

# REMOVAL OF CR (VI) FROM AQUEOUS SOLUTION USING EIHORNEA CRASSIPIES: CHARACTERISTIC AND EQUILIBRIUM STUDY

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## ABSTRACT

In this research, adsorption of chromium (VI) ions on Eihhornea Crassipies leaf has been studied through using batch adsorption techniques. The main objectives of this study are 1) To investigate the chromium adsorption from aqueous solution by Eihhornea Crassipies leaf, and 2) To determine appropriate adsorption isotherm of chromium (VI) adsorption on Eihhornea Crassipies leaf. The results of this study showed that adsorption of chromium by Eihhornea Crassipies leaf reached to equilibrium after 180 mts and change of chromium removal efficiency was observed. The obtained results showed that the adsorption of chromium (VI) by Eihhornea Crassipies leaf follows Langmuir isotherm equation with a correlation coefficient equal to 0.996. The results indicate that Eihhornea Crassipies leaf can be employed as a low cost alternative to commercial adsorbents in the removal of chromium (VI) from water and wastewater.

## INTRODUCTION

There is growing attention to the health risks on humans and animals due to existence of heavy metals in the environment. The accumulation of which living tissues thought the food chain poses a serious health problem<sup>1</sup>. Even though some of these heavy metal ions in traces play a significant role in human metabolic system, their higher concentrations are toxic which can cause severe physiological or neurological damage. Among the various heavy metals, chromium is one of the toxic pollutants generated by the electroplating, leather tanning, metal finishing, steel fabrication, textile industries and chromate separation's in nature exists in two most common and stable oxidation states, trivalent chromium and hexavalent Cr(VI) is more hazardous than Cr(III) as it can diffuse as  $\text{CrO}_4^{2-}$  or  $\text{HCrO}_4^-$  through cell membranes and oxidize biological molecules<sup>2</sup>, and has been reported as one of the top-priority toxic pollutants<sup>1,3</sup>. The maximum permissible limits of Cr(VI) for discharge into potable water,

inland surface water and industrial waste water are 0.05, 0.1 and 0.25mg/l, respectively<sup>4</sup>.

## MATERIAL AND METHODS

### Preparation of adsorbent

The Eihhornea Crassipies leaf was ground and particle sizes between 75 and 300 microns were obtained by passing the milled material through standard steel sieves. Then, they are used for experiments without washing or any other physical or chemical treatments.

### Batch sorption experiments

The sorption studies were carried out at  $30 \pm 1^\circ\text{C}$ . Solution pH was adjusted with  $\text{H}_2\text{SO}_4$  or NaOH. A known amount of adsorbent was added to samples and was agitated by jar test at 250 rpm agitation speed, allowing sufficient time for adsorption equilibrium. Then, the mixtures were filtered through filter paper, and the Cr(VI) ions concentration were determined in the filtrate using DR/4000U spectrophotometer by colorimetric techniques according to the standard method No. 3500-Cr

B (standard methods, 1992). The effects of various parameters on the rate of adsorption process were observed by varying contact time,  $t$  (30, 60, 120, 160 and 180 mts), initial concentration of chromium ion,  $C_0$  (20, 40, 60 and 80 mg/l), adsorbent concentration,  $W$  (0.5, and 1.5 g/100 ml) and initial pH of solution (2, 3, 5, 7, 9 and 11). The solution volume ( $V$ ) was kept constant (50 ml). The chromium removal (%) at any instant of time was determined by the following equation

$$\text{Chromium removal (\%)} = \frac{C_0 - C_t}{C_0} \times 100$$

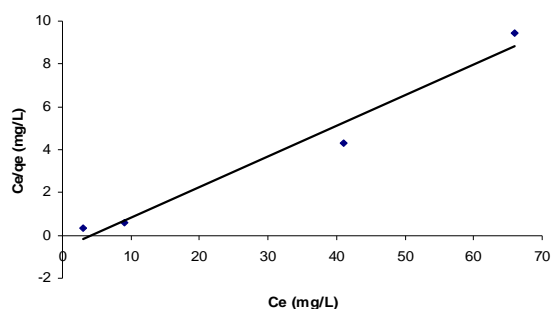
Where,  $C_0$  and  $C_t$  are the concentration of chromium at initial condition and at any instant of time, respectively.

### Adsorption isotherms

In order to establish the appropriate correlations for the equilibrium data in the region of adsorption system, two common isotherm models were tested: the Langmuir and Freundlich models. The applicability of the isotherm equations was compared by judging the correlation coefficients  $R^2$ .

The Langmuir adsorption model is based on the assumption that maximum adsorption corresponds to saturated monolayer of solute molecules on the adsorbent surface. The linear form of the Langmuir equation can be described by

$C_e/q_e = (1/Q_0 b) + (1/Q_0) C_e$  where  $C_e$  (mg/l) is the equilibrium concentration of the adsorbate,  $q_e$  (mg/g) is the amount of adsorbate per unit mass of adsorbent,  $Q_0$  and  $b$  are Langmuir constants related to adsorption capacity and rate of adsorption respectively. The linear plot of specific adsorption ( $C_e/q_e$ ) against the equilibrium concentration ( $C_e$ ). (Fig.1) shows that the adsorption obeys the Langmuir model. The Langmuir constants  $Q_0$  and  $b$  were determined from the slope and intercept of the plot are presented in table.1 The  $R^2$  values (0.996) suggest that the Langmuir isotherm provides a good fit to the isotherm data.

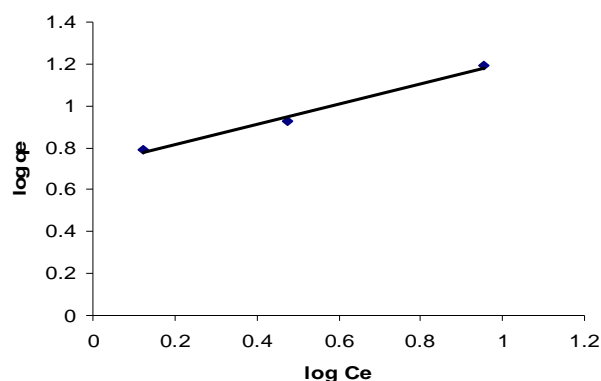


**Fig. 1: Langmuir isotherm for Chromium (VI) sorption onto Eihhornea Crassipies**

The Freundlich isotherm is the earliest known relationship describing the sorption equation, the fairly satisfactory empirical isotherm can be used for non-ideal sorption that involves heterogeneous surface systems and is expected by the following equation:

$Q_e = K_F C_e^{1/n}$  where  $K_F$  (mg/g (L/mg)<sup>1/n</sup>) is roughly an indicator of the adsorption capacity and  $1/n$  is the adsorption intensity. In general, as the  $K_F$  value increases the adsorption capacity of adsorbent for a given adsorbate increases.

Values of  $K_F$  and  $n$  are calculated from the intercept and slope of the plot (Fig. 2) and are listed in Table.1 The  $R^2$  value (0.921) is lower than Langmuir isotherm. The value of Freundlich exponent  $n$  (1.459) is in the range of  $n > 1$  indicating a favorable adsorption. The best equilibrium model was determined based on the linear square regression correlation coefficient  $R^2$ .



**Fig. 2: Freundlich isotherm for chromium (VI) onto Eihhornea Crassipies**

**Table 1: Langmuir and Freundlich isotherm constants and correlation coefficients for adsorption of chromium (VI) on to Eihhornea Crassipies adsorbent**

| Langmuir isotherm | Freundlich isotherm |
|-------------------|---------------------|
| $Q_0 b = 0.10$    | $K_F = 2.039$       |
| $b = -0.80$       | $n = 1.459$         |
| $R^2 = 0.996$     | $R^2 = 0.921$       |

The essential characteristics of the Langmuir isotherm can be expressed in terms of a dimensionless constant separation factor  $L = 1/(1 + bC_0)$  where  $C_0$  (mg/L) is the highest initial concentration of adsorbent and  $b$  (L/mg) is Langmuir constant. The parameter  $R_L$  indicates the nature of shape of the isotherm accordingly

|               |                         |
|---------------|-------------------------|
| $R_L > 1$     | unfavourable adsorption |
| $0 < R_L < 1$ | Favourable adsorption   |
| $R_L = 0$     | Irreversible adsorption |
| $R_L = 1$     | linear adsorption       |

The value of  $R_L$  in the present investigation has been found to be 0.93777 at 30 ° C showing that the adsorption of Cr (VI) on Eihhornea Crassipies is favourable at temperature studied

From Table 1 it was observed that the equilibrium sorption data were very best represented by the Langmuir isotherm The best fit isotherm expression confirm the monolayer coverage process of Cr(VI) onto Eihhornea Crassipies.

### CONCLUSION

The results revealed the potential of Eihhornea Crassipies leaf an agricultural waste material is low cost adsorbent for removing metal ion solutions. Equilibrium data well with Langmuir isotherm model with monolayer adsorption and the value of the separation factor  $R_L$  indicated the Cr (VI) on Eihhornea Crassipies system was favorable adsorption.

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