Removal of Heavy Metals from Electroplating Industrial Waste Water Using Activated Finger Millet Grass as An Adsorbent

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***Abstract*—Electroplating industries generate significant quantities of wastewater containing heavy metals like chromium (Cr), cadmium (Cd), nickel (Ni), and lead (Pb), which pose severe environmental and health risks. Conventional treatment methods, such as chemical precipitation and ion exchange, often fail to provide sustainable and cost-effective solutions. This study investigates the potential of activated finger millet grass (Eleusine coracana) as a low-cost, eco-friendly biosorbent for removing heavy metals from electroplating wastewater**

***Index Terms*—Electroplating wastewater, heavy metals, activated finger millet grass, biosorption, environmental remediation.**

I. INTRODUCTION

The rapid progress in industrial activities have led to the increased production of industrial waste. In addition to polluting the water, air, and soil, these industrial wastes cause serious environmental problems. Depending on the type of industry, wastewater quality and quantity vary. In addition to decaying waste like paper, leather it can also contain non-decaying waste like heavy metals, pesticides. Industrial wastewater can be hazardous, reactive, and carcinogenic in nature. As a result, discharging wastewater into water bodies without adequate treatment and management can have dreadful effects on the environment and the health of humans. In industrial effluent, toxins cause acute poisoning, immune system suppression, and reproductive system failure. Waterborne diseases account for around 80% of all diseases,according to the World Health Organization. In order to address the environmental and health issues created by industrial wastewater, it is vital that it is treated adequately with physical, chemical, and biological methods in order to recycle it for water conservation. The most important sources of pollution in the environment are industrial wastewater. A large amount of industrial effluent has been released into rivers and lakes during the last decade, causing serious pollution problems and adverse effects on humans and ecosystems. Different industries and contaminants generate different types of industrial effluent. Depending on the type of effluent generated, industrial wastewater treatment must be designed effectively. Each industry sector generates waste water based on its production process. Ministry of Water Resources, states that 40 billion cubic meter of water is used in industrial activities which is about 6% of total accessibility of water. According to Central Pollution Control Board of India, industries use about 500 billion cubic metre waters by annually. Out of this, about 10 billion cubic metreswater is used for manufacturing and 30 billion cubic metres is used for refrigeration purposes

II. METHODOLOGY

In this project the selected adsorbent is Eleusine coracana,which is commonly known as millet grass. It belongs to the family Gramineae, also known as coracan in India, kodo in Nepal, it is a annual vascular plants, grown as a cereal crop within the arid and dry areas in Africa and Asia. It is a tetraploid and pollination species most likely germinate from its wild relative Eleusine Africana. Finger millet can grow on varied soils as well as extremely warm equatorial soils.Usually one hundred gram of millet grass is reportable to contain 3.7gm protein, 0.9 gm fat, 87.3 gm total carbohydrate, 35.9 gm fiber, 110 mg Ca, 160 mg phosphorous, and 1500 mg potassium (C.S.I.R., 1948-1976). The amount of potassium in Eleusine coracana grass is high, which binds with metallic element and copper present in wastewater. Considering these factors Eleusine coracana (Finger millet) was selected as the adsorbent. (N. Gandhi et al. 2021)

2.1. Materials used

The materials used for the removal of heavy metals from electroplating industrial wastewater using activated finger millet grass as an adsorbent include finger millet grass as the raw material, which is activated using chemical agents such as phosphoric acid (H_3PO_4), potassium hydroxide (KOH), zinc chloride ($ZnCl_2$), or sodium hydroxide (NaOH) to enhance its adsorption capacity. Deionized or distilled water is used for cleaning the raw material and preparing chemical solutions. The wastewater used in the study contains heavy metals such as chromium (Cr), nickel (Ni), cadmium (Cd), zinc (Zn), and copper (Cu). Essential laboratory equipment includes a furnace or oven for drying and carbonization, grinding and sieving apparatus for preparing the adsorbent, beakers and flasks for experimental procedures, a pH meter for monitoring solution pH, a shaker or stirrer for uniform mixing, and a spectrophotometer or Atomic Absorption Spectrometer (AAS) to analyze metal concentrations before and after treatment. Neutralizing agents like hydrochloric acid (HCl) or sulfuric acid (H_2SO_4) and bases such as sodium bicarbonate ($NaHCO_3$) may also be used to adjust solution pH as needed.

2.2. PREPARATION OF ABSORBENTS

The preparation of activated finger millet grass adsorbent begins with the collection and cleaning of the grass, which is thoroughly washed with deionized or distilled water to remove impurities and then dried, either by air or in an oven at 60–80°C, until completely dry. The dried grass is chopped into smaller pieces and ground into a fine powder, which is then sieved to obtain uniform particle sizes, typically in the range of 100–200 mesh. For activation, the powdered material is mixed with a chemical agent such as phosphoric acid (H_3PO_4), potassium hydroxide (KOH), zinc chloride ($ZnCl_2$), or sodium hydroxide (NaOH) in appropriate proportions and soaked for about hours to ensure proper impregnation. The soaked material is then carbonized in a furnace or muffle furnace at high temperatures, typically between 400–800°C, under a controlled inert atmosphere for 1–3 hours. After carbonization, the activated material is cooled, thoroughly washed with deionized water to remove residual chemicals until the wash water is neutral, and then dried in an oven at 100–110°C to eliminate moisture. The prepared adsorbent is stored in an airtight container for use in experiments involving heavy metal removal from industrial wastewater.

2.3. Sample collection

Sampling process is defined as a little portion of waste water collected from required industries to determine the characteristics of a complete batch of wastewater. The sample should be taken whenever the waste is mixed and close to the centre of the flow channel, between 40 and 60 percent of the water depth, where the disturbance is at its greatest and the risk of solids subsidingis at its lowest. Avoid touching the channel bottom when rebounding on the water's surface. However, flow varies, allowances should be made for differences in water depth. Sampling from wide natural passages should be reported to transversion sample quantification. Before crushing the separate aliquots into the combined container if manual composting is being used, the various sample components should be thoroughly mixed. Rhodamine WT dye is also used as an assistance in determinant the foremost sampling locations. The specific sample aliquots needed to be preserved at the time of sample collection for manual composite sampling.

2.4 Experimental setup

The experimental setup for testing the removal of heavy metals from industrial wastewater using activated finger millet grass as an adsorbent involves several key components. A beaker is used to hold a measured volume of the wastewater sample, into which a pre-determined amount of the activated adsorbent is added. A magnetic stirrer with a hot plate is employed to ensure uniform mixing of the adsorbent in the wastewater, and the hot plate helps maintain a controlled temperature if required. A pH meter is used to monitor and adjust the pH of the solution, with precise pH adjustments achieved using a burette containing a neutralizing agent, such as hydrochloric acid (HCl) or sodium hydroxide (NaOH). This setup is arranged in a clean, well-ventilated laboratory workspace, with proper safety equipment such as gloves and goggles for handling chemicals. This comprehensive setup facilitates precise and controlled experimentation to evaluate the adsorption efficiency of activated finger millet grass.

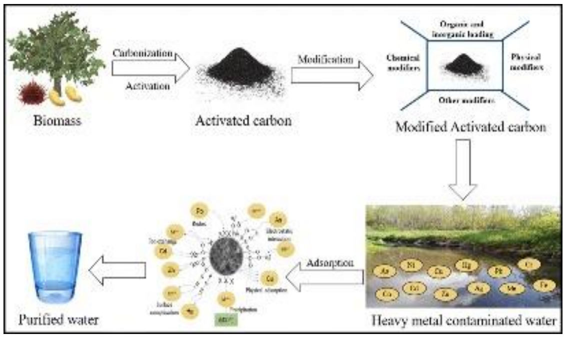

Fig 1: Adsorption process diagram

III.RESULT AND DISCUSSION

The physiochemical characteristics of the untreated electroplating industrial water were indicated in table 4. At the collection point the effluent had a pH of 7.37 and the ambient temperature was 27ºC. The variations in the temperature will govern the solubility of the salts and chemical reactions are influenced by the pH variations (K.G Akpomie et al., 2014). Hence in the entire period of adsorption experiment the temperature and pH were maintained from 27ºC and 7 to 9 respectively. From the analysis of the untreated waste water, it can be observed all the parameters are beyond the permissible limits. The COD value of waste water is found to be higher than the BOD value, indicating the greater contribution from inorganic wastes. According to the BIS standards the copper and chromium content in the wastewater before discharge to the river/public sewer/ land need to be 3 mg/l and 2mg/l respectively. From the Table 4.1 it can be noted that the copper and chromium content in the untreated wastewater is very high than recommended limits.

Table 3.1: Physiochemical Parameters of the ElectroplatingIndustry Effluent

S. NO	Parameters	Before Treatment	Units
1	pH @24.7 ºC	7.37	-
2	Alkalinity	861.17	mg/l
3	Conductivity@ 25 ºC	16590	µs/cm
4	Total Dissolve Solids	7480	mg/l
5	Total Suspended Solids	610	mg/l
6	Total Volatile Solids	354	mg/l
7	Total Settleable solids	486	mg/l
8	Total Hardness	15000	mg/l
9	Calcium	1002	mg/l
10	Magnesium	3036.3	mg/l

GRAPH 1: Effect of Dosage of Adsorbent on the removal of copper

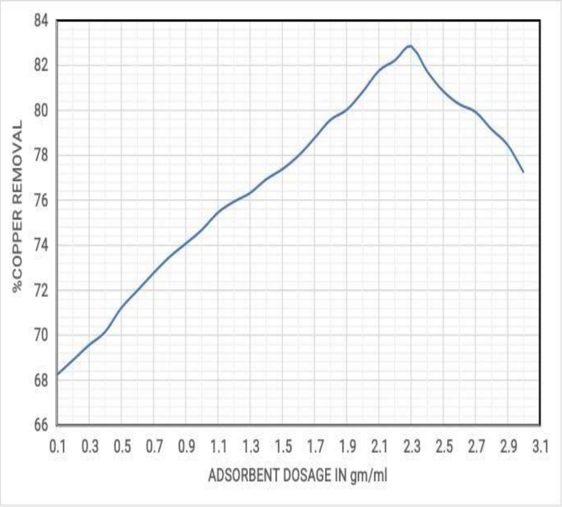

Table 3.2: Effect Of Dosage Adsorbent on The Removal of Copper

dsorbent dosage in gm/ml	Initial concentration of copper before treatment inmg/l	Final concentration of eatmentin mg/l	% of copper removal
0.1	17.53	5.57	68.23
0.2	17.53	5.46	68.89
0.3	17.53	5.38	69.31
0.4	17.53	5.31	69.75
0.5	17.53	5.28	69.92
0.6	17.53	5.24	70.15
0.7	17.53	5.15	70.65
0.8	17.53	5.05	71.21
0.9	17.53	4.94	71.84
1	17.53	4.87	72.26

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Table 3.3: Effect Of Dosage of Adsorbent on The Removal of Chromium

Graph 2: effect of dosage of absorbent on the removal of chromium

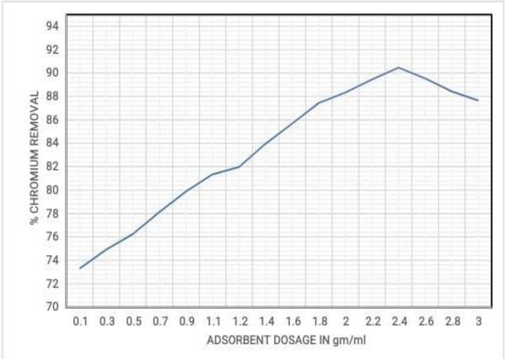
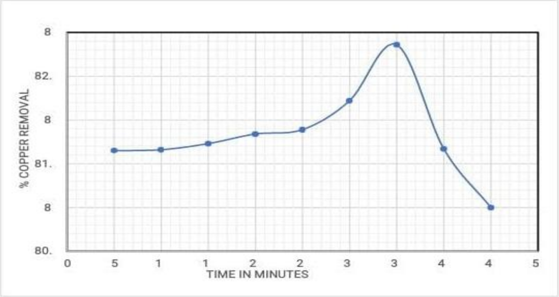


Table 3.4: Removal Of Copper with Varying Time of Contact OfAdsorbent

DOSAE (gm/ml)	TIME (min)	% OF COPPER REMOVAL
2.3	5	81.65
2.3	10	81.66
2.3	15	81.73
2.3	20	81.84
2.3	25	81.52

GRAPH 3: Removal of copper of varying Time of contact of absorbent



IV. CONCLUSION

The present study mainly focuses on elimination of the copper and chromium from the electroplating industrial effluent using activated finger millet grass as an adsorbent. The adsorption process is carried out by varing the adsorbent dosage from 0.1 to 3 gm/ml. The governing parameters like pH, time of contact and dosage of adsorbent were optimised based on the removal efficiency of copper and chromium. The phenomenon of adsorption isotherm was explained by Langmuir adsorption isotherm. Due to the homogeneous nature the obtained experimental data correctly fitted the Langmuir adsorption isotherm. The following conclusions can be derived from the present study,

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