

complex and intensity of this complex was read at 540 nm using the Varian Cary 50 spectrophotometer.

2.3 Infrared Spectral Studies

The CAAC and SSAC samples (10 mg) were ground with 200 mg of KBr (spectroscopic grade) in a mortar pressed into 10mm diameter disks under 10 tonnes of pressure and high vacuum for 10 min. FTIR spectra were obtained on a PerkinElmer spectrometer. The analysis conditions used were 16 scans at a resolution of 4 cm^{-1} measured between 400 cm^{-1} and 4000 cm^{-1} .

2.4 Analytical Method

The concentration of Cr (VI) was determined by spectrophotometer at wavelength of 540 nm by using biphenyl carbazide as chromogenic reagent. The removal percent (%) is calculated by using the equation.

$$\text{Removal \%} = \frac{C_0 - C_e}{C_0} \times 100 \text{ \%} \dots \dots \dots (2.1)$$

Where,

C_0 is the initial concentration of Cr (VI) in suspension,

C_e is the equilibrium concentration of Cr (VI) in supernatant after centrifugation.

The distribution Coefficient (K_d) is regarded as a standard parameter in the assessment of the physiochemical behavior of metal ions between solid and liquid phase. It can be calculated by the following equation,

$$K_d = \left(\frac{C_0 - C_e}{C_0} \right) \times \frac{M}{V} \dots \dots \dots (2.2)$$

Where, M = mass of adsorbate.

3. Results and Discussion

3.1 FTIR Studies of Adsorbents

The FTIR spectra of CAAC and SSAC after adsorption are shown in **Fig. 1 & Fig. 2**. The FTIR spectra of CAAC showed peaks at 2909, 1577, 1213, 1069 and 719 cm^{-1} , which may be assigned to OH group, aliphatic C-H group, unsaturated groups like alkene, amide, CH deformation, OH deformation, aromaticity and OH stretch, respectively. The intensity of the peaks were either minimized or shifted slightly in case of treated and adsorbed samples.

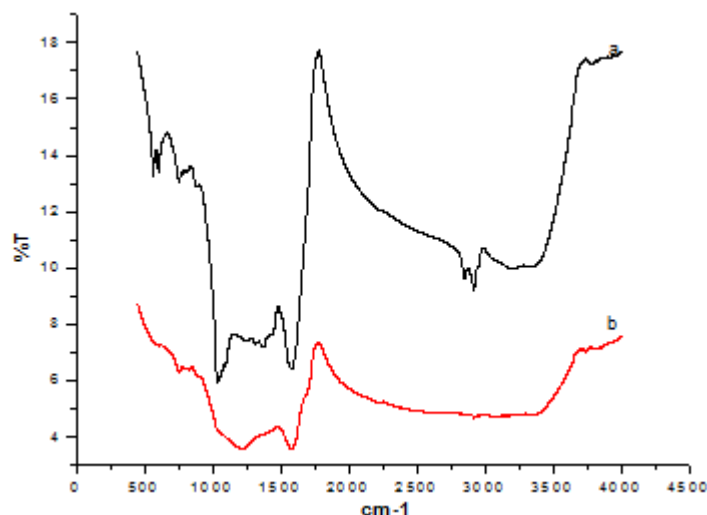


Figure 1: FTIR Spectra of (a) CAAC before adsorption of chromium (b) CAAC after adsorption of chromium

These results are similar to the ones reported earlier [15]. The FTIR spectra of Sapoto seed charcoal after adsorption are shown in Fig. 2. The FTIR spectra of SSAC showed peaks at 3381, 2921, 1641, 1411, 1096, 853, 774 and 607 cm^{-1} , which may be assigned to OH group, aliphatic C-H group, unsaturated groups like alkene, amide, CH deformation, OH deformation, aromaticity and OH stretch, respectively.

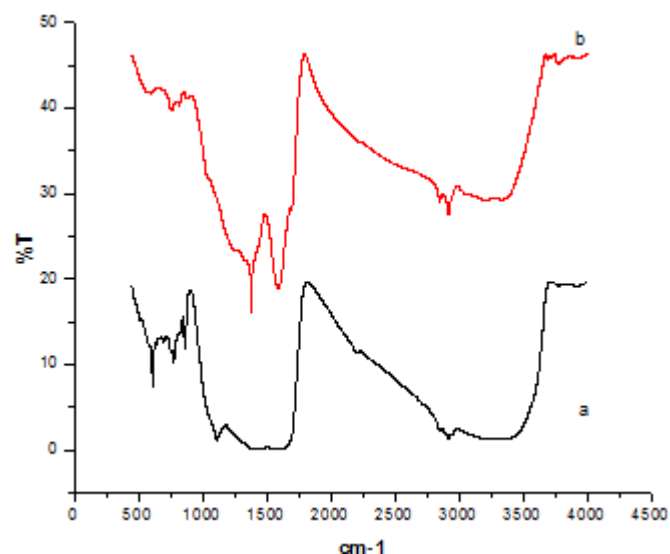


Figure 2: FTIR Spectra of (a) SSAC before adsorption of chromium (b) SSAC after adsorption of chromium.

The intensity of the peaks were either minimized or shifted slightly in case of treated and adsorbed charcoal.

3.2. Standardization of Cr (VI)

Different concentration of Potassium dichromate solution was diluted to 50 ml and 1 ml of biphenyl carbazide was added, and then standardized using spectrophotometer at 540 nm.

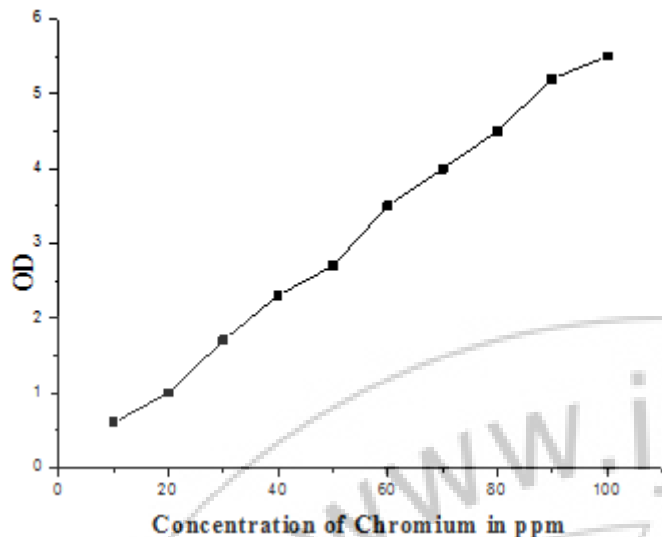


Figure 3: Standardization of Cr (VI)

3.3 Effect of Adsorbate Concentration

Different concentration of Potassium dichromate solution were diluted to 50 ml and taken into different beakers. Then 1ml of biphenyl carbazide was added to each solution, to this 0.5g of CAAC and SSAC charcoal were added then the solution was stirred for 30 minutes using magnetic stirrer. After that the concentration of chromium was determined colorimetrically as mentioned above.

3.4 Effect of Adsorbent Dosage

50ml of Potassium dichromate solution were taken in eight different beakers, to this 1ml of biphenyl carbazide was added. Then different quantities of CAAC and SSAC (0.1 to 1g) were added. The solutions were stirred using the magnetic stirrer for 30 minutes. After the amount of chromium present in the solution were measured as before.

3.5 Effect of Contact Time

50 ml of Potassium dichromate solution were taken in eight different beakers, together with 1ml of biphenyl carbazide. Then 1g CAAC and SSAC powders were added. Each solution was stirred magnetically with different time interval (15 to 150 mins) then the concentration of chromium was measured.

3.6 Effect of Concentration of Cr (VI)

Adsorption of chromium by charcoal is shown in Fig 4. The results show that maximum adsorption takes place at lower concentrations. At higher concentration of chromium, for a fixed amount of charcoal, the removal efficiency decreases.

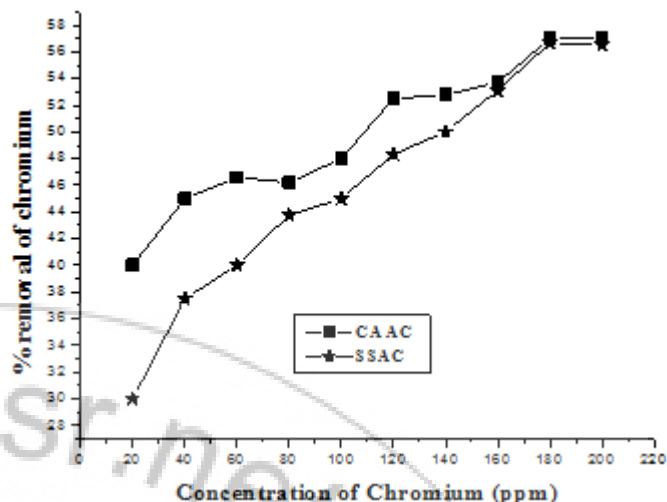


Figure 4: Effect of Adsorbate Concentration on the Adsorption Efficiency of Custardapple (CAAC)

3.7 Effect of Adsorbent Concentration

The effect of different amount of charcoal used to adsorb chromium metal ion is shown in Fig 5. The concentration of Potassium dichromate solution and stirring time 30 minutes are constant and the amount of charcoals of the two adsorbents varied from 0.1 to 1g. This results reveals that minimum amount of charcoal is enough to adsorb chromium from solution.

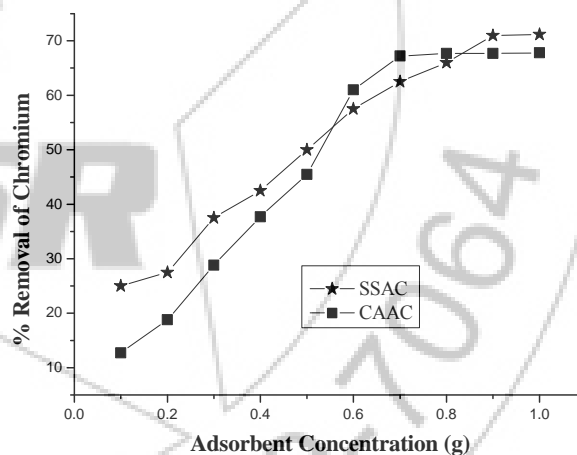


Figure 5: Effect of Adsorbent Dosage on the Adsorption Efficiency of custard apple (CAAC)

From the results, it is evident that both the adsorbents significantly removed the chromium and the optimum amount for efficient adsorption was found to be 0.7 g for both custard apple and SSAC. There is no significant increase in the removal of chromium and the efficiency of sapota seed activated carbon (SSAC) was marginally superior to the custard apple activated carbon (CAAC). Further increase of adsorbent did not show any marked efficiency in the chromium removal.

3.8 Effect of Contact Time

The effect of contact time on removal of chromium metal ion from solution by SSAC and CAAC is shown in Fig. 6. Both concentration of chromium and amount of charcoal were fixed while the contact time was varied from 15 minutes to 150 minutes.

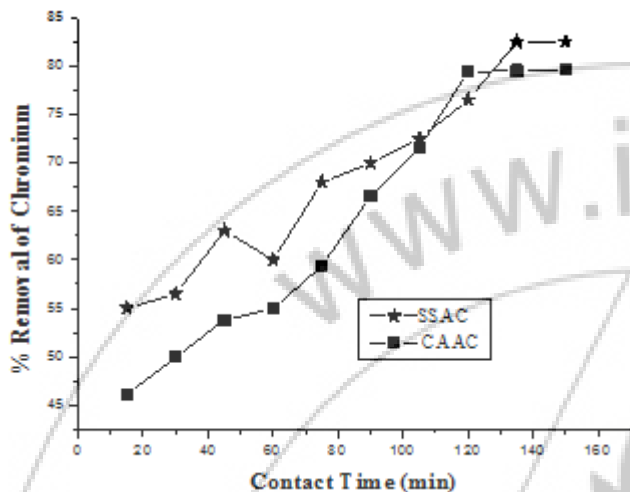


Figure 6: Effect of Contact time on the Adsorption Efficiency of custard apple activated charcoal (CAAC).

The result shows that the maximum adsorption occurred at 120 minutes there is no considerable change in further increase in the contact time.

3.9 Langmuir Model

The Langmuir plot of C_e/q_e (ppm) Vs C_e (ppm) at 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2, 2.4 and 2.6 ppm is shown in Fig.7. The Langmuir isotherm fits the experimental data very well for both the materials, which may be due to homogeneous distribution of active sites on the particle surface. The nature of adsorption is Chemisorption.

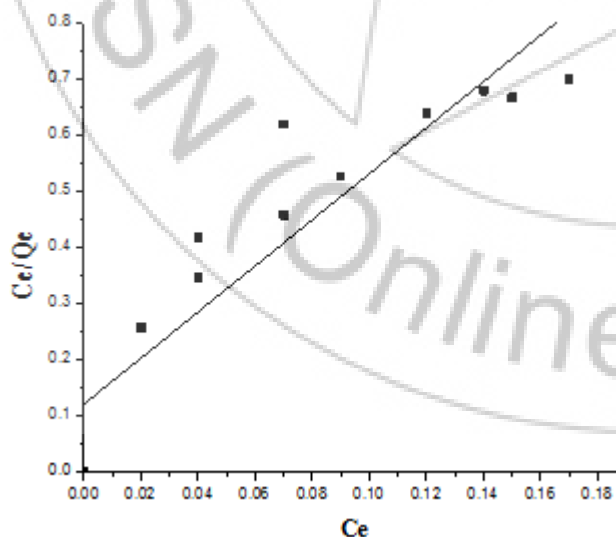


Figure 7: Langmuir isotherm for Cr (VI) adsorption

3.10 X-ray Diffraction Studies

Figure 8 shows the XRD pattern of the powdered sample. The XRD pattern shows the presence of amorphous carbon in the sample. The peaks in the XRD peaks correspond to the adsorption of chromium by both the activated carbons (SSAC and CAAC).

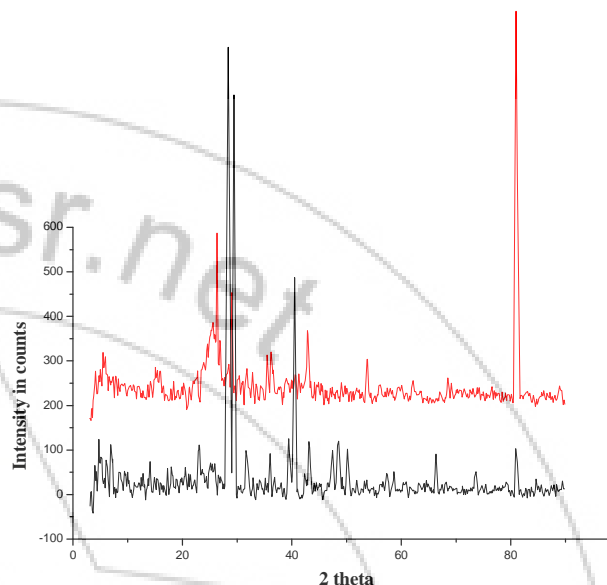
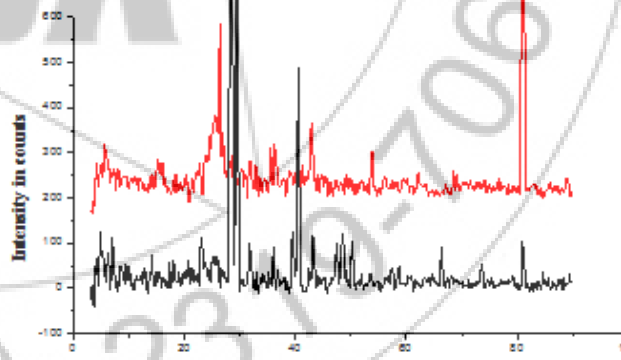


Figure 8: XRD pattern of SSAC and CAAC after adsorption of chromium

3.11 Scanning electron microscopic studies

Figure 9 and 10 show the SEM micrographs of the sample before and after chromium coating. The porosity is less in case of figure 10 compared to that in case of figure 9 which indicates the adsorption of chromium in the pores of the sample.



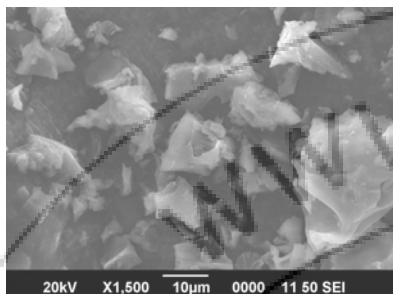
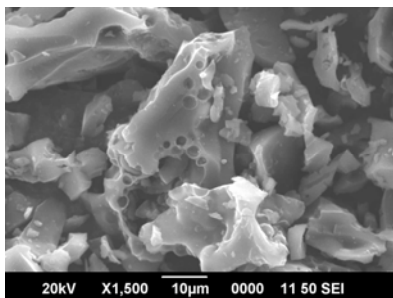


Figure 9 &10: SEM images of adsorbents CAAC and SSAC after adsorption of chromium

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4. Conclusions

From the experimental results it can be concluded that both activated carbon materials obtained from CAAC and SSAC were found to be effective adsorbents of Cr (VI). This adsorption of Cr (VI) onto activated carbon is found to be time and concentration dependent. The adsorption isotherm values also confirm the above observations. Thus the use of custard apple seed and sapota seeds activated charcoal as an adsorbent seems to be an economical and promising an alternative over the conventional methods for removal of Cr (VI) from industrial effluents.

References

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