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HEAVY METALS AND RARE EARTH ELEMENTS BIOACCUMULATION IN PERENNIAL PLANT SPECIES FROM BUCHAREST

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Introduction

The European Environment Agency declares that air pollution is the single largest environmental health hazard in Europe, resulting in a lower quality of life and causing premature deaths and severe diseases. Urban plants are capable of reducing environmental pollution through bioaccumulation of contaminants and can be used as bioindicators in heavy metal (HMs) and rare earth elements (REEs) airborne pollution. Therefore, the main objective of the research was to evaluate the bioaccumulation of HMs and REEs in leaves of six tree species (*Populus nigra* L., *Populus tremula*, *Populus x canadensis* Moench, *Betula pendula* Roth, *Fraxinus excelsior* L.and *Aesculus hippocastanum* L.) from Bucharest.

Materials and methods

The leaves were harvested from trees located in different areas of Bucharest in October 2019, analyzed using the X-ray fluorescence system (XRF - Rigaku ZSX100e) and visualised by scanning electron microscopy (SEM - *Jeol JSM 66-10LV*). The results were compared with threshold levels previously published and the accumulation capacity of different plants was evaluated using the accumulation index for heavy metal (HMAI) and rare earth elements (REEsAI).

Results and conclusions

The perennial plant species accumulated fourteen HMs (Ni, Sr, As, Hg, Zn, Pb, Co, Cu, Cr, Ag, Mn, Fe, Tc, V) and six REEs (La, Eu, Tb, Dy, Tm, Y).

Populus nigra L. is considered a good bioindicator for air quality and our results proved that leaves bioaccumulated the highest number of HMs (9). However, the highest heavy metal accumulation capacity was found in *Fraxinus excelsior* L. (HMAI=237.28) and *Betula pendula* Roth (HMAI=234.27). Different plant species had varying HMs concentrations. Moreover, clear differences were noticed between *Populus* sp. species analyzed (*Fig. 1*). Increased concentrations of Zn, Cr, Co and Fe that exceeded the normal range have been found in some plant species, but the other chemicals were within the normal range.

All tree species, except *Betula pendula* Roth, bioaccumulated 1 to 3 different REEs, with a total of 6 being detected (La, Pr, Eu, Gd, Tb, Dy, Tm, Y). The highest REEsAI value was found in *Populus tremula* L. (REEsAI=229.15), which was over 10 times higher than the REEsAI from *Aesculus hippocastanum* L. The values for each rare element may fluctuate from species to species and huge differences were noticed

between *Populus* species (figure 1). The Eu and La concentrations were exceeded, while other light elements were below the normal ranges.
The electron microscopy studies indicate the presence of particles between 1-50 µm, including that of harmful particles for human beings (<2µm) and clogged stomata all over the leaf's surface and the presence of many fungal colonies as well (figure 2).

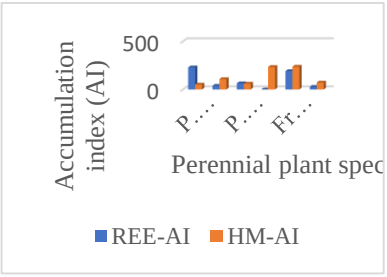

Figure 1. Bioaccumulation of HMs and REEs by XRF analysis

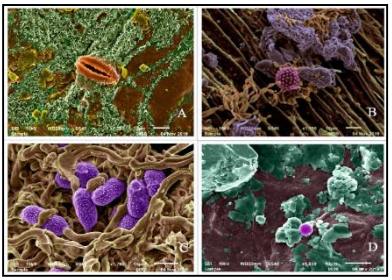

Figure 2. HMs and REES analyzed by SEM (example)

Besides the fact that the level of air pollution in Bucharest is suggested to be at a high level, with toxic HMs left from old industrial sites, the results also have implications for urban landscaping, as HM-AI and REEsAI can be used as an indicator for future screening trials of tree species. In addition, our results conclude that plants can be used as a bioindicator for a wide range of anthropogenically derived HMs and REEs and their pattern of bioaccumulation is species-specific and it presents itself as a signature of the waste streams.