Research Article

Microwave-assisted Digestion for Determination of Pb, Mg, Mn, Cd and Zn in *Salvinia molesta* by Flame Atomic Absorption Spectrometry

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ABSTRACT

The most important sorts of contaminant in the environment are heavy metals. Several methods are there for the removal of heavy metals in the environment, but most of them are costly and difficult to get optimum results. Currently, microwave assisted digestion process for the extraction of plant extracts is an effective and affordable technological solution which used to extract and then further removal of inactive metals and metal pollutants from contaminated soil and water. This technology is environmental friendly and potentially cost effective. In the present study, the presence of heavy metals such as Lead, Zinc, Cadmium, Manganese and Magnesium were quantitatively estimated from the leaf part of the *Salvinia molesta*. These heavy metals were analyzed using Atomic absorption spectrophotometry (AAS). The obtained results revealed that the content of heavy metals (less than 10ppm) was within the permissible levels, except cadmium and lead. The results revealed that *Salvinia molesta* can grow healthy with the accumulation of these metals. Further this plant material can be used for the production of biodiesel.

Keywords: Heavy Metal Analysis, Accumulation, *Salvinia molesta*, AAS.

INTRODUCTION

Metal analysis of plants is an essential feature of environmental, biological and chemical research. Metals in plants display biological activity as essential or toxic agents, hence being important to establish their normal concentration range and evaluate their role as part of the food chain. Similarly, on the other hand, human actions often mobilize and redistribute natural substances in the environment so much so that they can cause adverse effects[1,2]. The higher concentration of heavy metals in sediments, sludge and soils were transformed into groundwater and plants, may have a negative effect on human health as well as animal health[3]. Hence, removal of heavy metals from the environment using bio-accumulation process is advisable.

Phytoremediation is the natural ability of certain plants which will undergo bioaccumulation and biodegradation process. Microwave-assisted acid solubilisation has proved to be the most suitable method for the digestion of complex matrices such as soils and sediments containing oxides, clay, silicates and organic substances. This procedure allows shorter digestion times and good recoveries also for very volatile elements. In addition, it reduces the risk of external contamination and requires smaller quantities of acids, thereby improving detection limits and the overall accuracy of the analytical method.

Salvinia molesta is an aquatic fern commonly known as giant salvinia and kariba weed which is a free floating plant on surface of water and native to southern eastern part of Brazil[4]. It grows in slow moving water (or) still water like ponds, lakes, rivers and prefers nutrient rich water such as eutrophic water and polluted water. The plant grows best at pH less than 7.5 and the Optimum temperature range is 25-36^{o}C[5,6]. Even though the entry of *S. Molesta* in India involves in different views, but it was first observed in Veli Lake, Trivandrum and in 1964 it assumed pest status[7]. It is used for the treatment of blackwater effluent in eco-friendly sewage system[8,9]. This plant can accumulate and remediate the heavy metals present in the soil and water, because of this reason removal of heavy metal[10-15]. Hence, in the present study, the presence of heavy metal accumulation by the plant was successfully determined using atomic absorption spectrophotometric method. The extraction of plant extracts was done using microwave assisted digestion process.

Figure 1: Represents *Salvinia molesta*

MATERIALS AND METHODS

Collection of the plant materials

Salvinia molesta was collected from leather industrial area in Kerala, India. After collecting the plant material, it is washed using distilled water, further the plants were dried at shade and powdered.

Reagents and Standards Stock Solution

Standard sample solutions of Cd, Pb, Mg, Zn, and Mn (1000 mg/mL) were obtained from Merck (Germany). All the solutions were prepared using double distilled water.

Standard Solution Preparation

Metals like Mn, Pb, Zn, Cd and Mg were collected in the form of salts as shown in the tabular column from Environmental Quality Management Laboratory at VIT University, Vellore.

The fraction of molecular weight of the salt to the atomic weight of the metal gives the amount of salt required to prepare the 1000ml of stock solution

The standard solutions of 10ppm, 20ppm, 30ppm, 40 ppm and 50ppm were prepared from the stock solutions for each salt.

Sample Preparation

About 0.1 g of sample were weighed into the Teflon vessel, and then, a mixture of 5 ml 69.5% m/m nitric acid and 0.5 ml 48% m/m hydrofluoric acid was added.

The digestion vessel was closed and heated in the CEM microwave oven for a preselected program (i.e. two stages of 1 min at 40 and 80 psi, and a final stage of 5 min at 120 psi). Once the digestion program was finished, the reactor was cooled in an ice bath before opening.

The contents of each vessel were heated to dryness and dissolved with 1 ml of 37% m/m hydrochloric acid. The solution was quantitatively transferred into a 5-ml volumetric flask and made up to volume with deionised distilled water. The prepared solution was used for the AAS analysis.

Analysis of Heavy Metals using AAS

Metals like Mg, Mn, Cd, Cu, and Mg were analyzed using AAS which is equipped with flame and graphite furnace. The metal content in the sample were determined by using Air-Acetylene flame.

RESULTS AND DISCUSSION

The heavy metals present in the whole plant Salvinia molesta were analyzed using AAS. They are non-degradable and can be accumulated in the plant tissues. The metals chosen for this study were Magnesium, Zinc and Cadmium, Lead and Manganese, since they are extremely toxic even in very small amounts. The results of the quantitative estimation of heavy metals using atomic absorption spectrometer are presented in Table 1.

Table 1: Showing the elements with their corresponding concentrations

Heavy Metals and corresponding concentrations			
S. No	**Elements**	**Wavelength (nm)**	**Concentration (ppm)**
1.	Mn	279.5	2.924±0.0016
2.	Mg	248.3	4.567± 0.0016
3.	Zn	285.2	5.228±0.0014
4.	Pb	228.8	5.856±0.0021
5.	Cd	324.8	7.425±0.0018

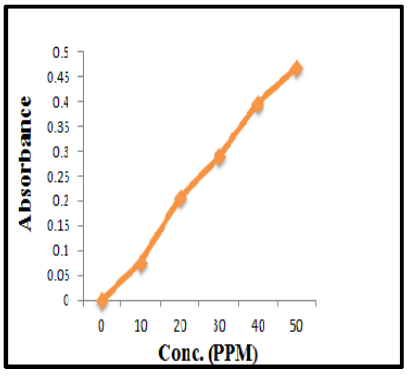

Figure 2: AAS for Manganese

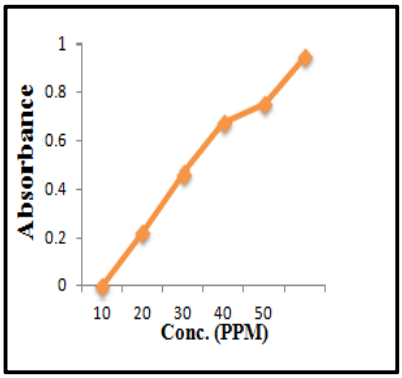

Figure 3: AAS for Magnesium

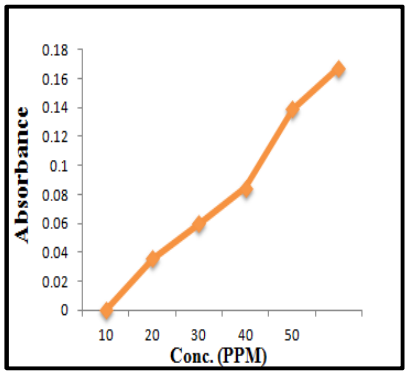

Figure 4: AAS for Zinc

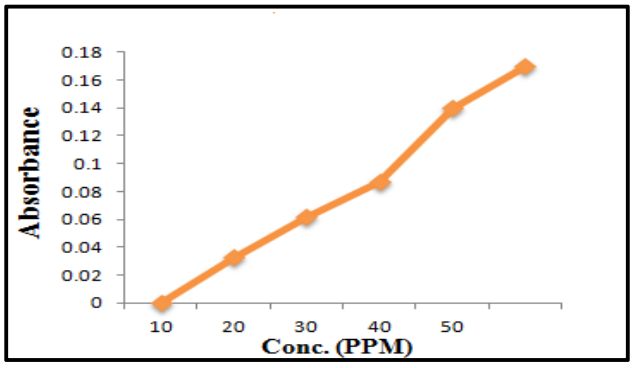

Figure 5: AAS for Cadmium

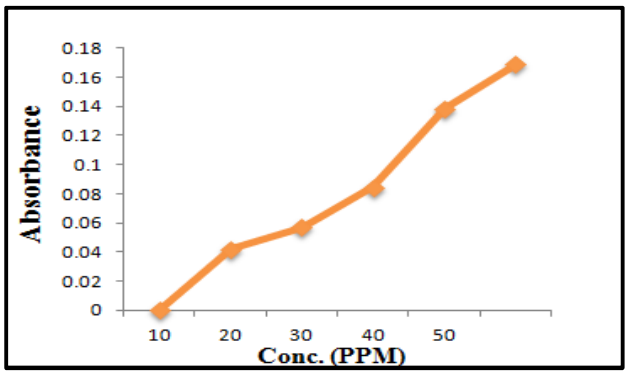

Figure 6: AAS for Lead

Based on the results, mentioned in the Table 1, metals like cadmium and lead were in higher limits. The plant material was collected from industrial polluted area of Kerala. From the results, we can clearly confirm that *Salvinia molesta* consumed the heavy metals like cadmium and lead, but still there is no change in the growth regulation process. This is one of the best evidence for the accumulation of heavy metals by *Salvinia molesta*. On the other side, the plant contains high percentage of lipids nearly 50-60%, which can be used for the production of biodiesel. The heavy metal concentrations were characterised using atomic spectrometer. The samples were analysed through standard solution of their respective metal salts. The results were compared with calibrated standard solutions.

CONCLUSION

In the conclusion, heavy metals like Cd, Pb, Mn, Mg and Zn were analysed in *Salvinia molesta*. The analyzed plant samples from the specified locations have an insignificant amount of Cadmium and Lead, although a relative higher content was observed in a contaminated environment but still below the toxicity level. *Salvinia molesta* utilised these heavy metals for their growth regulations. Therefore, it is appropriate to analyze the content of heavy metal in herbal plant in order to decrease the possibility of heavy metal toxicity to the people. Our study proves that plant selected by us accumulate metals in assimilation organs and roots. Thus, they can be recommended as indicators for determination of pollution levels of the environment.

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