Assessment of the possibility to use deciduous trees bark as biomonitor of heavy metals air pollution

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Abstract

The aim of the carried out research was to assess the possibility to use deciduous trees bark in biomonitoring of urban areas. Various deciduous trees bark was used in the research, among others *Betula* L., *Quercus* L., *Acer* L. and *Populus* L. growing in the Opole Province area (south-western Poland).

Concentrations of the following heavy metals were determined in bark, by the flame atomic absorption spectrometry (*FAAS*): Mn, Fe, Ni, Cu, Zn, Cd and Pb. On the basis of carried out research it was determined that the type of a tree, the distance from pollution source, elevation from the ground and the side of the trunk, from which bark was sampled, all influence the research results.

It was demonstrated that deciduous trees bark can be used as bioindicator in assessing air pollution with heavy metals, due to its occurrence in urban areas. However, it is important to validate all stages of analytical procedure, which uses deciduous trees bark.

Keywords: biomonitoring, bark, deciduous trees, heavy metals, atomic absorption spectrometry

THE FOLLOWING CHARACTERISTICS CONFIRM BIOINDICATION USEFULNESS OF BARK:

- high resistance to gas and dust pollution from continuous emission (due to the presence of thick cork outer bark);
- ability to long-term accumulation of pollution within bark, due to its constant presence during a tree growth;
- total absence of metabolism in this tissue and no possibility to extract redundant products;
- possibility of accumulation of pollution from various sources: wet (compounds dissolved in rain water) and dry deposition;
- adsorption of pollution directly from the atmosphere;
- collection through the whole tree bark surface (the more coarse - the better accumulation) and through spiracles;
- easy access for research throughout the whole year.

The research methodology

The bark collected from deciduous trees *Betula* L. (birch), *Quercus* L. (oak), *Acer* L. (maple), *Populus* L. (poplar), *Sambucus* L. (elder), *Sorbus* L. (rowan), *Carpinus* L. (hornbeam) and *Crataegus* L. (hawthorn) growing in Opole (south-western Poland) was used in the research. The bark was collected and dried at 295 K temperature, to obtain dry mass. Such prepared samples were stored in tightly closed polyethylene containers.

The representative (averaged) bark samples with the mass of 0,500 ± 0,001 g d.m. (d.m. – dry mass) were mineralised in the mixture of nitric acid (V) and hydrochloric acid (HNO_3 65% : HCl 37% = 1:3) using a Speedwave Four Berghof, DE microwave oven. The mineralization process temperature was 180°C. MERCK company reagents were used to prepare solutions. Heavy metals (Mn, Fe, Ni, Cu, Zn, Cd and Pb) in mineralised samples were determined by atomic absorption spectrometry method (*AAS*), using the equipment iCE 3500 made by Thermo Electron Corporation (USA).

Analysis of the studies results

The initially smooth bark changes in time; new cork layers accumulate, crack, decorticate and discolour.

cracked (oak, poplar) | fibrous (juniper) | peeling off (birch) | smooth (beech, hornbeam)

Fig. 1. Differences in bark morphological structure

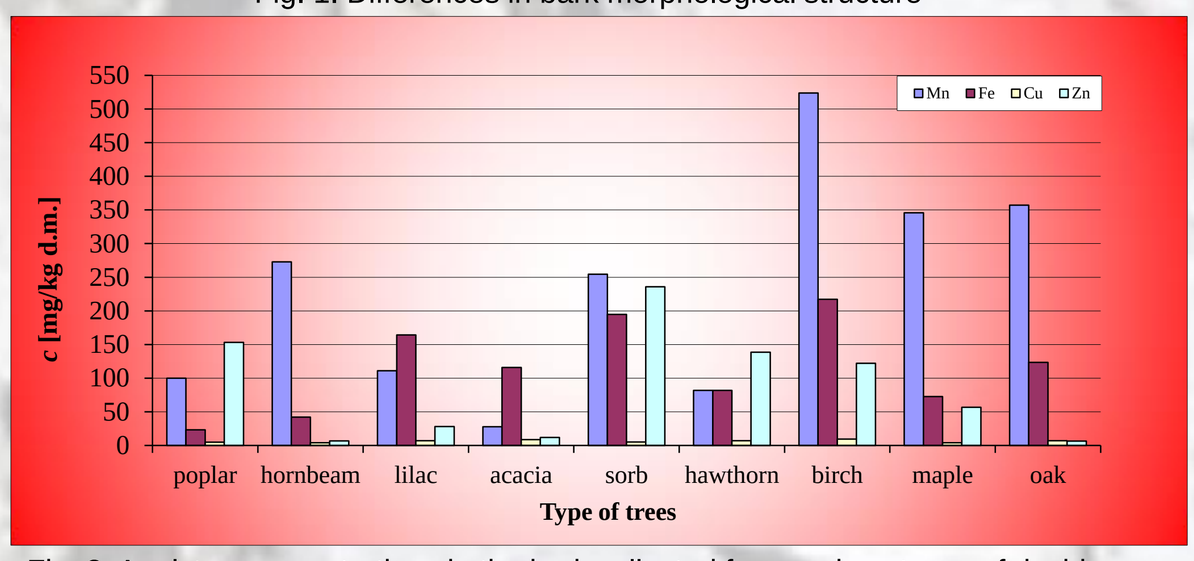

Fig. 2. Analytes concentrations in the bark collected from various types of deciduous trees

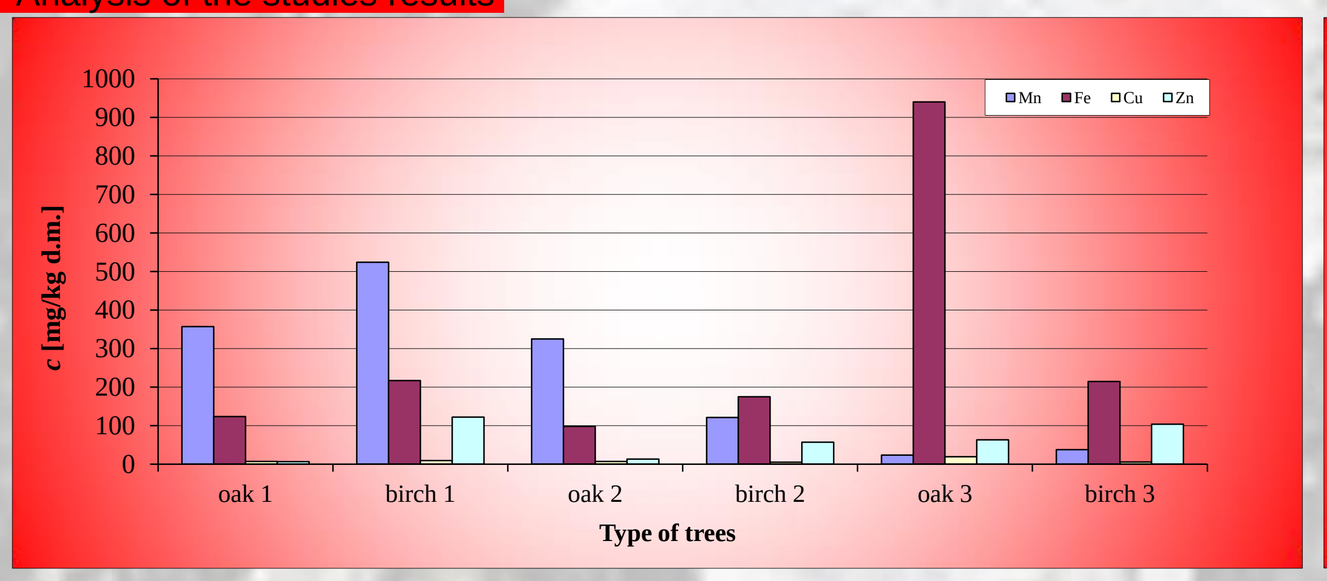

Fig. 3. Analytes concentrations in oak and birch bark collected from trees growing in various locations

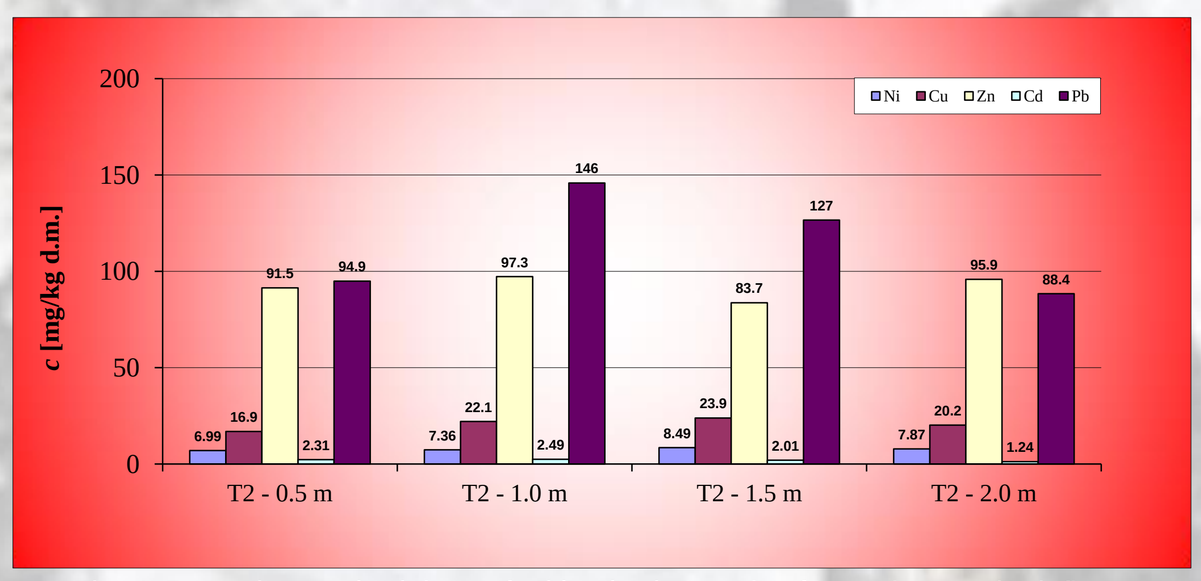

Fig. 4. Preparing methodology of taking bark samples for analyses - the influence of height of the sample taking place

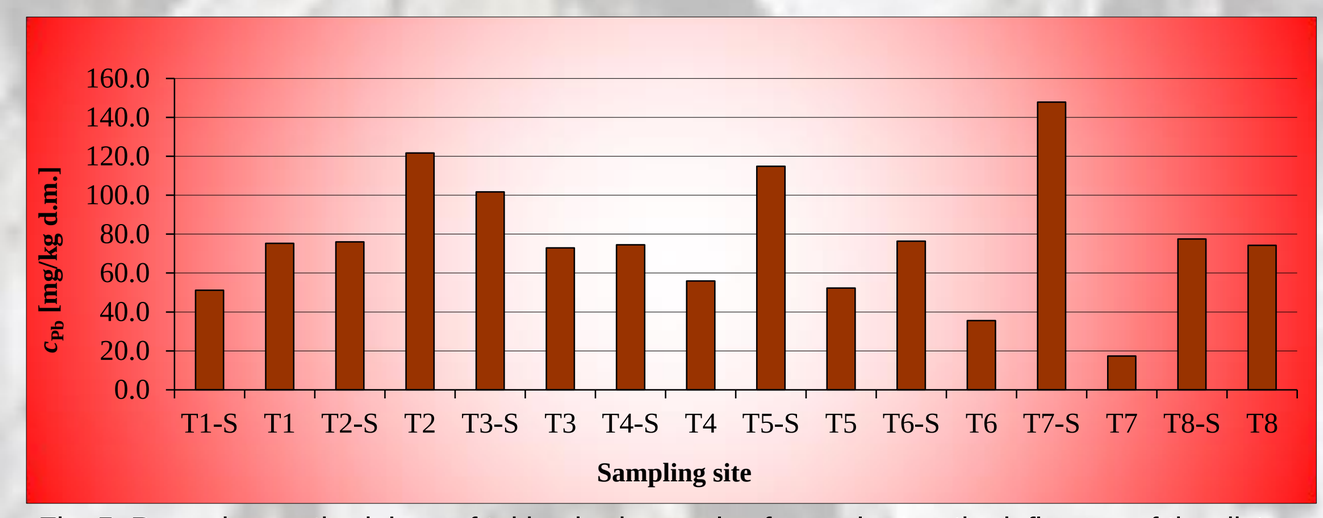

Fig. 5. Preparing methodology of taking bark samples for analyses - the influence of the distance from emission source (S- street)

Table 1. Assessment of representativeness of the bark samples used during research

Parameter	Analyte				
	Ni	Cu	Zn	Cd	Pb
Minimum [mg/kg d.m.]	6,58	15,5	74,2	0,88	**19,8**
Medium	8,80	20,9	117	1,22	**46,5**
Maximum [mg/kg d.m.]	12,7	38,0	179	1,74	**92,0**
SD	1,5	6,4	32	0,32	**20,9**
CV **[%]**	**17,5**	**30,7**	**27,3**	**25,8**	**44,9**

The research objective is to reduce the variability coefficient value!

Summary and conclusions

Research centres are very interested in bioindicators of environment pollution, among others tree bark, mosses and lichens, because they are simple and not expensive to obtain research material. However, it is important to validate all stages of analytical procedure, which uses trees bark. On the basis of carried out research it was demonstrated that a tree type, distance to a pollution source, height from the ground, the side of a trunk, influence the quality of research results. It was demonstrated that deciduous trees bark can be used in future as bioindicator in assessing air pollution with, among others, heavy metals, due to its occurrence in urban areas.