Eco. Env. & Cons. 29 (August Suppl. Issue) : 2023; pp. (S225-S228)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i04s.036

Absorption of hexavalent chromium from tannery effluent using Blackberry (Jamun) saw dusts

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(Received 2 March, 2023; Accepted 28 April, 2023)

ABSTRACT

Hexavalent chromium is highly toxic and used in different industries such as leather tanning, paints, wood preservation, electroplating, dye and pigment manufacturing. Cr (VI) was soluble in water and enter living cell. It can cause cancer, gastrointestinal ulcer and dermatitis in human beings. Various method have been used to remove hexavalent chromium including chemical precipitation, solvent extraction, reverse osmosis, evaporation, electrolysis, ion exchange and chemical reduction. These methods are more expensive and not suitable for small scale. The adsorption process using suitable adsorbent was effective, low-cost and innovative method to remove Cr (VI) form industrial waste water. Jamun saw dust was used as an adsorbent to remove chromium (vi). in this various parameter such as temperature, adsorbent dose, adsorbate dose, and pH were investigated.

Key words: *Adsorbents, Potassium dichromate (K2Cr2O7), 1, 5-diphinyle carbazide hydrochloric acid adsorption UV- Visual spectroscopy.*

Introduction

Tanning is the chemical process that converts animal hides and skin into leather and related products. The transformation of hides into leather is usually done by means of tanning agents and the process generates highly turbid, colored and foul-smelling wastewater (Raju and Naidu, 2013). The major components of the effluent include sulfide, chromium, volatile organic compounds, large quantities of solid waste, suspended solids like animal hair and trimmings. For every kilogram of hides processed, 30 liters of effluent were generated and the total quantity of effluent discharged by Indian industries is about 50,000 m^3/day (Niranjana *et al.,* 2014). The various components present in the effluent affect human beings, agriculture and livestock besides causing severe ailments to the tannery workers such as eye diseases, skin irritations, kidney failure and gastrointestinal problems (Midha and Dey, 2008). The untreated release of tannery effluents containing high COD, BOD levels, trivalent chromium, sulfides, sodium chloride, Ca, Mg, organics and other toxic ingredients, to the natural water bodies effect flora and fauna of the ecosystem and increases the health risk of human beings (Mandal *et al.,* 2010).

The maximum permissible limit of Cr (VI) for the discharge to inland surface water is 2.0 mg/l and in potable water is 0.05 mg/l. The Ministry of Environment and Forest (MOEF), Government of India has set Minimum National Standards (MINAS) of 0.1 mg/l for safe discharge of effluent containing Cr

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(VI) in surface water. To comply with this limit, industries have to treat their effluents to reduce the Cr (VI) concentration in wastewater to acceptable levels (Das *et al.*, 2015). There are about 2161 tanneries in India; however, sustenance of tanneries is becoming increasingly difficult because of alarming level of environmental pollution caused by various tannery operations and practices. The main pollutants of concern in tanneries are BOD/COD, suspended solids and heavy metals (Gupta and Babu, 2006).

However, 90% of tanneries in the world are using chromium salts to produce leather given that it provides better leather flexibility, water resistance and prevents putrefaction, properties that are all important for good leather quality. The World Health Organization (WHO) recommends a maximum acceptable concentration of Cr (VI) as 2.0 mg/L in wastewater which discharging outside. It has been reported that excessive intake of chromium by human leads to hepatic and renal damage, capillary damage, gastrointestinal irritation and central nervous system irritation. The release of untreated tannery effluent to affects the natural water bodies flora and fauna of the ecosystem and increases the effect of human health and environment.

Materials and Methods

Preparation of Biosorbents

The biosorbents will be prepared from saw dusts of jamun by the method given by Mishra and Shukla (2021). In this method the sawdust will be dried, grinded and will be treated with Formaldehyde to remove colouring materials. The treated sawdust will be further washed with distilled water and dried at 50 °C for 24 hours. Further the dried sawdust mixed with 1% Formaldehyde and 0.2 N H_2SO_4 will be heated on hot plate at 50 °C. After this the sawdust will be washed and dried at 60%c to prepare bio sorbents.

Preparation of Stock Solution

The stock solution of 1000 ppm Cr (VI) will be prepared by dissolving 1.4143 g quantity of Potassium Dichromate (K2Cr2O7) in 500 ml of de-ionized, distilled water. Working solutions of Cr (VI) standards will be prepared by diluting the appropriate quantity of the above stock solution. The pH of the solution will be adjusted with 0.1 N HNO_3/0.2N H_2SO_4 and NaOH solutions.

Cr (VI) analysis

The Cr (VI) in the sample will be analyzed by 1,5-diphenyl carbazide method as per APHA (1998). In this method 1,5-diphenyl carbazide react with Cr (VI) in acidic medium and form pink colored complex, which can give concentration of Cr (VI) at 540 nm.

Screening of adsorbent

For screening of appropriate bio-adsorbent for the efficient removal of Cr (VI) experiments will be conducted in 250 ml Erlenmeyer flasks at optimum pH, temperature and metal ion/adsorbent concentration. The amount of metal ion absorbed per gram of adsorbent and the adsorption efficiency (%) will be calculated according to following formula.

$$R\% = \frac{Co - Ce}{Co} X\ 100$$

R% = Percent reduction

Co = Initial concentration of working solution in mg/L

Ce = Final concentration in mg/L (After being adsorbed by adsorbent)

Adsorbent preparation

Jamun wood collected from the local area and was grinded to small particles of size 120-500 µm. It was washed with deionized water for removal of dirt, color and other particular matter and then dried. Jamun sawdust was treated with Hydrochloric acid (HCl). For this 10 ml of HCl was added to 100 ml of deionized water and then 10 grams of Neem sawdust was added and the final mixture was stirred and treated at 32°C for 24 hours till the mixture became thick slurry. The slurry was washed with deionized wateruntil the pH of filtrate was more than 5. Finally, the sawdust was dried and then stored in plastic bags at room temperature. Now it was ready to use as an adsorbent.

Stock solution of chromium

The stock solutions chromium ions were prepared from AR 1.4145 gram of Potassium Dichromate ($K_2Cr_2O_7$) was added in 500 ml of distilled water in 1000 ml volumetric flask. It was dissolved by shaking and the volume was made up to the mark.

Effect of different parameter on chromium adsorption

Effect of adsorbent dose: From Table 1 was clear

that more adsorption show 50gm (82%) as compare to 25gm(67%) and 75gm (71%). It was due to column fulfill by 50 gm so binding site increasing between chromium and saw dust , but 25 gm saw dust half filledcolumn and 75 gm saw dust fulfilled with pressure so both cases binding site decreases (Shukla and Mishra, 2021)

Effect of adsorbate dose

The adsorbent dose was also affected to adsorption of chromium as shown Table 1 and Figure 2. The more adsorption shows at 50 ppm (82%). The reason of this increasing the binding site due to increasing the chromium concentration (Mishra and Shukla 2021).

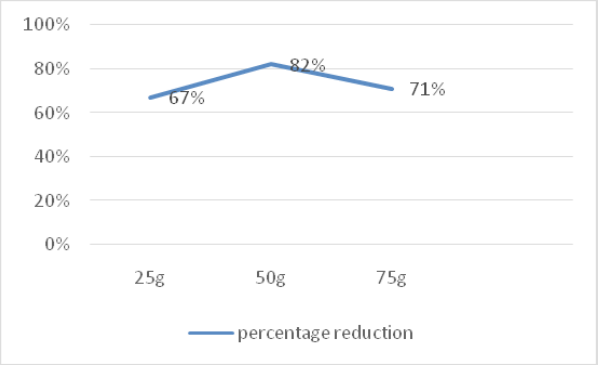

Fig. 1. Percentage reduction in different concentration of saw dust

Effect of temperature: From Table 2 results indicate the maximum at 30^0c as compare to 32 and 27°C. The adsorptionincreases with increasing the temperature from 27°C to 30°C. This is the reason of chemical interaction between adsorbate and adsorbent by the endothermic process. Although further increase in temperature the adsorption percentage was decreases because higher temperature some chromium leaves the solid phase and change to liquid phase (Mishra and Shukla, 2021).

Effect of pH

Table 3 was show more adsorption at pH 6.5 as compare to pH 5.5 and 7.5.

It is the general trend the increasing pH the adsorption process is also increase but above pH 7 the percentage reduction is decreases; it is due to deprotonation of binding sites which makes different functional group available for Cr (VI). (Mishra Anoop Kumar, 2022).

Results

The removal of hexavalent chromium by using jamun saw dust is efficient and also cost effect. Results indicate that more adsorption show as 82% at 32°C, 6.5 pH, 50ppm adsorbate solution and 50g adsorbent dose.

Table 1. Effect of adsorbate dose

Name of sawdust	Chromium adsorption at different concentration of potassium dichromate solution in percentage reduction of saw dust				
Jammun	10 ppm	20 ppm	30 ppm	40 ppm	50 ppm
	40%	55%	60%	67%	79%

Table 2. Effect of temperature

Name of sawdust	Chromium adsorption at different temperature in percentage reduction of saw dust		
Jamun	27°C	30°C	32°C
	75%	85%	72%

Table 3. Effect of pH

Name of sawdust	Chromium adsorption at different pH in percentage reduction of saw dust		
Jamun	5.5	6.5	7.5
	65%	80%	72%

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