Short report
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The radioactivity of Vojvodina agricultural soil

Ištvan S. BIKIT
Miroslav J. VESKOVIĆ
Jaroslav M. SLIVKA
Miodrag D. KRMAR
Ljiljana U. ČONKIĆ
Sofija M. ĆURČIĆ

INSTITUTE OF PHYSICS, FACULTY OF SCIENCES, NOVI SAD, YUGOSLAVIA

The widespread public belief that during the bombardment Vojvodina was also contaminated with depleted uranium makes the perceiving of the state of agricultural soil radioactivity very actual. Based on gamma-spectrometric analysis of 50 soil samples taken from the region of Vojvodina one can conclude that there is no increase of radioactivity that could endanger the food production. Measured activity concentrations of ^{137}Cs, taking into account the transfer factors of this isotope into plants, should not endanger the health safety of the produced food.

KEY WORDS: *Uranium; Soil Pollutants, Radioactive; Spectometry, Gamma; Food Contamination, Radioactive; Yugoslavia; War*

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INTRODUCTION

The soil of Vojvodina is subject to radioactive contamination from a number of sources. First of all, these are the reactors of nuclear power plants in the region of southeast Europe that could contaminate a broader environment by their emission into air and water. As second, the use of phosphate fertilizers with high uranium concentration may cause a gradual increase of the uranium series activity concentration in soil. The widespread public belief that during the shelling Vojvodina was also contaminated with depleted uranium makes the perceiving of the state of agricultural soil radioactivity very actual.

RESULTS OF MEASUREMENT AND DISCUSSION

Activity concentration of man-made radionuclides, except ^{137}Cs, is below the detection limit. The radionuclide ^{137}Cs is present in all soil samples. This radionuclide originates from the accident of the nuclear power plant "Lenin" in Chernobyl, in 1986. Due to the long half-life of this radionuclide of 30 years, it will be relocated, washed out and redistributed, but it will be still present in the ecosystem of Vojvodina for a long time. The great standard deviation and the great difference between the minimum and maximum ^{137}Cs activity concentrations show typical features of a man-made contaminant. Mean values of activity concentrations of the detected radionuclides are presented in Table 1.

Table 1. Arithmetic mean values, standard deviations, minimum and maximum activity concentrations of radionuclides on the Vojvodina territory

Radionuclide	$\bar{A}_s$ [Bq/kg]	$\sigma \bar{A}_s$ [Bq/kg]	$A_{s(min)}$ [Bq/kg]	$A_{s(max)}$ [Bq/kg]	Location (min)	Location(max)
^{137}Cs	11.8	9.2	1.1	55.0	Horgoš	Bavanište
^{238}U	51.4	9.3	24.0	72.0	Palić	Obedska Bara
^{226}Ra	39.3	7.2	19.7	51.0	Horgoš	Višnjićevo
^{232}Th	53.2	8.3	22.0	64.0	Horgoš	Boka
^{40}K	554	92	238	730	Horgoš	Rusko Selo Vojvoda Stepa

Because the ^{238}U activity concentration in all samples is at the usual level, and because the $^{238}U/^{226}Ra$ ratio is not substantially changed, it can be concluded that the measured samples show no indication of depleted uranium presence (2,3). The activity concentrations of the natural radioactive series of ^{232}Th and the natural radionuclide ^{40}K are within usual limits.

Table 2. Measured activity concentrations of ^{137}Cs for the regions of Subotica, Vršac and Novi Sad

	activity concentration ^{137}Cs [Bq/kg]		
region	1988.[4]	1989.[4]	2001.
Subotica	9.0(12)	6.5(9)	4.7(25)
Vršac	44(6)	23(3)	31(13)
Novi Sad	8.7(14)	6.6(13)	8.2(7)

If we compare the obtained results with previous measurements (4-7), we note a decreasing tendency of activity concentrations after 1988, except in the region of Vršac and Novi Sad where the values are slightly higher than in 1989 (Table 2). This difference might be due to the sampling from different micro locations in previous and this year. The precipitation process of ^{137}Cs after the Chernobyl accident is obviously very nonuniform.

Address correspondence to:

Prof. Ištvan Bikit, Institute of Physics, Faculty of Sciences, Trg Dositeja Obradovića 4, 21000 Novi Sad, Yugoslavia

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