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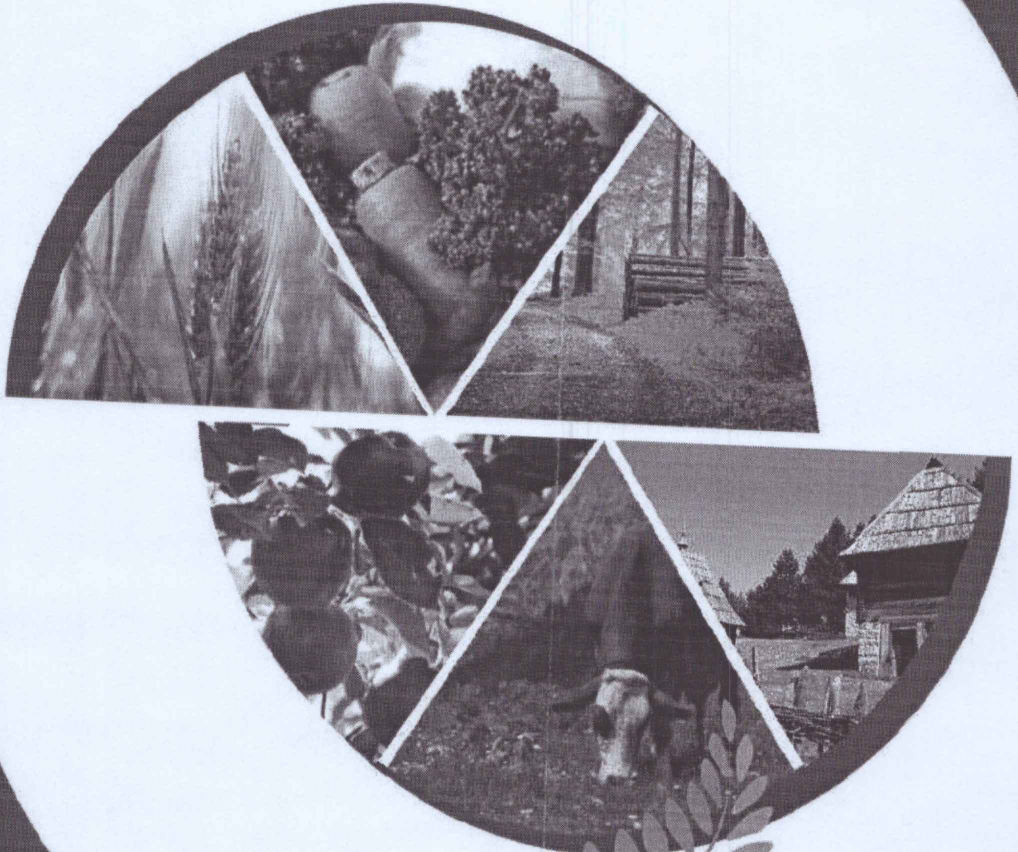
Jahorina, October 05-08, 2017



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EVALUATION OF DOSES OF RADIATION DUE TO NATURAL RADIOACTIVITY IN CORN AS ANIMAL FEED IN THE VICINITY OF THE CITY OF SKOPJE (MACEDONIA)

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Abstract

Soil is the first link of the ecological chain soil-food-animals-human, and for this reason it has an important role in the distribution and transfer of radionuclides in fodder. The natural radionuclides come from the soil to the crops by means of migration and contribute for the total radiation burden in the population. The goal of this study was focused on investigation of the radioactivity in corn, and presence of natural radionuclides, and on the basis of the specific activity of the crops, we will calculate the dose which the human receives if the person consumes the examined crops. The corn samples were collected in 2016 from different locations in the surrounding of the city of Skopje. The sampling was performed so that 3 samples were taken from every location, which is in accordance with the recommendations from IAEA. The samples are measured on an instrument – gamma spectrometer (Canberra Packard) by using the program GENIE 2000. The values of specific activity and the calculated doses obtained in this study, regardless of the location, did not exceed the safety limits, pointing out the insignificant danger for radiation which arises from soil radionuclides which are naturally present. From the indicated above it follows that at a current level of radioactive contamination of corn, it would not be necessary to take measures in regard to reduction of the radioactive contamination, considering that the values of the radioactive contamination, compared to the level of radiological contamination of natural origin, are lower.

Key words: *radioactivity in corn; radionuclides; gamma spectrometry.*

Introduction

The radioactive contamination of animal feed, which is the most important factor for the radiation safety of people through the food chain, imposes the need of continuous radiation control of various types of crops for animal use. Usually radionuclides penetrate in crops from the soil through the root system. The very radioactive contamination of soil can be caused by radioactive substances of natural origin, however also radioactive isotopes that are a result of the experimental nuclear explosions, nuclear reactors, as well as a many other atomic techniques and plants. The behavior of radionuclides in soil, their retaining and transfer to plants, are very complex processes that depend on many factors (Jasinka, 1980). In the soil are present about 40 different radionuclides whose contribution is different (Bockok, 1981; Tzortzis et al., 2004).

The entry of radionuclides from the soil to plant crops depends on certain factors such as: the soil type, physical and chemical properties of the soil, the fertility of the soil, its texture, pH, conductivity, carbonate and sulfate content, etc. (Clarck and Smith, 1988). In addition, the use of phosphate fertilizers in agricultural land, such as phosphorus fertilizers, which are extremely rich in radioactive substances and belong to products of uranium decomposition, increases the contamination of plants (Abdel-Rassoul, 2007). The level of radioactive contamination of soil will mainly determine the extent to which the radioactive substance will reach the organs of the corn, and further into the other links of the trophic chain. It is necessary to pay attention to the contamination of radioactivity in soil and its absorption in corn. Thus, keeping in mind that the main purpose of the radioactive contamination investigation is its impact on people, there are numerous undertaken studies for the crops radioactivity (Vasconcellos, 1987; Arogunjo et al, 2005; Tahir, 2005; Al-Kharouf et al, 2008; Changizi et al, 2013). The purpose of this study was to examine the level and redistribution of certain radionuclides in maize production, as well as to provide preliminary (preparatory) assessment of the doses of earth exposure of the population in the surrounding of the city of Skopje, and to assess the potential danger for radiation of the population that lives in the areas under research.

Materials and methods

Sampling. The corn samples were collected during the summer of 2016 from different locations in the surrounding of the city of Skopje. The corn samples with the root are collected so that three samples with a quantity of 1 kg are taken from each location. During the sampling, it was ensured that the micro-location is a flat terrain, which excludes the consequences of a possible horizontal translocation of radionuclides. The collected samples were carefully cleaned and root, stem, leaf, and fruit were separated.
Afterwards, the samples were air-dried at room temperature for a period of approximately three weeks in order to remove the moisture. After the drying, the samples were crushed, placed on a stand and grinded to a predetermined particle size according to the analytical requirements, and in the end the samples were passed through a sieve. The homogenized samples were packed in plastic containers that had the same geometry as the one for the reference materials wherewith the measurement equipment was calibrated.
Instrument. Gamma ray spectrometry technique was used for determination of radioactivity of the tested samples. The spectrometer consisted of an HPGe detector, model 3020 (Canberra Packard, Meriden, CT, USA), with an active volume of 180 cm^2, relative efficiency of 30 %, an operating voltage of 3000 V, and a resolution of 2 keV at 1332.5 keV. The detector was enclosed in massive 12 cm thick lead shielding and internal lining of 2 mm high purity cooper. Data acquisition and analysis were performed with 8192 channel digital analyzer; the duration of the acquisition interval for each sample was 65 ks. The activity of ^{226}Ra was determined from the gamma lines associated with low half-live time daughters of ^{214}Bi (609.31, 1120.29, and 1794.49 keV) and ^{214}Pb (351.93 keV). The ^{232}Th activity was determined by 338.4, 911.2 and 969.1 keV gamma lines form ^{228}Ac and its decay products. The gamma line at 1460.8 keV was used to determine the activity of ^{40}K.
Efficiency calibration was performed with mixed calibration standard sources MBSS2, supplied from the Czech Metrological Institute, Inspectorate for Ionizing Radiation. In order to determine the background distribution in the detector environment, empty sealed Marinelli beaker with the same geometry was measured at equal counts as the soil samples. The analysis procedure included the subtraction of the background spectrum.
Absorbed dose rate in air (D). The natural decay of radionuclides in the soil is one of the main sources of the human exposure to radiation. This level of radiation is different depending on the content of minerals and radioactive elements of each region. The dose of gamma radiation which is due to natural radioactive contents of the soil is important for the population in the area where they live. The rate of absorbed does in the air for the

radionuclides with a height of 1 meter above the ground surface was calculated on the basis of the instructions provided below (UNSCEAR 2000).

$$D(nGy/h)=0.462A_{Ra}+ 0.604\ A_{Th}+0.042\ A_k \quad (1)$$

where A_{Ra}, A_K and A_{Th} accordingly are the average activity concentrations of ^{226}Ra, ^{40}K and ^{232}Th, expressed in Bq/kg.

Calculation of the external hazard index (H_{ex}). The external hazard index is calculated with an equation proposed by Beretka and Mathew (1985).

$$H_{ex} = C_{Ra}/370+ C_{Th}/259+ C_K/4810 \quad (2)$$

where H_{ex} is the external hazard value, C_{Ra}, C_{Th} and C_K are the mean activity concentrations (Bq kg^{-1}) of ^{226}Ra, ^{232}Th and ^{40}K, respectively. The value of this index must be less than unity, thus keeping the radiation hazard insignificant. The maximum value of H_{ex} = 1, corresponds to the upper limit of Ra_{eq} (370 Bq kg^{-1}).

Calculation of radium equivalent activity. As the distribution for ^{226}Ra, ^{232}Th and ^{40}K in soil samples in not uniform, exposure to radiation can be defined in terms of radium equivalent (Ra_{eq}), to compare the specific activity of the radionuclides of (Beretka and Mathew, 1985). The radium equivalent activity could be defined as:

$$Ra_{eq} = A_{Ra} + 1.43A_{Th} + 0.077A_K \quad (3)$$

where A_{Ra}, A_{Th} and A_K are the specific activities (Bq kg^{-1}) of ^{226}Ra, ^{232}Th and ^{40}K, respectively. By defining the Ra_{eq} according to previous equation, it is assumed that 370 Bq kg^{-1} ^{226}Ra or 259 Bq kg^{-1} ^{232}Th or 4810 Bq kg^{-1} ^{40}K produce equal gamma dose rate (Singh et al, 2005).

Results and discussion

Determination of a specific activity. In Table 1 the average radionuclide concentrations for ^{226}Ra, ^{232}Th and ^{40}K obtained from three measurements of individual corn samples are presented, associated with the respective standard deviations (SD).

Table 1. Mean values of specific activities of values of 226 Ra, 232Th and 40K in corn samples

	Specific activity*±SD		
	^{26}Ra	^{232}Th	^{40}K
C1	0.40±0.1.0	0.06±0.02	108.15±2.00
C2	1.30±0.40	<MDA	99.00±2.00
C3	0.16±0.04	0.02±0.12	69.70±1.00
C4	0.73±0.42	0.08±0.03	85.35±1.50
C5	0.17±0.11	<MDA	99.86±1.54
C6	0.40±0.05	0.17±0.20	115.54±2.40
C7	0.08±0.33	<MDA	115.26±2.00
C8	0.29±0.20	0.15±0.03	92.00±1.70
C9	0.38±0.20	0.10±0.40	89.57±1.50
C10	0.61±0.21	1.02 ±0.45	117.21±2.50
C11	0.48±0.20	0.30±0.25	78.02±2.00
C12	0.61±0.25	0.11±0.20	195.97±2.00
C13	0.33±0.15	0.17±0.05	107.50±2.35
C14	0.62±0.08	0.94±0.04	112.48±2.50

The presented results in the table are mean values from measurements performed on corn samples taken from 14 different locations, 3 samples from each location. It can be concluded that corn absorbs ^{232}Th significantly less than ^{226}Ra, which is in accordance with the physical-chemical properties of this radionuclide. By analyzing potassium which is necessary for the normal course of the life functions of crops, another behavior can be observed i.e. the transport from the soil to the corn is more intensive.
The concentration of activity of ^{40}K in corn is greater than the one of ^{232}Th and ^{226}Ra, which is consistent with the literature data (Saracević, 1990).The average activity concentrations for ^{226}Ra, ^{232}Th and ^{40}K and their ranges were 0.44 Bq kg^{-1} (0.08-1.30 Bq kg^{-1}), 0.22 Bq kg^{-1} (0.08-1.02 Bq kg^{-1}) and 105.68 Bq kg^{-1} (69.70-195.97 Bq kg^{-1}), respectively. The global average concentrations of the respective radionuclides are 40 Bq kg^{-1} (^{226}Ra), 40 Bq kg^{-1} (^{232}Th) and 580 Bq kg^{-1} (^{40}K) (UNSCEAR, 2008). According to the results presented (Table 1) the levels of ^{226} Ra, ^{232}Th and ^{40}K for the corn samples cultivated in the Skopje city surounding are lower than the levels determined for USA and Brasil (in Akhtar, 2005; in Changizi et al, 2013).
Absorbed dose rates. On basis of the data for activity concentrations applying the equations 1-3, absorbed dose rate in air (D), radiation risk index (H_{eks}) and radium equivalent (Ra_{eq}) were calculated, and the respective results are presented in Table 2.

Table 2. Obtained results for absorbed dose rate in air (D), radiation risk index (H_{eks}), radium equivalent (Ra_{eq})

	Specific activity*		
	D(nGy/h)	H_{eks}	Ra_{eq}
C1	4.76	0.023	8.81
C2	4.87	0.024	8.92
C3	4.24	0.014	5.55
C4	3.95	0.019	6.20
C5	4.27	0.021	7.85
C6	5.13	0.025	9.30
C7	4.87	0.024	8.97
C8	4.08	0.020	7.29
C9	3.74	0.020	7.04
C10	5.81	0.029	11.09
C11	3.67	0.018	6.91
C12	8.57	0.042	15.85
C13	4.76	0.023	8.85
C14	5.31	0.027	9.52

The mean value of the absorbed dose for corn samples is 4.85 nGy/h and it is lower than the global average value of 55 nGy/h (Al-Hamarneh and Awadallah, 2009). The average value of the H_{eks} radiation risk index is 0.02, which shows that there is no significant radiation risk for the population in the surrounding of Skopje. From the table itself, it may be seen that the specific average for the radium equivalent Ra_{eq} for corn samples is within the range from 5.55 to 15.85 Bq/kg and it is below the maximum recommended limit, i.e. 370 Bq kg^{-1} (El-Aydarous, 2007).

Conclusions

The results of this study are completely compared to the international values and the results of other studies in other countries in the world. It was found that the natural levels of radioactivity in the vicinity of Skopje are not with the range of high risk and they are in accordance with the international standards. The amount of radioactive elements in corn was so low that the health of consumers was not threatened. From the indicated above it arises that at the current level of radioactive contamination of corn, it would not be necessary to undertake measures related to reduction of radioactive contamination, considering that the values of radioactive contamination, compared to the level of radiological contamination of natural origin, are lower. These results can be used as reference values for current assessment of doses due to natural radioactivity in the surrounding of the city of Skopje.

References

Al-Hamarneh and M. Awadallah, (2009).Soil radioactivity levels andradiation hazard assessment in the highlands of northerm Jordan, Radiat. Meas., 44, 102.

Arogunjo A.M., Ofuga, E.E., Afolabi, M.A. (2005). Levels of natural radionuclides in some Nigerian cereals and tubers, J. Environ. Radioactivity, 82: 1-6.

Abdel-Rassoul A.A., Lasheen Yasser F, Seliman Ayman F. (2007). Simultaneous measurement of 226Ra and 228Ra in natural water by liquid scintillation counting. Journal of Environmental Radioactivity, 95: 86–97.

Akhtar N, Tufail M, Ashraf M, Mohsin Iqbal M. (2005). Measurement of environmental radioactivity for estimation of radiation exposure from saline soil of Lahore, Pakistan. Radiation Measurements, 39(1): 11–14.

Al-Kharouf S. A, Al-Hamarneh, I. F., Dababneh, M. (2008). Natural radioactivity, dose assessment and uranium uptake by agricultural crops at Khan Al-Zabeeb, Jordan, J. Environ. Radioactivity, 99, 1192-1199.

Bocock K.L. (1981). Radionuclides in terrestrial ecosyistems. Institute of terrestrial ecology Merlwood Research Station Grange-Over-Sands, Gumbria.

El-Aydarous A., (2007). "Gamma Radioactivity Levels and Their Corresponding External Exposure of Some Soil Samples from Taif Governorate, Saudi Arabia", Global Journal of Environmental Research (GJER) Vol.1, No. 2, P: 49-53.

Berekta J. and Mathew, P.J., 1985. Natural radioactivity of Australian building materials waste and by-products. Health Physics, 48(8).

L.Saracević. Research on the Effects of Acute Radioactive Contamination of Soils on the Effective Equivalent Dose and Radiation Risk of the Population of the Region of Sarajevo, Doctoral Dissertation, Sarajevo 1990.

Clark,M.J. and Smith, F.B., 1988. Wet and dry deposition of Chernobyl releases. Nature, 332(6161), pp.245-249.

Jasinska M., Niewiadomski, T. and Schwabenthan, J., (1980). On a new possibility of estimating population exposure to terrestrial sources. Health physics, 38(3), pp.416-419.

Singh S., Rani, A., Mahajan R.K. 226Ra, 232Th and 40K in soil samples from some areas of Punjab and Himachal Pradesh, India using gamma ray spectrometry. Radiat. Meas., 39, 431-439 (2005).

Tahir SN, Jamil K, Zaidi JH. (2005). Measurements of activity concentrations of naturally occurring radionuclides in soil samples from Punjab province of Pakistan and assessment of radiological hazards. Radiat Prot Dosimetry, 113(4): 427–470.

Tzortzis M., Svoukis, E. and Tsetos, H. 2004 A Comprehensive Study of Natural Gamma Radioactivity Levels and Associated Dose Rates from Surface Soils in Cyprus. Radiation Protection Dosimetry, 109(3), 217--22

UNSCEAR (2000) Report to the General Assembly, with scientific annexes, Sources and effects of ionizing radiation, United Nations Scientific Committee on the Effects of Atomic Radiation, United Nations, New York.

Vahid CHANGIZI, Elham SHAFIEI, and Mohammad Reza ZAREH Measurement of 226Ra, 232Th, 137Cs and 40K activities of Wheat and Corn Products in Ilam Province – Iran and Resultant Annual Ingestion Radiation Dose, Iran J Public Health. 2013 Aug; 42(8): 903–914.

Vasconcellos LMH, Amaral ECS, vianna ME. (1987). Uptake of 226 Ra and 210Pb by food crops cultivated in a region of high natural radioactivity in Brazil. J Environ Radioact, 5 : 287–302.