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TREE LEAVES AND SOILS AS LEAD ACCUMULATORS IN THE CLUJ-NAPOCA TRAFFIC

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Abstract: As the number of pollution sources rises heavy metal contamination of the environment becomes increasingly higher. This problem particularly manifests itself in urban areas. The objectives of our investigation were to measure the distribution of Pb in tree leaves Tilia cordata and Acer platanoides which occur frequently in majority streets of Cluj-Napoca, Romania and in soils. The relatively relationship between the total Pb content of soil and its concentration in the tree leaves was investigated. To evaluate the accumulation of Pb by plants grown on polluted areas, the enrichment ratio (ER- ratio of concentration in polluted plants to its content in control plants) was calculated. The analysis of Pb in the simultaneous collected leaves and soil samples in studied area and in the same type of samples collected from the background station (Botanical Garden) allowed to estimate the relative degree of pollution in Cluj-Napoca.

Introduction

Urban pollution gives a serious contribution to global contamination of the environment. The extent and type and kind of this type of pollution depends on many factors among which are the number of inhabitants, their habits, types of energy sources types and dimensions of the industrial zones, types and intensity of the motor traffic and of course a lot of climatic factors [3].

Numerous investigation have demonstrated that urban roads exert various detrimental effects on their environment. They serve as substantial source of environmental pollution deriving from traffic. Besides CO, NO_x, aromatic and cyclic hydrocarbons, stress should be laid on heavy metals. Predominantly contamination of lead, zinc, cadmium, copper, iron and nickel should be taken into account. Lead contamination originates from the combustion of leaded petrol by motor vehicles. Cadmium and zinc are primarily derived from tyres, lubricating oils, alloys and galvanized automobile parts. Copper and iron are important constituents of different alloys, pipes, and wires. These metals are released in to the environment with mechanical abrasion, wear and tear of vehicle parts [8]. These metals are released into the atmosphere of urban streets environment as particles from 0.01μm to several millimeters in diameter and then transferred to the soil, plants or animals via sedimentation,precipitation, or inhalation.

For the investigations of town metal contamination a wide range of plant materials have been used including lichens [4,6], mosses [2], leaves and bark of trees [1,5], and grasses [3].

The combustion of petrol containing lead is a major source of lead urban pollution. During the combustion lead forms normally halide particles with ethylene halides added to petrol as scavanger, resulting into atmospheric release of PbBrCl, $(NH_4)_2BrCl\cdot$ PbBrCl, $2PbBrCl\cdot NH_4Cl$ etc. [3].

Vascular plants are continuously exposed to potentially phytotoxic gases and airborne particles and actively take up heavy metals from the soil. They grow naturally or are planted in fields, have been widely used to monitor the deposition of heavy metals along road sides, and in urban and industrial areas. The most important elements Pb, Zn, Cu, Cd reach plant leaves mainly as airborne particles. Many of these particulates are blown or washed away, while others remain on the leaves or may enter via stomata. Soil acts as a buffer by controlling the bioavailability and transport of toxic substances in the environment. Many contaminants are thus immobilized by soil.

One of the aims of this paper is to outline the suitability of the tree leaves and soils as lead accumulation indicators of air pollution in the Cluj-Napoca traffic. Monitoring of Pb levels in the tree leaves and soils is essential for assessment of environmental pollution. The relatively relationship between the total Pb content of soil and its concentration in the tree leaves were investigated. To evaluate the accumulation of Pb by plants grown on polluted areas, the enrichment ratio (ER-ratio of concentration in polluted plants to its content in control plants) was calculated.

The analysis of Pb in the simultaneous collected leaves and soil samples in studied area and in the same type of samples collected from the background station (Botanical Garden) allowed to estimate the relative degree of pollution in Cluj-Napoca.

Sampling and sample digestion procedure

To obtain representative leaves samples, *Tilia* and *Acer* leaves were collected from the outside of the tree crown canopy and from branches which are not covered by higher ones. All samples were collected in the same day (16 November 2001). In the laboratory the samples were dried at about 40^0C for 10 hours and than ground in a mortar. For digestion, about 0.75 g of the sample was treated with concentrated HNO_3 overnight. After heating in a sandbath for evaporation of nitrogen oxides, 6 ml of H_2O_2 were added and heating continued until a volume of 2-3 ml was left. The cooled sample was transferred to 50 ml volumetric flask and diluted to volume with distillate water.

The soil samples (approximately 200 g) were collected from the surface horizons (0-10 cm depth) and 2 m distance from the road border. These samples were collected using a trowel and were placed into plastic bags. All soils were air-dried at room temperature prior to grinding in agate mortars, sieving (at 80 mesh).

Ten milliliters of 1:1 HCl were added to the 0.2 g soil sample and the solution was fumed to near dryness. After cooling, 10 ml of 1:3 HCl:HNO_3 (v/v) was added, and again the acid was fumed off to near dryness. The residue was dissolved in 25 ml 1:4 HCl and hated for approximately 15 min. The cooled sample was transferred to 50 ml volumetric flask and diluted to volume with distillate water.

The lead from all samples were analyzed by flame atomic absorption spectrometry (Perkin Elmer 3030B) and the results expressed in mg/kg dry weight.

Results and discussions

Tilia and *Acer* trees occur frequently and regularly both in Cluj-Napoca town area. They have resistance to the impact of acid gases, dust, and road salt and broad ecological valence. This is a decisive reason for its distribution in heavily polluted agglomeration areas.

Tilia and *Acer* leaves and soils were collected in Cluj-Napoca town from 20 sites with different traffic loads (highways: sites 1-6; bystreets: sites 7-10; green spaces: sites 11-20). The results were compared with the Pb content in the background leaves and soil collected in Botanical Garden (site 21) considered unpolluted area.

In Fig. 1 are presented the Pb concentrations measured in the leaves and soils collected in the studied sites of Cluj-Napoca town. The accumulation of Pb in leaves and soils has been recorded in all locations. The Pb concentration in leaves ranged between 10 – 73 mg/kg, while in the background sample is 6 mg/kg. The values of Pb content in the soils vary between 47 – 333 mg/kg comparatively with 29 mg/kg in the background soil sample.

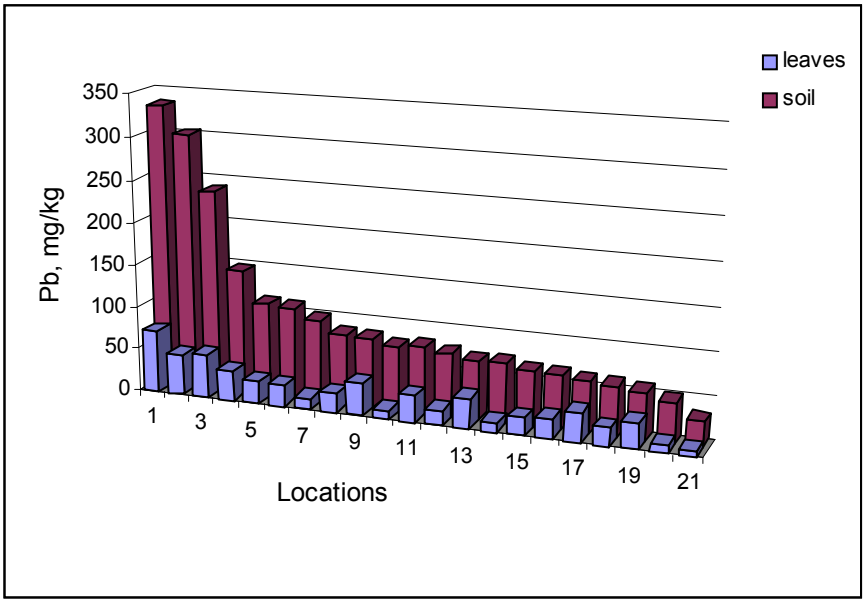

Fig. 1: Lead concentration (mg/kg) in the leaves and surface soils (0-10cm) in 21 different locations of Cluj-Napoca town studied region (highways: site 1-6; bystreets: sites 7-10; green spaces: sites 11-20; control: site 21.

As shows Fig.1 the results were grouped in three categories of different traffic loads:

1. highways, where Pb ranges between 26-73 mg/kg in leaves and 108-333 mg/kg in soils;
2. bystreets, where Pb ranges between 10-38 mg/kg in leaves and 75-97 mg/kg in soils;
3. green spaces, where Pb ranges between 10-35 mg/kg in leaves and 47-78 mg/kg in soils.

The concentration of Pb found in the samples collected from bystreets and green spaces are similar because the green space are surrounded by roads with high traffic.

In the studied locations of Cluj-Napoca town Pb levels in top soil and in *Tilia* and *Acer* showed a similar pattern of distribution (Fig. 2), but a significant relationship did not materialize (correlation coefficient only 0.6862), this because it is not an absolute connection between the soil and tree leaves. The Pb concentration in soils are approximately 4 times higher than in the leaves. This is because in the soil the Pb was accumulated along many years, while in the leaves only in vegetation period (six months).

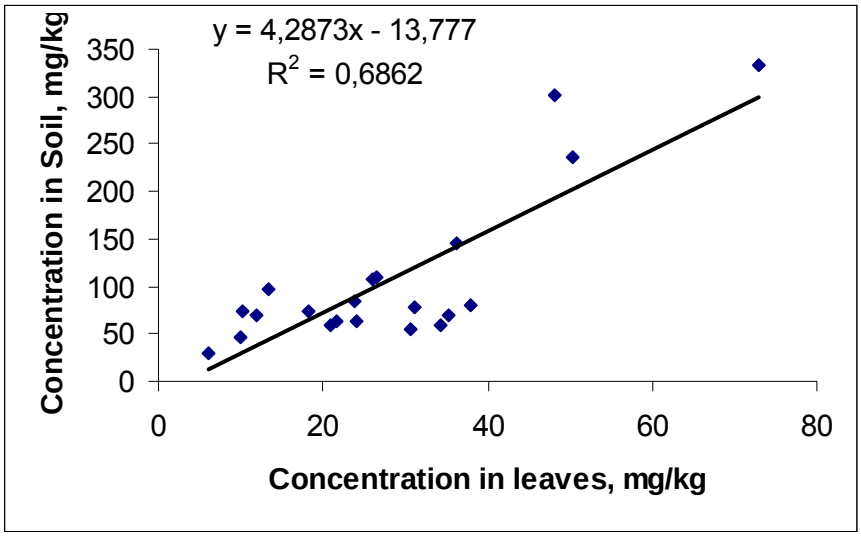

Fig. 2: Relations between Pb concentrations in surficial soil and in tree leaves *Tilia* and *Acer*

In Table 1 are presented the pH values of the collected soils in studied locations of Cluj-Napoca. The pH values of soils range between 4.52 and 8.25, but in general, the pH of soils is slowly acid to neutral. The pH values is influenced both by the soil type and the gas pollution. The extreme values, 8.25 pH in location 1 is maybe due to the fertilization of the soil, while in the location 9 an accumulator content was pour out and the pH of soil decreased to the 4.52 value.

Table 1: pH values of the soil samples collected in the studied location of Cluj-Napoca

Locations	pH	Locations	pH	Locations	pH
1-B-dul Eroilor	8.25	8-P-ța 14 Iulie	6.63	15-Pădurea Hoia	7.26
2-P-ța Unirii	7.19	9-P-ța Ion Agârbiceanu	4.52	16-Parcul Central	6.59
3-Calea Turzii	6.91	10-str. Miron Costin	6.32	17-Muzeul Etnografic	6.26
4-str. Kogălniceanu	7.18	11-Fac. Geografie (Clinicilor parc)	7.04	18-Parcul Iuliu Hațeganu	5.93
5-str. Aurel Vlaicu	7.05	12-CasaTineretului (parc)	7.53	19-Aleea Snagov	5.54
6-Băile Someşeni	7.99	13-Parcul Mărăşti	6.61	20-Parcul Cetățuie	7.43
7-str. Grigore Alexandrescu (Mănăştur)	7.54	14-Parcul Feroviarilor	6.31	21-Grădina Botanică	7.30

Lead concentration in soils versus pH is presented in Fig. 3. No correlation between pH and Pb concentration in soils were observed. Where the Pb concentration is higher the pH value is over 7.

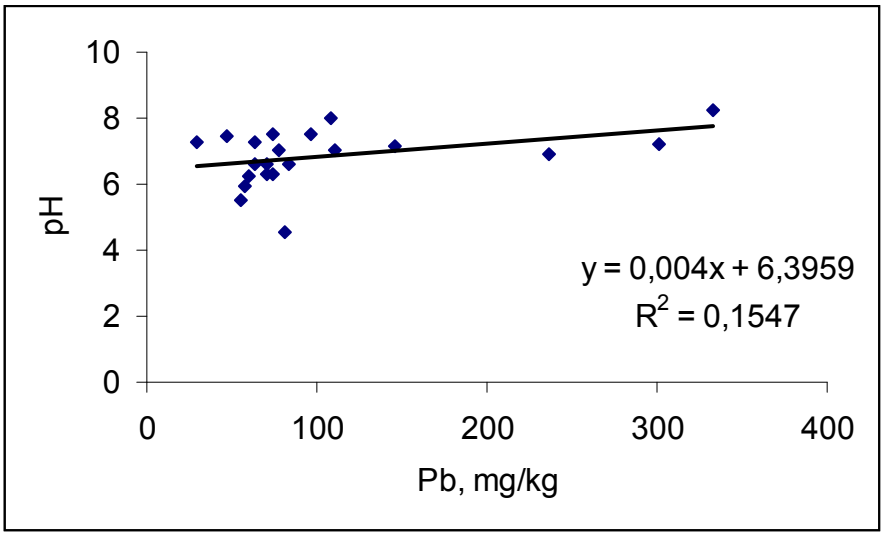

Fig. 3: Pb concentration in soils versus soil pH.

To evaluate the pollution degree in Cluj-Napoca town, the enrichment ratio for plants and soils collected in the 20 different locations were calculated (Fig. 4).

In the most polluted site the enrichment ratio is 12, while in the less polluted site only 1.7.

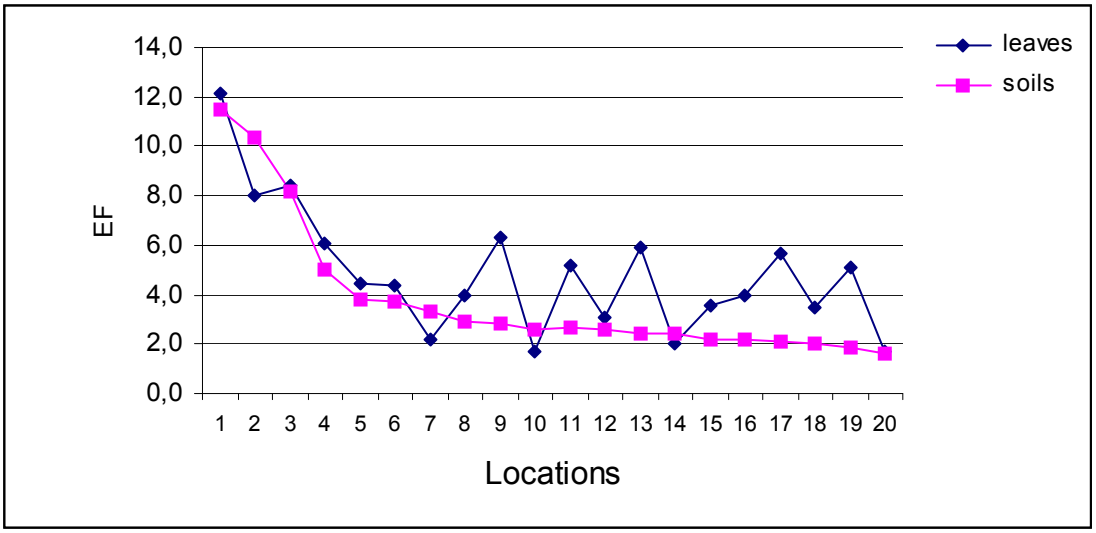

Fig. 4: Enrichment ratio for tree leaves and soils in 20 different locations of Cluj-Napoca town studied region.

The results of this paper gives a possibility to evaluate the contamination of an urban area and can be used as a model for assessment and comparative studies with other urban, rural and industrial region.

BIBLIOGRAPHY

1. Bathory, D., Nicoara, A., Bercea, V., 1997, Efectul toxic al metalelor grele asupra unor procese fiziologice la fag. *Studii si cercetari (ST. Naturii) Bistriţa*, **3**: 239-248.
2. Bruning, f., Kreeb, K. H., 1993, Mosses as biomonitors of heavy metal contamination within urban areas. In: *Plants as biomonitors*, Ed. Bernd Markert, Weinheim, New York, Basel, Cambridge: 295-402.
3. Djingova, R., Kuleff, I., 1993, Monitoring of heavy metal pollution by Taraxacum officinale. In: *Plants as biomonitors*, Ed. Bernd Markert, Weinheim, New York, Basel, Cambridge: 435-461.
4. Farkas, E., Lökös, L., Vershegy, K., 1985, Lichens as indicators of air pollution in Budapest agglomeration, *Acta Bot. Hung*., **31**, (1-4): 45-68.
5. Kovacs, M., Podani, J., Tuba, Z., Turcsany, G. *A környzeyetszennyezést jelzö és mérö élölények*, Mezögazdasági Kiadó, Budapest, 1986.
6. Nimis, P.L., Lazzarin, G., Lazzarin, A., Skert, N., 2000, Biomonitoring of trace elements with lichens in Veneto (NE Italy), *The Science of the Total Environment,***225**: 97-111.
7. Öztürk, M.A., Türkan, I., 1993, Heavy metal accumulation by plants growing alongside the motor road: a case study from Turkey. In: *Plants as biomonitors*, Ed. Bernd Markert, Weinheim, New York, Basel, Cambridge: 515-522.

8. Tuba, Z., Csintalan, Zs. 1993, Bioindication of road motor traffic caused heavy metal pollution by lichen transplants. In: *Plants as biomonitors*, Ed. Bernd Markert, Weinheim, New York, Basel, Cambridge: 329-341.

FRUNZELE ŞI SOLURILE - ACUMULATORI DE PLUMB IN TRAFICUL DIN CLUJ-NAPOCA

(Rezumat)

Contaminarea cu metale grele a mediului înconjurător creşte odată cu creşterea surselor de poluare. În special, această problemă se manifestă în centrele urbane. Obiectivele investigaţiei noastre au fost măsurarea distribuţiei Pb în soluri şi frunzele de *Tilia cordata* şi *Acer platanoides* răspândite frecvent pe străzile oraşului Cluj-Napoca, România. Concentraţia de Pb în frunze a variat între 10 şi 73 mg/kg, pe când în proba de control a fost de 6 mg/kg; în sol, conţinutul de Pb a variat între 47 şi 333 mg/kg în comparaţie cu 29 mg/kg măsurată din proba de control. A fost investigată relaţia între concentraţia totală de Pb din soluri şi concentraţia aceluiaşi element în frunzele copacilor (coeficientul de corelaţie 0.6862). Pentru evaluarea gradului de acumulare a Pb în plante s-a calculat raportul de îmbogăţire (concentraţia elementului în planta poluată / concentraţia elementului în planta martor). În zona cea mai poluată factorul de îmbogăţire a atins valoarea cea mai mare de 12, în timp ce pe străzile mai puţin circulate a scăzut până la valoarea 2. În cazul solurilor, factorul de îmbogăţire scade şi ajunge la o valoare constantă, în timp ce în cazul plantelor factorul de îmbogăţire prezintă fluctuaţii. Analiza simultană a concentraţiei de Pb în frunzele copacilor şi solurile colectate din aria studiată şi din probele martor a permis estimarea relativă a gradului de poluare în oraşul Cluj-Napoca.