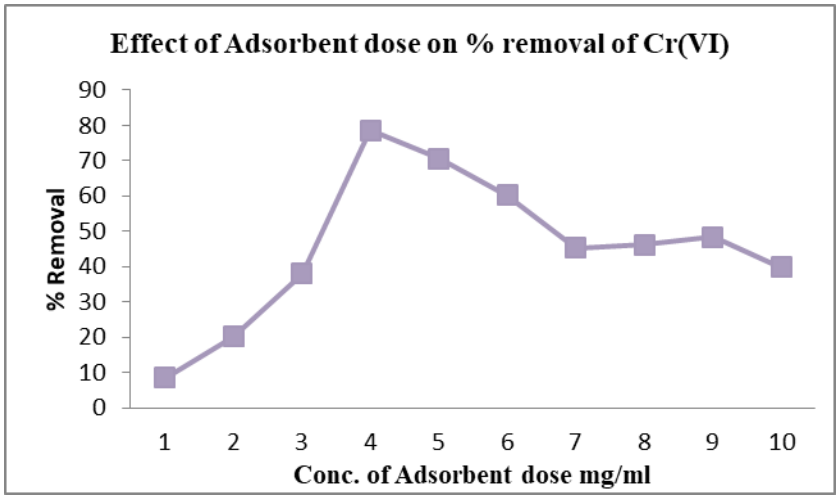

Figure:3 Effect of Adsorbent dose on % of removal of Cr(VI)

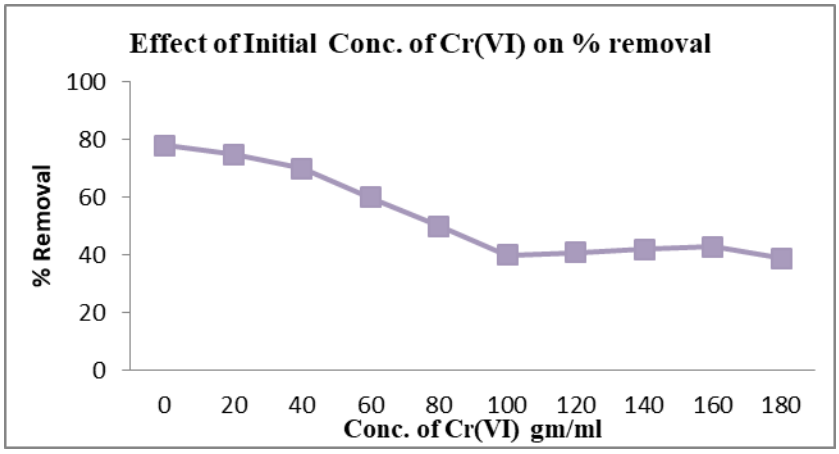

Figure:4 Effect of initial conc. of Cr(VI) on % of removal of Cr(VI)

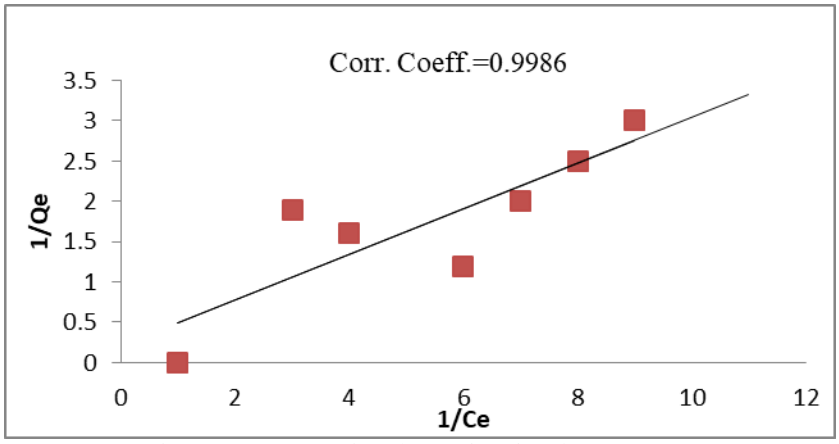

Figure:5 Langmuir adsorption isotherm curve

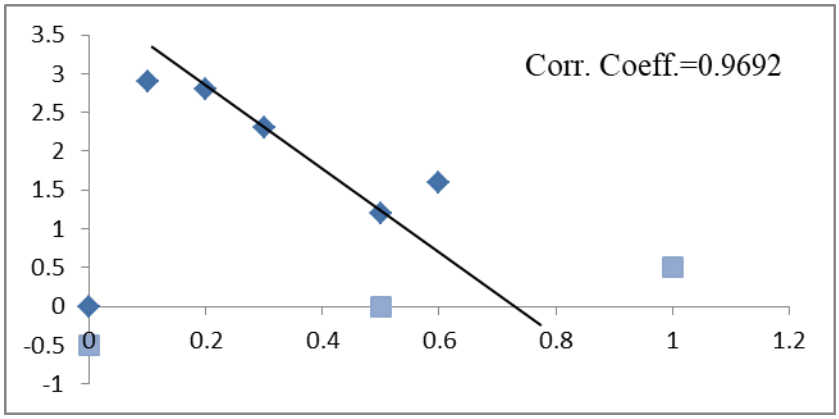

Figure:6 Freundlich adsorption isotherm curve

ADSORPTION ISOTHERM

To study the process of adsorption the mechanism of equilibrium adsorption isotherm is most important tool. In the present study the two popular adsorption isotherms Langmuir and Freundlich adsorption isotherm were consider. The Langmuir adsoption isotherm equation can be represented as

$$Q_e = Q^o\ b\ C_e / 1 + b\ C_e$$

It was observed from the following graph the Langmuir adsorption valid for monolayer adsorption of Cr(VI) on the powder of Moringa Olefera Legumes waste.

Freundlich adsorption isotherm can be represented as

$$Q_e = K_f\ C_e^{1/n}$$

From the following graph it was observed that the Freundlich adsorption isotherm is well followed by the the adsorbent and the slope 1/n indicates that the adsorbent is well for entire concentration range of adsorbent.

4. Conclusion

Moringa Olefera Legumes waste was found to be the potential adsorbent for the removal of Cr(VI) heavy metals from all types of samples. The efficiency of removal of Cr(VI) was found to be 79.9 % at the optimum pH 2.0 and the contact time was 80 min for the toxic metal Chromium (VI). This adsorbent is the ecofriendly cost effective and easily available and will became the better substitute adsorbent for the removal of heavy metal Cr (VI)

Conflicts of interest: The author stated that no conflicts of interest.

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