

Jan Kochanowski University in Kielce

Institute of Biology

Abstract

Title: Common dandelion *Taraxacum officinale* agg. Web. ex Wigg. as an indicator of the geochemical status of urban soils

Author: mgr Ewelina Zajęcka

Supervisor: dr hab. inż. Anna Świercz, prof. UJK

This doctoral thesis is a source of information on the content of selected heavy metals, i.e. Pb, Cu, Zn, Cd, and Cd in surface soil levels of Kielce and Olsztyn; physicochemical properties of these soils; as well as the role of *Taraxacum officinale* agg. as a sensitive indicator of the geochemical status of urban soils.

The main aim of this thesis was to assess *Taraxacum officinale* agg. in terms of the bioindicative properties for urban soils, as well as to assess the pollution of soil environment with heavy metals in two cities characterised by similar area and demography, but dissimilar quality of atmospheric air defined by the results of research carried out by the Regional Inspectorates of Environmental Protection.

In chapters 1 and 2, the reasons for undertaking such a subject of research work as well as aims of the thesis are presented. Chapter 3 outlines the research issues of urban soils, their role in an urban ecosystem, and the importance of bioindication for monitoring of these soils, with particular emphasis on the current state of knowledge on the indicative properties of *Taraxacum officinale* agg.

Chapter 4 contains the research methodology, including sampling locations with a distinction among four types of land use, i.e. urban allotment gardens, urban forests, green areas, and industrial areas. In each city, 60 soil and common dandelion samples were collected (divided into roots and leaves). This chapter includes a detailed description of the sampling methodology and determination of soil physicochemical properties, total and bioaccessible content of heavy metals in urban soils, and concentrations of heavy metals in common dandelion roots and leaves. Chapter 5 explains precisely the physiogeographic characteristics of Kielce and Olsztyn, including their spatial and demographic structures, natural and social conditions, and the state of natural environment.

Chapter 6 presents the results of research, illustrated by means of tables, charts and statistical measures, and the links among analysed characteristics defined using statistical tests. Spatial

differentiation of the content of analysed heavy metals in the surface soil levels of Kielce and Olsztyn as well as in dandelion roots and leaves is presented on raster maps made using the kriging interpolation method. The applied spatial modelling enhances the relationships between concentrations of heavy metals in soils and common dandelions, so that it is possible to determine zones with high (deviating from the average values) heavy metal concentrations. Chapter 7 provides a critical reference of the obtained research results to other authors' research results in order to answer the question about the properties of common dandelion as a sensitive indicator of the geochemical status of urban soils as well as levels, factors and properties affecting concentrations of heavy metals in urban soils. The discussion, supported by calculated geoaccumulation indexes, translocation coefficients and phytoaccumulation factors, allows for a better understanding of the spatial variability of soil characteristics and content of heavy metals in common dandelions, and thus an assessment of the state of natural environment in Kielce and Olsztyn.

Chapter 8 summarises conclusions drawn out of the thesis. In the case of soils, both cities were characterised by comparable physicochemical properties, i.e. grain size dominated by sandy clay and light clay, pH ranging from slightly acidic to slightly alkaline, with a clear shift towards pH alkalinity, high calcium carbonate content, low Al^{3+} and Hw values in adsorption complex, comparable adsorption values expressed by cation exchange capacity, and significant abundance in P, Mg and K digestible forms. However, the results indicate that Kielce and Olsztyn differ in the content of heavy metals in their surface soil levels. Definitely higher content values were noted for Kielce - this applies to: Pb, Cu, Zn, and Cd. Both for Kielce and Olsztyn, there was a considerable variation in the values obtained. It should be emphasised that the content of heavy metals (except for Cd and Cr) found in the total content was correlated with their amount included in the bioaccessible content, which is extremely important from the point of view of their bioavailability. The share of bioaccessible content in relation to the total content for all heavy metals was much higher for the soils in Kielce. This may indicate a higher lability of soil environment in Kielce with regard to the content of analysed heavy metals. In the case of common dandelion, it was found that the content of some heavy metals in *Taraxacum officinale* agg. biomass depended on the (bioavailable) cation exchange capacity in soils. This especially concerns Pb (strong correlation between the content in soils and plant roots and leaves). A significant, though weaker, correlation was found for Zn (only for plant roots) and Cd. However, there was no tendency for accumulation of higher concentrations of heavy metals by a specific part of common dandelion, which would be expressed by clear relationships in the accumulation

of heavy metals by roots or leaves. The research conducted suggests the necessity to analyse the whole plant biomass in terms of heavy metal concentrations.

On the basis of the whole research, it may be determined that both root and leaves of *Taraxacum officinale* agg. can be a very good indicator for lead concentrations. Common dandelion also have bioindicative properties (although weaker than in the case of lead) in relation to cadmium, while its root - for zinc.

Emeline Lepelue