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ACTIVITY CONCENTRATION OF RADIONUCLIDES IN VARIUS GAME MEAT SPECIES IN SERBIA

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Summary: The activity concentration of ^{40}K, ^{238}U, ^{232}Th and ^{137}Cs in game meat from mountain regions Tara and Maljen as well as around the Belgrade city were measured by the gamma-spectrometric method. In game meat from mountain regions the activity concentration of ^{137}Cs was higher (22-54 Bq kg^{-1}) compared with samples collected around the Belgrade city (<0.2 Bq kg^{-1}). The content of natural radionuclides was low in all investigation samples.

Key words: game meat, radionuclides, ^{137}Cs, gamma-spectrometric method

Introduction

The behaviour of radionuclides in forest ecosystem is different than in agriculture ecosystem, which is mainly affected in longer maintenance of higher radionuclides concnetration. The importance of radioactive contamination of forest as a significant source of radiation exposure was recognised after the Chernobyl accident (Calmon et al., 2009) when an increased level of radioactive caesium was detected in environment. Numerous authors (Delfanti et. al., 1999; Dragović et al., 2004; Mitrović et al., 2009, Grdović et al., 2010) concluded that mosses, lichens, mushrooms and wild game are bioindicators for radiocaesium. The radionuclides concentrations in game meat depend of the feeding habits of the animals. In animals tissue the levels of radiocaesium increased by eating mushrooms and lichens, which was observed for roe deer (Karlén et al., 1991; Strandberg and Knudsen, 1994).

The consumption of game meat in Serbia by general population is low, but hunters consumption relatively large quantities of these products. Therefore, the aim of this study was to determine and compare the activity concentration of natural (^{40}K, ^{238}U, ^{232}Th) and artificial (^{137}Cs) radionuclides in various game meat species from different region in Serbia. The game meat samples were collected in two mountain region (Tara and Maljen) and around Belgrade city. Because the mushrooms are the mainly source of radioactive contamination of wild animal, concentration of radionuclides in mushrooms were investigated.

Material and Methods

The samples of game meat were collected in period 2002-2007 in the area of Maljen and Tara mountains. During 2007-2010 the samples of game meat and mushrooms were collected around the Belgrade city (Fig. 1). Mushroom samples were collected in area where animals were hunting.

Figure. 1. Geographic map of Serbia – location of Tara and Maljen mountains and Belgrade city

Game meat samples (Venison, Wild board, Pheasant, Rabbit) were homogenized and measured in 1l Marineli beakers. Mushroom samples were first cleaned of soil and other impurities and dried at 80°C until constant mass, homogenized and packed in 200 ml plastic vessels.

Before the measured samples were kept at least 30 days. The activity of samples was determined by gamma-spectrometric measurement on HPGe detector (Ortec), with relative efficiency 30% and energy resolution 1.85 keV (1332.5 ^{60}Co). The analysis of each measured γ-ray spectrum has been carried out by a software program GAMMA VISION®-32.

Results and Discussion

The activity concentrations of natural and artificial radionuclides in game meat are presented in Table 1. Table 2 presents the activity concentration of natural and artificial radionuclides in mushrooms. In wild boar meat from mountain region the activity concentration of ^{137}Cs was higher (31-54 Bq kg^{-1}) compared to the venison meat (22-24 Bq kg^{-1}). In game meat hunting in Belgrade environment the activity concentration of ^{137}Cs was below the detection limit.

The wild boars are omnivores, and they like to eat the mushrooms, as venison. In forest ecosystem the mushrooms are the main source of radioactive contamination of ruminants (Hove et al., 1990), and can participate up to 20% of rumen content (Karlén et al., 1991). In game meat from Belgrade environment the activity concentration of ^{137}Cs was below detection limit (<0.2 Bq kg^{-1}). In our earlier investigation on Maljen we detected that the activity concentration of ^{137}Cs in mushrooms ranged from 93-385 Bq kg^{-1} (Mitrović et al., 2009), while in Belgrade environment the activity concentration of ^{137}Cs ranged from 0.3-27 Bq kg^{-1} (Table 2). This can explain higher ^{137}Cs activity concentration in venison and wild boars meat founded on Tara and Maljen mountains than in Belgrade environment. The activity level of natural radionuclides was low in game meat. In mushrooms (Table 2) ^{40}K was dominant radionuclide and its activity concentration ranged from 111-790 Bq kg$^{-1,}$ depending of the type of mushrooms.

Table 1. ^{40}K, ^{238}U, ^{232}Th and ^{137}Cs activity concentration (Bq kg^{-1}) in game meat from Tara, Maljen and around Belgrade city

Samples	No. of samples	^{40}K	^{238}U	^{232}Th	^{137}Cs
		Tara			
Venison	5	125 ± 4	<4.3	<2.5	24 ± 7
Wild boar meat	5	157 ± 5	<3.2	<0.3	54 ± 6
		Maljen			
Venison	5	88 ± 3	<12.2	<1.5	22 ± 2
Wild boar meat	5	48 ± 2	<6.5	<5	31 ± 2
		Belgrade city			
Venison	3	136 ± 4	< 1.2	<0.2	<0.2
Wild boar meat	6	95 ± 3	<1.1	<0.2	<0.1
Pheasant	6	85 ± 4	<1.6	<0.3	<0.2
Rabbit	6	90 ± 3	<1.5	<0.2	<0.1

Values are presented as mean ± standard deviation

Table 2. ^{40}K, ^{238}U, ^{232}Th and ^{137}Cs activity concentration (Bq kg^{-1}) in mushrooms around the Belgrade city and Maljen mountain

Area/Samples	^{40}K	^{238}U	^{232}Th	^{137}Cs
Belgrade				
Avala-Zuce				
seasonal mushrooms	547 ± 18	< 5	< 3	19 ± 2
Kosmaj- Nemenikuće				
seasonal mushrooms	276 ± 4	< 4	< 1.6	18 ± 3
Barajevo				
seasonal mushrooms	790 ± 22	< 3.5	< 2	27 ± 2
Grocka-Vinča				
seasonal mushrooms	338 ± 8	< 6	< 1.2	7 ± 1
Opovo				
seasonal mushrooms	211 ± 5	< 5.8	< 1.8	9 ± 2
Jakovo- Bojčin forest				
seasonal mushrooms	111 ± 4	< 3.5	< 2.2	< 0.3
Maljen*				
seasonal mushrooms	97 ± 3	< 2.1	< 0.3	93 ± 3
seasonal mushrooms	118 ±1	< 3.0	< 0.7	294 ± 8
seasonal mushrooms	105 ± 3	< 3.2	< 0.3	385 ± 11
seasonal mushrooms	142 ± 6	< 2.6	< 1.5	258 ± 9

Values are presented as mean ± standard deviation
* Mitrović et al., 2009.

Conclusion

On the basis of obtained results it can be observed that the game meat and mushrooms are the good bioindicators of radioactive pollution, even so many years after the accident. The low level of ^{137}Cs activity in the Belgrade environment, than on Tara and Maljen, can be explained by lower amounts of rainfalls after the Chernobyl accident. This study shows that the necessary continuous radioactivity monitoring of wild animals is important for assessing the radiation doses caused by consumptions of these meat.

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