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MONITORING OF AIR POLLUTION IN BUDAPEST, HUNGARY USING TREE LEAF SAMPLES - PRELIMINARY RESULTS

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Abstract

The main goal of this study was to examine different leaf samples (Acer Platanoides 'Globusum', Tilia Tomentosa, Fraxinus Excelsior 'Westhof's Glorie') collected alongside major roads and at Buda Arboretum of Corvinus University of Budapest. Three experiments were carried out at different times. For every one of them 30 leaf samples were collected from each taxon and from each area, on which 5 repeated experiments were performed (6 leaves per group). Groups of leaves were washed off with distilled water. After soaking and ultrasonic shaking filtrates were prepared. Conductivity (total salinity), pH, nitrate ion, ammonium ion, chloride ion, and sulphate ion concentrations were determined from these filtrates. According to our preliminary results higher air pollution level was associated to higher values of examined parameters. Detailed results are listed in our paper.

***Key words**: air pollution, leaf samples, filtrates.*

INTRODUCTION

Atmospheric pollution is one of the major problems in urban environment (Sawidis et al., 2011). Pollutants are originated from several different anthropogenic sources: as industry, combustion of fossil fuels in vehicular traffic and energy production. In urban areas transport is the most significant source of air pollution (Bargagli, 1998).

Now it is well accepted that plants can be effectively used as biomonitors of environmental pollution. Chemical analyses of plant samples has for many years been an alternative, easy and effective way of conducting ecological research in urban areas (Markert, 1995). Vegetation is passive sampler in biomonitoring with the advantage of high spatial and temporal resolution due to the excellent availability of plants and low sampling costs (Sawidis et al., 2011).

It is known that trees are worse indicator for monitoring air pollution than lower plants, but they are widely distributed in many countries as a major plant type of polluted urban area (Celik et al., 1995). They are long-living, so that a repetition of investigation is possible (Witting, 1993).

Many studies have used trees for monitoring elemental deposition from the atmosphere. In several case trees were used as biomonitors for air and soil pollution of urban environments (Song et al., 2015) (Aničić et al., 2011) (Sæbø et al., 2012).

Roadsides in urban area are commonly polluted by particulate matter originated mostly from traffic: motor vehicle emission, abrasion of tyres, brake linings as well as road surface, cycling of dust suspension due to vehicular movement, dispersion of construction materials (Gautam et al., 2004).

Dry deposition of air pollutants depends on physical characteristics of particles (size and shape), on meteorological conditions, (wind speed and thermal stability), and also on the morphological characteristics of the biological surface (Harrison&Yin, 2000).

MATERIALS AND METHODS

Leaves were sampled from three deciduous tree species: globe Norway maple (*Acer Platanoides 'Globusum)*, silver linden *(Tilia tomentosa)* and European ash *(Fraxinus excelsior 'Westhof's Glorie')*. The samples were collected from Buda Arboretum of Corvinus University of Budapest and alongside major roads with heavy traffic in three different times: 16.10.2013., 11.06.2014 and 12.11.2014. Each sampling was performed in a dry period.

5 subsamples (6 fully developed leaves) were taken from the trees, randomly from all sides of the crown. The leaves were cut off from the lowest part of the foliage.

The subsamples (6 leaves) were washed off with distilled water. The leaves were put into a plastic box and 250 mL of distilled water was added, then subsamples where ultrasonic shaken for 10 min. The dust containing suspension was filtered through a sieve. Conductivity (total salinity), pH and chemical composition (nitrate ion, ammonium ion, chloride ion, and sulphate ion concentrations) were determined from these filtrates.

Conductivity was measured by platinum electrode (ADWA AD32 EC/TDS) and pH was measured by combination electrode (ADWA AD14 pH/ORP). Nitrate ion, ammonium ion and sulphate ion were determined by spectrophotometric measurements (MACHEREY-NAGEL Photometer PF-12) after color reaction. Calculations were performed after preliminary calibration. Mohr method was used to determine the chlorides by titration with silver nitrate (argentometric titration).

RESULTS AND DISCUSSIONS

The total salinity and nitrate result from the combustion gases of vehicles and firewood burning (Gillies et al., 2001). Ammonium is originated from vehicles with catalyst and industrial sources and agricultural activities (Harrison & Yin, 2000). The nitrate concentration is directly related to the traffic of the road because it is formed from NO_2 (Celis et al., 2004). The chloride is an element that normally is present in nature, generally part of the atmosphere (Matsumoto & Tanaka, 1996).

Systematic differences were not observed between filtrates of leaves from busy roads and protected area. Spatial and temporal variability of chemical compounds for each species is shown in Tables 1-3.

In case of *Fraxinus excelsior 'Westhof's Glorie'* notable difference was observed in ionic composition of filtrates from busy roads and Buda Arboretum. This difference was not seen in case of *Acer Platanoides 'Globusum* and *Tilia tomentosa.* Variations of dust deposition can be explained by leaf properties such as hair and wax cover (Sæbø et al., 2012).

Table 1. Parameters of filtrates from ***Acer platanoides 'Globosum'***

Acer platanoides 'Globosum'	**pH**			**Total salinity (mg/dm^3)**		
	16.10.2013.	11.06.2014	12.11.2014.	16.10.2013.	11.06.2014	12.11.2014.
Buda Arboretum	5.96 ± 0.05	6.68 ± 0.06	7.03 ± 0.29	33.20 ± 1.37	74.63 ± 28.10	18.26 ± 2.70
Busy road	6.18 ± 0.15	6.40 ± 0.20	6.80 ± 0.04	72.67 ± 3.00	109.77 ± 38.85	36.70 ± 5.56
Acer platanoides 'Globosum'	**c (NO_3^-) (mg/dm^3)**			**c (NH_4^-) (mg/dm^3)**		
	16.10.2013.	11.06.2014	12.11.2014.	16.10.2013.	11.06.2014	12.11.2014.
Buda Arboretum	9.00 ± 1.00	5.33 ± 1.53	3.17 ± 0.58	0.11 ± 0.00	0.43 ± 0.40	2.29 ± 0.02
Busy road	8.33 ± 0.58	6.67 ± 4.62	6.83 ± 0.76	0.18 ± 0.06	0.20 ± 0.17	2.33 ± 0.02
Acer platanoides 'Globosum'	**c (Cl^-) (mg/dm^3)**			**c (SO_4^{2-}) (mg/dm^3)**		
	16.10.2013.	11.06.2014	12.11.2014.	16.10.2013.	11.06.2014	12.11.2014.
Buda Arboretum	34.32 ± 4.10	66.14 ± 22.01	28.99 ± 5.13	9.62 ± 0.64	16.52 ± 8.28	11.21 ± 1.87
Busy road	53.25 ± 3.55	88.18 ± 22.77	60.35 ± 15.17	6.56 ± 0.47	26.86 ± 12.68	16.81 ± 1.18

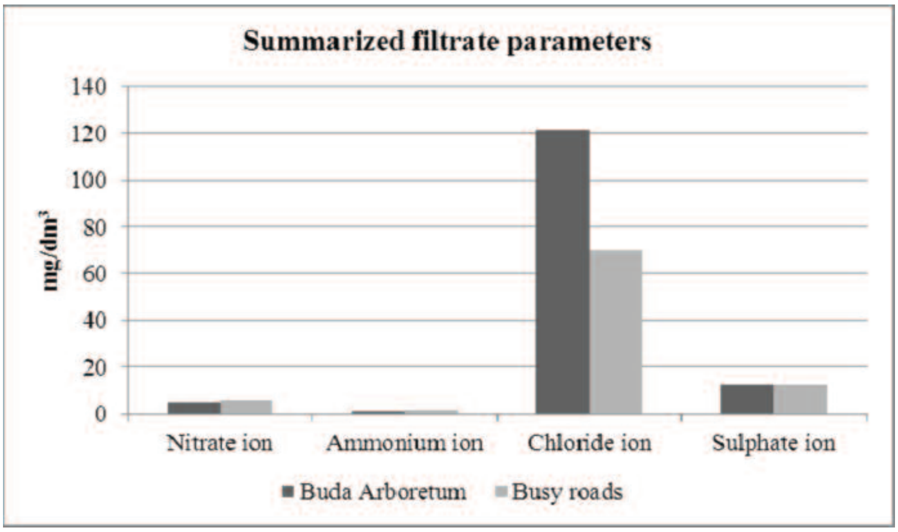
Table 2. Parameters of filtrates from ***Tilia tomentosa***

Tilia Tomentosa	**pH**			**Total salinity (mg/dm^3)**		
	16.10.2013.	11.06.2014	12.11.2014.	16.10.2013.	11.06.2014	12.11.2014.
Buda Arboretum	3.18 ± 0.13	6.70 ± 0.02	7.08 ± 0.05	16.47 ± 4.55	27.47 ± 6.70	8.08 ± 0.67
Busy road	6.06 ± 0.07	6.79 ± 0.03	6.91 ± 0.02	24.77 ± 6.71	38.80 ± 4.49	20.62 ± 0.89
Tilia Tomentosa	**c (NO_3^-) (mg/dm^3)**			**c (NH_4^-) (mg/dm^3)**		
	16.10.2013.	11.06.2014	12.11.2014.	16.10.2013.	11.06.2014	12.11.2014.
Buda Arboretum	6.00 ± 0.00	3.33 ± 0.58	2.00 ± 0.50	0.28 ± 0.06	0.37 ± 0.06	3.91 ± 0.03
Busy road	4.67 ± 3.79	4.00 ± 0.00	3.50 ± 0.00	0.46 ± 0.34	0.53 ± 0.06	5.60 ± 0.35
Tilia Tomentosa	**c (Cl^-) (mg/dm^3)**			**c (SO_4^{2-}) (mg/dm^3)**		
	16.10.2013.	11.06.2014	12.11.2014.	16.10.2013.	11.06.2014	12.11.2014.
Buda Arboretum	28.40 ± 0.00	6.30 ± 8.93	40.23 ± 0.80	3.12 ± 0.27	5.42 ± 0.92	4.78 ± 0.80
Busy road	41.42 ± 2.05	45.56 ± 3.70	57.98 ± 12.08	4.60 ± 0.39	5.60 ± 0.77	9.86 ± 0.47

Table 3. Parameters of filtrates from ***Fraxinus excelsior* ‘Westhof’s Glorie’**

***Fraxinus Excelsior* ‘Westhof’s Glorie’**	**pH**			**Total salinity (mg/dm^3)**		
	16.10.2013.	11.06.2014	12.11.2014.	16.10.2013.	11.06.2014	12.11.2014.
Buda Arboretum	5.99 ± 0.05	6.76 ± 0.04	6.80 ± 0.04	341.00 ± 156.64	53.67 ± 7.87	15.66 ± 1.01
Busy road	5.64 ± 0.04	6.82 ± 0.18	7.11 ± 0.09	94.17 ± 15.15	135.93 ± 82.89	50.00 ± 5.34
***Fraxinus Excelsior* ‘Westhof’s Glorie’**	**c (NO_3^-) (mg/dm^3)**			**c (NH_4^-) (mg/dm^3)**		
	16.10.2013.	11.06.2014	12.11.2014.	16.10.2013.	11.06.2014	12.11.2014.
Buda Arboretum	8.00 ± 1.73	4.67 ± 0.58	3.67 ± 1.15	0.11 ± 0.00	0.27 ± 0.15	3.22 ± 0.37
Busy road	1.13 ± 1.62	11.33 ± 4.16	7.67 ± 2.08	0.11 ± 0.00	0.60 ± 0.20	3.36 ± 2.52
***Fraxinus Excelsior* ‘Westhof’s Glorie’**	**c (Cl^-) (mg/dm^3)**			**c (SO_4^{2-}) (mg/dm^3)**		
	16.10.2013.	11.06.2014	12.11.2014.	16.10.2013.	11.06.2014	12.11.2014.
Buda Arboretum	718.28 ± 915.35	51.47 ± 3.55	60.94 ± 7.39	46.09 ± 39.09	6.76 ± 1.82	8.99 ± 1.45
Busy road	111.23 ± 24.93	78.69 ± 38.99	92.89 ± 8.39	5.91 ± 0.26	18.89 ± 7.75	18.89 ± 6.20

Without varieties are taken into account, concentrations (nitrate ion, ammonium ion, sulphate ion) were higher alongside major roads with heavy traffic, but chloride ion concentration was lower in the filtrate from busy roads.



CONCLUSIONS

Examination of dust deposited on three tree species was performed in three different times, sampled from Buda Arboretum and alongside major roads.

In every plant species and for all times, the water soluble fraction of the leaf deposits were analyzed. It has been shown that the effect of air pollution can be reflected in deposits on leaves.

Therefore, *Acer platanoides ‘Globusum’, Tilia tomentosa, Fraxinus excelsior ‘Westhof’s Glorie’* could be used as a suitable biomonitor of atmospheric pollution in urban areas.

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