STUDY REGARDING THE CAPACITY OF QUANTIFYING POLLUTION WITH MICRONUTRIENTS (Pb, Cd) USING ORNAMENTAL TREES AS BIOMONITORS IN CLUJ-NAPOCA

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Abstract. *In present conditions, in which urban pollution generates many concerns at the level of international establishment involved in assuming decisions regarding Earths health, an important role is played by the green areas located in cities. These green areas are, also, of high importance, especially when their presence involves the existence of ornamental trees, used frequently in urban spaces (chestnut, linden, pine) that can substantially contribute in improving air quality. Regarding the quantification of air quality using trees as biomonitors, samples of tree leafs' tissue and/or needles were collected from three species of ornamental trees, located in the proximity of two monitoring stations in Cluj-Napoca, subjected to different intensity of pollution degrees, twice a week, during the experimental period April-September 2014-2015. The research results, proves that the species Aesculus hippocastanum have the highest capacity of bioaccumulation of lead (33.9 ppm, CLU – 4). In terms of the capacity to bioaccumulate cadmium, the best results were obtained in the case of the species Aesculus hippocastanum (3.45 ppm, CLU-4) and Pinus nigra (3.22 ppm, CLU-1).*

Key words: *air quality, biomonitors, micronutrients, ornamental trees.*

INTRODUCTION

The air quality control is the process of the quantitative, qualitative and repetitive observation and measurement of the concentration of one or several air constituents. The data delivered by the monitoring network allow the calculation of the indicators of the air quality, identification of the polluted areas, comparisons with threshold values of air quality established by regulations, and rapid measurements of pollution degree. The placement of the network of the air quality surveillance must be selected in a manner that allows the monitoring of the cumulated effect of industry, traffic, warming of houses, and commercial spaces (PROOROCU ET al., 2008).

As SMITH mentions (1990), the capacity of environmental toxicity absorption and accumulation in leafs, which have the advantage of an increased mass and easy disposal, allows plants to eliminate toxic substances through in situ phytoremediation, and, in consequence, to reduce pollutants concentration in the urban environment (RAO, 1985).

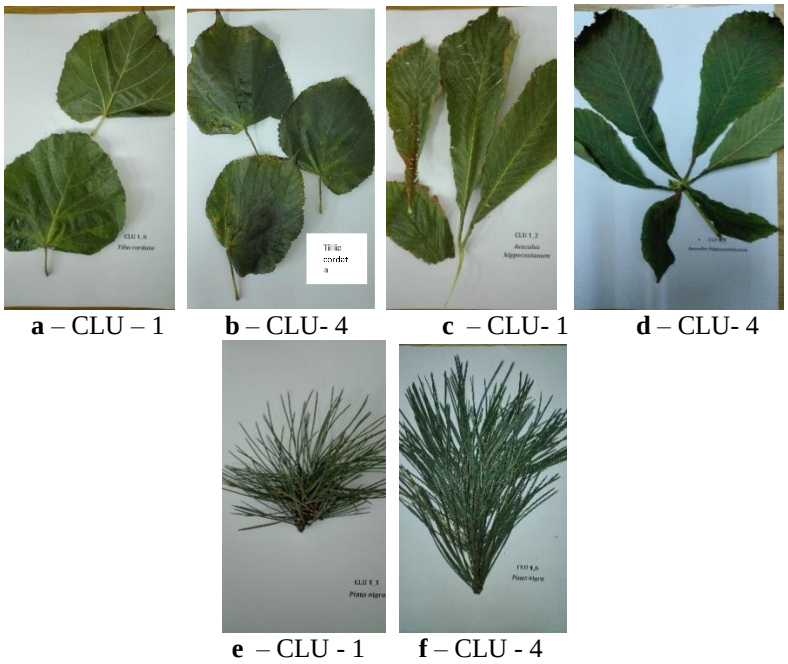
The biomonitoring processes by which trees can improve urban air quality through gas and particulate biofiltration receive more and more interest. Thus, preoccupation is focused on eliminating pollutant particulate using ornamental trees and forested areas, with the purpose of quantifying urban areas varieties (OROIAN ET ALL. 2012; TITSEESANG ET ALL. 2008; PENEGHI ET ALL. 2015). Therefore, the development of green belts can be an effective technique for decreasing air pollution especially in urban areas using tolerant planting susceptible species.

MATERIAL AND METHODS

In order to quantify the biomonitoring capacity of the ornamental trees against air pollution with Cd and Pb, leaf tissue and/or needles from 3 species of ornamental trees were

sampled. The trees are located in the proximity of 2 monitoring stations from Cluj-Napoca, subjected to sources of pollution of varying degrees of intensity. Leaf tissue samples were collected during the vegetation period (April-September, 2014, 2015), from the trees species selected at the level of each air quality monitoring stations from Cluj-Napoca (Environmental Protection National Agency Cluj, Environmental Reports, 2010-2015). Monitoring station CLU-1 is located in Mărăşti, Aurel Vlaicu Street and monitoring station CLU-4 is located in Mărăşti, Dâmboviţei Street in the precincts of EXPO TRANSILVANIA.

The biological material taken into consideration in order to quantify air quality, in the present study, consists from tree species used in urban spaces. This, corresponding to each of the monitoring stations CLU-1 (traffic) and CLU-4 (industrial), are: black pine (*Pinus nigra*), chestnut (*Aesculus hippocastanum*) and linden (*Tilia cordata*).



a – CLU – 1 **b** – CLU- 4 **c** – CLU- 1 **d** – CLU- 4

e – CLU - 1 **f** – CLU - 4

Fig. 1. The sampled leaf/needle tissues in monitored trees (a, b – *Tillia cordata*, c, d - *Aesculus hippocastanum*, e, f – *Pinus nigra*) from the experimental sites, Cluj – Napoca, 2014 - 2015

The experiments were carried out in the sites provided by the work protocol, that foresees the collection of leaves from each of the three ornamental tree species, representative for trees used for ornamental purposes, in sites located in the proximity of two air quality monitoring stations, in Cluj-Napoca, where exposure to air pollutants is different.

Perkin-Elmer AAS spectrometer was used for Pb and Cd quantification from foliar tissue. Statistical data processing was realised using STATISTICA v.8.0 programme for Windows.

RESULTS AND DISCUSSION

In the needle tissue of *Pinus nigra* specie, it is recorded a lead content equal with 16.06 ppm, while the content of cadmium achieve 3.22 ppm. The values of the coefficient of variation corresponding to the lead concentration in the needle tissue of black pine, of less than 15%, indicates the homogeneity of the analysis, while Cd mean (CV% = 29.27) has moderate representativeness (Table 1).

Table 1

The mean and statistical indicators of Pb and Cd (ppm) in the needles tissue of the *Pinus nigra* specie, in traffic monitoring station CLU – 1, Cluj – Napoca

Statistical indicator		Pb ppm	Cd ppm
n		106	106
Mean		**16.06**	**3.22**
The interval of confidence	+95%	14.91	2.55
	-95%	17.21	3.89
Variance		2.58	0.89
Standard deviation		1.61	0.94
Standard error of the mean		0.15	9.68
Coefficient of variability		10,01	29.27

In *Aesculus hippocastanum* specie, Pb and Cd concentrations correspond to the values of 15.04 ppm and 1.47 ppm, respectively. Similar to the situation recorded in *Pinus nigra*, variability coefficients corresponding to Pb concentration in chestnut leaf tissue indicates the homogeneity of the analysis, but unlike the mentioned specie, in the case of chestnut (*Aesculus hippocastanum*) the high value of the variability coefficient obtained in the case of cadmium concentration (36.85%), corresponds to the lack of homogeneity, the mean having a weak representativeness in the present case (Table 2). This demonstrates the fact that there is a high dispersion due to the variation in large limits of cadmium in chestnut leafs determined by the environmental conditions.

Table 2

The mean and statistical indicators of Pb and Cd (ppm) in the foliar tissue of the *Aesculus hippocastanum* specie, in traffic monitoring station CLU – 1, Cluj – Napoca

Statistical indicator		Pb ppm	Cd ppm
n		106	106
Mean		**15.04**	**1.47**
The interval of confidence	+95%	14.10	1.08
	-95%	15.98	1.86
Variance		1.73	0.29
Standard deviation		1.32	0.54
Standard error of the mean		0.13	0.05
Coefficient of variability		8.74	36.85

If we take into consideration the evolution of analysed micronutrients concentration in *Tillia cordata* specie, the concentrations of Pb and Cd in leaves tissue, correspond to the values of 22.23 ppm and 2.41 ppm, respectively (Table 3). In this tree species, de variability coefficient corresponding to both analysed micronutrients concentrations in leaves' tissue,

indicates the homogeneity of the analysis, the means being representative (Table 3). In *Tillia cordata*, during the experimental period April-September 2014-2015, the average concentration of lead is equal with 30.13 ppm and mean cadmium concentration reaches 2.97 ppm (Table 4).

The values of the coefficient of variability, under 15%, of Pb concentration in linden (*Tillia cordata*) leaves' tissue indicate the homogeneity of the analyses, while in the case of cadmium, the mean concentration corresponding to the experimental period 2014 - 2015, records just a medium homogeneity (CV = 27.17%), corresponding to a moderate scattering of individual data (Table 4).

Table 3

The mean and statistical indicators of Pb and Cd (ppm) in the foliar tissue of the *Tilia cordata* specie, in traffic monitoring station CLU – 1, Cluj – Napoca

Statistical indicator		Pb ppm	Cd ppm
n		106	106
Mean		**22.23**	**2.41**
The interval of confidence	+95%	20.05	2.14
	-95%	24.41	2.68
Variance		9.28	0.14
Standard deviation		3.05	0.38
Standard error of the mean		0.29	0.04
Coefficient of variability		13.71	15.70

Table 4

The mean and statistical indicators of Pb and Cd (ppm) in the needles tissue of the *Tillia cordata* specie, in industrial monitoring station CLU – 4, Cluj – Napoca

Statistical indicator		Pb ppm	Cd ppm
n		106	106
Mean		**30.13**	**2.97**
The interval of confidence	+95%	26.62	2.39
	-95%	33.64	3.55
Variance		24.01	0.65
Standard deviation		4.90	0.81
Standard error of the mean		0.47	0.08
Coefficient of variability		16.26	27.17

Regarding the specie *Aesculus hippocastanum*, during the experimental period 2014 – 2015, the lead content was equal to 33.90 ppm, while the cadmium content is equal to 3.45 ppm (Table 5).

Table 5

The mean and statistical indicators of Pb and Cd (ppm) in the foliar tissue of the *Aesculus hippocastanum* specie, in industrial monitoring station CLU – 4, Cluj – Napoca

Statistical indicator		Pb ppm	Cd ppm
n		106	106
Mean		**33.90**	**3.45**
The interval of confidence	+95%	29.79	2.85
	-95%	38.01	4.05

Variance	32.99	0.70
Standard deviation	5.74	0.84
Standard error of the mean	0.55	0.08
Coefficient of variability	16.94	24.26

The study of black pine needles (*Pinus nigra*), monitored in the experimental field, regarding the micronutrients content during the experimental period April-September 2014-2015, emphasises a Cd content equal to 2.55 ppm and Pb of 28.67 ppm (Table 6). The values of the variability coefficient corresponding to lead concentration in pine needle tissue, lower than 15%, indicates the homogeneity of the analysis but for the average cadmium concentration, variability coefficients equal with 24.75%, corresponds to a medium homogeneity, afferent to a moderate dispersion of individual data (Table 6).

Table 6

The mean and statistical indicators of Pb and Cd (ppm) in the foliar tissue of the *Pinus nigra* specie, in industrial monitoring station CLU – 4, Cluj – Napoca

Statistical indicator		Pb ppm	Cd ppm
n		106	106
Mean		**28.67**	**2.55**
The interval of confidence	+95%	25.61	2.10
	-95%	31.73	3.00
Variance		18.29	0.40
Standard deviation		4.28	0.63
Standard error of the mean		0.41	0.06
Coefficient of variability		14.92	24.75

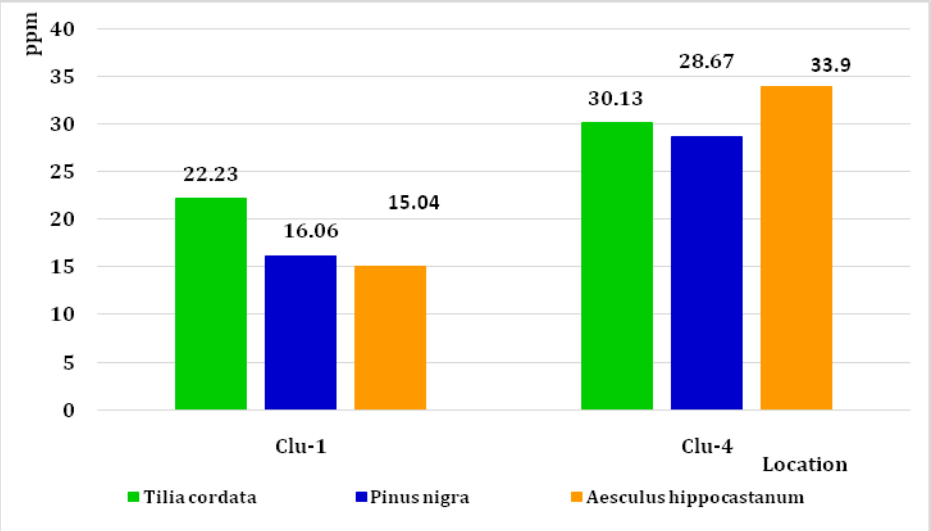


Fig. 2. The evolution of lead concentrations, in foliar tissue of *Tilia cordata*, *Pinus nigra*, *Aesculus hippocastanum*, in experimental sites localized in Cluj – Napoca, 2014 – 2015

Regarding lead bioaccumulation, we mention the *Aesculus hippocastanum* specie, were there was recoded a mean lead concentration of 33.9 ppm, in the leaves tissue, during the experimental period, while in *Tillia* cordata there was recorded a mean lead concentration of 31.13 ppm in the leaves tissue, in the experimental site located in the proximity of the air quality monitoring station type industrial CLU-4 (Fig. 2).

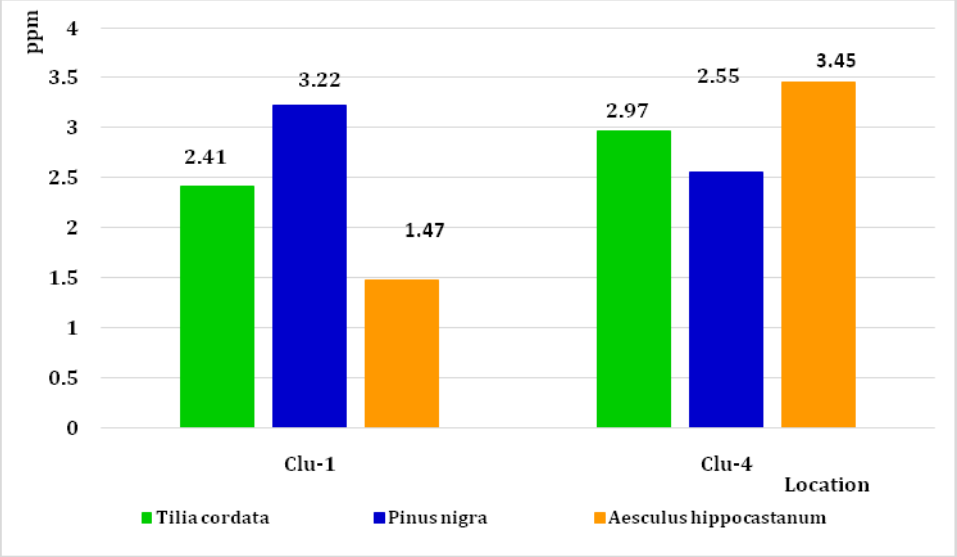


Fig. 3. The evolution of cadmium concentrations, in foliar tissue of *Tilia cordata*, *Pinus nigra*, *Aesculus hippocastanum,* in experimental sites localized in Cluj – Napoca, 2014 – 2015

The cadmium concentrations in *Tilia cordata* (2.97 ppm) and *Aesculus hippocastanum* (3.45 ppm) species in locations from the proximity of the air monitoring station of industrial type CLU-4 recorded specific values. The same thing may be reported for *Pinus nigra*, where a mean cadmium concentration equal with 3.22 ppm was recorded, during the experimental period, in the experimental site located in the proximity of air quality monitoring station type traffic CLU-1 (Fig. 3).

CONCLUSIONS

The research results, proves that the species *Aesculus hippocastanum* has the highest capacity of bioaccumulation of lead (33.9 ppm, CLU – 4). In terms of the capacity to bioaccumulate cadmium, the best results were obtained in the case of the species *Aesculus hippocastanum* (3.45 ppm, CLU-4) and *Pinus nigra* (3.22 ppm, CLU-1).

According the present study, we recommend planting chestnut species (*Aesculus hippocastanum*) and linden (*Tilia cordata*) in urban areas where there is a risk of pollution with Cd and Pb.

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