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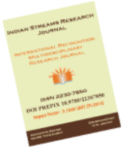

TECTONA-GRANDIS LEAVES AS LOW COST ADSORBENT FOR THE REMOVAL OF Cr(VI) FROM AQUEOUS SOLUTION

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ABSTRACT

Tectona-grandis leaves powder (TGLP) is used in removal of Cr (VI) from aqueous solution conducting batch equilibrium adsorption. The adsorbent which has been developed and used newly is more effective than the traditional ones. Present studies show that, Tectona-grandis leaves powder (TGLP) has good adsorptive capacity to remove chromium (VI) from aqueous solution. Different parameters like agitation time, adsorbent dosage, temperature and initial concentration of chromium the equilibrium studies carried out. The adsorption behavior is perfectly matches the Langmuir and Freundlich Adsorption Isotherm.

KEYWORDS: Tectona-grandis leaves, chromium solution, Adsorption Isotherm.

INTRODUCTION :

Industries such as electroplating, dye, plastics, metal-processing, alloy, batteries, ammunition and Tannery industries etc. generate large quantities of waste water containing various types of concentration of heavy metal ions. The presence of heavy metals in drinking water sources and in edible agricultural crops is harmful to human e.g. these pollutants damage nerves, liver and bones also they block functional groups of vital enzymes.[1]

According to the information collected in Blacksmith's inventory of sites, South Asia, and in particularly in India, Pakistan and Bangladesh has the highest number of tanning industries, with South America also at risk of large populations being exposed to chromium contamination. In Bangladesh Tannery waste water flows through an open canal in Dhaka. Thus it becomes necessary to remove chromium ion from industrial water before discharging it into the nallas and rivers. The chromium exists in Cr (III) and Cr (VI) oxidation states as all other oxidation state are not stable in aqueous solutions. Both valences of chromium are potentially harmful[2] .The hexavalent chromium which is primarily present in the form of chromate (CrO_4^{2-}) and dichromate (CrO_7^{2-}) poses significantly higher levels of toxicity than the other valency state [3].

The traditional methods like reduction[4] reduction followed by chemical precipitation[5] Fly ash[6], membrane filtration and adsorption[7]. Waste slurry from a fertilizer plant[8] furnace flue dust[9]and Fe(III)/Cr(III) from petrochemical industry[10], and photo film wastesludge[11], are used to remove Cr (VI) ions from industrial waste water.

Most of these which involve high capital cost, study on treatment of effluents bearing heavy metals have revealed adsorption to be highly effective cheap of an easy method among the physicochemical treatment process[12] Many researchers have identified the low cost adsorbent like bituminous coal[13], sphagnum peat moss[14], coconut husks and palm pressed fibers[15], sawdust[16], sugarcane bagasse, sugar beet pulp and maize cob, distillery sludge[17] neem leaf [18], Barks of Moringa oleifera lam [19],

. Present study proved that Tectona- grandis leaves powder (TGLP) is used for removal of Cr(VI) from aqueous solutions. The effects of agitation time, adsorbent dosage, temperature and initial concentration of chromium is also studied. The adsorption behavior perfectly matches the Langmuir and Freundlich Adsorption Isotherm.

Materials and methods:

2.1. Preparation of Adsorbent:

The tectona-grandies dry leaves collected from local area and washed with distilled water, then dried at $60^{o}{}_{C}$ temperature crushed and sieved to small particle size of range 50-60 mesh for use of adsorbent. It is grounded and treated with H_2SO_4 and formaldehyde, then was heated at 50^{o}c temp. for six hours stirred occasionally in an oven

2.2. Preparation of chromium stock solution

Potassium dichromate ($K_2Cr_2O_7$) is used as the source for chromium stock solution. All the required solutions are prepared with analytical reagents and double-distilled water. A 99% $K_2Cr_2O_7$ (2.835 g) is dissolved in distilled water of 1.0 L volumetric flask up to the mark to obtain 1000 ppm (mg/l) of Cr (VI) stock solution. Synthetic samples of different concentrations of Cr (VI) are prepared from this stock solution by appropriate dilutions.

Cr equivalent to 1 gm = Molecular Wt. of $K_2Cr_2O_7$ x 100/ (Atomic Wt of Cr x 2) x purity

Experimental Procedure: 1 mg/ml of chromium solution was prepared. The 100 ml of chromium solution was treated with 1g of adsorbent for180 min. agitating time at room temperature. The sample was allowed to settle and then filtered through a whatman no.1 filter paper. The filtrate of the sample was analyzed using Standard titration method of analyses[20] of chromium solution for the final concentration of chromium in aqueous solution. The percentage removal of chromium (VI) was calculated as

$$\% \text{ Removal of chromium} = ((C_0-C_e)/C_0) \times 100$$

Where, C_0 and C_e were the initial and final concentration of Cr(VI) in the solution, respectively.

The effect of adsorbent dosage was studied by varying the adsorbent from 0.25 gm to 1.25gm, the effect of contact time was studied by varying the contact time from 30 min to 180 min, the effect of initial Concentration was studied by varying the concentration 200 mg/l to 1000 mg/l and the effect of Temperature was studied by varying the temperature 28^{o}C to 50^{o} C while keeping other factor constant

Results and Discussions:

Effect of various parameters on the adsorption of chromium (VI) by Tectona- grandis Leaves powder (TGLP)

Characterization of adsorbent

The proximate analysis of dry sagvan (Tectona-grandies) Leaves powder was done with the surface morphology of TGLP before and after adsorption was visualized via scanning electron microscopy (SEM). Examination of SEM micrographs of the TGLP showed rough areas of the surface and the microspores were identifiable. Comparison of these micro graphs before and after Cr adsorption shows that the adsorption of Cr occurs on the surface of the **TGLP** (Fig. 1 and 2).

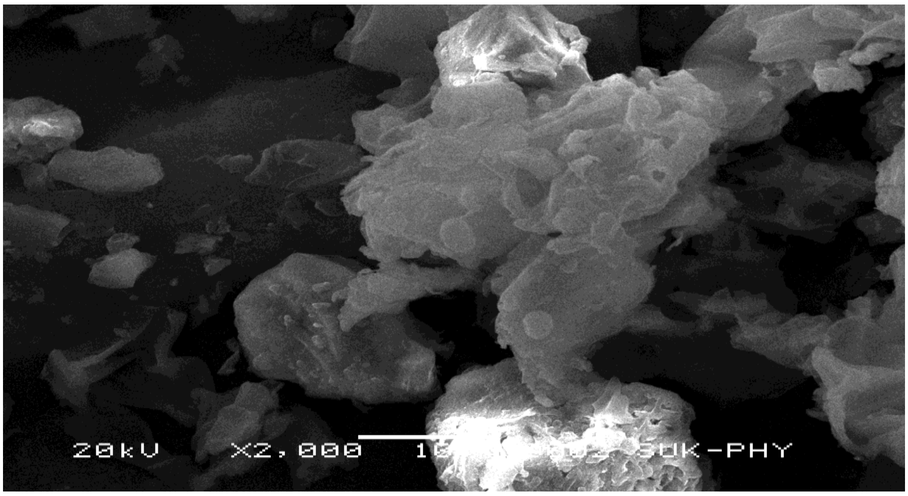


Fig. 1. SEM image of TGLP before Chromium (VI) adsorption

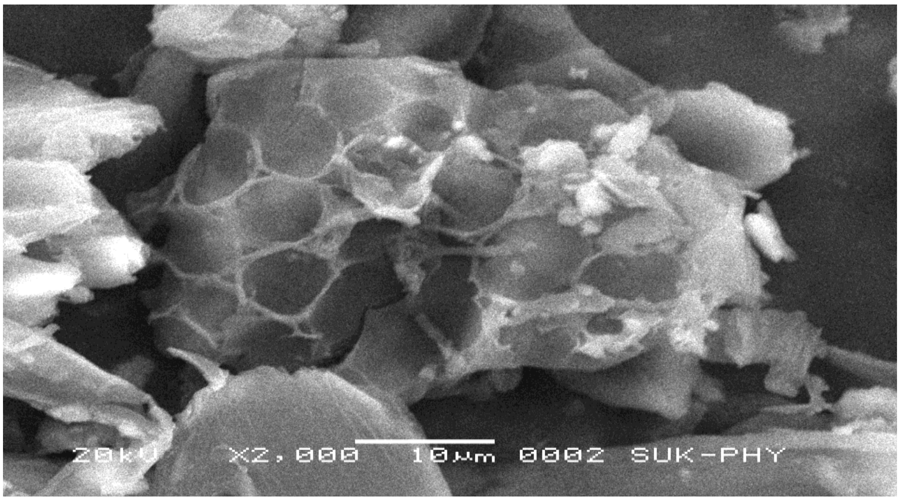
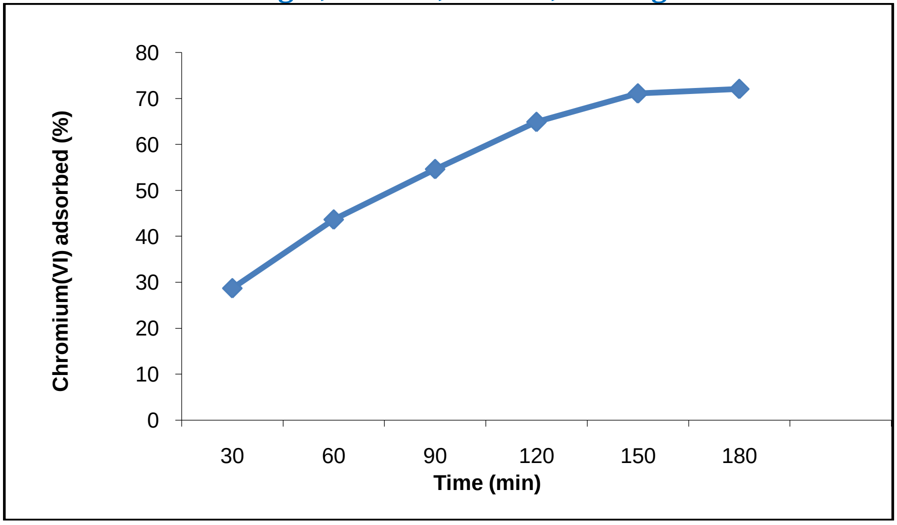


Fig. 2. SEM image of TGLP after Chromium (VI) adsorption

Effect of agitation time on Cr(VI) adsorption :-

The effect of agitation time for initial concentrations was studied (figure3). The percentage adsorption Cr(VI) increased with increase in agitation time. The time required to attain equilibrium was 180 minutes. The maximum percentage adsorption was 72.1%, for initial Cr(VI) concentration

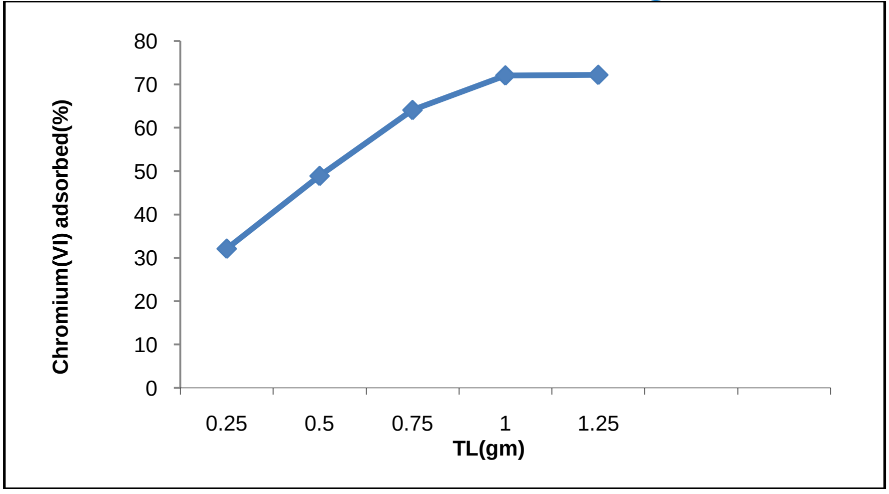
Fig. 3. Effect of agitation time on Cr(VI) adsorption
m=1gm, v=50ml, T=28^{0}c, C=1mg/ml



Effect of adsorbent dosages on Cr(VI) adsorption :-

The percentage adsorption of Cr(VI) was studied by increasing adsorbent dosages from 0.5 to 1.25 gm for 50 ml of Cr(VI) concentration (Figure 4) The result revealed that the percentage of Cr(VI) adsorbed increased with an increase in adsorbent dosage for Cr(VI) concentration

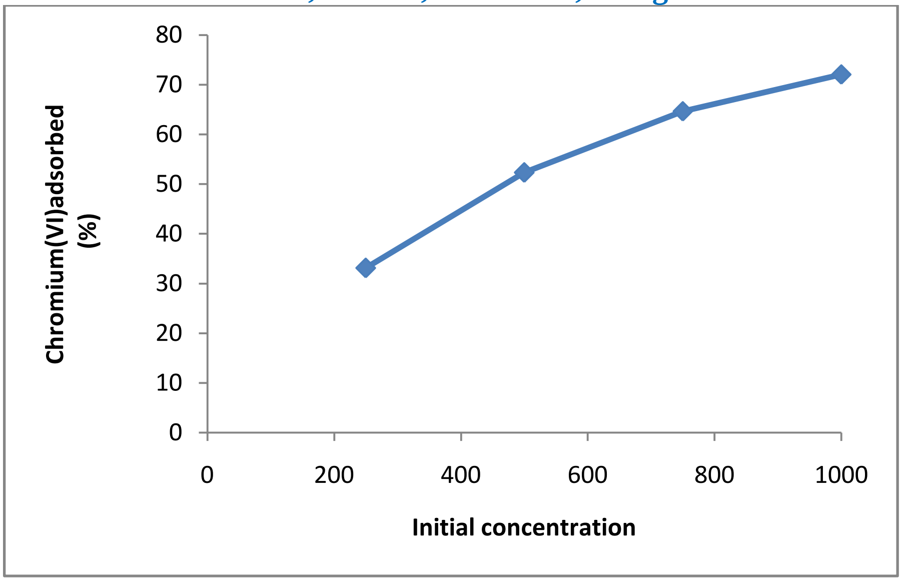
Fig. 4. Effect of adsorbent dosages on Cr(VI) adsorption
v=50ml, T=28^{0}c, t=180 min, C=1mg/ml



Effect of Initial Concentration on Cr(VI) adsorption :-

The effect of initial concentrations was studied by increasing initial concentration from 250mg/l to1000 mg/l (figure5). The experimental results showed that the percentage adsorption increased as the initial concentration of chromium increased.

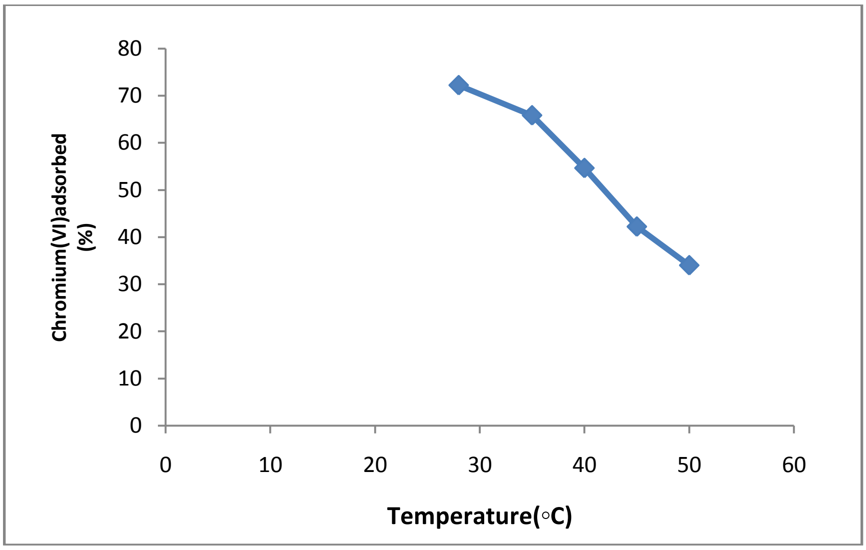
Fig.5. Effect of Initial Concentration on Cr (VI) adsorption
v=50ml, T=28^{0}c, t=180 min, m=1gm



Effect of Temperature on Cr(VI) adsorption :-

The percentage adsorption of Cr(VI) was studied by increasing temperature from 28^{0}c to 50^{0}c for 50 ml of Cr(VI) concentration (Figure 6). The result indicated that the percentage of Cr(VI) adsorbed increased with an decrease in temperature for Cr(VI) concentration

Fig. 6. Effect of temperature on Cr(VI)adsorption
v=50ml, m=1gm, t=180 min, C=1mg/ml



Adsorption Isotherm:

Langmuir adsorption isotherm: The Langmuir adsorption isotherm is given by,

$q_e = q_m K_L C_e / 1 + K_L C_e$

which is linearized to,

$C_e / q_e = 1/q_m K_L + C_e / q_m$

where, Ce is the equilibrium concentration (mg/l); q_e is the amount of metal ion adsorbed (mg/g); q_m is q_e for a complete monolayer (mg/g); K_L is sorption equilibrium constant (dm^3/mg). A plot of C_e/q_e versus C_e should indicate a straight line of slope $1/q_m$ and an intercept of $1/K_L q_m$

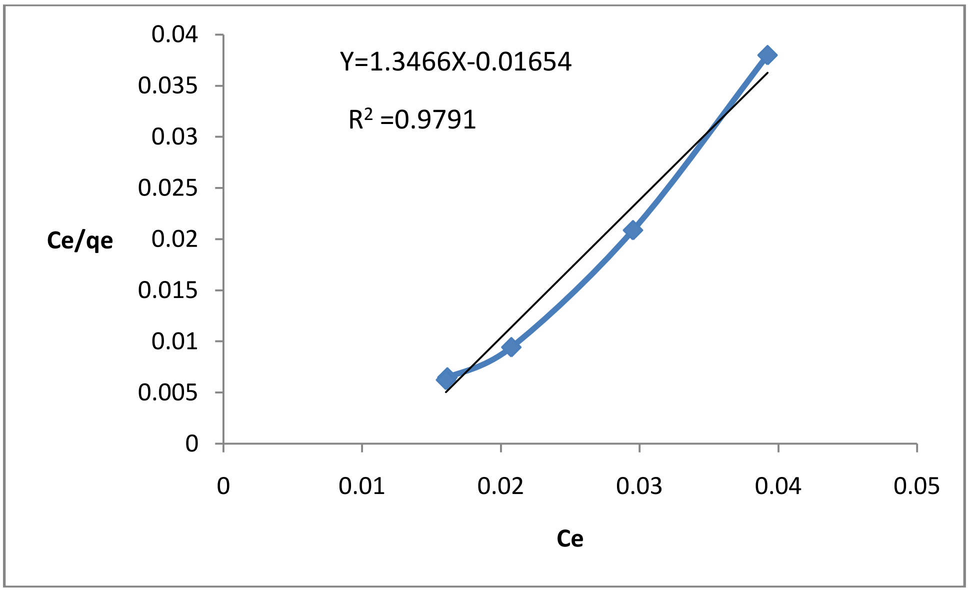
A further analysis of the Langmuir equation can be made on the basis of a dimensionless equilibrium parameter, R_L also known as the separation factor, given by

$R_L=1 / (1+K_L C_e)$

The value of R_L lies between 0 and 1 for favorable adsorption, while $R_L > 1$ represents unfavorable adsorption, and $R_L = 1$ represents linear adsorption while the adsorption process is irreversible if $R_L = 0$.

The adsorption of Cr(VI) on TGLP follows the Langmuir isotherm model for metal adsorption. The dimensionless parameter R_L between 0 to 1 is consistent with the requirement for favorable adsorption. The high value of correlation coefficient **R^2=0.9791** indicates a good agreement between the parameters and confirms the monolayer adsorption of Cr(VI) onto the adsorbent surface.

Fig. 7. The Langmuir adsorption isotherm



Freundlich Adsorption Isotherm: The Freundlich adsorption isotherm is tried for the adsorption of Cr (VI) on Tectona-grandies Leaves power.(TGLP)

The function of Freundlich:

$x/m = k_f C_e^n$

x/m = adsorbed substance per gram TGLP, C_e = equilibrium adsorbate concentration, K_f, n = specific constants.

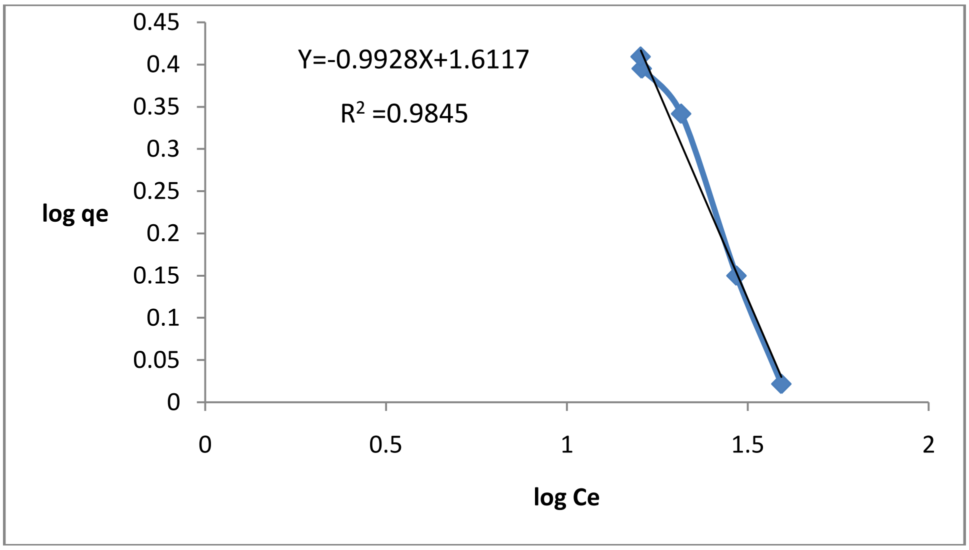
The above equation can be written as,

$q_e = k_f C_e^n$

where, K_f is the measure of adsorption capacity and n is the adsorption

intensity. Linear form of Freundlich equation is,
$\log q_e = \log k_f + n \log C_e$
where, q_e is the amount adsorbed (mg/g), C_e is the equilibrium concentration of adsorbate (mg/l) and K_f and n are the Freundlich constants related to the adsorption capacity and adsorption intensity, respectively. The present data, when plotted shows good linearity for Freundlich relationship (correlation coefficient, $\mathbf{R^2=0.9845}$) in case of TGLP. The slope of isotherm (n) also satisfies the condition of $0<n<1$ for favorable adsorption**.**

Fig, 8. The Freundlich adsorptin isotherm



CONCLUSION:-

The experimental result shows that Tectona-grandis leaves are an excellent alternative for the removal of Cr(VI) from aqueous solutions. The adsorption of Cr(VI) was dependent on agitation time, adsorbent dosage, temperature and initial metal ion concentration. The adsorption behavior perfectly matches the Langmuir and Freundlich Adsorption Isotherm. The present adsorbent can be used at an industrial scale to remove chromium ion from the effluents before discharging into the environment. The Tectona-grandis leaves can replace the expensive activated carbon in the adsorption process. The most of the electroplating effluents contain chromium as one of the major contaminant which can be removed in a cost effective and efficient manner by Tectona-grandis leaves.

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