

Salvinia auriculata: Aquatic bioindicator studied by instrumental neutron activation analysis (INAA)

Daniel Crístian Ferreira Soares^a, Ester Figueiredo de Oliveira^a, Grácia Divina de Fátima Silva^b, Lucienir Pains Duarte^b, Vali Joana Pott^c, Sidney Augusto Vieira Filho^{d,*}

^aCentro de Desenvolvimento da Tecnologia Nuclear (CDTN/CNEN), Avenida Antônio Carlos, 6627 Pampulha, CEP 30123-970 Belo Horizonte, Minas Gerais, Brazil

^bDepartamento de Química, ICEx, Núcleo de estudos de Plantas Medicinais (NEPLAM), Universidade Federal de Minas Gerais, Avenida Antônio Carlos, 6627 Pampulha, 31270-901 Belo Horizonte, Minas Gerais, Brazil

^cEmpresa Brasileira de Agropecuária (EMBRAPA), BR 262 km 4, Caixa Postal 154, CEP 79002-970 Campo Grande, Mato Grosso do Sul, Brazil

^dEscola de Farmácia, DEFAR, Universidade Federal de Ouro Preto, Rua Costa Sena, 171, CEP 35400-000 Ouro Preto, Minas Gerais, Brazil

Received 7 August 2007; received in revised form 26 November 2007; accepted 30 November 2007

Abstract

Through instrumental neutron activation analysis (INAA) the elemental chemical composition of *Salvinia auriculata* and Ouro Preto city public water was determined. Elements Ce, Th, Cr, Hf, Sb, Sc, Rb, Fe, Zn, Co, Au, La and Br were quantified. High chromium concentration was determined in this plant. But, chromium was determined only in low concentrations in the water. The results indicate the great capacity of this plant to absorb and accumulate inorganic elements.

© 2007 Published by Elsevier Ltd.

Keywords: Aquatic macrophyte; *Salvinia auriculata*; Salvinaceae; INAA; Elementary analysis

1. Introduction

The bioremediation, phytoremediation, and biosorption processes act through both living and dead organic matter to extract organic and inorganic compounds from polluted soil and water. These procedures have been used since the 1970s (Litchfield, 2005). It was known for decades that bacteria, algae and aquatic plants can absorb certain heavy metals, but only recently has this information been applied to remove dangerous heavy metals from contaminated soil and water. Among the great variety of plants, lichens are used to track metals in the environment (Saiki et al., 1997; Vaz et al., 1995). These organisms have been also used to uptake and isolate heavy metals by absorption from water or soil followed by burning the organic material to obtain an inorganic residual material (Eccles, 1999). Other studies have been conducted to find plants and other microorgan-

isms with potential capacity to remove heavy metals from soil and aqueous solutions.

Roots of some aquatic macrophytes have great ability to uptake and bioaccumulate elements, phosphates, nitrogen oxides and/or non-polar organic compounds from water or sediments (Garg and Chandra, 1990; Schneider and Rubio, 1999). For these reasons aquatic macrophytes also represent an excellent bioindicator of the quality of water and sediments (Klumpp et al., 2002; Srivastav et al., 1994). These plants can remove metals encountered in low concentrations from a public water supply in a few hours (Forno and Harley, 1979).

Salvinia auriculata (Salvinaceae) is a good example of aquatic macrophytes that present the ability to uptake elements and organic compounds from water and wastewater. *S. auriculata* has a common name of floating water moss or eared water moss. It is a free-floating aquatic plant lacking true roots, a rhizome with stele U-shaped in cross section. Its leaves have green to brown colors, are oblong-elliptic to nearly circular, with apex obtuse or retuse, base cordate or subcordate and larger ones 1.5–2.5 cm long. Its

*Corresponding author.

E-mail address: bibo@ef.ufop.br (S.A.V. Filho).

upper surface is densely provided with short to greatly elongated papillae, arranged in rows parallel to the main lateral veins and each of them develops at the apex in a group of 4 trichomes which are all joined at their ends (Stolze et al., 1983). *S. auriculata* is a fertile specie. It is dependent on spore production and overwintering for annual recurrence. Floating plants completely die during the winter months in low-temperature countries. New populations develop from wintered spores that, having lain dormant in the sediment, rise to the water surface and germinate during the warming temperatures of spring. The same cycle takes place in a wet-and-dry habitat.

The concentration of elements in an aquatic ecosystem is dependent on their mobility (Callender and Rice, 2000). This property is a function of many factors like adjacent soil composition, solubility in water and the interaction with sediment and soil components. The kind of interaction is directly dependent on reactions involving ionic charge, atomic ray, temperature, pH, ligand types and others (Larcher, 2000).

The study of inorganic composition is very important since many elements participate directly in many plant metabolic processes (Pardeshi and Rajurkar, 1997). However, the detection of elements is difficult because of their very low concentrations in natural water, generally below 0.1%.

In order to determine trace elements, various analytical methods have been developed (e.g. inductive coupled plasma-atomic emission spectroscopy, X-ray fluorescence, isotope dilution thermal ionization mass spectrometry, neutron activation analysis, and others), but each method has different limitations (e.g., sample preparation, sample dissolution, limited number of analyzed elements). Instrumental neutron activation analysis (INAA) has excellent sensitivity and rapidity and the advantage of being largely insensitive to matrix effects; it also has precision and can execute simultaneous multi-element determinations (International Atomic Energy Agency, 2001). These INAA characteristics have been widely applied, mainly to trace element determinations in soil, and in different substrates. Nevertheless, by this technique it is not possible to determine the structural position, kind of coordination and the oxidative state of the elements in these substrates (Filby, 1995).

The present work reports an elemental chemical composition determined in *S. auriculata* and samples of Ouro Preto city public water supply using neutron activation analysis through the k_0 -standardization method (De corte et al., 1987). The purpose of this study is to investigate the metal bioaccumulation in *S. auriculata* (Salvinaceae) and to detect the metal occurrence in public water of a specific place.

2. Experimental

2.1. Water and plant sample collection

S. auriculata was collected in the Pantanal wetland of Campo Grande, Mato Grosso do Sul state, Brazil. The

specimens were adapted and grown in natural water obtained from a natural well located in Cel. Quintiliano street (19.48°51'S, 43.40°28'W) at Ouro Preto city, MG, Brazil. Samples of this water were separated for its use as plant growth medium and also directly collected into a polyethylene flask to be further submitted to INAA (Fig. 1).

2.2. Analytical procedure

Sample and standards: Approximately 250 mg of dried and ground *S. auriculata* samples were weighed and stored in a high-density polyethylene flask. Samples of dried *S. auriculata* were first ground in a corindon mortar. Two standard reference materials (SRMs) were simultaneously analyzed to assess the traceability of the results. Samples of water (15.0 mL) were directly collected from a natural mine stored in a polyethylene flask and submitted to a freeze drying process and the residue obtained was submitted to INAA (Fig. 1).

Irradiations: The irradiation of samples in the polyethylene flask was carried out on a TRIGA MARK-I IPR-R1 nuclear reactor at the Centro de Desenvolvimento da Tecnologia Nuclear-Comissão Nacional de Energia Nuclear (CDTN-CNEN), Brazil. Samples and SRM were irradiated at 100 kW, under thermal neutron flux of $6.6 \times 10^{11} \text{ n cm}^{-2} \text{ s}^{-1}$ for 10 h.

Counting conditions: Two counting sequences were carried out. (1) After 1 week of cooling, the first count for 300 s allowed the determinations of ^{140}La , ^{82}Br and ^{199}Au and (2) after 1 month of cooling, samples were submitted for the other count for $3.0 \times 10^4 \text{ s}$ to determine the presence of ^{46}Sc , ^{52}Cr , ^{59}Fe , ^{60}Co , ^{65}Zn , ^{86}Rb , ^{124}Sb , ^{144}Ce and ^{233}Pa . The counting system acquisition was constituted by a Canberra hyperpure germanium detector with a full-width at half-maximum (FWHM) resolution of 1.75 keV at 1332 keV, with 15% relative efficiency. All counts were performed at constant geometry in a position where the analyzer deadtime indicator registered less than 5%. The software Genie-2000 was used for spectra processing and peak area determinations.

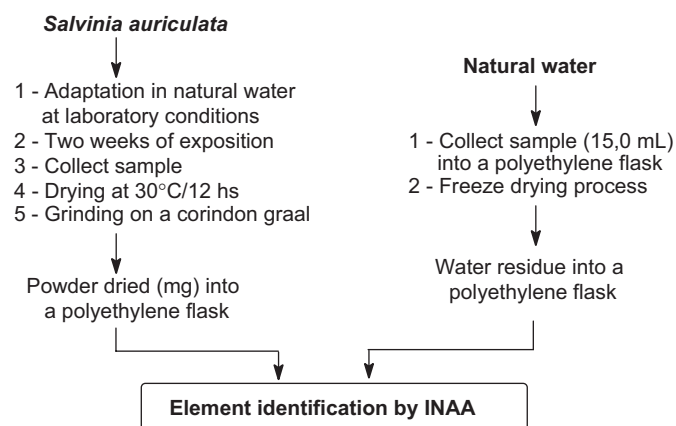


Fig. 1. Scheme of *S. auriculata* and water sample preparation for INAA.

Download English Version:

<https://daneshyari.com/en/article/1879697>

Download Persian Version:

<https://daneshyari.com/article/1879697>

[Daneshyari.com](https://daneshyari.com)