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Radioecological investigation of food of animal origin in Belgrade environment

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Abstract

The activity concentrations of ^{40}K , ^{238}U , ^{232}Th and ^{137}Cs were measured using gamma spectrometric method in different food chain samples from Serb Belgrade environment during the periods May-June 2007 and May-June 2008 year. Relatively high activities of ^{40}K and ^{137}Cs were detected in the soil. These results indicate that ^{137}Cs is present in Belgrade environment even 20 years after nuclear accident in Chernobyl. However, in the samples of feedstuffs, animal products and bio indicators (meat of wild animals and fish), activity concentrations of primordial radionuclides and ^{137}Cs were low and below the detection limits. Results of these trials have shown that investigated animal products from the natural environment around Belgrade, are radioactivity safe.

Key words: Belgrade, Chernobyl, food chain, radionuclide

Radioactive contamination of environment with anthropogenic radionuclides in Serbia appeared after the nuclear accident which occurred in Chernobyl, Ukraine (1986) and even 20 years after the accident presence of ^{137}Cs may be detected in the environment, because of its long half-life (30 years). Wild animals present good indicators of environment radioactive contamination. Because of their nutrition habits they accumulate in tissues higher level of ^{137}Cs ⁵⁾. Worldwide use of nuclear energy, application and nuclear weapon probes, coal combustion,

production and application of phosphorus fertilizers, mining industry and formation of radioactive waste dumps contribute to distribution of natural radioactivity^{3,8,9)}. One of the most important anthropogenic source of environment pollution with primordial radionuclides (^{238}U , ^{226}Ra , ^{232}Th and ^{40}K) is production and application of phosphorus fertilizers^{1,4)}.

For radiological investigations of certain area, sample collection present basic element in order to investigate influence on health of animals and humans. Samples of soil, grass, products of

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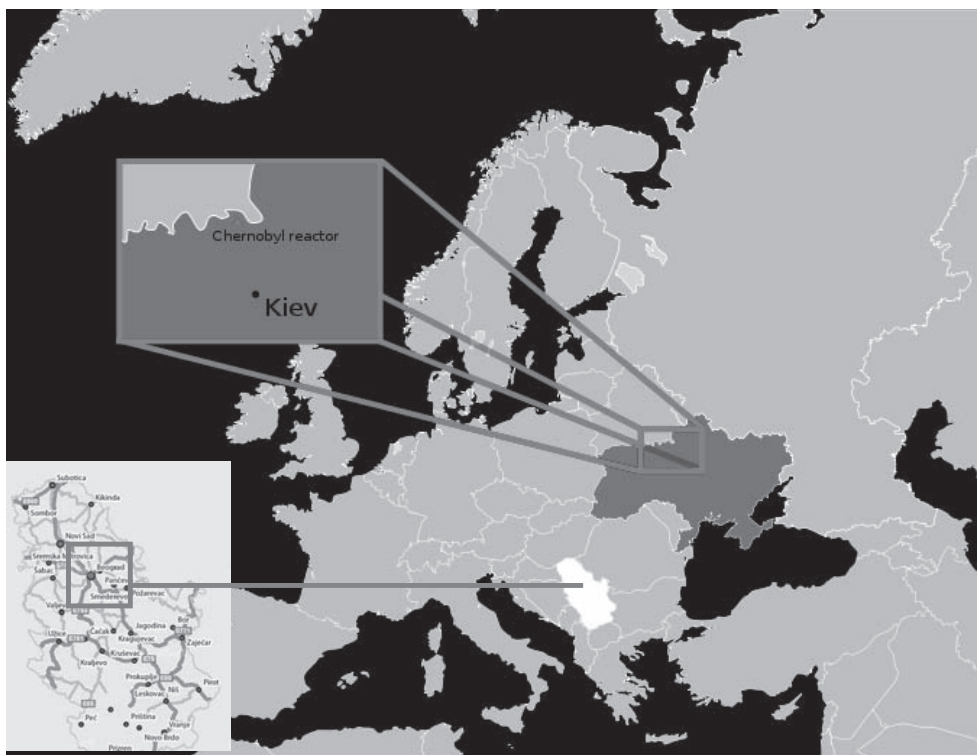


Fig. 1. Position of Chernobyl-nuclear reactor (Kiev, Ukraine) and Serb Belgrade (sampling area) on map of Europe

animal origin^{2,11)}, meat of wild animals and fish^{6,7,12)} were investigated for these purposes.

The goal of this paper was to determine the level of activity and presence of radionuclides (^{40}K , ^{238}U , ^{232}Th and ^{137}Cs) in the food chain: soil-plants-animals-humans on the territory of six regions around Serb Belgrade from where the most food for human consumption originates.

The samples were collected during the period May-June 2007 and May-June 2008 year in the area of six regions around Serb Belgrade (Avala-Zuce, Kosmaj-Nemenikuće, Barajevo, Grocka, Surčin, and Opovo). From each of sample types it was taken by 3 samples from one sampling site. Positions of Serb Belgrade and Chernobyl on a map of Europe are shown in Fig. 1. Sampling locations are shown in Fig. 2.

Soil samples in amount of 3 to 5 kilos were collected from a depth of 10–20 cm, homogenized, dried at temperature of 105°C and put in 11 Marineli beakers. Alfalfa and maize samples were collected in amounts of 2–5 kg, grinded and



Fig. 2. Position of sampling sites (six regions) in Serb Belgrade surrounding area with a position of rivers Danube, Sava and Tamiš. Sampling sites: 1. Avala-Zuce; 2. Kosmaj-Nemenikuće; 3. Barajevo; 4. Grocka; 5. Surčin; 6. Opovo.

burned to mineral ash. Plastic vessels of volume 200 ml were used for measurements.

Milk samples were collected in amounts of

Table 1. ^{40}K , ^{238}U , ^{232}Th and ^{137}Cs activity concentration in the soil, feedstuffs, milk, cheese, eggs, meat of domestic and wild animals and in fish meat samples (Bq/kg).

Samples	^{40}K	^{238}U	^{232}Th	^{137}Cs
Soil cultivated (f.w.)	608 ± 15	47 ± 7	50 ± 4	25 ± 2
Soil non cultivated (f.w.)	560 ± 16	41 ± 5	47 ± 2	39 ± 1
Alfalfa (f.w.)	538 ± 19	< 5	< 1.6	< 0.4
Maize (f.w.)	95 ± 5	< 1.9	< 0.3	< 0.1
Cow milk	50 ± 5	< 1.2	< 0.2	< 0.1
Goat milk	57 ± 2	< 1.4	< 0.3	< 0.3
Cow cheese	37 ± 4	< 1.5	< 0.3	< 0.1
Eggs (chicken)	52 ± 2	< 1.7	< 0.7	< 0.1
Beef meat (f.w.)	102 ± 4	1.1 ± 0.3	< 0.8	< 0.1
Sheep meat (f.w.)	96 ± 6	3 ± 0.2	< 2.5	< 0.3
Pork meat (f.w.)	94 ± 3	1.1 ± 0.4	< 1.3	< 0.1
Chicken meat (f.w.)	92 ± 3	2.7 ± 0.4	< 1.5	< 0.1
Rabbit meat	90 ± 3	< 1.8	< 0.2	< 0.1
Pheasant meat	85 ± 4	< 1.6	< 0.3	< 0.2
Roe deer meat	136 ± 4	< 1.2	< 0.2	< 0.2
Wild boar meat	95 ± 3	< 1.1	< 0.2	< 0.1
White (mixed) fish meat	85 ± 3	< 1.5	< 0.5	< 0.5
Cat fish meat	91 ± 3	< 2.1	< 0.5	< 0.2
Carp fish meat	94 ± 4	< 1.8	< 0.4	< 0.2
Pike perch fish meat	98 ± 7	< 2.5	< 0.7	< 0.1
Bream fish meat	85 ± 3	< 1.4	< 0.5	< 0.1

f.w.: fresh weight

Values are mean $\pm$ standard deviation.

5 l, evaporated to 1 l and then placed in Marineli beakers. Samples of fresh meat, eggs, cheese and fish were homogenized and measured in 1 l Marineli beakers. Fish samples originated from the rivers Sava and Danube which flow in these regions.

All samples were kept 40 days prior to measurements in order to achieve radioactive balance. All samples were of the same age (fresh) from May–June 2007 or May–June 2008 year only maize originated from previous year.

Radioactivity of samples was determined by gamma spectrometric measurement on HPGe detector (Ortec[®], USA), with relative efficiency 30% and energy resolution 1.85 keV (1332.5 ^{60}Co). Radioactive measurements were performed

according to procedure described by *Mitrović et al.*⁷⁾

All obtained results were expressed as means $\pm$ standard deviation¹⁰⁾ and are shown in Table 1.

Average values of activity of natural and artificial radionuclides in samples of cultivated and uncultivated soils, feedstuffs (alfalfa and maize), animal products (milk, cheese and eggs) and meat (domestic and wild animals and fish) gathered from six sites around Belgrade are shown in Table 1.

Average values of activity levels of natural and artificial radionuclides in fish meat samples gathered from several locations of the Sava, Danube and Tamiš rivers are displayed in Table 1.

^{40}K represents the most dominant natural

radioactive element. Detected average activity levels of this radionuclide was high in both samples of soil (cultivated 608 ± 15 and 560 ± 16 Bq/kg for uncultivated) and alfalfa (538 ± 19 Bq/kg), while in samples of maize it was significantly lower (95 ± 5 Bq/kg). The activity levels of other natural radionuclides (^{238}U and ^{232}Th) were lower and ranged within limits of average values in Serbia which were detected by Pantelić *et al.*⁸⁾.

The activity level of ^{137}Cs in the soil samples ranged from 25 ± 2 in cultivated to 39 ± 1 Bq/kg in non cultivated soils. Activity is 1.6 times higher in non-cultivated soil, which is in compliance with results reported by Mitrović *et al.*⁷⁾, and these results indicate that even after 20 years after Chernobyl nuclear accident, this radionuclide is still present in the natural environment of Belgrade. Lower levels of ^{137}Cs are found in the cultivated soil than in non cultivated one. This result is in accordance with results of other authors^{2-4,11)} which have suggested that applying of agro technical procedures (ploughing, manureing) are measures which are undertaken to decrease ^{137}Cs in soil.

In the samples of feedstuffs, which are mostly present in diet of animals (alfalfa, maize) low level activity of natural radionuclides was measured and for ^{137}Cs was in limit of detection range.

Obtained results (Table 1) indicate that meat samples of domestic animals, originated from regions around Belgrade, are radioactively-hygienic safe for human consumption. Activity levels of natural radionuclides and ^{137}Cs were low (within a range of detection) except for ^{40}K which was ranged from 92 ± 3 to 102 ± 4 Bq/kg. Similar results were presented by Mitrović *et al.*⁷⁾.

In the examined samples of milk, cheese and eggs (Table 1), low level of activity in both natural and artificial radionuclides was identified and ^{137}Cs was in on a border of detection range. Obtained results suggested that examined animal products are safe for human consumption.

Data presented in Table 1 indicate that the

level of investigated radionuclides in meat of wild animals was low (in a range of detection). Activity of ^{40}K was in a range from 85 ± 4 Bq/kg (pheasant) to 136 ± 4 Bq/kg (roe deer).

Levels of investigated radionuclides in fish meat (Table 1) were low (at the lower limit of detection). Activity of ^{40}K was in a range between 85 ± 3 (white fish) and 98 ± 7 (pike perch) Bq/kg, which is in compliance with results reported by Vilic *et al.*¹²⁾.

Based on the results obtained in our research we can say that the natural environment around Belgrade is radiologically safe.

Determined level of ^{137}Cs in animal products is on a low border of detection limit, which proves that environment in investigated locations of Belgrade is radioactively safe.

Radioactive activity of fish meat samples indicate that the natural environment of the rivers Sava, Danube and Tamiš is radioecologically safe and that fish originating from these rivers is safe for human consumption.

Food of animal origin produced in Belgrade environment used daily in human consumption is radioactively hygienic safe and can be recommended for export to foreign markets.

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