

ASSESSMENT OF PHYSICOCHEMICAL PARAMETERS AND HEAVY METAL REMOVAL FROM WATER USING RIVER GRASS BIOADSORBENT**Vandana Rathore*, Rashmi Verma****Department of Chemistry Dr.CV Raman University Kota (C.G) India***Corresponding Author's E mail: Vandanarathore@gmail.com

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ABSTRACT

Water pollution due to heavy metal contamination poses significant environmental and health risks. This study evaluates the physicochemical parameters of water samples collected from the Hasdeo River and investigates the potential of river grass (*Paspalum paniculata*) as a bioadsorbent for heavy metal removal. River grass was processed and optimized for biosorption through SEM and FTIR analysis, confirming surface modifications and functional groups responsible for metal binding. The study demonstrated that river grass is an effective, eco-friendly, and sustainable bioadsorbent for removing heavy metals from contaminated water. These findings suggest that river grass can be utilized as a low-cost and efficient alternative for water purification, contributing to sustainable environmental management and pollution control strategies.

Keywords: Water pollution, heavy metals, river grass (*Paspalum paniculata*), biosorption, SEM, FTIR.

INTRODUCTION

Water pollution is a major global concern, with industrialization and urbanization contributing significantly to the contamination of natural water bodies. Among various pollutants, heavy metals such as lead (Pb), iron (Fe), manganese (Mn), copper (Cu), and zinc (Zn) are particularly hazardous due to their non-biodegradable nature, bioaccumulation, and severe toxic effects on human health and aquatic ecosystems. The presence of these metals in water sources beyond permissible limits can lead to adverse health effects, including neurological disorders, organ damage, and carcinogenic risks. Therefore, the removal of heavy metals from contaminated water is a critical environmental and public health challenge¹⁻⁶. Physicochemical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), temperature, and total hardness play a crucial role in determining water quality and its suitability for consumption and industrial use. Monitoring these parameters helps assess the extent of pollution and the effectiveness of water treatment methods. Conventional techniques for

heavy metal removal, including chemical precipitation, ion exchange, membrane filtration, and activated carbon adsorption, often have limitations such as high operational costs, secondary waste generation, and inefficiency at low metal concentrations⁷⁻¹¹. Biosorption using natural bioadsorbents has emerged as an eco-friendly, cost-effective, and efficient alternative for heavy metal remediation. Among various plant-based bioadsorbents, river grass (*Paspalum paniculata*) has shown promising potential due to its high surface area, functional groups capable of metal binding, and abundant availability. This study investigates the effectiveness of processed river grass as a bioadsorbent for heavy metal removal from Hasdeo River water samples. The physicochemical characteristics of water samples were analyzed and compared with BIS and WHO standards, followed by optimization of biosorption conditions, including bioadsorbent dosage, particle size, contact time, pH, and agitation speed¹²⁻¹³. Furthermore, Scanning Electron Microscopy (SEM) and Fourier Transform Infrared Spectroscopy (FTIR) were utilized to study the morphological and structural changes in the bioadsorbent before and after metal adsorption. The study aims to provide a sustainable and effective solution for mitigating heavy metal contamination in water, contributing to environmental conservation and public health protection¹⁴⁻¹⁵.

Preparation of Bioadsorbent: River Grass (*Paspalum paniculata*)

Raw river grass was collected and thoroughly washed with double-distilled water to remove impurities. The cleaned grass was then cut into small pieces and dried in a hot air oven at 100°C for 24 hours. After drying, the material was crushed and sieved, retaining particles of 52 mesh size. The selected samples were washed with distilled water and filtered through standard filter paper. To enhance adsorption properties, the samples were treated with 1N nitric acid for 12 hours, followed by repeated rinsing with distilled water to remove soluble and pigmented substances. After drying under sunlight, they were further soaked in 1N NaOH for 12 hours, rinsed with deionized water, and dried at 100°C for another 12 hours. Finally, the processed bioadsorbent samples were stored in polythene bags for further analysis¹⁶⁻¹⁸.

Preparation of Stock Solution and Working Solutions

A stock solution of lead nitrate ($\text{Pb}(\text{NO}_3)_2$) was prepared by accurately weighing 1.59 g of $\text{Pb}(\text{NO}_3)_2$ and dissolving it in 5 mL of concentrated nitric acid within a 1000 mL standard flask. Distilled water (200 mL) was added to dissolve the salt, and the solution was further diluted to achieve a final concentration of 1000 mg/L¹⁹. Working solutions were prepared using sterilized glassware by diluting

the stock solution to obtain concentrations ranging from 10 to 60 mg/L. The pH of these solutions was adjusted using reagent-grade sulfuric acid, hydrochloric acid (HCl), or sodium hydroxide (NaOH) as required for biosorption studies²⁰.

Scanning Electron Microscope (SEM) Analysis

According to Alsaeed et al., 2023, a Scanning Electron Microscope (SEM) was used to examine the surface microstructures of river grass bioadsorbents. SEM analysis relies on electron interactions with sample atoms, producing signals that provide insights into surface topography. Since SEM requires a high vacuum, the samples were thoroughly dried before analysis. SEM images of untreated bioadsorbents were captured using a Joel JSM-6390 instrument. For metal-laden bioadsorbents, samples were filtered post-biosorption, dried, pulverized, and then examined under SEM²¹.

Fourier Transform Infrared Spectroscopy (FTIR) Analysis

As per Khajvand et al., 2023, Fourier Transform Infrared Spectroscopy (FTIR) was conducted using a Perkin-Elmer GX2000 spectrometer with an auto-image microscope system to identify functional groups responsible for metal ion adsorption. Both untreated and Pb (II)-laden bioadsorbents were dried at 100°C for 12 hours and stored in a desiccator before analysis. FTIR spectra were recorded over a range of 400 to 4000 cm⁻¹ ²²⁻²³.

RESULT AND DISCUSSION

The SEM micrographs provide insights into the surface morphology of river grass adsorbents. **Figure 1** shows the pristine river grass with entangled fibers due to polymers, lignin, and cellulose. In contrast, **Figure 2** reveals the presence of new, shiny, and larger particles on the metal-loaded adsorbents, indicating significant morphological changes after lead adsorption. The FTIR spectra of river grass confirm the presence of various functional groups, highlighting its complexity as a bioadsorbent. Using a Perkin-Elmer Model GX2000, spectra were recorded from 4000 cm⁻¹ to compare raw and lead-loaded samples. Figures 4.2 and 4.3 display distinct peaks, indicating functional groups involved in lead uptake. Notable shifts and new peaks suggest interactions with lead and possible chemical modifications. The impact of adsorbent particle size on lead ion removal was systematically analyzed, revealing its crucial role in sorption efficiency. Increasing the bioadsorbent dosage from 0.5 to 3.0 g/L enhanced adsorption from 94% to 97.13%, but further increase led to a decline. Contact time significantly influenced lead biosorption, with rapid initial removal reaching equilibrium. Solution pH

(3–8) played a vital role in metal speciation and adsorption efficiency. Agitation speed also notably affected lead ion removal using river grass as a bioadsorbent.

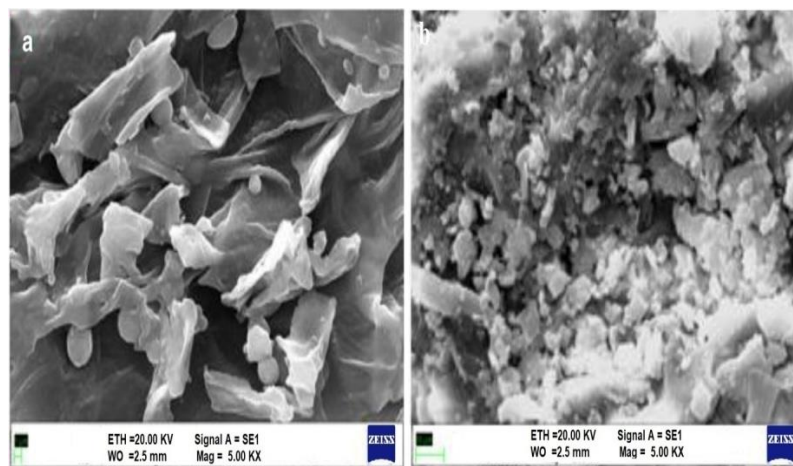


Figure 1: SEM Micrographs of River Grass (a) Before adsorption (b) After adsorption

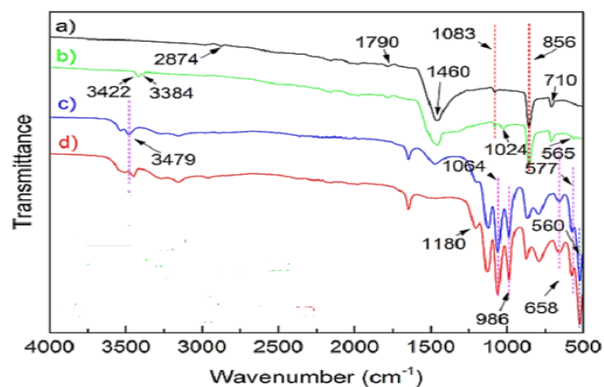


Figure 2: FTIR of river grass after adsorption

CONCLUSION

The capacity of the river grass bioadsorbent to bind and remove heavy metals through intricate surface interactions was validated by SEM and FTIR investigations, which revealed significant morphological and structural changes following metal uptake. The study emphasises river grass's potential as a cost-effective, environmentally responsible, and very successful substitute for traditional water treatment techniques. It is a viable option for extensive water purification applications due to its remarkable adsorption capacity and wide availability, which will support both public health and sustainable environmental management. To increase the bioadsorbent's practical viability, further studies could examine long-term field usage and the material's capacity for regeneration.

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