APPLICATION OF SOME BIOINDICATORS FOR STUDIES OF RADIOACTIVE AND TOXIC FALLOUT ACCUMULATION

Marek Reszka, Aneta Wołoszyn
Maria Curie-Skłodowska University, Department of Radiochemistry and Colloid Chemistry, Pl. M. C. Skłodowskiej 3, 20-031 Lublin, Poland

Due to their commonness, availability, permanent contact with environment and relatively short generation time plants seem to be excellent material for studying consequences of environment contamination. Vast variety of species enables selection of organisms particularly vulnerable to specific toxins.

For studying concentration of heavy metals and gamma radioactive isotopes in plant samples the species selected were especially liable to suffer such contaminants due to their anatomy or its nutrional way. The plant samples were collected from areas of various emission levels of toxic gas and dusts. Radionuclide and heavy metal concentrations were compared to those of surface soil samples from respective sites. Concentration of heavy metals and main gamma radioactive isotopes both natural and anthropogenic origin (post Chernobyl ^{137}Cs) were measured using AAS and gamma spectrometric methods, respectively.

Sample collection sites

The material was collected late autumn 2004 at territory of Eastern Poland in extensive forest of similar kind of species in following sites: Zemborzyce near Lublin, Obojna (Puszcza Sandomierska-Wilderness), Łomnica (Poleski National Park). These sites represent various contamination levels.

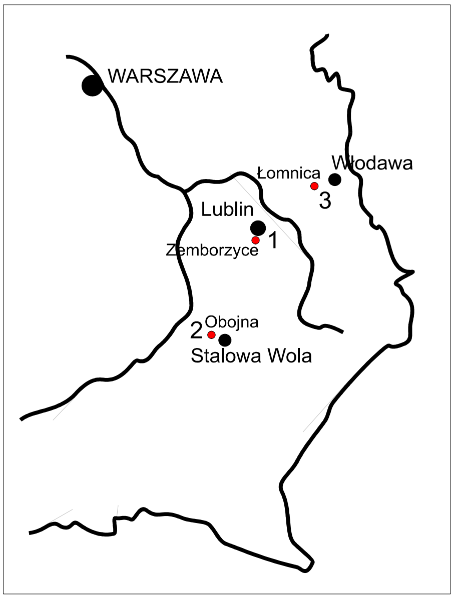

Fig.1 Location of sampling points.

Point 1 was located about 5 km from the center of a big town - Lublin. In previous years a heavy industry factories were in operation (foundry, car factory). Nowadays the only working factory that may emit contaminations to atmosphere is heat and power station „Wrotków" using hard coal. The town is surrounded by farmlands of low agriculture level;

Point 2 was located at wilderness Puszcza Sandomierska. This region is known as one of the most unpolluted in Poland but not far away (7 km) there are potentially dangerous points for environment. There is a town of Stalowa Wola with coal powered heat and power station and until 1993 sulfur strip mine worked in Tarnobrzeg, a town nearby. Surrounding farmlands are also of low level.

Point 3 was selected in borders of Poleski National Park. Due to lack of industry this region seemed to be relatively clean potentially threatened only by develop of Bogdanka coal mine located in vicinity as well as fertilizers and herbicides used in agriculture.

Collection and preparation of samples

Samples of lichens were picked up from tree trunks at height 1-2 meters. The bedding was removed and lichens were air dried in laboratory. Mosses were collected in exposed clearings and air dried after removing of leaves and soil particles. Coniferous needles were collected from young pine-trees. Surface bark of older trees was removed with knife and after cleaning from lichens was grinded and air dried. Faded leaves of various trees was collected from clearings and dried. To avoid problems with collection of mushrooms of the same type an arboreal type fungus - polyphore (*Fomes fomentarius*) was chosen.

Radioactivity measurements

Air dried material was grinded and weighted to standard 500cm^3 Marinellli vessel. The concentration of gamma isotopes was measured with Silena/Canberra spectrometer equipped with HPGe detector. Identification of isotopes and calculation of their concentration was made with Genie 2000 (Canberra) software.

Results

The level of radioactivity of the most important gamma isotopes in plant and soil samples was similar to their concentration in the samples of the same type measured in previous years and is much lower than values measured soon after explosion of Chernobyl power plant [1]. In studied samples of lichens, mosses and mushrooms the concentration of ^{137}Cs was much higher than in other samples collected in the same sites. The highest concentration was noticed for Obojna that was in agreement with previous measurements [2].

Natural isotopes concentrations are much lower than measured for ^{137}Cs. Sometimes even below detection limit of the spectrometer. An exception is ^{210}Pb which beside ^{40}K and ^{137}Cs has greatest share in gamma radioactivity of the all samples. Such as for cesium the higher concentration of ^{210}Pb was observed in lichens and mosses. For these samples collected in Łomnica also the concentration of natural isotopes was relatively high. It was probably caused by intense dusting from surrounding fields.

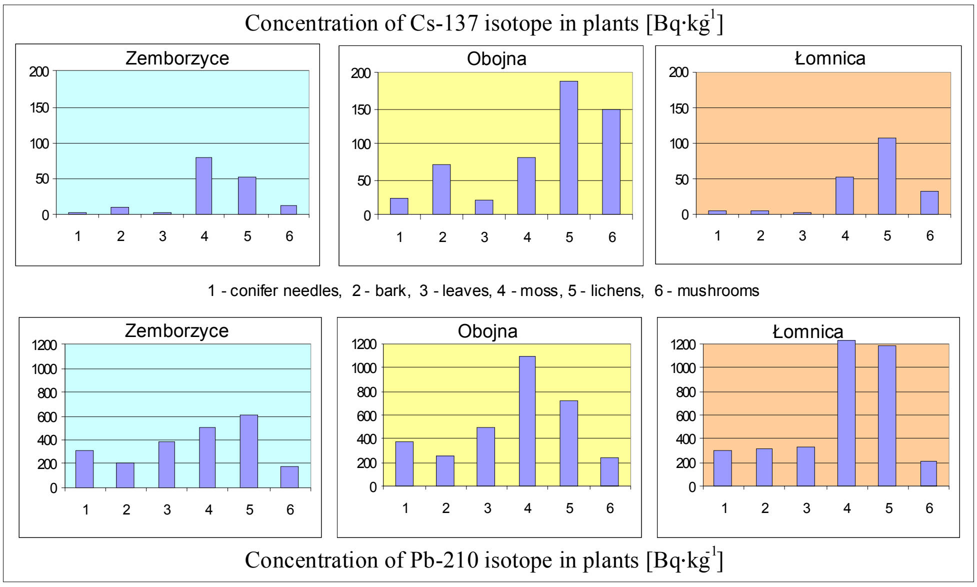

Fig 2. Concentration of main gamma isotopes in plant samples

Table 1. Concentration of main natural gamma isotopes in soil samples

Site	Zemborzyce		Obojna		Łomnica	
Izotope	Radioactivity [$Bq \cdot kg^{-1}$]	Error [$Bq \cdot kg^{-1}$]	Radioactivity [$Bq \cdot kg^{-1}$]	Error [$Bq \cdot kg^{-1}$]	Radioactivity [$Bq \cdot kg^{-1}$]	Error [$Bq \cdot kg^{-1}$]
K-40	272.08	6.31	220.38	5.62	252.20	5.82
Cs-137	0.12	0.37	3.14	0.97	6.12	0.21
Pb-210	3.72	1.41	5.44	2.04	1.41	0.53
Bi-212	0.86	0.51	6.07	0.56	9.53	0.48
Pb-212	1.68	1.08	1.10	0.93	1.65	1.07
Bi-214	1.16	0.38	1.07	0.36	1.14	0.32
Pb-214	1.13	0.98	1.04	0.90	1.12	0.91

Heavy metal concentration measurements

Concentration of some heavy metals in the samples was measured with Spectr AA880 Varian spectrometer. Considering results of similar measurements in Poland one may state that obtained values are on the level obtained for non-polluted areas. [3,4] The concentration of selected heavy metals in soils ranges considerably (20-3000$\mu g \cdot g^{-1}$) and is much higher than in plants (from 0.2 to 1200 $\mu g \cdot g^{-1}$). The higher concentration in mushrooms results from their ability to cumulate zinc, copper, iron and manganese from soil. Slightly lower concentration of these metals may be noticed also in mosses and lichens. The lowest concentration of these elements was noticed in leaves and needles. Because similar concentration was measured in the bark samples one may state that there no emission of contaminating dusts nor compounds was in the last years.

Table 2. Concentration of main heavy metals in plant and soil samples [$\mu g \cdot g^{-1}$]

Sample	Site	Zn	Mn	Cu	Cd	Fe	Cr	Ni	Pb
conifer needles	1	43.2	0.43	2.5	0.43	453	0.7	0.4	2.2
	2	42.2	0.8	4.8	0.68	612	2.8	0.6	11.8
	3	35.1	1.36	3.4	0.21	438	1.2	0.4	10.6
bark	1	62.7	0.43	6.5	0.53	453	2.7	1.4	14.2
	2	64.3	0.8	8.8	0.66	612	3.5	1.6	18.1
	3	46.5	1.36	7.4	0.51	438	2.2	1.4	10.6
leaves	1	13.3	0.46	3.78	0.21	461.4	0.61	0.3	6.08
	2	18.2	1.14	4.65	0.3	467.8	0.48	0.5	7.07
	3	13.1	0.17	2.71	0.31	491.4	0.71	0.2	3.78
moss	1	39.6	12.5	15.8	0.36	870	0.2	0.53	14.2
	2	43.8	18.9	16.5	0.52	1151	4.9	2.11	22.7
	3	22.6	6.8	4.2	0.32	387	2.35	1.34	16.8
lichens	1	25.3	17.6	15.4	0.14	356	2.6	3.16	40.3
	2	74.7	32	22.9	0.25	740	2.9	4.43	122.3
	3	48.4	28.3	11.6	0.11	271	2.8	1.88	12.23
mushrooms	1	72.2	55.4	24.4	1.67	410	7.5	5.1	17.9
	2	124.1	78.8	67.4	2.8	1220	11.4	6.4	40.6
	3	64.4	43.2	66.2	0.94	1108	9.8	1.3	28.5
soil	1	75.2	112.4	24	22.9	2100	92.1	71.9	130.2
	2	86.4	135.6	28.3	24.8	3368	96.9	83.8	179.8
	3	63.7	11.6	23.5	22.3	1698	76.8	58.9	122.4

Conclusions

Lichens, mosses and mushrooms, accumulating in their tissues radioisotopes and heavy metals are very sensitive indicators of environment pollution. However, quantitative measurements demands consideration of many factors connected with biological diversity of these plants and climate fluctuation. Obtained data may inform of the contamination level of studied areas and warn us against hazardous situations.

References

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