Measurements of the radioactivity in cereals using gamma-ray spectrometry and gross alpha-beta measurements

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Introduction

In the modern age, the agricultural sector is using manure and chemicals to increase the efficiency and yield of the crops, thus introducing new elements inside the plants, and favoring the absorption in the plant of other elements existing in the soil. Considering that almost 80% of the agricultural products of Romania are cereals, measurements of the amount of radioisotopes in grains is very important to assure the radiation protection of the population according to the national and international regulations [1, 2]. SALMROM laboratory is a competent designated by CNCAN (LI 458/2022) to perform analyses of radioactive materials in environmental samples, in accordance with the standard SR EN / ISO 17025: 2018.

Materials and Methods

In this study, gross alpha-beta using MPC 2000 DP and gamma spectrometry using HPGe detectors were used to analyzed the samples. A number of samples of cereals (corn and wheat) were measured and analyzed, the laboratory recording a higher demand in the last part of the year 2021 and the beginning of 2022. The samples were fine grounded and the integral powder was used for measurement. For the gross alpha-beta measurements, the mass of the sample was usually ~2 g, while for gamma, the mass of the sample was larger, ~100-130 g. In both cases, the measurements were performed for an acquisition time between 60 000 s and 300 000 s, in order to obtain a low minimum detectable activity.

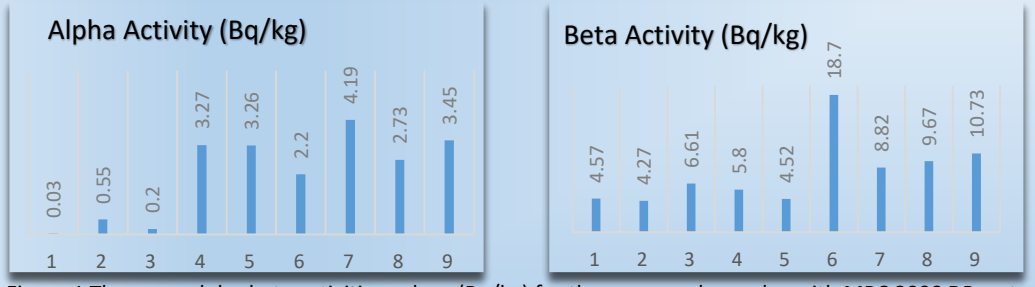


Figure 1 The gross alpha-beta activities values (Bq/kg) for the measured samples with MPC 2000 DP system.

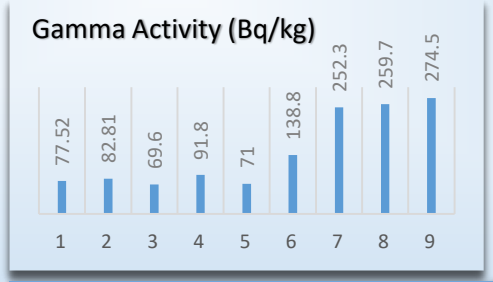
Figure 2 Measurements performed with MPC 2000 DP system and the volume samples ready to be measured with HPGe detector.

Results

Out of all the samples, only sample three was corn, while the others were wheat of different protein composition and cultivated during different years. Sample 7, 8 and 9 were measured two years ago, and we can see a visibly higher activity concentrations both for gamma and gross alpha activity.

The results showed that the gross alpha activity was between 0.030 ± 0.003 Bq/kg and 4.19 ± 0.4 Bq/kg, with an average of 2.21 ± 0.24 Bq/kg, for both corn and wheat, and for gross beta activity these were between 4.27 ± 0.45 Bq/kg and 18.70 ± 1.7 Bq/kg, with an average of 8.20 ± 0.90 Bq/kg. Since the gamma spectrum discriminate the radionuclides, we took in consideration three categories: natural radionuclides (^{238}U, ^{226}Ra, ^{232}Th, ^{40}K), ^{134}Cs and ^{137}Cs, but also because is was at the customer's request. Although the acquisition time was a lot longer than that of alpha-beta measurements, both ^{134}Cs and ^{137}Cs were below the minimum detectable activity (MDA) for both the corn and the wheat, as expected due to the fact that ^{134}Cs has relatively short half life (~2 y), and both were found in soil samples only after the Chernobyl accident, but at the same time the soil-to-plant transfer factors for such radionuclides are small [3].

The natural radionuclides activity concentrations, from gamma spectrometry, showed varied results between 71.00 ± 6.5 Bq/kg and 274.5 ± 18.5 Bq/kg, with an average of 146.44 ± 10.2 Bq/kg.



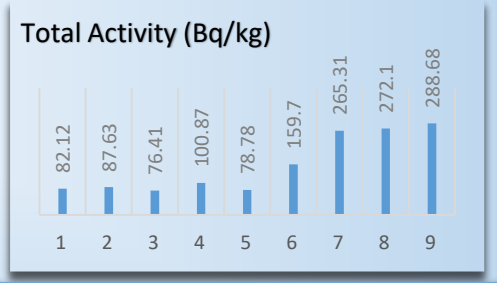


Figure 3 The gamma activities resulted from natural radionuclides (^{238}U, ^{226}Ra, ^{232}Th, ^{40}K) activities values (Bq/kg) for the measured samples with HPGe detector. Total activities represents the sum of alpha, beta and gamma activities.

Conclusions

The analyses results of cereals under investigation in this paper showed that in all cases the activity concentrations of the radionuclides measured were below the IAEA guideline levels, where the maximum value is 1000 Bq/kg. Also, the gross alpha and beta activities were below the recommended guideline levels. Therefore, the cereals measured are in concordance with the regulatory laws, and they are safe for use for human consumption.

References

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