Study on Activated Carbon Adsorbent Made from Drumstick Seeds Removes Hexavalent Chromium

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ABSTRACT—Saragava seeds (MoringaOlivera) have been used as an agro-base product since they are widely accessible. It's known as a drumstick. It is well known that they contain carbon. In the lab, attempts have been undertaken to make activated carbon (DSSAC) from them. They were then tested for chromium adsorption in wastewater and found to be effective. All of the experiments were done in batches in a conical flask shaken with a motorized shaker. The optical density was measured using a colorimeter after filtering with Whitman No. 41 filter paper. The weighing was carried out using a computerized balance. Impregnation with zinc chloride was used to make the adsorbents at five different activation temperatures: 3000 C, 4000 C, 5000 C, and 6000 C. The influence of initial chromium solution concentration on adsorption was tested at 0.5 mg/L, 1.0 mg/L, 2.0 mg/L, and 3.0 mg/L in the chromium adsorption study. The best dose of adsorbents for removing chromium from wastewater was determined using adsorbent dosages of 25 mg/50 mL, 30 mg/50 mL, 35 mg/50 mL, 40 mg/50 mL, and 50 mg/50 mL. The optimal time for each starting concentration and the adsorbents synthesized at varied activation temperatures was found using these optimum dosages. The maximum removal of chromium was seen for all four adsorbents; however, the impact is stronger at 5000C. DSSAC's performance was compared to commercially available PAC and GAC in a comparative study. It was discovered that DSSAC removed almost twice as much chromium as PAC. In several circumstances, GAC was shown to be less effective than DSSAC at removing chromium.

KEYWORDS:DSSAC, Adsorption, Activation Temperature, Optimum Dose, Optimum Contact Time

1. INTRODUCTION

The use of adsorption techniques for heavy metal removal has become a lot of interest in recent years. [1] Adsorption occurs when molecules are distributed between two phases, one of which is a solid and the other of which might be liquid or gas. [2] Adsorption is defined as the separation of material from one phase followed by its accumulation or concentration on the surface of another. The adsorbent is the adsorbing phase, while the adsorbate is the substance condensed or adsorbed on the surface of that phase. Adsorption differs from absorption, which occurs when material moved from one phase to another (for example, liquid) interpenetrates the second phase to produce a "solution." Sorption is a broad word that refers to both of these processes. [3] The three processes in the adsorption removal of a pollutant may be recognized. To begin, the adsorbate must go

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from the liquid or gaseous phase to the adsorbent's exterior across a fluid boundary layer. It must then attach itself to the adsorbent. Through the three steps are stated as taking in sequentially, in the practice all three may be occurring concurrently in various sections of the adsorbent because circumstances are not consistent throughout. Until equilibrium conditions are reached, concentrations will be greater on the adsorbent's outer surface than in the center. The pores structure will also have a variety of pore sizes, with the spread of the distribution dependent on the adsorbent's origin and manufacturing condition [4].

2. PRIORITY POLLUTANT: CHROMIUM

Chromium (Cr) is a metallic element that is one of the most toxic heavy metals and is recognized by the Environmental Protection Agency as one of 129 priority pollutants. [5] It is not found in nature in its natural state. Steel is made from the metal chromium, which is in its chromium (0) state. Chrome plating, dyes & pigments, leather tanning, and wood preservation all require chromium (VI) and chromium (III). Chromium (III) and chromium (VI) are the most common types of chromium that enter the air, water, and soil. [6] Chromium compounds are typically found in the air as tiny dust particles that fall over land and water. Only a little quantity of chromium may dissolve in water and go deeper into the soil to reach subsurface water. Fish do not absorb a lot of chromium from the water they swim in. [7] In the presence of oxidizable organic matter, hexavalent chromium compounds are reduced to trivalent form. Hexavalent chromium compounds are more stable in natural waters with a low concentration of reducing material (EPA 1984) [8]. Chromium improves an alloy's hardenability, creep and impact strength, corrosion, oxidation, and wear resistance. [9]

3. THE BRIEF DESCRIPTION OF SCOPE WORK

Adsorbents are suggested to be made from agricultural products such as drum stick seeds in the proposed experiments. The adsorbent will be used to treat synthetic wastes that include chromium as a primary contaminant. The following stages are included in this research:

- To make an adsorbent out of drumstick seeds, which are abundant in our land?
- Activation temperatures of 300oC, 4000oC, 5000oC, and 6000oC were used to produce the adsorbents.

• To investigate the adsorbents' physical qualities, including sieve examination for average particle size and density of adsorbents, moisture content, soluble in water matter present in adsorbent, and acid and ash content.

- To create the sample's calibration curve.
- To make the 1, 5 diphenyl carbide solution.

• To make chromium solutions of various concentrations that could be present in industrial effluent and cause serious environmental issues. The chromium solutions recommended for usage include the following concentrations: 0.5 ppm, 0.75 ppm, 1.0 ppm, and 1.5 ppm.

• The influence of activation temperature, adsorbent dose, contact duration, and starting concentrations of chromium solutions on the adsorption of chromium from the solution will be investigated.

• The goal of this project is to investigate the equilibrium conditions of the chromium adsorption process, which includes looking at adsorption isotherms (not reported in this paper)

• To compare the outcomes of low-cost adsorbents with commercially available powdered activated carbon and granular activated carbon, and to conclude the findings of the research.

4. MATERIALS AND METHODS

4.1 Adsorbent Selection

Activated carbon may be made from a range of raw materials and with a variety of surface qualities to fulfill the needs of certain applications with relative simplicity and at a reasonable cost. The relevance of research in the synthesis of activated carbon from locally accessible raw materials cannot be overstated. 10 and 11] the current inquiry was done to prepare activated carbon from indigenous raw materials due to the multifunctional usage of activated carbon in water and wastewater treatment in the industry. The adsorbent is made from the agro-based product drumstick seeds powder, which is used to remove chromium from industrial effluent.

4.2 DSSAC Preparation of Adsorption



Figure 1:depicts a schematic illustration of how to make activated carbon from DRUMSTICK

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A. Preparation of the Raw Material consists of the following steps

Drumstick seeds were harvested from a nearby village farm and allowed to dry in the sun. For the experiment, the pods and shells of the stick were removed, and the seeds were collected. The seeds are left to dry in the sun for a longer period. The dried material was then extensively ground and filtered using conventional 20 mesh sieves to obtain consistent particle size for powdered activated carbon production.

B. Activated Charcoal Preparation

To eliminate any soluble contaminants, the produced raw materials were first rinsed with distilled water. After that, it was dried in an oven at 1100 C for 30 minutes before being impregnated with zinc chloride solution in a mixing cylinder. The impregnation time for zinc chloride desire absorption was 12 hours. The optimum period for impregnation ranges between 12 and 36 hours. For carbonization, the impregnated samples were put in a muffle furnace. To avoid oxidation, the furnace was sealed off from the outside world. Carbonization was carried out at various temperatures, including 300°C, 4000°C, 5000°C, and 6000°C. The carbonization process took between 4 and 5 hours. After 5 hours, the carbonized product was placed in desiccators to cool to ambient temperature, and then it was crushed from coarse lumps to minute particles. The activated product comprises a significant proportion of the impregnation zinc chloride were dissolved. Because zinc chloride has a basic character, the pH was adjusted using strong hydrochloric acid. The filtrate liquor was then washed with water until the pH was neutral. This washed activated product was dried for 2 hours in a hot air oven at 100 + 50 C. The consistent particle size of the adsorbent was achieved by grinding the material and screening it to 400 meshes ASTM.

4.3 DSSAC'S Properties

The properties of the laboratory-made adsorbent DSSAC were evaluated and compared to powdered activated carbon.

Adsorbents	PAC	DSSAC
Bulk density, g/mL	0.7	0.42
Matter soluble in water, (%)	1.5	2.9
Matter soluble in acid, (%)	2.5	4.15
Moisture content (%)	5.6	9.10
Ash content (%)	6.8	9.5

Table 1 shows the properties of the adsorbents

4.4 Adsorbate

To eliminate influence from other metals, a synthetic waste solution of chromium was created in the lab for this investigation.

A. Synthetic Chromium Waste Preparation [13]

The calibration curve must be prepared using chromium standard solutions. The calibration curve is required for translating the optical density obtained with the colorimeter into the appropriate chromium concentration in mg/L.

For the experimental investigation, a stock solution of chromium is necessary to prepare the synthetic effluent of chromium at a certain concentration. The obtained stock solution is used for dilution to get a variety of varied chromium concentrations.

• The following are the steps for preparing stock and standard solutions Using a weighing balance to precisely weighing the sample.

• The weighed sample is dissolved in distilled water in a partly filled measuring cylinder and thoroughly agitated to achieve full dissolution.

• Finally, the solution is diluted in the measuring cylinder to the desired concentration Chromium Solution in Stock.

• The solution was made by dissolving 14.14 mg of anhydrous potassium dichromate in distilled water and diluting it to 100 ml. As a result, 1.00 mL equals 50 micrograms of chromium and Chromium Standard Solution.

• Dilute 20 mL of stock chromium solution to 1000 mL to make this. 1.00 ml Equals 1.00, microgram hexavalent chromium in this case.

• Preparation of 1, 5 – Diphenyl carbo-hydrazide Reagent This was made by dissolving 200mg of 1, 5– Diphenyl carbo-hydrazide in 200mL of water.

• diphenylcarbo-hydrazide in a solution of 95 percent ethyl alcohol in 100 mL The acid solution, which was made by combining 40 mL concentrated sulphuric acid with 360 mL distilled water, was then added to this. This solution was then refrigerated for roughly a month to keep it stable. In this case, the reagent's function is unaffected by the color shift from colorless to tan.

B. Sample Concentration Measurements

The standard calibration curve was created by graphing concentration against optical density and measuring the optical density of a standard solution of a specified concentration. The optical density of the produced solution was measured in a colorimeter to determine the chromium content, and the corresponding chromium concentration was approximated using the standard calibration curve. The succeeding chromium concentration

solutions were made by repeated dilution of the concentrated chromium solution. The concentrations of treated and untreated chromium solutions were determined in the same way as previously stated. However, the optical density was measured with caution, with the measuring tube being rinsed with distilled water after each measurement. As utilizing a colorimeter, a maximum wavelength must be established at which the solution exhibits the greatest optical density or minimal transmission when compared to other wavelengths. Because we're only interested in visible wavelengths, the optical density can only be determined across a broad range of wavelengths between 450 and 750 nm. The colorimeter should be calibrated by using distilled water in a 1 cm diameter measuring tube for infinite transmission and a black rubber tube for zero transmission. The maximum wavelength for chromium is 550 nm.[14] The calibration curve was produced.

5. RESULTS AND DISCUSSIONS

The studies were carried out to see how dosage and activation temperature affected the percentage of chromium removed (VI). Experiments were also carried out to see how to contact duration and activation temperature affected the percentage of chromium removed (VI). The findings of the trials are shown in the Summary Tables (Tables 2–6), DSSAC, PAC, and GAC Results Summary table 30 minutes is the ideal amount of time.

	Dose		.+6				
Sr.No.	(mg/50 mL)						
		300°	400°	500°	600°	PA	GA
		С	С	С	С	С	С
1	25	48	50	55	45	54	60
2	30	53	65	67	52	60	63
3	35	60	72	74	60	72	65
4	40	65	80	83	65	76	70
5	45	70	82	85	72	80	73
6	50	70	82	85	72	80	74

Table 2: Initial Concentration = 0.5 mg/L

Sr. No.	Dose	% Removal of Cr ⁺⁶						
	(mg/50 mL)		DSS					
		300	400	500	600	PAC	GAC	
		°C	°C	°C	°C			
1	25	52	54	56	45	50. 25	48. 25	

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2	30	60	62	60.	68.	53.	53.
				27	51	49	51
3	35	64	65	72.	72	58.	59.
				27		51	49
4	40	70	72.	78	75.	66	64
			25		33		
5	45	75	81	84.	80.	79.	72.
				23	53	25	27
6	50	75.	82	86.	81	80	72.
		50		27			23

Table 3: Initial Concentration = 0.75 mg/L

	Concentration	% Removal Of Cr ⁺⁶							
Sr.	mg/L		DSS						
No.		300	400	500	600	PA	GA		
		°C	°C	°C	°C	С	С		
1	0.5	79.	88.	92.	84.	86.	78		
		5	5	4	6	2			
2	0.75	84	86.	89.	83.	84	77.		
			53	07	07		5		
3	1	78.	84.	90.	82	78.	70.		
		5	25	5		3	2		
4	1.5	63.	68.	72.	65.	67	65.		
		27	27	53	5		27		

Table 4: Equilibrium time is 60 minutes, and the equilibrium dosage is 45 mg/50 ml

Sr.No.	Dose	% Rer	noval o	of Cr ⁺⁶			
	(mg/50 mL)						
		300	400	500	600	PA C	GA C
		°C	°C	°C	°C		
1	25	18.6 7	44.2 7	46.5	34.5	38. 25	32

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2	30	48.5	48	50	42.2 7	48. 25	45
3	35	53.2 5	55.2 5	55.2	45	55	52
4	40	53	57.5	56	54	55	53
5	45	58.5 3	62	63	59	62. 25	58
6	50	59	62	63	60	62. 48	58

Table 5: Initial Concentration = 1.5 mg/L

6. CONCLUSIONS

The following conclusions have been formed based on the experiments:

• Using Drumstick seeds to remove chromium from synthetic wastewater created in the lab was discovered during the testing.

• The optimal dosage is determined to be 45mg/50mL in all circumstances, regardless of concentration or temperature in Tables 5, through 64exhibits the information

• At any given Cr+6 content in wastewater, the greatest removal is observed at 500oC activation temperature. The maximum percentage removal at 500oC with 0.5mg/L concentration is reported to be 90.5 percent.

• When compared to PAC and GAC, DSSAC is shown to function better at any given Cr+6 concentrations. The % elimination of benzene at 1.5 mg/Concentration isCr+6 is determined to be 67 percent and 65.27 percent by PAC and GAC, respectively.

• However, utilizing DSSAC at 500oC, the proportion of Cr+6 removed is determined to be 75.53 percentAs the concentration of Cr+6 rises at any given activation temperature, the proportion of Cr+6 removed decreases. When the concentration is 0.5 mg/L at 300oC, the percentage removal is 79.5 percent, but when the concentration is 1.5 mg/L, the percentage removal is 63.5 percent. When PAC and GAC were used in experiments, similar findings were achieved.

• When the concentration of Cr+6 is 0.5 mg/L, the percentage removal by commercially available PAC and GAC is 86 percent and 78 percent, respectively, which decreases to 67 percent and 65.27 percent when the concentration is increased to 1.5 mg/L.

• When compared to the results obtained when activation temperatures were 300oC and 400oC, 500oC showed the maximum quantity of elimination. When the activation temperature is increased to 600oC, however, the percentage elimination decreases.

• The ideal contact time was discovered to be 30 minutes. However, the equilibrium dosage is 45mg/50mL and the equilibrium time is 60 minutes.

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