



REMOVAL OF HEAVY METALS FROM CONTAMINATED WATER BY SALVINIA MOLESTA, EICHHORNIA CRASSIPES AND CRAB SHELL SODIUM ALGINATE BEADS

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ABSTRACT:

Water is the essential part for a human being to live and it is utilized for various purposes. Water treatment is evident and the most important segment in segregation of contamination from the water so that the water can be useful for other sources. This study explains how bad the water has been contaminated due to various industries and anthropogenic activities. The X-ray Fluorescence gives the varied points of the specific elements such as Nickel, Arsenic, Lead, Chromium, Cadmium and Mercury. The toxicity level is observed and it is reported with graphical representation from the instrument. The toxicity level is deteriorated by treating it with Seaweed *Salvinia molesta* and *Eichhornia crassipes* and crab shell powder by combining the seaweeds and crab shell powder with sodium alginate beads for the treatment. The variation and reduction after treating it with seaweed and crab shell powder showed a difference in the X-ray fluorescence report.

KEYWORDS: Water, Contamination, reduction, seaweeds, Crab shell powder, Sodiumalginate beads.

1. INTRODUCTION

Water is one of the most essential components for living beings to survive on a daily basis. Despite the fact that water is abundant on the planet, we only have access to 2.5 percent of it as fresh water. Humans, plants, and animals all benefit from clean water. In this case, humans use water to break down larger compounds into smaller substances and move them to other body regions as part of the metabolic process. Harmful substances have contaminated the water; it must be treated before it can be consumed by humans. Likewise, contaminated water can be harmful to plants and animals if their metabolic processes are exposed as a result of drinking it (Hasan, H. A., et al 2020). Lakes are one of the most significant sources of freshwater, but they are becoming increasingly contaminated as a result of increased urbanization, rapid industrialization, and pesticide use in agricultural activities (Priyanga, G., et al., 2015). Certain harmful metals can persist in the environment for prolonged periods of time and cause harm. They can eventually Bio accumulate to higher amounts over time, posing a threat to human health, animals, and plants (George, G.T., et al 2017). Phytoremediation, on the other hand, is low-cost. Wastewater treatment is defined as the purposeful utilization of green plants to remove or eliminate pollutants from the environment, such as heavy metals, trace elements, organic molecules, and radioactive compounds in many aquatic ecosystems (Zaidi, J., et al 2017). Water bodies with thick macrophyte vegetation have less turbidity and lower organic matter concentrations. As a result, these aquatic plants play an important role in determining the water quality of shallow water columns and have the potential to polish polluted water. (Ng, Y. S., et al 2017). *Eichhornia crassipes*, popularly known as water hyacinth, has generated a lot of attention as an aquatic plant that has the potential to absorb toxins from aquatic environments quickly. *Salvinia molesta* (*S. molesta*) is a floating aquatic fern that is used to remove heavy metals from wastewater through phytoremediation. It prefers nutrient-rich water, such as eutrophic water and contaminated water.

2. NEED OF THE STUDY:

Soils become polluted due to the accumulation of industrial wastes and other external factors and the lakes and ponds are as well besmirched. This study asserts that the remediation for the lake water in Pallavaram Lake in Chennai by cost-efficient materials, a combination of seaweed and crab shell powder is given in the form of Sodium alginate bead used for the effective removal of heavy metals especially cadmium and lead from the lake water. The analysis and remediation of the water treatment by organic materials will pave the way for the blooming researchers and spread awareness for the localities and industrialists not to expose the effluents into the water.

3. MATERIALS AND METHODS

3.1 Collection of crab sample

The raw materials used in the present work include the exoskeletons of crabs. The *Scylla serrata* crab was collected from the Corporation Fish Market at Nadukuppam, near Marina Beach in Chennai. The carapace was cut from the crab. The carapace was washed thoroughly with water until the unwanted particles were removed. It was air dried for an hour at room temperature after washing.



Fig: 1. *Scylla serrata* crab

3.2 Materials required

Hot air oven, Vortex, Sieve the dried water hyacinth leaves are kept in a hot air oven for 2 days at 50 to 60⁰ c, then the dried hyacinth is made into a coarse powder and vortexed. Then the coarse powder is sieved, and the hyacinth is made into a fine powder. This powder is stored inside an airtight container.

3.3 Collection of *Echhornia Crassipes* (Seaweeds)

Samples of water hyacinth were collected from Narayanapuram Lake located in Pallikaranai, Chennai. The water hyacinth plant was collected in clean plastic bags. The plants were half submerged in the water. The whole plant was collected and only leaves were separated. The leaves were washed with running tap water to remove the unwanted dust particles and then it is dried in sunlight for 2 to 3 days.



Fig 2. *Echhornia Crassipes*

3.4 Collection of *Salvinia molesta* (Seaweeds)

A sample of *Salvinia molesta* plants used in this research work was obtained from Koovathur in the Kanchipuram district. The *Salvinia* plant is collected in plastic bags. The collected plant samples were washed with tap water to remove sand particles. Then the *Salvinia* leaves are isolated from the plant. The leaves of *Salvinia* are dried in sunlight for 2 to 3 days.



Fig 3. *Salvinia molesta*

3.5 Preparation of *Salvinia molesta* Powder

The dried *Salvinia* is kept in a hot air oven for 2 days at 50 to 60° c. The dried *Salvinia* is made into coarse powder using Vortex. Then the coarse powder is sieved and the *Salvinia* is made into fine powder. The *Salvinia* powder is stored in the airtight container as followed by *Eichhornia crassipes*.

3.6 Collection of water sample

The water sample was taken from the Pallavaram lake (Periya Lake) in Chennai. These water samples are contaminated with harmful heavy metals which are unsafe for human consumption



Fig 4. Water sample collection site

3.7 Methodology

Batch 1: *Salvinia molesta* and crab shell powder

Batch 2: *Eichhornia crassipes* and crab shell powder

Batch 1: (*Salvinia molesta*, crab shell powder and sodium alginate beads)

30 g calcium chloride is taken and it is dissolved with 200ml of distilled water (deionized water) and it is chilled using a deep freezer. Then 0.4 g of sodium alginate powder, 1 g of *Salvinia molesta* powder, 1 g of crab shell powder is taken in a beaker and 40 ml of distilled water is added into it so that combination of three powder that is completely dissolved in distilled water and again it is stirred continuously until the powder dissolves into the solution. The obtained emulsion is taken in an injecting pump and added drop wise to chilled 30 g calcium chloride solution prepared in 200 ml distilled water. But here, only 100 ml of solution was taken from that and obtained emulsion is added drop wise. Formation of beads can be seen now. *Salvinia molesta*, crab shell powder and sodium alginate beads are now ready for the treatment of contaminated lake water. 20 beads are taken carefully and put inside the 10 ml of collected lake water sample. This beads are treated for 14 days in the water sample.

3.8 X-RAY FLUORESCENCE SPECTROMETER(XRF)

When electrons are accelerated at high voltage and bombarded against the metal anode, x- rays are generated the window for recovering the incident x-ray is generally made of beryllium foil. For specific applications, beam filters are used to filter out unwanted or interfering components of tube radiation, improving the signal-to-noise ratio.

3.9 Biological oxygen demand

Titration box containing the titration apparatus. The inside walls should be covered with white lab paper to aid in end point detection. Burette for thiosulfate titrations Clean, dry 125 mL Erlenmeyer flasks (one per titration-125 mL beakers can also be used) Glass eye dropper bottle for starch indicator.

3.10 Procedure

Take 100 ml of lake water sample and fill the water in a reagent bottle closed with a stopper. The stopper is removed and 1 ml of magnesium chloride is added to the reagent bottle and is followed by addition of 1ml of alkaline iodide using pipette. The Reagent bottle is closed with a stopper and turned well upside down to mix the reagents. Allow it to store for 2 minutes which results in formation of white color precipitates in the bottom. Without disturbing the bottle add 1ml of conc.H₂SO₄ and mix thoroughly, by closing the stopper. It will turn the solution into a pale yellow color.

From this take 50 ml of sample in a conical flask and add a few drops of 1% starch, it will turn solution into blue violet color. After this titrate it against the sodium thiosulphate in burette. Disappearance of blue Color indicates the end of titration process and final reading is noted from burette. To get concordant value, titration is repeated and Biological oxygen demand (BOD) is calculated.

Table 3.10 Dissolved oxygen concordant values

S.NO	Volume of the Sample	Burette Reading (ml)		Volume of the sample titrated with Sodium thiosulphate	Concordant Value
		Initial (ml)	Final (ml)		
1	50 ml	0	1.4	2.8	2.8
2	50 ml	1.4	2.8		

3.11 Estimation of salinity

Take 10ml of the water sample is taken in a conical flask. The sample is filtered first if it contains a lot of suspended matter. Add 2 drops of potassium chromate indicator solution in the water (test sample). Silver nitrate (AgNO_3) solution taken in a burette is run into a test sample(water). The flask is swirled during the addition of AgNO_3 . The titration is continued until the precipitate is formed and solution turns into brick red color. This color is the end point of the experiment. 10ml of the water sample is taken in a conical flask.

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Table 3.11 Concordant Value for Estimation of Salinity

S.NO	Volume of the Sample	Burette Reading (ml)		Volume of the sample titrated with Silver nitrate	Concordant Value
		Initial (ml)	Final (ml)		
1	50 ml	0	4.5	4.5	4.5
2	50 ml	4.5	9		

3.12 Determination of total suspended solids (TSS)

Take clean whatman filter paper and measure the initial weight of the paper using analytical balance. Place a filtration apparatus with a weighted filter in the filter flask. Mix sample well and pour 50 ml of collected lake water sample into a graduated cylinder. Pour 50 ml into the filtration apparatus. Draw sample through filter into filter flask. Rinse graduated cylinder into filtration apparatus with three successive 15ml portions of water, allowing complete drainage between each rinsing. Continue suction for three minutes after filtration of final rinse is completed. Dry filter in an oven at $103-105^\circ\text{C}$ for at least 1 hour. Cool filter in desiccator in room temperature. When cool, weigh the filter and support.

Table 3.12 Calculation for Total suspended solids (TSS)

DESCRIPTION		WEIGHT (g)
Weight of the clean filter paper	W_1	1.1354
Weight of the filter paper & the residue	W_2	1.1515
Weight of the residue (g)	W	0.0161
Volume of the sample (ml)	V	50
Total suspended solid (mg/L)	TDS	322

4. RESULTS AND DISCUSSION

The main purpose of this study is to remove heavy metal concentration in lake water using *Salvinia molesta*, *Eichhornia crassipes*, and crab shell powder. The heavy metal chosen for this study was cadmium (cd), Mercury (Hg), Lead (Pb). The contaminated lake water collected was pallavaram lake (Periya Lake) in Chennai. The lake water was analysed before treatment with X-ray Fluorescence and after 14 days of treatment with sodium alginate beads of *Salvinia molesta* and crab shell powder in one batch. The sodium alginate beads of *Eichhornia crassipes* and crab shell powder in another batch for the estimation of heavy metals such as the cadmium (cd), Mercury (Hg), Lead (Pb) by X-ray Fluorescence Spectrometer (XRF).

4.1 Heavy metal concentration in lake water before treatment

Analysis of contaminated lake water samples before treatment, the heavy metal concentrated level was given in the graph below. The concentration of heavy metals was cadmium (1843.423cps), Mercury (286.021cps), Lead (929.375cps), Nickel (96.693cps), chromium (20.185cps), Arsenic (-638.459cps). The pH level of the lake water sample before treatment was 8(Alkaline).

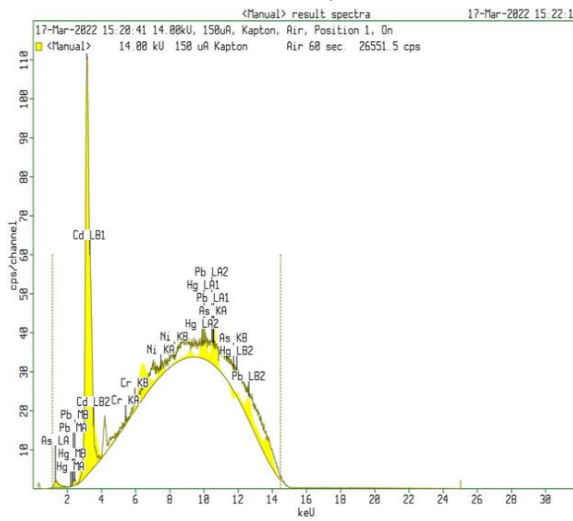


Fig 5. Before treatment the level of Cadmium, lead, mercury, Chromium, Arsenic and Nickel is high. With a pH level of 8.

4.2 Comparison of Batch 1 (*Salvinia molesta*) and Batch 2 (*Eichhornia crassipes*)

The removal of lead concentration in batch 2 (*Eichhornia crassipes*) is higher than the batch 1 (*Salvinia molesta*). So, water hyacinth, crab shell powder sodium alginate beads has highest efficiency for removing lead. The reduction of cadmium level is higher in batch 2 than batch 1. This implies that water hyacinth (*Eichhornia crassipes*), crab shell powder sodium alginate beads has highest efficiency for removing cadmium.

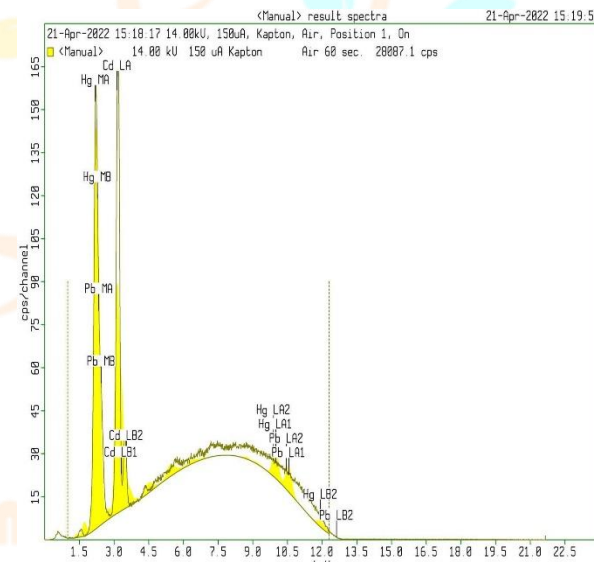


Fig 7. Graph showing reduction of heavy metal concentration after 14 days of treatment with *Salvinia molesta* and crab shell powder sodium alginate beads

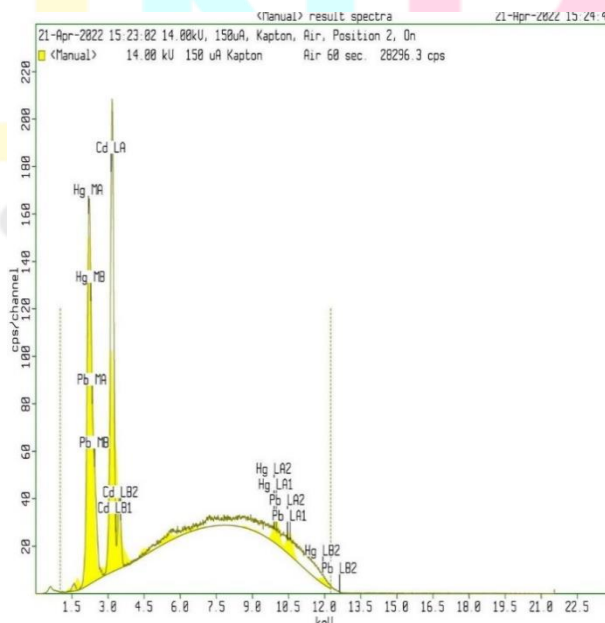


Fig 8. Graph showing reduction of heavy metal concentration after 14 days of treatment with *Eichhornia crassipes* and crab shell powder sodium alginate beads

4.3 Output of the water after treating it with Seaweeds and Crab shell powder

Table 4.3 Outcome after the treatment

Removal of Heavy Metals	Greater and Lower	Seaweed + Crab shell powder
Lead	Batch II > Batch I	More efficacy for the removal of lead by Eichhornia crassipes + Crab shell powder
Cadmium	Batch II > Batch I	More efficacy for the removal of Cadmium by Eichhornia crassipes + Crab shell powder

5. CONCLUSION

Lead is non-essential component of the human body. Lead that enters the human body through the food chain cannot be decomposed and accumulates in the body for a longer time, causing harm to the intestinal and nervous systems and a variety of physiological disorders such as colic, headaches, insomnia, and convulsions. Furthermore, lead has a stronger impact on children during their growth. Children are 30 times more susceptible to lead ion than adults, according to previous studies, and enough lead can significantly impair their capacity to communicate, remember, and pay attention. As a result, research into the removal of lead ions from water is critical (Li, K., *et al* 2018)

Sodium alginate remove the lead and cadmium in the water because water molecules pull the sodium and lead ions apart, breaking the ionic bond that held them together. After the salt compounds are pulled apart, the sodium and lead atoms are surrounded by water molecules. Adsorbents synthesized from sodium alginate have shown greater absorption capacities and high removal rates for heavy metal ions after surface grafting and cross-linking

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