NATURAL AND ARTIFICIAL RADIOACTIVITY DETERMINATION OF ALBANIAN HERBAL TEA SAMPLES

ERJON SPAHIU[1], MANJOLA SHYTI[2], FLORINDA CFARKU[2]

[1]Faculty of Natural Sciences, University of Tirana, Tirana, Albania

[2]Institute of Applied Nuclear Physics, University of Tirana, Tirana, Albania

e-mail: erjon.spahiu@fshn.edu.al

Abstract

The objective of this study is to determine the natural and artificial radioactivity levels in different wild herbal teas grown in Albania. This study provides the first data of the radioactivity levels in 15 samples of wild tea in order to ensure consumer safety due the daily use of these commercial products. The activity concentrations of radionuclides are determined by High Purity Germanium (HPGe) gamma-ray spectrometry. The activity concentrations of natural radionuclides reported as dry weight (dw) vary from 4.22 to 8.16 Bq kg^{-1} for ^{232}Th, 5.28 to 23.44 Bq kg^{-1} for ^{226}Ra, 12.47 to 25.64 Bq kg^{-1} for ^{210}Pb and 180.64 to 839.96 Bq kg^{-1} for ^{40}K. The activity concentration of the artificial radionuclide of ^{137}Cs is found to vary between 0.40 and 15.94 Bq kg^{-1} dw. The results obtained provide a useful information to carry out a dose assessment due to ingestion of these products.

Key words: gamma spectrometry, herbal tea, natural radionuclides, dose assessment

Introduction

Albania is one of the most important European countries for the export of wild growing herbs (Londoño, *et al.,* 2008). During the Communist regime (1945–1991), in particular Eastern Albania, served as a crucial area of medicinal and aromatic plants. This region is still recognized to be an important area for the harvesting of wild plants, mainly destined for the European markets (Pieroni, A. 2017). For many hundreds of years on all continents wild herbal tea or medicinal plant products, in various forms, have been used to treat illnesses. In recent times, the immense potential of the medicinal plants used in various traditional systems is well recognized (Desideri, *et al.,* 2010). Since, humankind uses traditional herbal medicine for the treatment of various diseases and ailments, it is rather important the characterization of radionuclide concentration in such plants. This work aims to study the natural and artificial radioactivity of selected herbals used in Albania. The presence of radionuclides in these constitutes the pathway for their migration to the human, via the food chain. There are several sources contributing to plant contamination which can result from direct deposition on surfaces, deposition on soil, root uptake and transfer to leaves, barks, seeds, flowers, fruits, and berries. Natural and artificial radionuclides are present in the environment in various amounts. In this work, ^{40}K, some radionuclides of the ^{238}U family (^{214}Pb, ^{214}Bi, ^{210}Pb), ^{232}Th family (^{228}Ac) and ^{137}Cs are taken into account.

Experimental

Fifteen wild herbal tea samples from different locations are purchased in the dried form of roots, leaves, barks, seeds, flowers, fruits, berries and thallus from local herbalists. The samples are left to dry naturally for about one week and then oven dried at a temperature of 60°C (± 5°C) for 2 to 4 hours until a constant mass is obtained. Each sample is grounded into fine powder using a stainless steel ball grinder. Then samples are packed into 0.5 liter Marinelli plastic beaker. The containers are sealed in order to avoid radon outgassing and stored for a period of 1 month to allow the radioactive equilibrium between ^{226}Ra and its short-life decay products. The mass of samples varies from 73 g to 240 g.

The natural (^{228}Ac, ^{214}Pb, ^{214}Bi, ^{210}Pb, ^{40}K) and artificial (^{137}Cs) radionuclides are measured by using the high-resolution gamma spectrometry analytical technique with High Purity Germanium detector (HPGe). All the measurements are performed with a low background configuration and an intrinsic p-type germanium detector equipped with and epoxy window. The absolute efficiency is calibrated using LabSOCS (Laboratory Sourceless Calibration Software) considering the energy range of interest from 30 keV to 2000 keV. The absolute efficiency uncertainties vary from 10% at low energies to 4% at high energies. The efficiency calibration curve is validated using certified reference material supplied by the International Atomic Energy Agency (IAEA) and through the participation in intercomparison exercises for environmental radionuclides (Shyti., 2019). The validation exercise showed a satisfactory agreement with relative bias of less than 10%.

The photopeaks used for the determination of the activity concentration of ^{228}Ac are 911.2 and 969.0 keV, for ^{214}Pb are 295.2 and 351.9 keV, for ^{214}Bi are 609.3 keV and 1120.3 keV. In the case of ^{210}Pb, ^{40}K and ^{137}Cs the activity concentrations are determined by analyzing their photopeaks at 46.5, 1460.8 and 661.6 keV respectively.

Results and discussions

The activity concentrations of natural and artificial radionuclides determined in the samples analyzed in this study are shown in the Table 1.

Table 1. Activity concentrations of ^{238}U, ^{232}Th, ^{40}K, ^{210}Pb and ^{137}Cs in the wild herbal tea samples.

Sample ID	Activity concentration (Bq kg^{-1})				
Traditional name	^{238}U(^{226}Ra)	^{232}Th	^{40}K	^{210}Pb	^{137}Cs
Mountain tea South	13.44 ± 1.29	< MDA	485.15 ± 21.75	12.47 ± 9.55	0.95 ± 0.13
Blueberry	12.06 ± 0.95	4.22 ± 0.21	180.64 ± 8.52	< MDA	1.44 ± 0.12
Peppermint	19.69 ± 1.47	8.16 ± 0.63	584.41 ± 25.49	< MDA	< MDA
Perforate St.John's-wort	17.99 ± 1.38	< MDA	385.00 ± 17.26	22.53 ± 8.52	< MDA
Mistletoe	7.18 ± 0.79	< MDA	632.76 ± 27.23	18.59 ± 6.80	15.94 ± 1.03
Lavender	14.71 ± 1.18	< MDA	530.96 ± 23.14	18.96 ± 8.14	< MDA
Dill	13.27 ± 1.01	< MDA	776.76 ± 32.96	< MDA	< MDA
Rosemary	15.76 ± 1.26	< MDA	514.05 ± 22.53	25.64 ± 0.95	< MDA
Chamomile	18.50 ± 1.44	< MDA	839.96 ± 36.03	< MDA	< MDA
Basil	12.41 ± 1.06	< MDA	739.73 ± 31.63	< MDA	< MDA
Dog rose	5.28 ± 0.48	< MDA	250.01 ± 10.9	< MDA	< MDA
Large-leaved lime	12.63 ± 1.03	< MDA	467.24 ± 20.42	19.04 ± 7.51	< MDA
Bay laurel	23.45 ± 1.78	< MDA	246.36 ± 12.36	< MDA	0.4 ± 0.09
Oregano	14.03 ± 1.25	< MDA	578.76 ± 25.27	< MDA	0.53 ± 0.2
Cheeses	11.43 ± 1.11	< MDA	317.40 ± 16.76	< MDA	< MDA

The value of ^{232}Th concentration ranged between 4.22 and 8.16 Bq kg^{-1}; 13 out of 15 samples show a ^{232}Th activity concentration < MDA; the highest activity concentration is found in the peppermint sample. ^{238}U (^{226}Ra) ranged between 5.28 and 23.44 Bq kg^{-1}; the highest activity concentration is found in Bay laurel sample. ^{210}Pb ranged from 12.47 and 25.64 Bq kg^{-1}; 9 out of 15 samples shows a ^{210}Pb activity concentration < MDA; the highest activity concentration is found in Rosemary sample. ^{40}K ranged between 180.64 and 839.96 Bq kg^{-1}; the highest activity concentration is found in Chamomile sample. ^{137}Cs ranged between 0.40 and 15.94 Bq kg^{-1}; the highest activity concentration is found in Mistletoe sample. 10 out of 15 samples shows a ^{137}Cs activity concentration < MDA.

In the Table 2 are shown the results compared with data reported from other countries. The average values of the activity concentration of ^{238}U, ^{232}Th and ^{40}K are comparable with those reported in literature from other countries.

Table 2. Comparison of the activity concentration of ^{238}U, ^{232}Th and ^{40}K in the wild herbal tea samples from this study with those from other countries.

	Activity concentration (Bq kg^{-1})						
	^{238}U		^{232}Th		^{40}K		
Country	Range	Average	Range	Average	Range	Average	Reference
Albania	5.3 – 23.4	14.1	4.2 -8.2	6.2	180.6 – 840.0	502	This study
Ghana	20.4 – 46.9	31.8	42.0 – 70.6	56.2	566.4 – 1093.1	839.8	(Tettey-Larbi et al. 2013)
Brazil	-	-	< 11.0 – 43.0	21.7	666.0 – 1216.0	976.3	(Scheibel and Appoloni 2007)
Italy	< 0.1 – 7.3	0.4	-	-	5.4 – 3582.0	654.7	(Desideri et al. 2010)
Nigeria	14.7 – 16.2	15.6	7.0 - 11.4	8.5	66.8 – 70.2	67.9	(Olatunde et al. 2011)
Serbia	0.6 – 8.2	2.6	1.7 – 15.1	7.4	126.0 – 1243.7	589.6	(Jevremovic et al. 2011)

Concerning the differences in activity concentrations could be due to differences in the geological location of the plants and the radiochemical composition of the soils in which these herbal teas are grown or cultivated and the plant's ability to absorb particular elements more than the others could.

The high activity concentration of potassium present in some wild herbal tea may be due to application of potassium containing fertilizers to the soil of cultivated areas and/or the plant's ability to absorb more potassium from the soil (Lordford Tettey-Larbi., *et al.*, 2013).

Conclusions

In this paper, a study of the natural and artificial radioactivity of fifteen kinds of wild herbal tea grown in Albania is presented. The activity concentrations of ^{228}Ac, ^{214}Pb, ^{214}Bi, ^{210}Pb, ^{40}K and ^{137}Cs are reported. The study of radionuclide concentration in such plants has great significance, especially for tea, which is widely consumed in the world and for wild herbal tea due to their health promoting campaign. This study provides the first information of its kind to determine the level of radioactivity values in these products in order to ensure consumer safety. The results obtained in this study also provide a useful information to carry out in the future a dose assessment due to ingestion of these products.

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