

Investigation of Hexavalent Chromium Removal from Aqueous Solution

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KEYWORDS	Abstract		
Adsorption, Biomass, Chromium (VI), Bioaccumulation.	With its accume detrimental sid completely. The biosorption of a adding canola of ion concentration best results. Yo are the recomm 5 g/l of adsorf effectiveness we	ulation in living things, inability to b le effects, chromium (VI) in wast his includes hexavalent chromium. Cr (VI) in this classroom research bil. When the equilibrium contact per on, and physicochemical criteria are u should set each parameter to the for hended parameters: a pH of 3, a start bent, and a contact time of 75 m yras 99%. Our research indicates that	iodegrade, carcinogenic effects, and other tewater must be reduced or eliminated One of the liquids that improved the was water, which was made possible by riod, adsorbent dosage, pH, initial Cr (VI) e met, batch adsorption systems produce blowing values based on the results: Here ing concentration of 10 mg/l, a dosage of ninutes. At full capacity, its adsorption t an adsorbent with a maximum practical blue witch a section
	cupacity of abo	at 10.07 mg/g is the most economic	any viable option.

Introduction

Because heavy metals have their own distinct characteristics, water quality declines significantly. Thick metal chromium (Cr) comes in two main forms: trivalent and hexavalent. An important contributor to environmental chromium (Cr) levels is wastewater treatment plants. Some of these operations include preserving wood, polishing metal, managing rust, and tanning leather. Animal deaths, gastrointestinal cancer, stomach and lung pain, and stunted plant growth are some of cr's negative consequences. Because of this, it is a potentially dangerous element. As a result, removing Cr from wastewater and other sources of potable water is crucial. In order to successfully extract Cr from effluents, numerous methods have been devised, including electrodeposition, membrane filtration, ion exchange, and biological processes. The truth is that there are limits to these methods that make them less than optimal for removing Cr. In terms of reliability and efficiency, adsorption is among the best approaches.

Although activated carbon is adaptable, it does not meet the optimum standards for Cr removal due to its disadvantages. The goal of the ongoing study is to develop adsorbents that are more cost-effective. Just recently, natural materials such as azolla, banana peel, apple core, orange rind, and red mud were discovered to be efficient adsorbents for heavy metal removal. Among the many lignocellulosic waste products used in Iran and elsewhere is canola stalk. This substance is produced as an unwanted outcome of the canola oil processing that yields vegetable oils. Canola stalks are commonly utilized to evaluate the efficacy of methods for removing pollutants due to their appealing characteristics and convenience of availability. Assessing canola oil's efficacy in removing Cr was our primary objective in this study [1-3].

Materials and methods

In this study, researchers used canola, a cheap natural or agricultural waste, to extract carbon (VI) from water-

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based systems. The canola stalks were gently washed with water to get rid of any contaminants that remained. To complete the drying process, we baked it for five more hours at 105 degrees Celsius. To prepare the biomass for drying, it had to be treated with 0.1 M H2SO4 for two hours at 105 degrees Celsius. The following step involves rinsing it out with improved water. Before you start your inquiry, please make sure the adsorbents are well dried and sieved until their particle size reaches 18 mesh. They'll be set to go at that time. Researchers were supplied with superior analytical chemicals by Merck & Co. chemists. Using the BET-N2 technique and nitrogen adsorption-desorption isotherms set at 77 °K, the specific surface area of dried canola was calculated. The model of the ASAP 2020 that we employed in this context was the BET surface area analyzer. Prior to and following the adsorption process, pictures of the dried canola's surface were taken using a SEM (Philips, XL30). All of these were captured in the same moment.

Following the completion of the adsorption experiments, the concentrations of Cr (VI) in the control and experimental solutions were determined using a UV-visible spectrophotometer, more precisely a Hitachi DR5000 spectrophotometer. 3.73 grams of K2CrO4, 2H2O should dissolve in 1000 milliliters of doubledistilled water while being stirred to create a Cr (VI) solution with a concentration of 1000 mg/m2. The needed concentrations of the Cr (VI) stock solution must be diluted before beginning the tests. For each of the several 250 milliliter stopper conical flasks used in the batch adsorption testing, 100 milliliters of Cr (VI) solution was pumped. A solution of 0.1 N HCl or 0.1 N NaOH can be added to easily change the combination's pH to suit your needs. A precise duration of contact time was given to the flasks after they had been heated to -30 degrees Celsius and shaken at 120 to 125 revolutions per minute (rpm).

This gadget was made using an LSI-3016R electrically thermostatic reciprocating shaker from Daihan LabTech Co., Ltd., a South Korean manufacturer. An analysis of the literature indicates that four main parameters influence adsorption: pH, adsorbent dosage, contact time, and pollutant concentrations. As a result, it was decided to set the CRI level limit at 10 to 100 mg/l. We were able to ascertain the impact of altering the adsorbent dosage (0.1–1 g), contact time (10–180 minutes), and pH (3–8) on the results according to these factors.

We conducted regular interval sampling in order to approximate the equilibrium time. The Whatman no. 1 paper filter was used to filter the sample and is made by Whatman International Ltd. in Maidstone, England. A UV-visible spectrophotometer was used to precisely measure the amount of 1,5-diphenylcarbazide present in the sample solution. The results are displayed in Tables 6–10. We conducted three separate runs of each experiment.



Figure 1. The Scanning electron microscopy (SEM) image of dried canola: (a) before use; (b) after use

Results and discussion

The surface structure of canola, as shown in Figure 1, was obtained using scanning electron microscopy

(SEM). The textural properties of the dried canola can be better understood by consulting Figure 1(a). The figure 1(b) shows that the dried canola oil clearly



displays a pore textural hierarchy. It might happen in one of two ways: either the dried canola's pores let Cr in, or Cr builds up on the surface. On top of that, surface heterogeneity was noted due to the adsorbent's deep pores. The modified canola has a surface area of 32 square meters per gram. When acid blue 113 was dissolved in water using canola oil, the results were same.

Effect of contact time and initial Cr (VI) concentration

Contact time is one of many factors that establish the rate of biosorbent application in real-world settings; among these, it stands out as particularly essential. Figure 2 displays the changes in the concentration of Cr (VI) ions in canola over time, allowing us to observe these changes. There was an improvement in the biosorption efficiency of Cr (VI) during 75 minutes of exposure to water. It started out quite constant. The researcher used this information to determine that 75 minutes was the optimal amount of time for interactional study.

The biosorbent surface was effectively coated with Cr (VI) molecules, allowing for a more rapid biosorption

process. Since the material's internal structure slowed the diffusion of Cr (VI) molecules after that point, the concentrations of these components remained low. Given the high concentration of exchange sites in biosorption, it may initially be the better choice. A group of researchers led by Gupta looked at the biosorption of Cr (VI) onto spirogyra-a type of green algae-and how contact length affected the process. It took 90 minutes for the biosorption capacity (mg/g) to level off, but at first it was quite high. The absence of available adsorption sites led to a decrease in removal efficacy with increasing Cr (VI) levels; the adsorption rate peaked at 10 mg/l. Because we don't know the starting concentration of lead ions, we may say that the rate of biosorption by rice husk is directly proportional to the amount of lead ions.

To what extent biosorbents are effective lead ion absorbers may depend on the number of accessible sites. They can be produced by dual complexation with Cr2O72-, CrO42-, or OH-, even though OH-form anions were more common at pH values greater than 6.[28] in The ion exchange mechanism was probably less effective at lower pH levels because of physical adsorption and other processes [11–13].



Figure 2. Effect of contact time and initial Cr (VI) concentration on removal efficiency Effect of pH

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Figure 3. Effect of pH on Cr (VI) removal efficiency and adsorption

A metal's fate once sorbed depends on the pH level. Since it alters canola surface properties and releases many ions into chromium solutions, its binding capacity varies with pH. You can observe this variation in canola's adsorption capacity for Cr (VI) with respect to pH in Figure 3. In addition to the acid HCrO4-, chromium ions can also be found in the base Cr2O72-, acid HCrO4-, and alkaline Cr3O102 forms. You may find the HCrO4-type just about anywhere. Cl- changed to Cr2O72- and CrO42- as a result of an increase in pH. As the pH drops, chloride ions surround the adsorbent, making it easier for Cr (VI) to bind to the biosorbent's sites. The adsorption capacity of biosorbents is negatively affected by changes in pH due to their typically negatively charged surface.

Effect of biomass dosage

Figure 4 shows that Cr (VI) ions can be biosorbed at biomass doses between 1 and 10 g/l. These data show that the biosorption effectiveness is greatly affected by

the biomass concentration in the solution. Biomass consumption at 5 g/l causes a substantial rise in the rate of metal biosorption. There was a decrease in the biosorbent's adsorption capacity with increasing dosage. No matter how much biosorbent is added, these results still make sense since the amount of unsaturated biosorption sites stays the same throughout the biosorption reaction. The ability of rice husk to remove Cd+2 from water was also investigated by Kumar and Bandyopadhyay, which they did by adjusting the biosorbent doses. Improvements in removal efficiency of 38% and reductions in biosorption capacity of 7.5-1.24 mg/g were seen when the biosorbent dose was increased from 1-5 g/l. Even when tested in water, the results of Saccharomyces cerevisiae bioabsorption of cadmium were constant. But for the sake of future studies, 4 g/l of biomass should be the dosage target [14-16].

Concentratio n	Experimental qe	Pseudo-fi	rst-order			Pseudo-second-	
(mg/l)	(mg/g)	K 1				order	
			q	R ²	K ₂	q e	R ²
		e					
10	1.98	0.341	6.19	0.965	0.0021	2.24	0.999
50	6.95	0.574	13.24	0.941	0.0043	7.36	0.998
100	10.67	0.922	18.45	0.972	0.0072	11.14	0.999

Table 2. Kinetic parameters for the adsorption of Cr (VI) onto canola at various concentrations

The adsorbent's monolayer biosorption capacity is denoted as qm and is expressed in mg/g. The Langmuir biosorption constant, written as KL and measured in milligrams per liter, is related to the biosorption free energy. Ce is the solution's equilibrium concentration of Cr (VI) ions, Qe is the adsorbent's equilibrium

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Conclusion

Results suggested that canola biomass could be able to extract Cr (VI) from water. The biosorbent beats all of its competitors with a BET surface area of 32 m2/g. Biosorption of Cr (VI) is accelerated at low pH levels. The removal efficiency can only be maximized by using higher dosages and exposing the biosorbent to extended durations of contact. Canola showed potential as a biosorbent for mercury (VI) extraction from water.

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