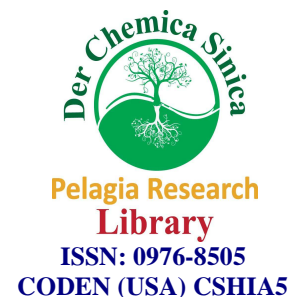




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Adsorption of heavy metals Fe, Cu and Cr from Aqueous solution of acid activated fruit waste material of Chiku

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ABSTRACT

The powder of fruit waste Chiku was used as adsorbent for removal of heavy metals like Fe (III), Cu (II) and Cr (II) from aqueous solution. Batch experiments were carried out as a function of varying adsorbent dose, temperature and time. The adsorption equilibrium data matches well with Freundlich and Langmuir adsorption models. The thermodynamic study reveals that the Fe (III), Cu (II), Cr (II) ions adsorption was spontaneous physical adsorption.

Key words: Chiku Fruit Waste, Heavy metal ions, Freundlich Isotherm, Langmuir Isotherm.

INTRODUCTION

Heavy metal pollution becoming one of the most serious environmental problems. Various methods for heavy metal removal from waste water have been extensively studied during the past decades such as chemical precipitation, electrochemical techniques, membrane filtration, ion adsorption and ion exchange. [1]

To date considerable research attention has been paid to the removal of heavy metals from contaminated water via adsorption process. Activated carbon is the most widely used adsorbent, but commercially available activated carbon are very expensive.[2-3]Therefore in recent past development of efficient and low cost adsorbents receiving attention by many investigators.[4-8]

The purpose of present work is to study the efficiency of Fruit waste Chiku (FWC) for adsorption of Fe (III), Cu (II), Cr (II).The effect of various operating parameters on adsorption like variation in adsorbent dose, change in temperature, change in contact time.

MATERIALS AND METHODS

2.1 Preparation of Adsorbent:

The adsorbent FWC is collected from locally available Chiku (sapota).The FWC was dried in shadow. The dried FWC is grinded into powder and boiled in distilled water to remove the suspended matter and dust for one hour and filtered. The FWC residues then treated with formaldehyde and finally with very dilute solution of sulphuric acid. Stirring of residue done for half an hour vigorously using mechanical stirrer at room temperature. FWC residue washed with distilled water repeatedly to remove free acid. Then this residue was dried first in air and finally in

oven at 90-100°C for 8-10 hours and powdered using electric grinder. The powder was pass through mesh for desired particle size (9.8-41.8 micron). This adsorbent was used for experimental work. The particle size of adsorbent selected for these experiments were on the basis of their settlement at the bottom of the system, so that the portion of the solution could be taken out conveniently from the supernatant liquid.

2.2 Preparation of Adsorbate Solution

The adsorbent selected for the present investigations were heavy metal ions Fe(II), Cu(II), Cr(II). The chemicals used were all of Analytical grade without further purification. The solutions made in doubly distilled water. The prepared solutions were standardized as per literature. [9]

2.3 Batch Adsorption Experiments

Each batch adsorption study was carried out by contacting acid activated FWC with heavy metals Iron, Copper and Chromium under different conditions for 60 minutes in glass tube. The uptake of metal study on FWC was carried systematically and at temperature 30°C to evaluate effect of adsorbent dose, contact time. The thermodynamic study of this process was carried out by the effect of temperature on the adsorption. Each study was conducted in thermo stated water bath and the residual metal ions were analyzed. The different amount of metal ions adsorbed from solution was determined by difference. [10] The concentration of metal ion solution were determined from calibration curve spectrophotometrically (shimatzu-1211) at their respective wavelength i.e. Iron ($\lambda_{\max} = 515 \text{ nm}$), Chromium ($\lambda_{\max} = 540 \text{ nm}$), Copper ($\lambda_{\max} = 560 \text{ nm}$).

RESULT AND DISCUSSION

3.1 Effect of Temperature

The magnitude of the temperature effects for the adsorption process is one of the most important criteria for the efficient removal of heavy metals from the waste water. [11]

The data of heavy metal ions adsorption onto FWC at different temperature indicates decrease in adsorption with rise in temperature. [12] This effects may attributes to a negative temperature co-efficient of solubility of the solute or to a steep simultaneous decrease of real adsorption of solvent. The effect of temperature on adsorption of metal ion on FWC is given in Figure 1.

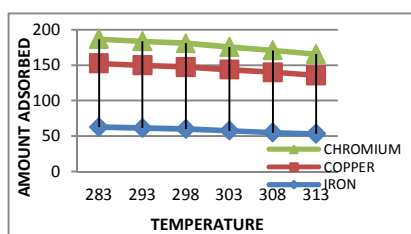


Figure 1 Effect of temperature on removal of metal ion

3.2 Effect of Contact Time

In adsorption studies, effect of contact time plays vital role irrespective of the other experimental parameters affecting adsorption kinetics and dynamics. The adsorption studies were carried out at different contact time at constant initial concentration of Fe (II), Cu (II), and Cr (II) with fixed dose of adsorbent. In the present investigation it is observed that at initial stage adsorption is rapid and become slow and get stagnated with increase in time. This may be due to immediate solute adsorption on the surface of adsorbent with subsequent slow removal of the remaining amount of metal ions. Similar findings are also reported by other researchers. [13] The effect of temperature on adsorption of metal ion on FWC is given in figure 2.

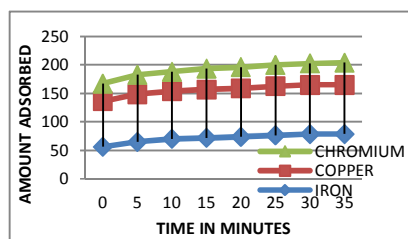


Figure 2 Effect of contact time on removal of metal ion

3.3 Effect of Adsorption dose

Effect of adsorption dose plays an important role in standardizing the adsorption process with quantification of adsorbate solution and the adsorbent. The present study reveals that as the adsorbent dose increase from 1 gm to 5 gm, the removal efficiency of all free metal ions increase on the surface of FWC as shown in figure 3. The increase in adsorption with increase in FWC dose may be attributed to the increase in the availability of active sites or surface area at higher concentration of the adsorbent. [13-15] The effect of adsorption dose on adsorption of metal ions on FWC is given in figure 3.

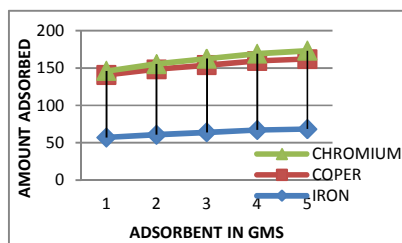


Figure 3 Effect of adsorbent dose on removal of metal ion

3.4 Adsorption Isotherms

The adsorption isotherm is a graphical representation of amount of substance adsorbed against the residual concentration of the adsorbate in the solution. [16] The adsorption data for a wide range of adsorbate concentration and adsorbent doses were analyzed using Langmuir and Freundlich isotherm in order to find the adsorption capacity of FWC adsorbate

Freundlich theory suggested that the ratios of the amount of solute adsorbed onto a given mass of adsorbent to the concentration of the solute in the solutions are not constant at different concentration of solution. [17] The Freundlich isotherm was verified by using least square fit and regression analysis and computer programming in EXCELL. The value of regression coefficient r^2 found to be very close to one which indicates the good correlation exists between $\log X/m$ and $\log c$. The Langmuir mode [18] represents monolayer adsorption on a set of distinct localized adsorption sites having the same adsorption energies. The essential characteristics of Langmuir isotherm is expressed in terms of dimensionless constant separation factor or equilibrium factor R_L which is indicative of the isotherm and is indicative of the nature of the isotherm and is enlisted below in Table No 1 as:

R_L value	Types of Isotherm
$R_L > 1$	Unfavorable
$R_L = 1$	Linear
$0 < R_L < 1$	Favorable
$R = 0$	Irreversible

Table No.1

The adsorption of all three metal ions are favorable on to the surface FWC as R_L value in the present study falls in the $0 < R_L < 1$ and in agreement with findings of Lodhaet.al.[19]

3.5 Thermodynamic parameter

Thermodynamic parameters evaluate the nature of adsorption of adsorbate and its magnitude during adsorption process. The change in Gibbs free energy (ΔG), enthalpy changes (ΔH) and entropy change (ΔS) was calculated.

According to Laura [20] ΔG up to -15 KJ/ mole are connected with physical interaction between adsorption site and metal ions is physical adsorption. In the present investigation ΔG values of Fe (III), Cu (II), and Cr (II) are below -15 KJ/mole indicates physical adsorption. The negative value of ΔH indicates exothermic process. Our observation supported by Soon-Yong *et al.* [21] The positive value of ΔS suggest increased randomness at the solid-liquid interface solvent molecule which are displayed by the adsorbed species gain more translational entropy than was lost by the adsorbate ions. [22-23] Furthermore before adsorption process takes place the adsorbate ions are heavily solvated (the system is more ordered) and this order may be lost when the ions are adsorbed on the surface due to release of solvated water molecules.

CONCLUSION

It has been proved that activated FWC is an excellent adsorbent for removal of heavy metal ions from aqueous solution under certain physiochemical conditions. The result indicates the potentially practical value of FWC as adsorbent. The dimensionless equilibrium parameter R_L found to be in the range between 0 to 1 is indicative of favorable adsorption onto the surface of FWC adsorbate, thermodynamic parameters ΔG , ΔH and ΔS shows spontaneous process.

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