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Biosorptional Analysis of Cr (VI) by Zea mays cob Powder

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Abstract: ***The present research work describes bio-sorption of Cr(VI) ions by Zea mays cob powder. Zea mays, corn or maize, is a annual grass in the family, said as Poaceae is also found in Central America. Here we used batch absorption technique In this study, an attempt has been made for bio sorption of Cr (VI) from aqueous solution by Zea mays cob powder using batch absorption technique. Zea mays are basically found in the sub-humid region and Arawali hills region of the Rajasthan. Effect of contact time, pH and metal ion concentration on bio-sorption has been studied with the help of Langmuir and Fruendlich adsorption isotherms. Removal efficiency of Cr (VI) by Zea mays cob powder has been found 85.5% at pH 4.***
Keywords: Hexavalent chromium ions, bio-sorption, Zea maize cob powder, removal efficiency, adsorption kinetics.

I. INTRODUCTION

Worldwide water pollution is a major problem. Here we are mainly concerned about heavy metal pollution cause by indiscriminate disposal of waste water. Different water bodies are like rivers, lakes, wetlands and underground aquifers but these sources are polluted by different chemical discharged from industries. [1]- [2]Leather tanning industries use chromium compounds for their product formation and discharge waste chemicals into the environment without proper standard treatment. Chromium is a transition metal which occurs in nine different forms of oxidation states, but the two common valences are trivalent and hexavalent chromium forms. Hexavalent chromium has mutagenic and carcinogenic properties. It is hazardous substances for both human and aquatic life. Current techniques: - Physicochemical approaches i.e. AdjustingpH, Membrane filtration, Ion- exchange, Adsorption, Flocculation. [6]

These techniques are used in large scale andin in-situ operations. [3]-[5] These are inefficient and expensive. When concentration of ions is low, these techniques are not much effective. Biological approaches:-When naturally occurring processes are used for removal of heavy metals, it is called biological approach. Here we are using Zea mays cob powder for the removal of the hexavalent chromium ion. This is a biopolymer which can be applied for biosorption of Cr (VI) from aqueous solution by Zea *mays* cob powder using batch absorption technique.

II. MATERIALS AND METHODS

A. Preparation of Adsorbent

The maize cob of Zea Mays were collected from CAZARI (Central Arid Zone of Agriculture and Research Institute) Jodhpur. Each of the cobs were rinsed thoroughly with tap water and then with distilled water and dried in sun light and then in oven for 42 hours at 65 ^{0}C. These were crushed in a mechanical grinder and sieved at different mesh sieves (100-300 µm) to obtain Zea Mays Cob Powder (ZMCP).

Zea mayscob powder → Rinsed by tap water and distilled water → Oven dried at 65 ^{0}C
Powdered maize cob ← Crushed in mechanical grinder ↓

B. Preparation of Cr (VI) Solution

A stock solution of Cr (VI) was prepared by dissolving 2.828 g of 99.00% of $K_2Cr_2O_7$ in 1L double distilled water to obtain 1000 mg L^{-1} stock solution. Further, 50-300 mg L^{-1} strength of Cr (VI) was prepared with the help of stock solution. The pH of solutions was adjusted with the help of 0.1 N H_2SO_4 and 0.1N NaOH solutions as per the requirements, pH were measured by pH meter. Three parameters i.e. effect of concentration of Cr(VI) ,effect of Ph and effect of contact time were studied as shown in Table 1.

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Table 1. Experimental conditions

Experimental conditions	C_0mgL^{-1}	Ms,gL^{-1}	pH	t, min	S, rpm
Effect of concentration of Cr(VI), C_0mgL^{-1}	50	3-12	4	85.5	150
Effect of contact time t, min.	50	9	4	30-110	150
Effect of pH	50	9	2-4	85.5	150

C. Adsorption Experiment

Adsorption of metal ion by Zea mays was carried out by batch experiment as function of metal concentration (50, 100, 150, 200, 250, 300) mg L^{-1}, contact time (30-110)minutes. After the adsorption of metal ion by Zea mays , metal ion solution was filtered through sintered glass crucible G-3. 10mL of the solution was kept for Cr (VI) analysis. Series of various solutions (50-300) mg L^{-1}were also kept for analysis. After the completion of experiment, the concentration of Cr (VI) by double beam spectrophotometer. The following formula was used for the calculation adsorbance of metal ion by Zea mays.[7]- [10]

$$\% \text{ Removal of Cr (VI)} = \frac{C_0 - C_e}{C_0} \times 100 \quad (1)$$

Where C_0 is initial metal ion concentration and $C_e$is the concentration of metal ion after adsorption.

D. Adsorption Isotherm

According to Langmuir theory, the saturated monolayer isotherm can be represented as:

$$q_e = \frac{q_{max}\ bC_e}{1 + bC_e} \quad (2)$$

The equation 2 can be rearranged by following linear form:

$$\frac{C_e}{q_e} = \frac{1}{bq_{max}} + \frac{1}{q_{max}} C_e \quad (3)$$

Where $C_e$is the equilibrium concentration, q_e is the amount of metal ion adsorbed, $q_{max}$is q_e for a complete monolayer (mgL^{-1}) and b is sorption equilibrium constant (L mg^{-1}) . A graph of Ce versus C_e/q_e should indicate a straight line of slope 1/ q_{max} and an intercept of 1/ bq_{max}. Fruendlich found that if the concentration of solute in solvent at equilibrium C_e (mgL^{-1}) was raised to the power of m, the amount of solute adsorbed being q_e, then C_e^m/q_e was a constant at a given temperature. This fairly satisfactory empirical isotherm can be used for non ideal sorption and is expressed by the following equation in the form of logarithm of both sides. $\log q_e = \log K_f + m \log C_e$ (4)

An adsorption isotherm is characterized by certain constant, the value of which express the surface properties and affinity of the sorbent and can also be used to compare bio-chemosorptive capacity of biomass for different metal ions. Out of several isotherm equations, two have been applied for this study i.e, the Fruendlichan Langmuir isotherms.

III. RESULTS AND DISCUSSION

A. Effect of Concentration of Cr (VI) ion

The experiments were carried out, with the change in the concentration of hexavalent chromium ion from 50-300 mg L^{-1} and other conditions were maintained constant. As shown in the Fig. 1, with the increase in the concentration of metal ion, the absorption % decreases because the numbers of active sites are fixed. [11]

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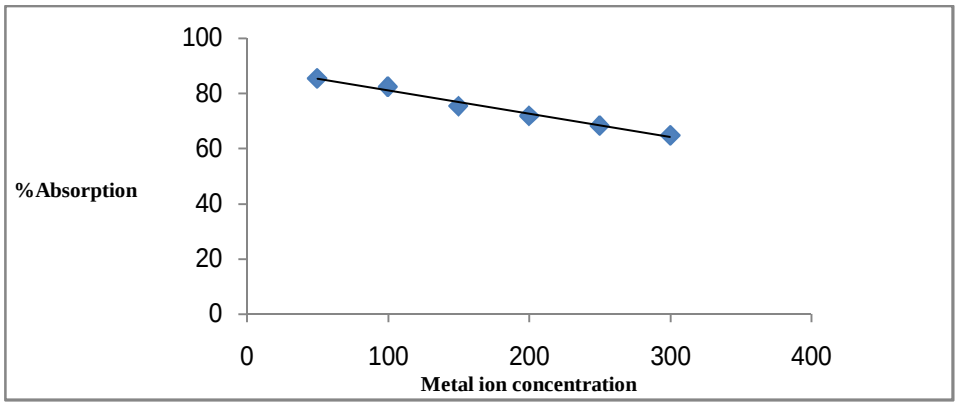

Fig. 1: Effect of metal ion concentration on the removal efficiency

B. Effect of Contact time

Experiments were carried out with the change in the contact time (30-110) hours and other parameters were kept constant. With the increase in contact time, % absorbance increases as shown in Fig. 2.

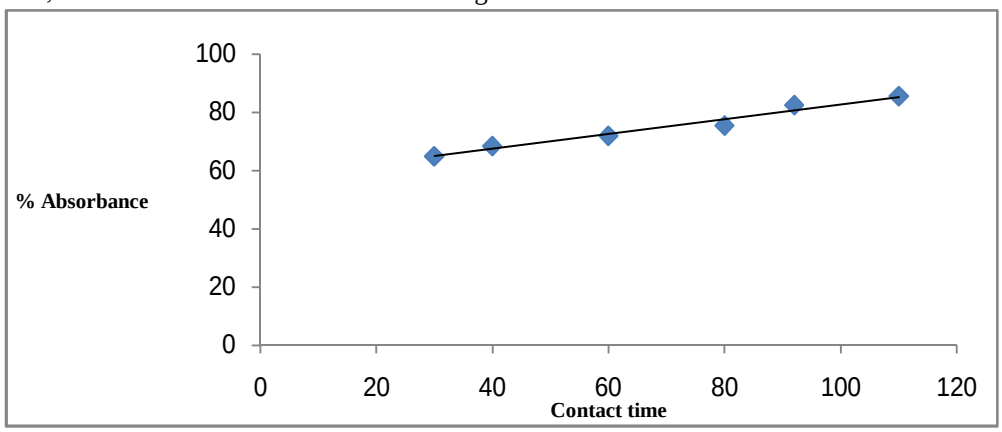

Fig. 2 Effect of contact time on the removal efficiency

C. Effect of pH

The experiment was conducted with the change in the pH 2-4 and adsorption dosage was maintained constant i.e. 9 gL^{-1}; the concentration of the metal ion Cr (VI) was taken 50 mg L^{-1} at 110 minutes. The removal of metal ion was maximum at 85.5% at pH 4.With the increase of pH, hydrogen ions get decreased. Thus, the interaction between metal and hydrogen ion also gets reduced and the removal of metal ion increases.[12]-[14]

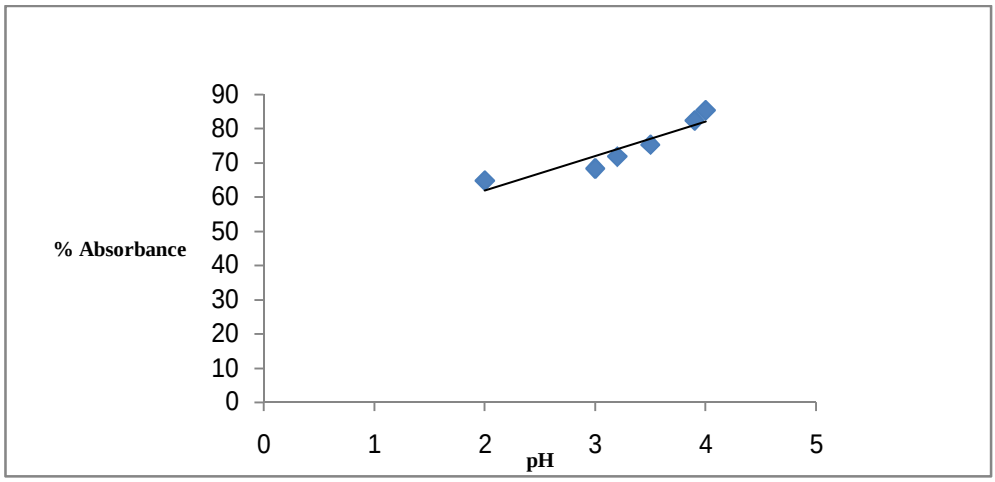

Fig. 3 Effect of pH on the removal efficiency

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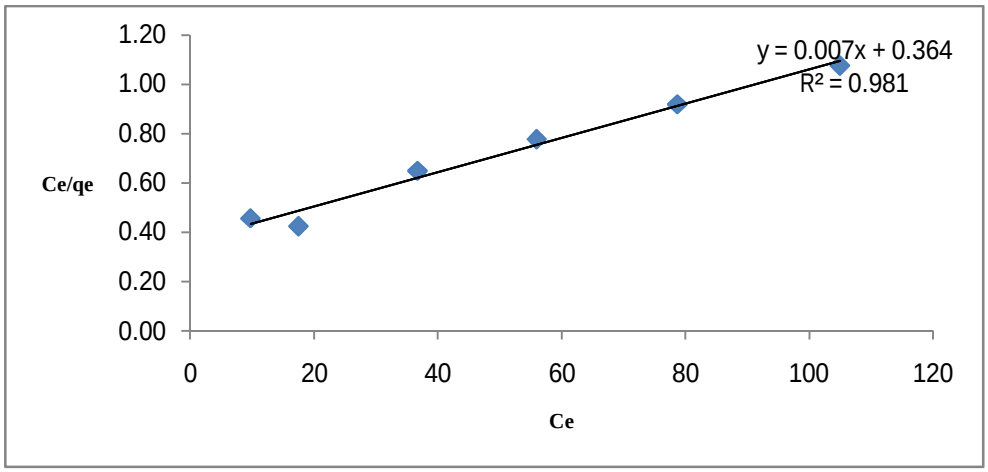

Fig.4 Langmuir adsorption isotherm.

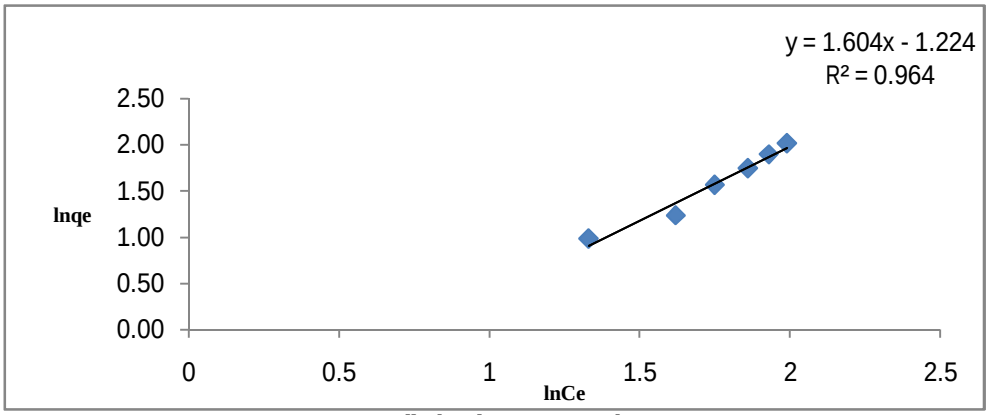

Fig. 5 Freundlich adsorption isotherm.

Langmuir and Fruendlich model parameters estimated from the fitting of experimental point of Cr (VI) adsorption are shown in Table 2.

Table 2. Langmuir and Fruendlich isotherm

Langmuir isotherm			Freundlich isotherm		
R^2	q_{max}mg g^{-1}	b, L mg^{-1}	R^2	K_f, mg g^{-1}	M
0.98	7.00	0.0025	0.96	0.0597	1.604

IV. CONCLUSION

The present study concludes that the Zea mays is an effective adsorbent for the removal of Cr(VI) from aqueous solution. The adsorption data fits well with Langmuir and Freundlich adsorption isotherm model. Herebio-sorption exists between solution of metal ion and algal sample. Experimental data indicate that the adsorption efficiency is dependent on operating variable such as hexavalent chromium ion concentration, effect of pH, effect of contact time.

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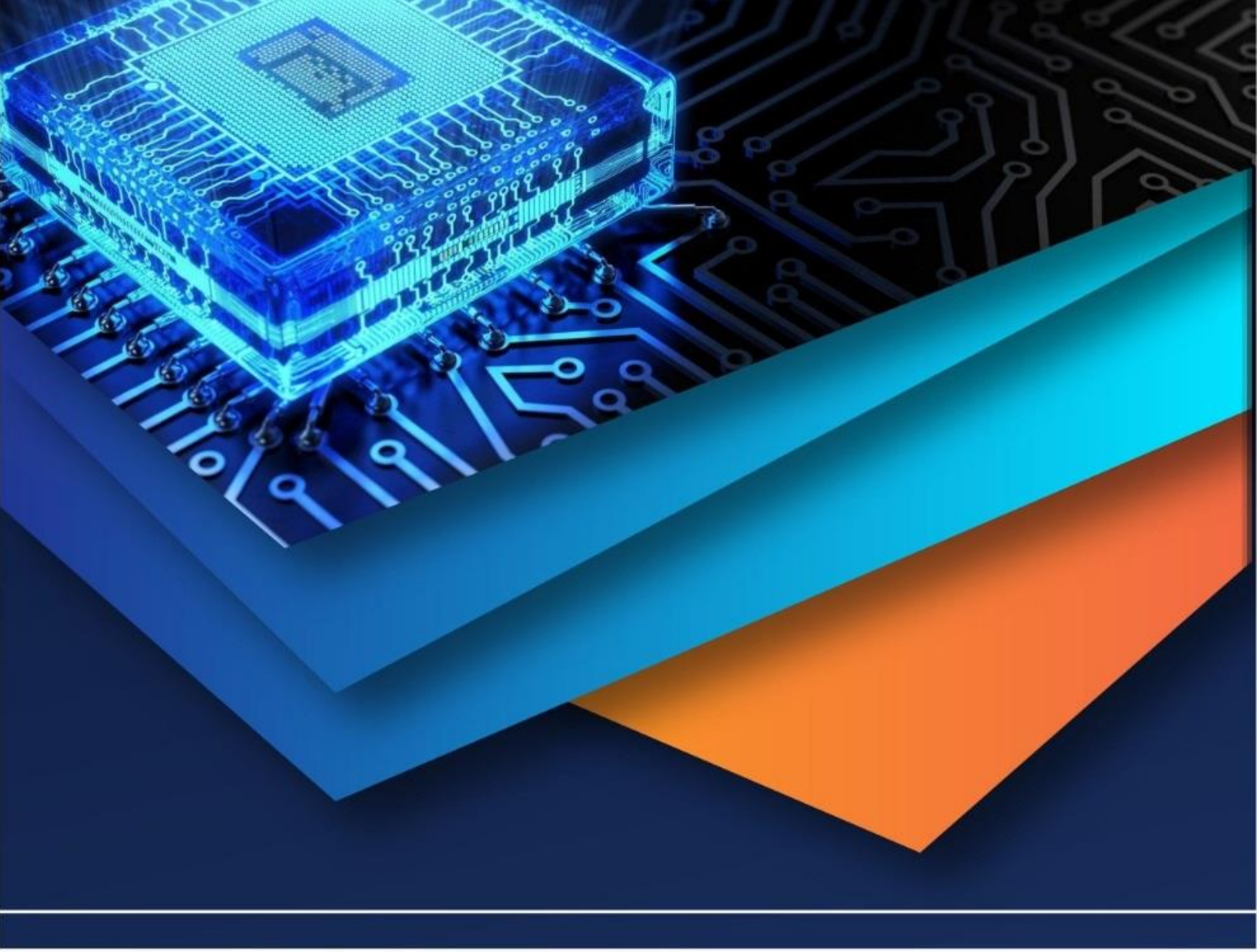

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