**Bulletin of Environment, Pharmacology and Life Sciences**
Bull. Env. Pharmacol. Life Sci., Vol 12 [11] October 2023 :276-281

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
**ORIGINAL ARTICLE** **OPEN ACCESS**

# Applications of Bioadsorbents for The Removal of Metal Ions from Squander Water Samples

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**ABSTRACT**
*This study's aim has to thoroughly explain the Zn and Hg adsorption performance from squandered water with the use of Aerva javanica based bioadsorbents. Nowadays, heavy metal contamination is thought to be one of the most significant environmental issues. Heavy metal ion removal from wastewater is critical because exceeding a particular concentration of toxic metals in water can be extremely hazardous and even fatal. As of late bio-sponges are being utilized to eliminate risky metal particles from squander water, albeit a considerable lot of these were viewed as ok while some were not, and extra improvements and changes are expected to expand the adsorption limit. The present research describes the use of Microwave irradiation for the rapid synthesis of Aerva javanica based bio-adsorbent and its uses for the removal of zinc(II) and mercury(II) ions from aqueous solutions. Through bunch and segment studies, the capacity of Aerva javanica blossom spongy to retain metals was researched. The agitation time, initial metal ion concentration, pH, and temperature of the tentative stock solutions were all investigated. The effects of these parameters on the removal of metal ions were observed. For zinc and mercury, the pre-focus and metal particle recuperation consequences of the segment technique were 96.9% and 97.7%, separately.*
***Keywords:*** *Industrial waste water, Bioadsorbent, Zinc, Mercury, Aerva javanica.*

Received 21.07.2023 Revised 22.08.2023 Accepted 27.10.2023

## INTRODUCTION

Water pollution is the polluting of water sources by contaminants that prevent the water from being used for purposes, such as drinking, cooking, swimming, and cleaning.The presence of heavy metal ions in water is a major component of water pollution. Numerous sources of water pollution by heavy metals are mining extraction operations, coal burning in power plants, plastics, textile industries, metal processing in refineries, microelectronics and petroleum combustion, etc[1]. High concentration of zinc ion leads to anaemia, lack of muscle coordination, abdominal pain[2]. Mercury is a particularly hazardous heavy metal. When mercury is taken up in the food chain, it accumulates in the human body and causes malfunction of various organs[3]. Numerous traditional techniques such as electro dialysis, reduction, precipitation, adsorption, reverse osmosis, evaporation and ion exchange are being used to reduce the high concentration of metal ions in wastewater[4-5]. Adsorption is a simple, inexpensive, and efficient process for removing heavy metal ions from wastewater at low and medium concentrations, therefore it is received a lot of attention. Lately scientists have been working to develop a bioadsorbent that is suitable for adsorbing metal ions and possesses a significant capacity for adsorption[6-7]. Recently rice husk[8], algal biomass[9], sugarcane waste[10], waste materials from plant(like neem wood, sawdust, pine cone wood, almond shell, walnut shell etc.)[11], plant wastes activated carbon[12], Coffee waste powder[13] and watermelon rinds[14] is used as a bio-adsorbents for efficient removal of hazardous metal ions from aqueous solution.The aim of the present work is to employ the low-cost Aerva javanica based bio-absorbent for the removal of Zinc(II) and Mercury(II) from wastewater[15]. It is a desert plant of an Amaranthaceae family that is used as anthelmintic, Also used as an anti-diarrheal and anti-carcinogenic drug[16].The trace evaluation of these metal ions in diverse samples has been effectively carried out using the novel Green bio-adsorbents, which are superior[17].

## MATERIAL AND METHODS

### Apparatus

The ECIL model 5651A digital pH meter and the Shimadzu AA-640-13 atomic absorption spectrometer were utilized. A glass column tube of 7 mm and 100 mm in internal diameter has been employed in the chromatographic column.

### Materials and solvents

A stock solution has been prepared by dissolving the salts of Zn(II) and Hg(II) ions in double distilled water and used after standardization. All the chemicals used are AR grade. Commercial samples have been taken from industrial areas of Bikaner zone, drainage and sewerage water of the city. The Green adsorbents, Aerva javanica flowers were collected from Shobhasar forests in the periphery of Bikaner, Rajasthan and authentication have been done at "Post Graduate Department of Botany, Government Dungar College (NAAC 'A' Grade), Bikaner".And it was used after its complete drying.

### General Procedure

For the purpose of the research, the batch approach and the column approaches have been applied.

### Batch method

The pre-concentration of Zn(II) and Hg(II) ions is carried out by a batch technique at 25˚C. The stock solution has been diluted with double distilled water to make different concentrations of different metal ion solutions from 100 - 10 ppm. A certain amount of green adsorbent (0.08g) was mixed with 10 ml of different solutions of Zn(II) and Hg(II) ions in a thermostatted shaker at the appropriate temperature and the desired shaking speed was adjusted. The pH of every mixture was retained between 3.0–9.5 (zinc 3.5–9.0 and mercury 3.0–8.0) whichever by borate buffer or sodium acetate[18].After some time the green adsorbent is allowable to snuggle down, the supernatant solution is separated, and an atomic absorption spectrophotometer(AAS) is used to measure the concentration of metal ions in the supernatant solution[19-20].

### Column method

In the column method, 0.08 g of green absorbent is packed to a height of approximately 16 mm in a glass column with a length of 50 mm and an inner diameter of 7 mm. the material was eluted with 7.0 ml of the proper buffer solution(pH 3.0 to 9.5, liable on the optimum pH range of metal ions), subsequently, 15 ml of the metal ion (20ppm) solution for 40 min at the same pH was maintained and then allowed to pass over the column at a flow rate of 0.8 ml/min. With the help of 15 ml of 0.05N $HNO_3$, the adsorbed metal ions were removed from the column, and their concentrations were then measured with an atomic adsorption spectrophotometer (AAS)[21-22].

## RESULT AND DISCUSSIONS

### Operational parameters' effects on the adsorption process

The effect of various parameters such as pH, initial metal ion concentration, contact time, adsorbent dosage and temperature has been studied in order to understand the process of removal of metal ions from aqueous solutions using Aerva javanica Flowering Tops adsorbent[23-25] (Table 1).

**Table 1- parameters that were evaluated for batch experiments**

| Parametric study | Metal ion concentration (ppm) | Temperature (°C) | Agitation time (min) | pH | Adsorbent dosage (g) |
|---|---|---|---|---|---|
| Adsorbent dosage | 10 | 25 | 70 | 6.0 | **0.02-0.16** |
| pH | 10 | 25 | 70 | **3-9.5** | 0.1 |
| Agitation time | 10 | 25 | **30-90** | 6.0 | 0.1 |
| Temperature | 10 | **15-40** | 70 | 6.0 | 0.1 |
| Metal ion concentration | **10-100** | 25 | 70 | 6.0 | 0.1 |

### Effect of the green adsorbent's quantity

To find out the effect of amount of green adsorbent, different amount of green adsorbent has been tested for the adsorption of metal ions by batch and column method. Keeping other factors constant, it is observed that 0.1g quantity of green adsorbent shows maximum adsorption capacity[26](Fig.1).

 

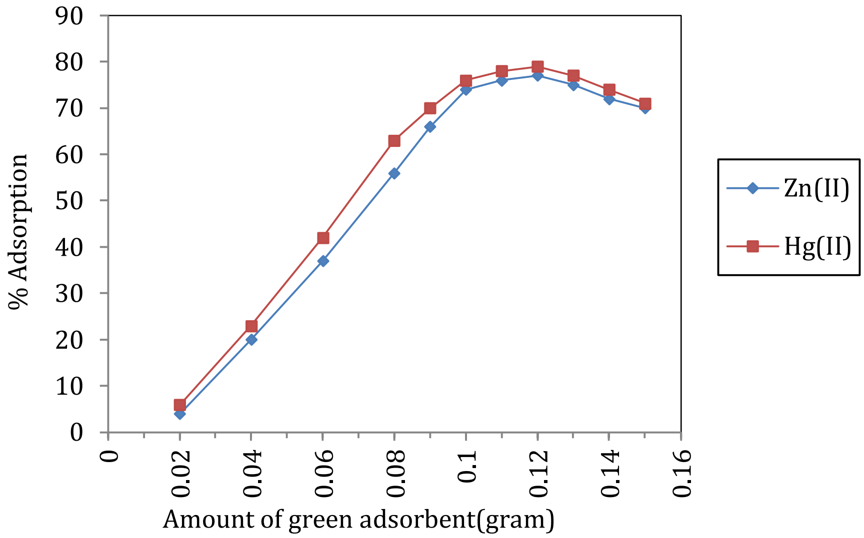


**Fig. 1 Effect of the green adsorbent's quantity on the adsorption of metal ions**

**pH Effect**

It has been investigated how pH affects the conception of metal ions on a column filled with green adsorbent. Adsorption of zinc and mercury ions from aqueous solutions was quantitatively studied in the pH range of 3.5–9.0 and 3.0–8.0, respectively. The ideal pH selected for further investigation is 8.0 for Zinc and 6.0 for Mercury[27] (Fig.2).

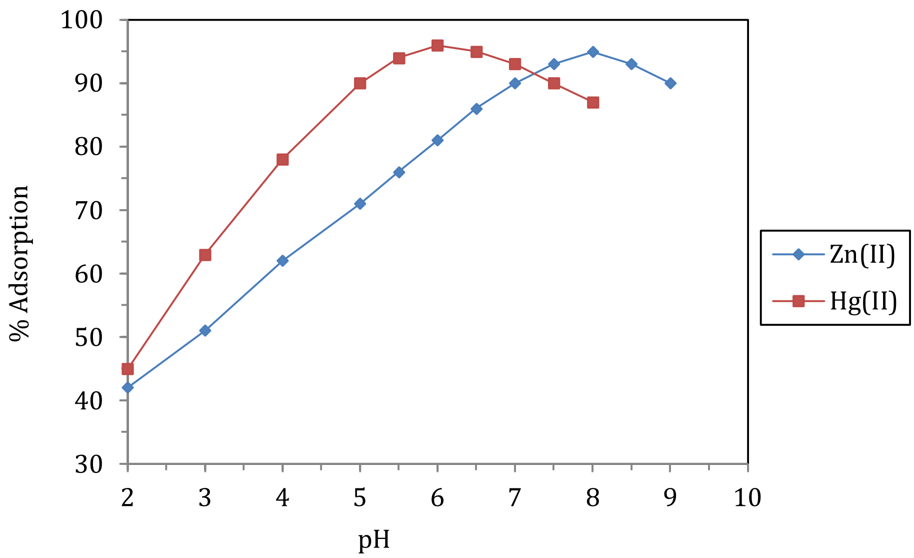


**Fig. 2 Effect of pH on metal ion adsorption**

**Optimization of adsorption time**

The speed with which the solid phase adsorbs metal ions from the aqueous solution and reaches a state of equilibrium is of great importance. It has been found that the time necessary to reach equilibrium is nearby 55 min for Zn and 50 min for Hg although equilibrium has been accomplished in between 6-8 minutes by using microwave radiation[28].

**Adsorption isotherms**

The uptake of Zn(II) and Hg(II) using bio-adsorbents as a function of metal ion concentration in a solution was determined by using batch and column methods. The adsorption isotherm signifies a good linear relationship over a relatively wide range of tested ion concentrations (Fig. 3). The approximate average value of D was nearly established to be $4.2 \times 10^2$ for Zn and $4.0 \times 10^2$ for Hg. Where D (distribution coefficient) has been distinct as D = N1/C, N1 is in mmol per gram and C in mmol per ml.Green adsorbents' adsorption capacity was plotted against the quantity of metal ions, and the intercept was virtually zero

(0.002). The adsorption isotherm plot's regression analysis showed that the association was strong, $R^2$ = 0.996[29].

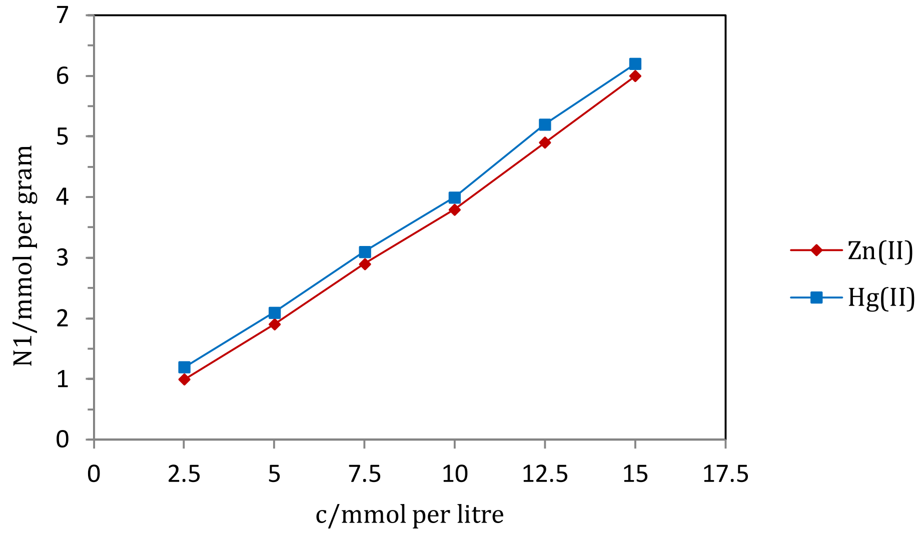


**Fig. 3 linear adsorption isotherms**

**Effect of temperature**

Temperature also has a role in the adsorption of a metal ion onto an adsorbent. The percentage adsorption and distribution coefficient of the complex reaction was observed to rise with temperature up to 35 °C, then it stayed constant up to 40 °C, followed by a minor drop.

**Effect of flow rate**

Adsorption of metal ions on green adsorbent was studied at different solution flow rates by column method. A column was run through for each metal ion solution (100 ml) containing 50 g of the ion at a flow rate ranging from 0.5 ml to 3 ml per minute. In the specified range, the adsorption is quantitative and repeatable. The optimal flow rate for improved adsorption was maintained at 1.2 ml per minute.

**Preconcentration and recovery of metal ions**

Each metal was run down a column at a rate of 1.2 ml per minute in varied volumes of samples in order to examine the performance of green adsorbent for Preconcentration Zn(II) and Hg(II). Recovery rates for Zn(II) and Hg(II) after the metal ions were eluted from the columns were 96.8% and 97.6%, respectively. These findings imply that large concentrations of these metal ions can be effectively concentrated from dilute aqueous solutions using the green adsorbent[30] (Table 2).

**Table 2- Preconcentration and recovery of Metal ions**

| Metal ions | Conc. (µg/ml) | Vol. of eluent (ml) | Recovery | |
|---|---|---|---|---|
| | | | (µg/ml) | % |
| Zn | 10 | 20 | 9.69 | 96.9 |
| Hg | 10 | 20 | 9.77 | 97.7 |

**Electrolytes effect**

It has been studied how different electrolytes, including sodium chloride, magnesium sulfate, calcium chloride, and potassium nitrate, affect the adsorption of metal ions by green adsorbents. It was found that the electrolytes had no impact on the green bio-adsorbents' ability to bind metal ions.

**Determination of Zinc and Mercury in different commercial samples**

A commercial sample of 200 ml was collected from many locations, and the metallic components were separated and dissolved in hydrochloric and sulphuric acid in turn. Residue was dissolved in nitric acid following filtering. A 250 ml Erlenmeyer flask was filled with 100 ml of the commercial sample. It underwent numerous rounds of nitric acid and sulphuric acid digestion. The majority of the acid was evaporated, and the remaining portion was neutralized using a 0.5% NaOH solution before double-distilled water was added to create the final volume.Using the borate buffer solution to maintain a pH of 7.0, aliquots of 4 ml from this solution were obtained and diluted to 20 ml. This solution was run over a column containing 0.12g of Aerva javanica, eluted with 0.05N $HNO_3$, and it's Zinc and Mercury content was calculated by AAS. A 96–98% recovery rate was discovered[31-32]. Results are given in Table 3.

**Table 3 Determination of Zinc and Mercury in commercial sample**

| Sample | Determination of Zinc | | | Determination of Mercury | | |
|---|---|---|---|---|---|---|
| | Zn added (μg/ml) | Zn det. (μg/ml) | % Recovery | Hg added (μg/ml) | Hg det. (μg/ml) | % Recovery |
| (A) | - | 15 | - | - | 14.9 | - |
| | 10 | 24.1 | 96.4 | 10 | 24.3 | 97.59 |
| (B) | - | 12 | - | - | 17.4 | - |
| | 10 | 21.4 | 97.2 | 10 | 26.9 | 98.17 |
| (C) | - | 18 | - | - | 15.2 | - |
| | 10 | 27.1 | 96.8 | 10 | 24.7 | 98.01 |
| (D) | - | 11 | - | - | 13.5 | - |
| | 10 | 20.4 | 97.1 | 10 | 22.9 | 97.44 |

## CONCLUSION

It is highly advantageous to utilize this bio-adsorbent to remove pollutants from the environment and GMBR may be used efficiently for the manufacturing of green adsorbent.These Aerva javanica-based green adsorbents can efficiently remove the Zn(II) and Hg(II) ions from a variety of aqueous samples. The solid phase extraction technique exhibits quick ion-exchange kinetics, high adsorption efficiency, and a strong correlation of the outcomes with the Langmuir isotherm model. For the detection and recovery of trace Zn and Hg in a range of commercial samples, the suggested approach is quite helpful.

**Declaration of Competing Interest:**

The authors report no declarations of interest.


## ACKNOWLEDGEMENT

One of the author (Kanhaya Lal) is thankful to UGC, New Delhi for the award of JRF


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## CITATION OF THIS ARTICLE

Kanhaya Lal, Divya K Shekhawat, Gautam Kumar Meghwanshi and N. Bhojak. Applications Of Bioadsorbents For The Removal Of Metal Ions From Squander Water Samples. Bull. Env.Pharmacol. Life Sci., Vol 12 [11] October 2023: 276-281