# The amount of $^{137}Cs$ in chosen parts of food chains from localities in the East of Slovakia

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The aim of this study was to compare the amount of radiocaesium in chosen parts of food chains from localities in the eastern Slovakia. Prevailing part of radiocaesium is in the upper layer of soils and specific activity of $^{137}Cs$ in the first layer for locality Stará Voda in 2000 achieved 152,4 $Bq.kg^{-1}$. On the base of results from modified Tessier sequential extraction method we determined that more than 50 % of this radionuclide is in the soil in not extractable fraction. From studied species of mushrooms the highest value was determined in sample of Rozites caperata the and specific activity achieved 1822,0 $Bq.kg^{-1}$ d. w.

At present an increased attention is devoted to the occurrence of radionuclides in environment, due to the development of power supply, industry, agriculture, traffic, etc. Monitoring of environment radioactivity is necessary because of determination of radioactivity influence on the health of today's and for future population. Our laboratory is one of the permanent component of radioactivity monitoring network in Slovak republic, that carries out regular measurements of individual parts of environment, individual parts of food chains and working place.

Caesium belongs to the alkali metals and is the least inert and thus most reactive element in this group. Its chemical and metabolic-physiological reactions are similar to those potassium which latter is essential for many organisms and is enriched intracellularly. Radiocaesium does not occur naturally on earth, it is exclusively anthropogenic in origin. Radioisotopes of caesium are of environmental concern due to their relatively long half life, emission of gamma radiation during decay and rapid incorporation into living organisms [3, 11].

The aim of our study was to determine the amount of caesium in chosen parts of food chains from localities in eastern Slovakia for period 2000-2004.

## Materials and methods

Soil samples were collected in localities where TL dosimeters are situated. Soil samples were taken from vertical profile 0-5, 5-15 and 15-30 cm. The soils under mushrooms were sampled from 0-10 cm. The lumps were crushed, dried separated from plant roots, homogenised and sieved to pass through 2-mm sieve.

Samples of fruits and vegetables were dried at $105^0C$ until total dehydration, homogenised and placed to Marinelli pots.

The fruiting bodies of mushrooms species (*Macolepiota procera, Lepista personata, Lactarius piperatus, Lycoperdon perlatum, Clitocybe geotropa and Agaricus sylvaticus*) were collected in the locality Jasov in 2001. The other species were sampled (*Lactarius deliciosus, Lycoperdon perlatum, Russula mustelina, Armillaria mellea, Rozites caperata and Amanita phalloides*) in 2004.

For determination of individual fractions of radiocaesium in soils the modified Tessier sequential extraction method [10] was used where two steps were added to the original method [13]: extraction with redistilled water (step 1), and extraction with 2M $HNO_3$ (step 8). Individual extraction agents and corresponding caesium fractions isolated from soil components are shown in Table 1. This experiment involved 125 g of dry soil and 500 ml of extraction agent placed into a 1000-ml bottle and shaken using end-over end shaker.

The specific activity of $^{137}Cs$ in the studied samples was measured gamaspectrometrically using multichannel analyser with Ge(Li) detector (Canberra Series 35 Plus). The data acquisition and analysis were performed using Gamat software.

Table 1. Individual extraction agents and corresponding caesium fractions isolated from soil components.

| Step | Reagent Composition | Action time /hour/ | Isolated fraction |
|---|---|---|---|
| 1 | Redistilled water (pH=5.5) | 1 | Watersoluble |
| 2 | 1M $MgCl_2$ (pH=7) | 1 | Exchangeable |
| 3 | 0.025 M $Na_4P_2O_7$ | 1 | Bound to humic acids |
| 4 | 1M NaOAc+HOAc (pH= 5) | 24 | Bound to carbonates |
| 5 | 0.04 M $NH_2OH.HCl$ | 24 | Bound to Fe/Mn |
| 6 | 30 % $H_2O_2$ + $HNO_3$ (pH=2) | 24 | Organically bound and bound to sulfates |
| 7 | 2M $HNO_3$ | 24 | Residue, soluble in mineral acid |
| 8 | 1 M NaOH | 24 | Residue, soluble in hydroxide |
| 9 | | | Insoluble rest |

HOAc=$CH_3COOH$

## Results and discussion

Gamma-spectrometric analysis of individual soil layers showed that the specific activity of radiocaesium in the first layer for studied localities ranged from 152,4 to 1,52 $Bq.kg^{-1}$. The highest values were determined for locality Stará Voda Radiocaesium activity is gradually decreasing and in the third layer is lower by one third in comparison with first layer. Behaviour of the radiocaesium vertical distribution is similar in individual years for observed period. Significantly lower values of radiocaesium were obtained for samples from locality Košice. For observed period values in the first layer varied in the range from 2,32 to 6,63 $Bq.kg^{-1}$.

Radiocaesium migrates vertically in soils very slowly and prevailing part of caesium is in the upper layer of soil in dependence on soil type.

Samples of the soils under mushrooms were taken upon the 10 cm. This is because all forest herbs and most trees take up nutrients from the uppermost 10 cm of soil. Considerably higher values were determined in the forest soil that was sampled in 2001 ($^{137}Cs$ = 182,8 ± 2,35 $Bq.kg^{-1}$) and lower values were obtained in sample for year 2004 ($^{137}Cs$ = 56,34 ± 1,40 $Bq.kg^{-1}$).

It can be clearly seen that the main accumulation of caesium in the upper 10 cm of soil. Absorption of radiocaesium in soil is increasing with increased amount of organic matter. The high radiocaesium activity in the top layer is probably also due to the subsequent supply of radionuclides through dropped needles and leaching from needles and bark [7].

Knowledge of the total content of radionuclides in soils provides a limited information only, and therefore, some measure of availability and mobility is required if reliable evaluations of pollution hazards are to be made [4,6]. In order to stop radionuclides transfer into plants and its intrusion into food-chains and groundwater it is necessary to know the extent and conditions of its binding to soil particles [1, 9, 14].

Our data showed very low caesium reactability from the given soil samples obtained by modified Tessier sequential extraction method. Watersoluble and exchangeable fractions that define intensity of vertical migration in soil samples is for caesium very low. For soil samples collected in 2001 and 2004 in the locality Jasov values are a little higher than 5 % of total activity. In comparison with other fractions, the fraction soluble in mineral acid (in studied soil sample is about 11 % of total activity) and fraction bound to organic matter are important, too. Prevailing part of this radionuclide is in the not extractable fraction as we assumed because of its strong affinity to clay minerals. Subdivision of radiocaesium in soil samples from individual collections in the locality Jasov is similar. It can be concluded that extremely low concentration of caesium in soil solution is the factor limiting caesium uptake by the root systems [11].

## Food contamination

The amount of artificial radionuclides in the individual compartments of food chains is at present at a very low level, generally at the limit of detection. Obtained results for vegetables showed that higher values were measured for parsley. The lowest values were determined in samples for potatoes and results were between 0,06 – 0,1 $Bq.kg^{-1}$. As to fruits two times higher values were obtained for samples of apple in comparison with pear. On the base of results for cereals we can conclude that oat is high in accumulation of radiocaesium. Specific activity of radiocaesium in samples of oat is four times higher as that in wheat.

Mushrooms are characterised by high ability to accumulate radiocaesium [2, 5, 7, 8, 12]. The reason why mushrooms work as such a good indicators of radioactivity in general is connected with their structure. Their bodies consist of gentle fibres, hyphae. Fungal metabolism differs from that of green plants. Mushrooms are heterotrophic organisms and depend on supply of organic compounds. Water constitutes about 90-95 % of mushroom fresh weight.
The specific activity of examined species of mushrooms from locality Jasov collected in 2001 varied from 4,09 $Bq.kg^{-1}$ d. w. up to 19,56 $Bq.kg^{-1}$ d. w. Higher values of radiocaesium were obtained for the samples from the year 2004. Minimal activity was determined for Lycoperdon perlatum, i.e. 31,14 $Bq.kg^{-1}$ d. w. and in Rozites caperata the specific activity achieved 1822,0 $Bq.kg^{-1}$ d. w. According to literature [7] this species is characterised by the high ability to accumulate caesium. This fact can be confirm by a high value of discrimination factor that is equal 8,84. Interesting is a high value of $^{137}Cs$ amount in Amanita phalloides.
The fruiting bodies of three species Armillaria mellea, Lactarius turpis and Clitocybe nebularis in the locality Košice were collected, too. The the highest value of radiocaesium was determined for Armillaria mellea, although this one is about three times lower in comparison with the sample form Jasov. $^{137}Cs$ is weakly cummulated by Clitocybe nebularis. This is an edible mushrooms but with low grade taste.

## Conclussions

On the base of obtained results we can conclude that radiocaesium migrates vertically in soils very slowly and prevailing part of caesium is in the upper layer. Prevailing part of radiocaesium is in the not extractable fraction. Extremely low concentration of caesium in soil solution is the factor limiting caesium uptake by the root systems, too. Mushrooms are characterised by high ability to accumulate radiocaesium.

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