

## CHARACTERIZATION OF INORGANIC CONSTITUENTS IN LEAVES OF *Tradescantia pallida* SPECIES BY NEUTRON ACTIVATION ANALYSIS

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### ABSTRACT

The purpose of this study was to evaluate the element levels in *T. pallida* leaves, as well as, to establish appropriate experimental conditions for sampling and preparation the sample for the elemental analysis. Leaves of this plant species were collected in different sites of São Paulo state. The method of neutron activation analysis (NAA) was applied in the element determinations. To evaluate the accuracy and the precision of the results, a certified reference material INCT-MPH-2 *Mixed Polish Herbs* was analyzed. The results obtained in these analyses indicated good precision and agreement with the certified values. The relative errors and the relative standard deviations obtained were lower than 8.2% and 8.6%, respectively. Results obtained in the replicate analyses of *T. pallida* samples also presented good reproducibility indicating the homogeneity of the prepared sample. In the analyses of young and adult leaves separately, higher concentrations of most of the elements were found in adult leaves than those in young ones. A preliminary comparison made between the results obtained for *T. pallida* leaves collected in different sites indicated differences depending on the element. The results indicated a good precision with the relative standard deviations lower than 11.3%, except Br. The findings of this study indicated the possibility of using *T. pallida* in an active biomonitoring by exposure of this plant species cultivated in vases.

### 1. INTRODUCTION

*Tradescantia pallida* (Rose) D. Hunt cv. *purpurea* is a plant species of Commelinaceae family widely used in the ornamentation of gardens, roadsides and streets. It is a decorative plant found even in places with high pollution levels. Due to its wide distribution and its easy cultivation and propagation, this plant species has been studied to be used as a bioindicator of environmental contamination.

In the last years *Tradescantia* plants have become widely acknowledged for detection of clastogenic effects of heavy metals ions by micronucleus assay and it is suggested to biomonitor metal-contaminated soils [1].

Fomin and Hafner [2] also investigate the suitability of using *Tradescantia* plant to evaluate genotoxicity of emissions from municipal waste incinerators and showed that micronucleus frequencies of this plant species are dependent on the distance from the incinerator. Misík *et al.* [3] in the monitoring of the genotoxicity effects of air pollution caused by gas emissions at

a site located near of the city incinerator and of a petrochemical, demonstrated that *Tradescantia* micronucleus assay can be used to monitor alterations of pollution levels.

Results of the studies on effects of various metals in micronucleus assays with *Tradescantia* have been also reported [4]. However, investigations on elemental accumulation by *Tradescantia* are practically inexistent.

From all these considerations, the purpose of this study was to evaluate the element levels in *T. pallida* leaves as well as to establish appropriate experimental conditions for sampling and preparation the sample for the elemental analysis.

## 2. MATERIALS AND METHODS

### 2.1 Collection and Preparation of the Samples of *Tradescantia pallida*

Leaves of *T. pallida* cultivated in vases or beds were collected in different sites of São Paulo state. These leaves were collected in the first and third knot from the edge. For the analyses, the leaf samples were washed using deionized water to remove possible dust particles deposited and then they were freeze-dried using a Modulyod lyophilizer under a pressure of about 45 mbar, for approximately 21 hours. In this drying process, a mean loss weight of 93.3% was obtained. After drying, the leaves were ground to obtain in a powder form that was placed in plastic vials and kept in a desiccator.

### 2.2 Analysis of the Certified Reference Material

To evaluate the quality of the analytical results, a certified reference material INCT-MPH-2 Mixed Polish Herbs from *Institute of Nuclear Chemistry and Technology*, Poland [5], was analyzed.

### 2.3 Preparation of Synthetic Standards of Elements

Solutions of synthetic standard elements were acquired from *Spex CertiPrep*, USA. From these standard solutions a diluted mixed or simple standards solutions were prepared. Aliquots of 50  $\mu\text{L}$  were pipetted on sheets of Whatman n° 40 filter paper that were placed into a desiccator to dry the aliquots of solutions at room temperature. After, these sheets were folded and placed in plastic bags. The plastics for preparation of these bags were cleaned using diluted nitric acid solution and purified water.

### 2.4 Procedures for Neutron Activation Analysis (NAA)

Approximately 200 mg of *T. pallida* sample or certified reference material were weight into plastic bags. For the irradiation of samples or certified reference material and standards, they were individually wrapped in aluminum sheets. After, they were placed into an aluminum device for irradiation at the IEA-R1 nuclear research reactor of IPEN-CNEN/SP, under a thermal neutron flux from  $4.0 \times 10^{12}$  to  $5.0 \times 10^{12}$   $\text{n cm}^{-2} \text{s}^{-1}$ , during 16 hours. After 3 days of

decay time, the samples, certified reference material and elemental standards were individually fixed on stainless steel planchets for gamma activities. The countings were carried out using a hyperpure Ge detector coupled to gamma spectrometer. The identification of radioisotopes was carried out by gamma ray energies and half life [6]. The elemental concentration was calculated by comparative method using the following equation [7]:

$$C_a = \left[ m_p \cdot A_a \cdot e^{0.693(tda-tdp)/t_{1/2}} \right] / \left[ M_a \cdot A_p \right] \quad (1)$$

Where the indices  $a$  and  $p$  indicate sample and standard, respectively.  $A$  is the rate counting of the radioisotope;  $M_a$  is the total mass of the sample;  $t_{1/2}$  is the half life of the radioisotope;  $m_p$  is the mass of the element in the standard;  $C_a$  is the concentration of the element in the sample;  $tda$  and  $tdp$  are the decay times of the sample and standard, respectively.

### 3. RESULTS AND DISCUSSION

The results of the certified reference material analyses presented in Table 1, indicate a good agreement with the certified values for most of the elements. The relative errors obtained were lower than 8.2%. In relation to precision, the obtained results indicate a good reproducibility with relative standard deviations lower than 8.6%.

**Table 1. Concentrations of elements obtained in the certified reference material INCT-MPH-2 Mixed Polish Herbs.**

Elements	This Study			Certified Values [5]
	Average $\pm$ SD <sup>a</sup> (n) <sup>b</sup>	RSD <sup>c</sup> %	RE <sup>d</sup> %	
Br, $\mu\text{g g}^{-1}$	7.1 $\pm$ 0.5 (4)	7.5	8.2	7.71 $\pm$ 0.61
Ca, %	1.06 $\pm$ 0.07 (4)	6.6	1.9	1.08 $\pm$ 0.07
Co, $\text{ng g}^{-1}$	202.8 $\pm$ 2.4 (4)	1.2	3.4	210 $\pm$ 25
Cr, $\mu\text{g g}^{-1}$	1.68 $\pm$ 0.09 (4)	5.4	0.6	1.69 $\pm$ 0.13
Cs, $\text{ng g}^{-1}$	79.2 $\pm$ 6.8 (4)	8.6	4.2	76.0 $\pm$ 7.0
Fe, $\mu\text{g g}^{-1}$	508.4 $\pm$ 34.7 (4)	6.8		460 <sup>e</sup>
K, %	2.01 $\pm$ 0.12 (4)	6.0	5.2	1.91 $\pm$ 0.12
La, $\text{ng g}^{-1}$	551 $\pm$ 35 (4)	6.3	3.4	571 $\pm$ 46
Rb, $\mu\text{g g}^{-1}$	10.4 $\pm$ 0.7 (4)	6.3	2.6	10.7 $\pm$ 0.7
Sc, $\text{ng g}^{-1}$	119.3 $\pm$ 5.4 (4)	4.5	3.0	123 $\pm$ 9
Zn, $\mu\text{g g}^{-1}$	34.5 $\pm$ 2.1 (4)	6.1	3.0	33.5 $\pm$ 2.1

a. Standard Deviation, b. n is the Number of Determinations, c. Relative Standard Deviation, d. Relative Error, e. Informative Value.

In Table 2 are presented the results of analysis of leaves collected from the same plant but in different knots. The young leaves from the first knot and the adult ones from the third knot. The results of young and adults leaves show a good precision with relative standard deviations lower than 8.1%. The comparison between the samples of different ages indicate higher concentration of elements Ca, Co, Cr, Fe, La and Zn in the adults leaves. This difference is probably associated with age of the leaf because the adult ones were more exposed to pollution.

**Table 2. Concentrations of the elements in the young and adults leaves.**

Elements	Young leaves		Adult leaves	
	A $\pm$ SD <sup>a</sup> (n) <sup>b</sup>	RSD <sup>c</sup> %	A $\pm$ SD <sup>a</sup> (n) <sup>b</sup>	RSD <sup>c</sup> %
Br, $\mu\text{g g}^{-1}$	10.5 $\pm$ 0.5 (3)	4.8	10.1 $\pm$ 0.2 (3)	2.0
Ca, %	4.1 $\pm$ 0.1 (3)	2.4	5.1 $\pm$ 0.1 (3)	2.0
Co, $\text{ng g}^{-1}$	76.5 $\pm$ 2.8 (2)	3.7	97.2 $\pm$ 0.9 (3)	0.9
Cr, $\text{ng g}^{-1}$	166.9 $\pm$ 12.2 (3)	7.3	350.5 $\pm$ 11.7 (3)	3.3
Cs, $\text{ng g}^{-1}$	95.5 $\pm$ 4.2 (3)	4.4	80.7 $\pm$ 2.2 (3)	2.7
Fe, $\mu\text{g g}^{-1}$	129.4 $\pm$ 2.5 (3)	1.9	175.7 $\pm$ 14.3 (3)	8.1
K, %	5.43 $\pm$ 0.03 (2)	0.6	3.9 $\pm$ 0.1 (3)	2.6
La, $\text{ng g}^{-1}$	685.2 $\pm$ 39.8 (3)	5.8	999.1 $\pm$ 24.5 (3)	2.5
Rb, $\mu\text{g g}^{-1}$	53.5 $\pm$ 0.8 (3)	1.5	36.6 $\pm$ 1.7 (3)	4.6
Zn, $\mu\text{g g}^{-1}$	122.0 $\pm$ 3.2 (3)	2.6	185.6 $\pm$ 9.2 (3)	5.0

a. Average and Standard Deviation, b. n is the Number of Determinations, c. Relative Standard Deviation.

**Table 3. Concentrations of the elements in samples of *Tradescantia*.**

Elements	Sample T1		Sample T2	
	A $\pm$ SD <sup>a</sup> (n) <sup>b</sup>	RSD <sup>c</sup> %	A $\pm$ SD <sup>a</sup> (n) <sup>b</sup>	RSD <sup>c</sup> %
Br, $\mu\text{g g}^{-1}$	38.3 $\pm$ 0.5 (4)	1.3	7.5 $\pm$ 1.7 (3)	22.7
Ca, %	4.4 $\pm$ 0.4 (4)	9.1	4.8 $\pm$ 0.1 (3)	2.1
Co, $\text{ng g}^{-1}$	171.8 $\pm$ 5.6 (4)	3.2	51.2 $\pm$ 3.0 (3)	5.9
Cr, $\text{ng g}^{-1}$	132.7 $\pm$ 6.2 (4)	4.7	163.1 $\pm$ 2.7 (3)	1.7
Cs, $\text{ng g}^{-1}$	113.2 $\pm$ 8.7 (4)	7.7	46.4 $\pm$ 5.1 (3)	11.0
Fe, $\mu\text{g g}^{-1}$	74.8 $\pm$ 3.5 (4)	4.7	93.8 $\pm$ 9.1 (3)	9.7
K, %	3.9 $\pm$ 0.2 (4)	4.7	nd <sup>d</sup>	
La, $\text{ng g}^{-1}$	258 $\pm$ 8 (4)	3.1	489 $\pm$ 24 (3)	5.1
Rb, $\mu\text{g g}^{-1}$	44.0 $\pm$ 3.4 (4)	7.8	27.4 $\pm$ 3.0 (3)	11.1
Sc, $\text{ng g}^{-1}$	4.6 $\pm$ 0.5 (4)	10.5	6.1 $\pm$ 0.3 (3)	5.7
Zn, $\mu\text{g g}^{-1}$	183 $\pm$ 14 (4)	7.5	272 $\pm$ 31 (3)	11.3

a. Average and Standard Deviation, b. n is the Number of Determinations, c. Relative Standard Deviation, d. Not Detected.

In Table 3 are presented the results of two samples collected in different sites of São Paulo state. The leaves of these samples were collected in the third knot. The sample T1 was collected at the Medicine School of the University of São Paulo (FMUSP), and the sample T2 was collected at the Campus of the University of São Paulo. The results of T1 presents relative standard deviations lower than 10.5%, and sample T2 showed results with relative standard deviations were lower than 11.3%, excepting Br. These results show that prepared samples present a good homogeneity with relation to several determined elements. A preliminary comparison made between the results obtained for T1 and T2 samples of *T. pallida* indicates difference for the elements Br, Co, Cs, La, Rb, Sc and Zn.

### 3. CONCLUSIONS

The accuracy and precision of the results obtained in the analyses of certified reference material indicate that NAA is suitable to analyze *T. pallida* samples. The results obtained for samples of the plant show that the procedure of sample preparation was suitable, once the results of the analyses indicate good reproducibility. The elements Ca and K are present in *T. pallida* species in levels of percentage, Br, Cr, Fe, Rb and Zn in levels of  $\mu\text{g g}^{-1}$  and the elements Co, Cs, La and Sc in levels of  $\text{ng g}^{-1}$ . The finding of this study indicate the possibility of using *Tradescantia* in an active biomonitoring by exposure of this plant species cultivated in vases.

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