ANALYSIS OF TREE BARK SAMPLES FOR AIR POLLUTION BIOMONITORING OF AN URBAN PARK

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ABSTRACT

Air pollution is receiving much attention as a public health problem around the world due to its adverse health effects from exposures by urban populations. Within this context, the use of vegetal biomonitoring to evaluate air quality has been investigated throughout the world. Air pollutant levels are high in the city of São Paulo, SP, Brazil and being the vehicle emissions its main source. The aim of this study was to evaluate concentrations of As, Ba, Br, Ca, Co, Cr, Cu, Fe, Mn, Pb, S, Sb and Zn in tree bark samples used as biomonitor of urban air pollution. Concentrations of these elements were determined in barks collected in trees of the Ibirapuera Park, one of the biggest and most visited parks of the city of São Paulo city. Samples of tree barks were also collected in a site outside the city of Sao Paulo, in a rural area of Embu-Guaçu, considered as a control site. The element concentrations were determined by the methods of Instrumental Neutron Activation Analysis (INAA) and of Energy Dispersive X-ray Fluorescence Spectrometry (EDXRF).
The findings of this study showed that tree bark samples may be used as biomonitors of urban air pollution in a micro scale, and both techniques, INAA and EDXRF, can be used to evaluate element concentrations in tree bark samples.

1. INTRODUCTION

Air pollution is receiving much attention as a public health problem around the world due to its adverse health effects caused from exposures by urban populations. Several studies have shown that air pollution adversely affects exposed populations, exacerbating respiratory inflammatory ailments as well as increasing cardiovascular morbidity and carcinogenicity [1-3].

In this context, the use of vegetal biomonitoring to evaluate air quality has been investigated throughout the world. One alternative to characterize gradients of air pollution on a small scale is the use of vegetal biomonitoring of, most commonly, lichens, plant leaves and tree bark [4-8].

The possibility of using tree barks for air pollution monitoring has been investigated since 1970 [9-13], due to its advantages. The biomonitoring using tree barks analysis is a cheap

and quick technique to obtain a large spatially resolved data set when compared with conventional methods[14].

According to Schelle et al. [14] it is possible to use tree barks from different species in similar environmental biomonitoring studies and differences between tree species and in the roughness of their barks are unlikely to be significant to determining the metal concentrations. Besides, the outer layer of barks and trees with rough, thick barks are more indicated to biomonitoring studies of air pollution [9,10].

Air pollutant levels are high in the city of Sao Paulo, SP, Brazil and the main source of its is vehicle emissions [15]. Nowadays, researches have suggested the elements Cl, K, Ca, Cr, Fe, Ni, Cu, Zn, Se, Br, Mo, Ag, Cd, Sb, Ba and Pb as new "traffic related substances" [11, 16, 17].

City parks may represent physical barriers to pollutants, serving as small "oasis" of lower levels of toxic substances inside the town. Ibirapuera Park is one of the biggest and most visited parks of São Paulo City, receiving during the weekends more than 400,000 visitors.

The aim of this study was to evaluate concentrations of As, Ba, Br, Ca, Co, Cr, Cu, Fe, Mn, Pb, S, Sb and Zn in tree bark samples used as biomonitor of urban air pollution in Ibirapuera Park.

2. MATERIALS AND METHODS

2.1 Study Region and Tree Bark Sampling

Tree barks samples were collected from six tree species (*Eucalyptus* sp. and *Tipuana* tipu) of the Ibirapuera Park, one of the biggest and most visited parks of the city of São Paulo. This park is surrounded by large avenues with heavy traffic of vehicles. For controlling purposes, we also collected tree bark sample outside of São Paulo city, in a rural area of Embu-Guaçu (42 km from São Paulo city), which is far from traffic or industry. Tree bark samples were collected at approximately 1.20m from the soil, using a knife, and were stored in brown paper envelopes. The sampling sites were also geo-referenced. In Figure 1 are presented map of Ibirapuera Park with tree barks sampling sites.

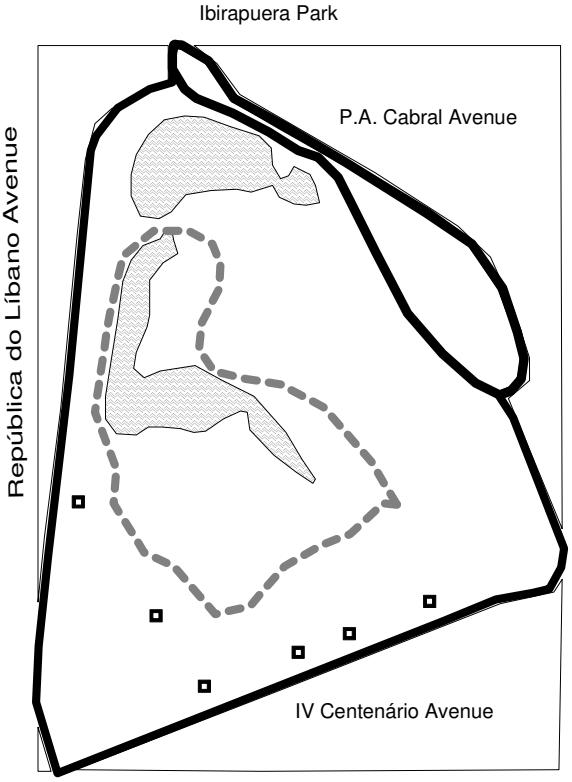

Figure 1. Map of Ibirapuera Park with sampling sites of tree bark.

2.2 Preparation and Analysis of Tree Bark Samples

The element concentrations were determined by the methods of Instrumental Neutron Activation Analysis (INAA) and Energy Dispersive X-ray Fluorescence Spectrometry (EDXRF). For the analyses, the tree bark samples were cleaned using a soft tooth brush and the outer layer of the bark was analyzed. The samples were also crushed and sieved to obtain grains of small size.

In the INAA, aliquots of each sample and the elemental synthetic standards were irradiated for 16 hours under a thermal neutron flux of about $40x10^{12}$ ncm^{-2} s^{-1} at the IEA-R1 nuclear research reactor. After adequate decay time, the samples and standards were measured using a hyperpure Ge detector coupled to a gamma ray spectrometer. The radioisotopes were identified according to half lives and gamma ray energies. The element concentrations were calculated by comparative method.

For the EDXRF analysis, the powered samples were pressed to produce pellets that were analyzed using the equipment EDXRF-720HS, of Shimadzu. The measurement parameters were: time counting of 180 s, target (Rh, 50kV x 100 μA) and Si (Li) detector. The calibration curves were adjusted by linear regression using the fundamental parameters to correct the matrix effects.

The accuracy and precision of the results were verified by the analysis of the reference material Mixed Polish Herbs (INCT-MPH-2). The results showed good accuracy (relative errors ≤ 10% for most of elements) and good precision (relative standard deviations ≤ 10%).

3. RESULTS AND DISCUSSION

The concentrations of As, Ba, Br, Ca, Co, Cr, Cu, Fe, Mn, Pb, S, Sb and Zn in six tree bark samples coded IBI-01 to IBI-06 from Ibirapuera Park and a sample from control area are presented in Table 1.
Instrumental neutrons activation analysis (INAA) was employed to determine As, Ba, Br, Ca, Co, Cr, Fe, Sb and Zn concentrations. Energy Dispersive X-ray Fluorescence Spectrometry (EDXRF) was employed to determine Cu, Mn, Pb and S concentrations.

Table 1 – Means and standard deviations of trace element concentrations in tree bark samples determined by INAA and EDXRF

Element	IBI-01	IBI-02	IBI-03	IBI-04	IBI-05	IBI-06	Control
As (μg kg^{-1})	1432.9±5.6	229.7±2.5	1650.6± 8.9	528.1± 9.6	124.8± 20.6	556.3± 9.5	ND
Ba (mg kg^{-1})	148.0±13.1	72.1±12.6	150.1±3.0	148.2±13.1	150.6±2.6	57.5±4.3	ND
Br (mg kg^{-1})	12.77±0.03	17.83±0.03	12.83±0.05	19.87±0.07	8.48±0.04	17.27±0.12	4.2±0.6
Ca (%)	0.203±0.004	3.874±0.058	0.398±0.007	0.521±0.069	2.884±0.035	0.195±0.032	0.30±0.001
Cr (mg kg^{-1})	6.94±0.06	1.77±0.02	18.04±0.13	4.27±0.04	1.67±0.02	5.76±0.05	1.6±0.5
Co (μg kg^{-1})	391.0±5.8	423.1±6.0	873.7±11.5	575.9±8.5	369.7±5.6	470.3±8.0	ND
Cu (mg kg^{-1})	32.17±2.1	28.92±2.2	43.11±2.1	40.92±2.0	33.82±2.3	38.1±2.1	21.7±2.7
Fe (mg kg^{-1})	3244.7± 18.7	555.0± 4.3	5832.0±32.7	1651.3±9.6	588.9±3.8	2515.9±14.7	193.25±27
Mn (mg kg^{-1})	27.9±2.3	23.62±2.4	57.97±2.3	52.71±2.3	28.46±2.5	25.61±2.2	39.7±2.5
Pb (mg kg^{-1})	2.61±0.35	2.07±0.37	4.67±0.43	2.80±0.33	3.16±0.43	3.87±0.39	2.0±0.1
S (%)	0.490±0.003	0.611±0.004	0.379±0.003	0.435±0.003	0.364±0.003	0.358±0.003	0.21±0.003
Sb (μg kg^{-1})	1479.0± 5.3	664.4± 4.1	4845.1±13.7	976.8±3.0	677.7±2.5	3971.3±11.8	ND
Zn (mg kg^{-1})	34.3± 0.2	83.3± 0.4	62.9± 0.3	63.9± 0.3	93.1± 0.5	77.3± 0.3	21.2±1.7

ND – indicates not determined

As expected, the analytical results indicated that tree bark samples from Ibirapuera Park present higher concentrations of most elements than those samples from control site of Embu-Guaçu, suggesting anthropogenic sources from its.

The high values of elements such as Br, Cu, Fe, S and Zn founded in samples from Ibirapuera park suggest vehicular emissions as principal source of these elements.

With these preliminary results, more samples of tree bark are being collected in Ibirapuera Park and in another urban parks in the city of São Paulo due to investigate the influence of vehicle traffic corridors in these parks.

4. CONCLUSIONS

The findings of this study showed that tree bark samples may be used as biomonitors of urban air pollution in a micro scale, and both techniques, INAA and EDXRF, can be used to evaluate element concentrations in tree bark samples.

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