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NATURAL RADIONUCLIDES IN POULTRY FEED AND ASSESSMENT OF RADIATION RISK

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Abstract

The researches of radioactivity in poultry feed are particularly important because a part of the quantity of radionuclides in the food that animals ingest could be transmitted to people by means of the path of radionuclides in the food chain.

The study was conducted in order to detect the natural radioactivity in poultry feed and its values were compared with the measured values with poultry feed which is being produced in other parts of the world. The samples were analyzed by means of an instrument – gamma spectrometer (Canbera Packard) with a high purity germanium detector. The measurement was performed in a hermetically sealed container, whereby the spectra obtained from the measurement were analyzed by using the program GENIE 2000.

The results showed that the activity concentrations in feed supplements are within the range from 59.6 to 127.4 Bq/kg for 40K, 12.7 to 18.5 Bq/kg for 226Ra and 4.6 to 11.7 Bq/kg for 232Th, while those of the compounded feed are within the range from 64.7 to 172.0 Bq/kg for 40K, 9.7 to 29.4 Bq/kg for 226Ra, and 19.6 to 42.1 Bq/kg for 232Th. As it was expected during the analyses, the obtained values for the compounded feed were higher than the values for the feed supplements, which is expected, since some of these supplements are used for compounding feeds. In addition, anthropogenic radionuclides were not detected which shows that there was no contamination due to artificial radionuclides. The values of the specific activity obtained in this study do not exceed the safety limits, emphasizing the insigificant danger of radiation that arises from the Earth's radionuclides that are naturally present.

Key words: gamma spectrometry, feeds, natural radioactivity.

Introduction

Animal feed is developed from an organic basis (plants or animals) and is intended to provide the fullest diet possible (Filho et al., 2016). Very often, in order to improve the nutritional value of animal feed, it is supplemented with substances that could increase the level of activity of radionuclides.

In Macedonia, the most commonly used poultry feed is soybean, maize and "Premix Vitamínico Mineral", a bone meal and a fish meal. Therefore, control of radionuclides of these specimens is required, especially in phosphate stone, which is another raw material used in the production of animal feed additives (Casacuberta et al., 2010), which provides calcium for domestic animals such as poultry. One of the most common ways in which radionuclides reach poultry is ingestion, that is, consumption of foods that may contain a specific level of radiation, which would impose concerns in regard to such used poultry feed.

Considering the fact that through the food chain radioactive substances reach the human, more attention has been paid to these problems in the last decades in terms of the radiation safety of the population.

People consume eggs and poultry meat, therefore it is expected to monitor the levels of radiation in poultry feed, because a part of the amount of radionuclides in the food that

animals ingest could be passed on to people through the path of radionuclides in the food chain (Mc Donald et al., 1999; Breuninger et al., 2002; Hernandez et al., 2004). For this reason, due to the transfer of radioactive substances from the environment to agricultural, livestock and fish products, radioactive contamination of food and its health effects have become a major concern for people (Ramasany et al., 2006; Kaplan et al., 2011).
The study was conducted in order to detect natural radioactivity in poultry feed and the results were compared with measured values of poultry feed produced in other parts of the world.

Material and methods

2.1 Sampling

The poultry feed samples were taken from several producers, and several samples were directly purchased from the market in Macedonia. All samples were homogenized in a blender and then placed in Marinelli (hermetically sealed containers with a weight of approximately 450 grams).
The Marinelli were stored for 10 days in order to achieve a balance of radium and thorium with their daughters.

2.2 Instrument

The spectral analysis of the radionuclides of these samples was conducted by applying a γ-ray spectrometer with high purity germanium (HPGe) detector with 30% relative efficiency and energy resolution (FWHM) of 1.8 keV for 1.33 MeV reference passage of ^{60}Co (Verdoya et al., 2009).
The detector was protected with 9cm-thick lead with an internal line with a 0.5 cm-thin copper panel covered by 1 mm aluminum in order to absorb the x-rays from the lead and the copper. The internal size of the cavity of the shell was 30 x 30 x 30 cm. The detector was given a high voltage through a preamplifier which was then connected to an amplifier with a computer based channel analyzer through an ADC (analogue to digital converter). The software used for obtaining the data is Canberra software package Genie-2000, including search of maximal value and modules for identification of nuclides. The system was regularly calibrated for energy and efficiency. The gamma rays of interest were within a range of 50-3000 keV. The prepared Marinelli glasses (samples) were placed on a final detector at a distance of approximately 10 mm. Every sample was measured within a period of around 62000s in order to get good statistics and the constant time was lower than 10%. The measurements with an empty Marinelli glass, in identical conditions were also conducted in order to determine the basic recounts. Then they were deducted from the measured spectrums of every sample in order to obtain the net activities of the radionuclides.

Results and discussion

The activity concentrations of ^{40}K, ^{226}Ra and ^{232}Th were assessed and they were shown in Table 1 and Table 2 as well as in Figure 1 and Figure 2. The results showed that the activity concentrations in feed supplements range from 59.6 to 127.4 Bq/kg for ^{40}K, 12.7 to 18.5 Bq/kg for ^{226}Ra and 4.6 to 11.7 Bq/kg for ^{232}Th, while that of the compound feed range from 64.7 to 172.0 Bq/kg for ^{40}K, 9.7 to 29.4 Bq/kg for ^{226}Ra and 19.6 to 42.1 Bq/kg for ^{232}Th.
Compound feed had higher values than poultry feed supplements, which is expected, because some of these supplements are used for combining the food. The results on the natural radioactivity were compared with the results from different countries of the world and were relatively higher compared to other such studies (Harb et al., 2010; Filho et al., 2016).
Presence of anthropogenic radionuclides was not found, which shows that there is no contamination due to artificial radionuclides.

Table 1. Activity concentrations of poultry feedstuff (Bq/kg)

Sampling sites	^{40}K	^{226}Ra	^{232}Th
Feed supplement	67.24±2.12	14.79±3.00	4.60±1.30
Feed supplement	111.60±2.54	12.70±2.00	10.21±1.50
Feed supplement	89.24±5.00	15.22±5.20	7.02±2.30
Feed supplement	127.40±3.00	12.98±3.00	7.12±2.50
Feed supplement	102.10±2.40	18.50±1.20	11.70±1.50
Feed supplement	113.17±4.20	17.54±1.95	5.10±1.65
Feed supplement	66.51±4.21	17.02±3.63	9.68±2.30
Feed supplement	111.35±2.50	13.22±1.95	5.55±2.50
Feed supplement	59.60±5.20	16.47±2.50	4.90±1.70
Feed supplement	63.06±2.60	14.02±3.80	4.60±1.30
Feed supplement	121.15±4.50	13.29±2.50	9.26±3.50
Feed supplement	73.30±3.55	15.45±3.50	9.01±1.50
Feed supplement	124.56±2.30	17.98±3.11	5.47±2.50
Feed supplement	68.07±2.50	13.27±5.00	7.62±2.50

procedure included the subtraction of the background spectrum.

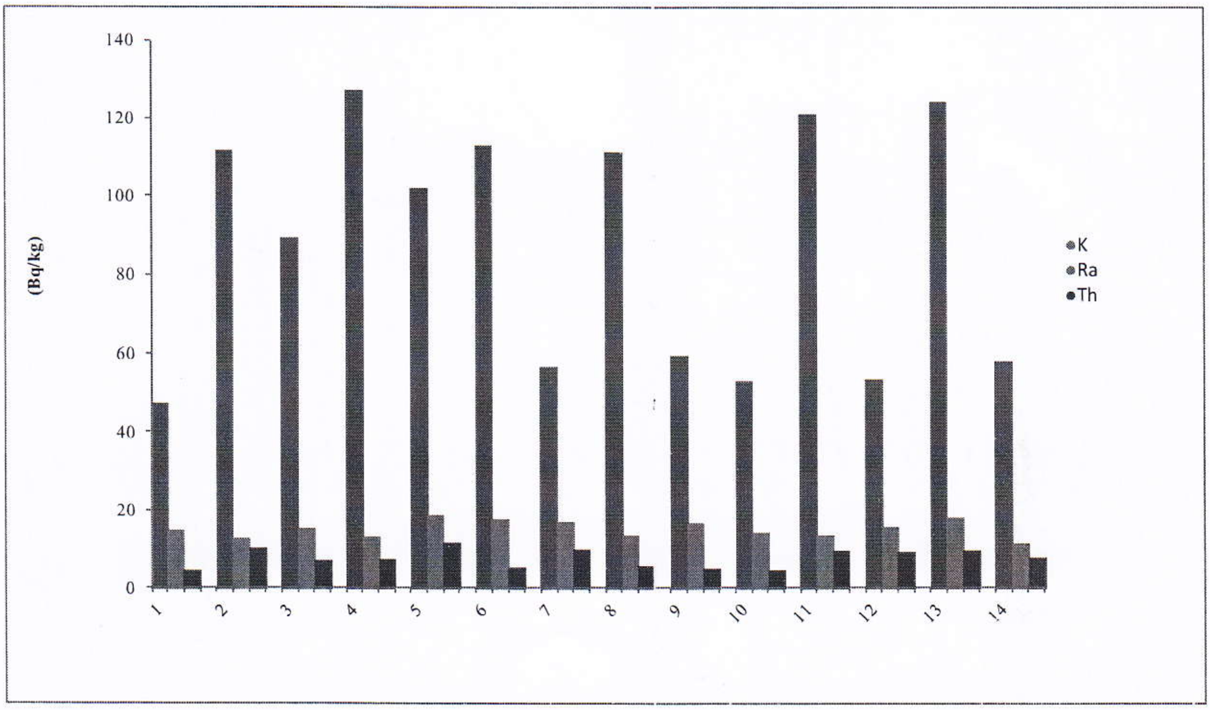

Figure 1. Activity concentration of K-40, Ra-226 and Th-232.

Table 2. Activity concentrations of compounded feed (Bq/kg)

Sampling sites	^{40}K	^{226}Ra	^{232}Th
Compounded feed	77.11±2.00	16.00±2.50	24.30±1.50
Compounded feed	172.00±2.50	25.13±2.22	42.10±1.70
Compounded feed	99.14±2.50	15.22±5.20	21.52±2.50
Compounded feed	127.40±3.00	29.40±1.50	38.22±2.55
Compounded feed	114.22±2.20	17.32±1.50	35.11±1.50
Compounded feed	113.17±4.20	15.14±1.90	21.10±1.80
Compounded feed	82.37±3.22	9.70±2.00	20.17±2.30
Compounded feed	154.35±5.50	23.12±1.90	39.55±1.50
Compounded feed	137.11±5.00	21.07±2.50	34.36±2.60
Compounded feed	64.70±5.20	10.35±3.50	19.60±1.50

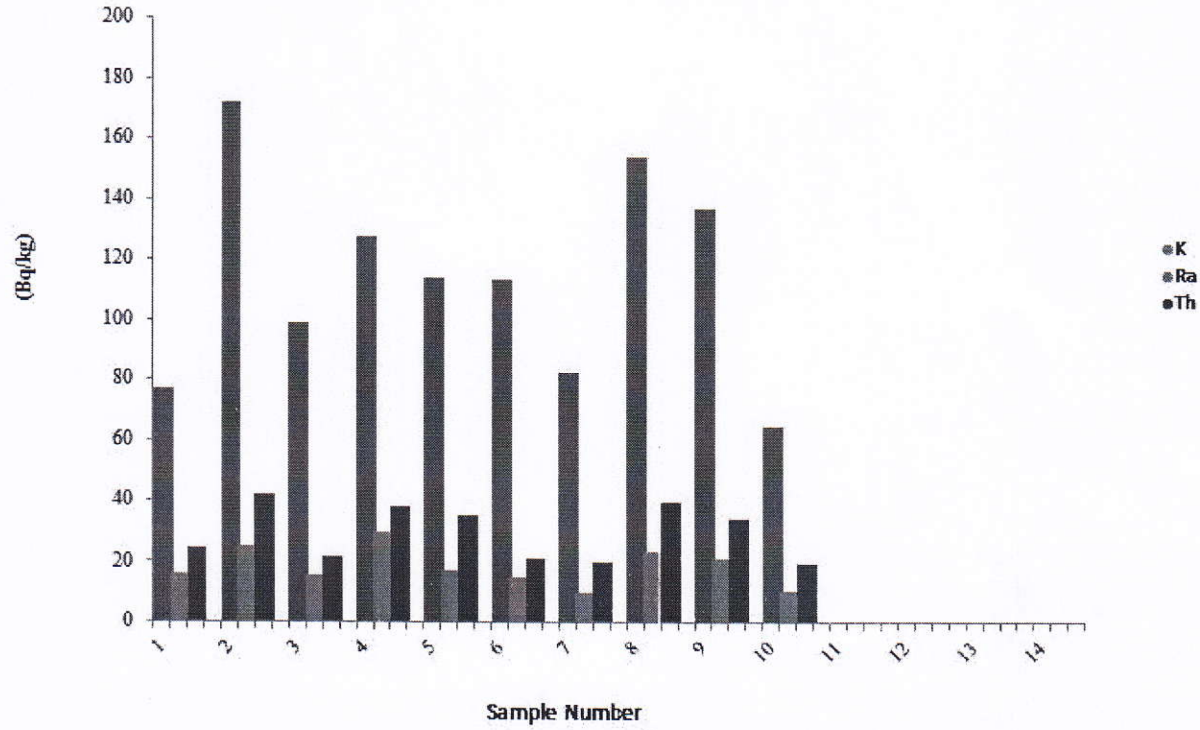

Figure 2. Activity concentration of K-40, Ra-226 and Th-232.

Conclusion

The values of the specific activity in this study did not exceed the safety limits, emphasizing the insignificant radiation hazard arising from naturally occurring earth radionuclides.

The results were compared with other poultry feed in other parts of the world, which shows that at the present level of radioactive contamination, there would be no need to take measures related to the reduction of radioactive contamination. The conclusion in this study is that the transfer of such levels to poultry meat and, ultimately, to the human, in the path of radionuclides, will not pose a danger when the public will eventually consume the meat and eggs from the poultry that consume such feed.

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