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Letters to Editor

The Content of Heavy Metals in an Indicator Plant *(Taraxacum Officinale)* in Warsaw

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Abstract

The present paper studies the content of heavy metals: Fe, Mn, Zn, Cu, Pb, Ni and Cd in the foliage of an indicator plant - dandelion - as collected from the lawns and parks of the Warsaw metroplitan area. The results suggest heavy accumulation of Fe, Zn, Pb and Cd as a consequence of the impact of traffic-born pollution.

Keywords! dandelion, indicator plant, zinc, copper, iron, lead, cadmium, pollution

Introduction

In the study of the pollution of various ecosystems by heavy metals, bio-indication methods have been more and more frequently used, in the last few years. Out of the indicator organisms it is most often that mosses are used for the determination of the actual pollution degree of the environment with heavy metals. Nonetheless, some higher plants also have been appreciated as good biological indicators, e.g. dandelion *(Taraxacum officinale* Web.). This plant has the ability of accumulating heavy metals in its leaves and roots [6-9].

The purpose of this paper was to learn the actual content of Fe, Mn, Zn, Cu, Pb, Ni and Cd in the foliage of dandelion plants growing in the city lawns and parks as well as assessment of the pollution degree at the study area.

Material and Methods

In 1996 (May-June) dandelion plants were sampled growing in sites along three highways. In order to study the impact of pollution on the adjacent terrain, dandelion leaves were collected at two distances from roads: adjacent to the road and 100 m from the road (parks, lawns, meadows). Similarly, soil was analyzed each time it was collected from the same sites [4].

The dandelion leaves were sampled washed carefully after collection, and dried at 60°C in a dryer with forced air circulation. The adequately cracked samples of leaves were dry mineralized at 500°C for 8 hours. This ash was hot dissolved in 6 molar HC1. In the resulting solutions, the concentrations of heavy metals (Fe, Mn, Zn, Cu, Pb, Ni and Cd) were determined with the use of ASA technique, with a Perkin-Elmer 2100 apparatus.

The analytical plant material was subsequently subjected to statistical analyses at the Department of Mathematical Statistics and Experimental Methodology of Warsaw Agricultural University in Warsaw.

Results and Discussion

The content of heavy metals in the leaves of dandelion has varied a lot (except manganese) (Tables 1-3). The dandelion foliage sampled at a control plot (Obra river valley) contained, on average the following amounts of heavy metals (all data in mg/kg dry matter): Fe - 126, Mn - 43, Zn - 34, Cu - 9.2, Pb - 1.2, Ni - 0.9 and Cd - 0.39 [10].

The concentration of **iron** as found in the present study has varied largely between 121 and 1056 mg/kg d.m. The difference between the maximum and minimum concentrations of Fe was, thus, 8.7 times. Those dandelion plants growing in the near-highway lawns accumulated especially

Table 1. Content of heavy metals in the leaves of dandelion plants along a Warsaw highway (East-West).

No	Locality	Fe	Mn	Zn	Cu	Pb	Ni	Cd
		mg/kg d.m.						
	Ostrobramska							
1	– near street	320	40	88	12.1	7.4	2.6	1.28
2	– 100 m distant	136	28	58	12.6	6.6	2.3	0.91
	Al. Waszyngtona							
3	– near street	325	25	66	10.9	7.7	2.2	1.12
4	– 100 m distant	308	13	29	10.5	5.7	2.1	0.87
	Al. Waszyngtona/Saska							
5	– near street	385	19	55	9.3	6.8	2.2	0.87
6	– 100 m distant	234	18	39	8.5	3.9	1.7	0.68
	Al. Jerozolimskie (Museum)							
7	– near street	252	19	44	18.8	8.2	2.4	0.84
8	– 100 m distant	184	17	38	13.7	6.9	1.8	0.69
	Al. Jerozolimskie/Pl. Starynkiewicza							
9	– near street	1056	58	203	14.9	11.1	3.2	1.39
10	– 100 m distant	712	31	55	14.1	8.7	2.4	1.28
	Al. Jerozolimskie (Włochy)							
11	– near street	257	31	55	16.4	7.2	2.3	1.02
12	– 100 m distant	183	28	44	13.6	6.6	1.8	0.89

increased loads of Fe (410 mg/kg d.m., on average). While those plants from the parks had smaller concentrations of elements in their leaves (212 mg/kg d.m., on average). Particularly large amounts of the element were found in dandelion plants sampled in the lawns of the city: on Jerozolimskie Ave. and Starynkiewicz Square (1056 and 820 mg/kg d.m., respectively) as well as in the Ochota Quarter: Narutowicz Square and Raszynska Street (833 and 820 mg/kg d.m., respectively). According to the data of the City Roads Board, the daily traffic intensity in these roads in 1998 was from 52 thousand to 59 thousand vehicles x 24 hours^{-1}.

A similarly high concentration of iron (502 mg/kg d.m. on average) was found in the leaves of dandelion plants at a petrol station in Bialystok [1].

The content of Fe in the studied dandelion plants was significantly correlated with the content of Zn, Pb, Ni and Cd (Table 4); that is, with those metals occurring in high concentrations in the dust of Warsaw streets [5].

Manganese concentration as found in the foliage of dandelion was low and suggests a deficit of the element. The average concentration of manganese in the tissues of dandelion was 24.5 mg/kg d.m., while the control value was equal to 43 mg/kg d.m. Anthropogenic soils from the area of Warsaw agglomeration are characteristic of either neutral or basic pH reactions [2, 4]. Given such reaction, manganese in soils occurs in oxidized forms, not available for plants. Similarly, trees' foliage sampled along the streets of Warsaw and Lodz contained little manganese, often below the level of 30 mg/kg d.m. [2, 3].

The leaves of dandelion contained from 0.7 to 3.2 mg/kg d.m. of **nickel.** These nickel amounts found in dandelion do not suggest any significant pollution of the natural environment of Warsaw with the element. On average, the concentration of nickel in the sampled dandelion was 1.9 mg/kg d.m. and it was comparable to the adequate figure of the agricultural region [9].

The concentration of **copper** in the bioindicator plant used was within the range 8.0 to 21.8 mg/kg d.m. (Tables 1-3). Dandelion plants growing in lawns adjacent to roads contained somewhat higher loads of copper (14.7 mg/kg d.m. on average) than those from the parks (12.4 mg/kg d.m. on average). Traffic-born pollution had a smaller impact onto the concentration of copper in plant tissue (short growing period) as compared with the metal accumulation in the soils of the same sites [4].

Dandelion plants sampled in the lawns of Biatystok contained, on average, more copper (19.3 mg/kg d.m.) than the plants sampled in the present experiment [1].

The concentration of **zinc** in the tissues of dandelion varied significantly: from 29 up to 209 mg/kg d.m. The difference between the maximum and minimum concentration was 7 times, slightly smaller than that found in the case of iron. Large concentrations of zinc (100-203 mg/kg d.m.) were found in samples of dandelion collected in four posts situated near roads with heavy traffic (Tables 1-3). Both the average content of zinc in dandelion from the near-street lawns (85 mg/kg d.m.) and from the parks (47 mg/kg d.m.) were above the control value (34 mg/kg d.m.).

The average concentration of zinc in dandelion tissues as found in the near-street lawns in Warsaw was similar to that (85 mg/kg d.m.) of the lawns of Bialystok [1].

Lead concentration in dandelion tissues in the lawns of Warsaw was less differentiated and it ranged from 3.9 to 13.0 mg/kg d.m. (Tables 1-3). Higher loads of lead were found in foliage collected from plants growing in the vicinity of highways (9.0 mg/kg d.m.), while lesser concentration of the elements were characteristic for those plants sampled in the parks (6.3 mg/kg d.m.). It should be emphasized that dandelion plants sampled at a meadow of Falenty, 100 m

Table 2. Content of heavy metals in the leaves of dandelion plants along a Warsaw highway (Trasa Lazienkowska).

No	Locality	Fe	Mn	Zn	Cu	Pb	Ni	Cd
		mg/kg d.m.						
	Al. Ujazdowskie/Park Ujazdowski							
13	– near street	300	–	100	21.8	9.6	–	1.20
14	– 100 m distant	150	–	73	14.0	6.8	–	1.18
	ul. Wawelska (Rondo Jazdy Polskiej)							
15	– near street	303	33	72	14.5	9.9	2.0	1.33
	Park Pole Mokotowskie							
16	– 100 m distant	126	20	52	13.6	5.3	0.9	0.73
	ul. Wawelska/Al. Wielkopolski							
17	– near street	407	22	77	14.0	12.4	2.4	1.08
	Park Pole Mokotowskie							
18	– 100 m distant	179	23	52	8.0	7.2	1.4	0.74
	ul. Wawelska/Raszyńska							
19	– near street	820	19	120	18.6	13.0	2.2	1.55
	ul. Batorego							
20	– near street	293	36	53	15.5	10.1	2.4	0.98
	Park Pole Mokotowskie							
21	– 100 m distant	140	19	40	12.9	4.2	1.5	0.68
	ul. Wołowska/Dąbrowskiego							
22	– near street	232	31	98	14.0	9.9	1.8	1.31
23	– 100 m distant	133	26	39	13.9	5.5	1.4	0.99

"-" not determined

Table 3. Content of heavy metals in the leaves of dandelion along a Warsaw highway (North-South).

No	Locality	Fe	Mn	Zn	Cu	Pb	Ni	Cd
		mg/kg d.m.						
	Plac Narutowicza – Rondo							
24	– near street	833	24	86	15.1	8.2	2.7	1.12
25	– 100 m distant	290	26	55	14.8	7.4	2.3	1.02
	ul. Grójecka/Bitwy Warszawskiej							
26	– near street	302	22	71	15.3	8.2	1.8	0.99
27	– 100 m distant	163	14	41	10.9	5.3	1.3	0.77
	ul. Grójecka/Dikensa							
28	– near street	235	19	54	11.6	6.6	1.3	0.83
29	– 100 m distant	121	18	44	11.3	6.2	0.7	0.67
	Al. Krakowska/Maciejki							
30	– near street	246	23	133	14.2	7.7	1.9	1.38
31	– 100 m distant	138	13	44	13.2	6.2	1.4	1.24
	Falenty							
32	– meadow 100 m from highway	175	14	50	13.0	8.9	1.9	1.35
	Agricultural region*	–	–	40	7.0	0.5	1.9	0.6
	Industrialized region*	–	–	70	13.0	3.0	4.2	1.2

* Kabata-Pendias, Motowicka-Terelak [9]

off a heavy traffic road, contained lots of lead (and also lots of cadmium) - Table 3. In the open terrain, the traffic born pollution was transported for long distances.

The concentration of **cadmium** in the leaves of dandelion varied in the rage 0.65-1.55 mg/kg d.m. The concentration of the element in the indicator plants was from 1.6 to 4 times that noticed in the control plot (in the latter it was equal 0.38 mg/kg d.m.). In some posts, the concentration of cadmium in dandelion leaves was the same regardless of the actual distance from the heavy traffic road. This finding suggests the even spatial character of the Warsaw lawns' pollution with cadmium.

It results from the statistical analyses performed that the content of cadmium in dandelion was significantly correlated with the content of zinc, lead and nickel (Table 4).

Table 4. Coefficients of correlation r between heavy metals in the leaves of dandelion plants.

Element	r
Fe – Zn	0.648**
Fe – Pb	0.569**
Fe – Ni	0.722**
Fe – Cd	0.464**
Zn – Mn	0.458**
Pb – Zn	0.457**
Ni – Zn	0.496**
Ni – Pb	0.460**
Cd – Zn	0.600**
Cd – Pb	0.558**
Cd – Ni	0.548**

** – p = 0.01

In summary, it has to be emphasized that the communication pollution of the atmospheric air has most heavily influenced the concentration of iron, zinc and lead in the leaves of dandelion plants. Its impact has been less pronounced considering the content of copper and cadmium. The average concentration of heavy metals in the tissue of dandelion plants from the lawns and parks of Warsaw was the following (all data in mg/kg d.m.): Fe - 310, Zn - 67, Mn - 24.5, Cu - 13.0, Pb - 7.6, Ni - 1.9 and Cd - 0.97. The study of concentration of heavy metals in the studied samples made it possible to assess the actual degree of pollution the green areas of the capitol. The average concentrations of Zn, Cu, Pb and Cd in the tissues of sampled dandelion plants were, in general, higher than respective values not only in the agricultural region, but also in the industrial region, as found by Kabata-Pendias and Motowicka-Terelak [9].

Conclusion

1. The leaves of dandelion plants growing on lawns along communication arteries contain more iron, zinc, lead and copper as compared with the plants sampled in parks.
2. The concentration of lead, copper, zinc and cadmium in dandelion plants growing in the lawns of Warsaw is either similar to or slightly higher than the respective values found for the industrialized region; the only exception is nickel - its concentration has been at the level of nickel concentration as found in the agricultural region.
3. The content of heavy metals both in foliage of dande lion and that the soil, from Warsaw, should be seen a good indicator of the natural environment pollution of the urban areas.

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