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Determination of the Radio-isotope Activity Concentration in Some Medicinal and Aromatic Plants in Bitlis

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ABSTRACT

Determination of the levels of radioactivity concentration in food is very important for the protection of human health. In this study, the level of radioisotope activity concentrations (^{226}Ra, ^{232}Th, and ^{40}K) naturally found in some medical and aromatic plants growing in Bitlis were determined. The analysis of ^{226}Ra, ^{232}Th and ^{40}K activity concentration of medicinal plants were performed using a high resolution gamma-ray spectrometer with HpGe detector.

Keywords: Radio-isotope activity, Medical and aromatic plants, Bitlis.

1. INTRODUCTION

In different countries of the world, people in different regions are using medicinal and aromatic plants as sweeteners or for being treated. About 70-80% of population in the world, particularly in the non-developed countries, relies on conventional treat medicine in their main healthcare [1, 2].

Radio-isotopes to the human body are taken through inhalation and ingestion, and basic pathway of this is considered to be food and water [3-5].

Natural radionuclides are the main sources of external and internal radiation in people. While inhalations of terrestrial radioisotopes (Th, U, K) are limited, these isotopes are taken by ingestion of foods to human body mainly [6, 7].

Radionuclides in ^{238}U, ^{232}Th and ^{235}U decay series are existence in different forms and quantities in the environment. These radionuclides and their daughter products can be found in soil with varying activity concentrations depending on geological features of the region and soil type [8].

The role of radionuclides in plant and animal has been determined and this is considerable important. However the effect and the concentration of radionuclides in medicinal plants had received little attention [9, 10].

This study focused on determining the activity concentration of radionuclides in medicinal and aromatic plants commonly used and growing in Bitlis.

Geologic formations on the Bitlis and near around were demonstrated the metamorphic rocks of the Bitlis massive, the upper cretaceous Ahlat-Adilcevaz mixed, the eocene Ahlat conglomerate, the miocene Adilcevaz limestone, the plio - quaternary volcanic and the alluvium exhumation. The geological formations in the general geology of Bitlis that demonstrating exhumation were the Bitlis massive, the Ahlat- Adilcevaz mixed, the Adilcevaz limestone, the alluvium and the Nemrut volcanic [11].

2. MATERIAL AND METHODS

Different medicinal and aromatic plant samples growing in Bitlis in this study analyzed for their natural radioactivity level. Plant samples were grinded for homogeneity and dried inside a stove/oven (at 110°C for 24 h). The plant samples were waited for 30 days (until such time as come up ^{226}Ra with their daughters to the radioactive equilibrium) in marinelli beakers (1 L), and these beakers were closed tightly much to prevent the radon escape.

The activity concentrations of the radionuclides (^{226}Ra, ^{232}Th, ^{40}K) in plant samples were determined using an p-type HPGe detector with energy resolution 2.1 keV at 1.33 MeV, energy rate range from 40 keV to 10 MeV and relative efficiency 50%. Detector calibrations were performed with multinuclide standard sources, which had an activity of 1.365 mCi (^{57}Co, ^{60}Co, ^{88}Y, ^{109}Cd, ^{139}Ce, ^{137}Cs, ^{203}Hg, ^{210}Pb and ^{241}Am). Sample spectra were taken at 86,400 s (24 h) intervals. Spectra analyses were performed using GammaVision (ORTEC) software. The energy and efficiency calibrations were made with a certified standard gel source with a similar density to the measured samples.

The sample activity (Bq/kg) for a given radionuclide can be calculated using equation 1 [12, 13]:

$$A = \frac{N_S - N_B}{\varepsilon \times P_\gamma \times t \times m} \tag{1}$$

where A, N_S, N_B, e, P_γ, t and m are the activity, the counts of the sample (Bq/kg), the background count, the absolute efficiency, the branching ratio, the counting live time (s) and the mass of the sample (kg or L (density ~1 kg L^{-1})), respectively, for certain radionuclides in a gamma ray with energy E. For the determination of specific activities, the daughter radionuclide gamma ray lines of 351.9 keV (^{214}Pb) and 609.3 (^{214}Bi) for ^{226}Ra, 911.2 keV (^{228}Ac) for ^{232}Th, were used. Because ^{40}K does not belong to a decay series as it has a stable daughter product, its characteristic gamma peak at 1460.8 keV was used, with a branching ratio of 11% of the energy. The concentration of ^{40}K is related directly to the total potassium content and the amounts of ^{226}Ra and ^{232}Th were determined using the peaks of the decay products in equilibrium with their parent nuclides. The minimum detectable activity (MDA) was calculated using equation 2 [12, 13]:

$$MDA = \frac{2.71 + 4.65\sqrt{N_B}}{\varepsilon \times P_\gamma \times t} \tag{2}$$

3. RESULTS AND DISCUSSION

The ^{226}Ra, ^{232}Th and ^{40}K concentrations in medicinal and aromatic plant samples have been measured. The results have been listed in Table 1. The specific activity of ^{226}Ra, ^{232}Th and ^{40}K recorded values are in range (3.74 to 48.02 Bq kg^{-1}), (<MDA) and (129.80 to 786.27 Bq kg^{-1}), respectively (Figure 1).

It is seen that the ^{232}Th radioactivity concentration in all plant samples are under of MDA value when Table 1 and Figure 1 were examined. For it was understand to cause of this, the water and soil of plant habitat must examined in terms of radioactivity. ^{40}K radioactivity concentration values are higher than ^{226}Ra radioactivity concentration values.

TABLE I. The radio-isotope activity concentration of some medicinal and aromatic plant samples.

Sample No	**Sample Name**	**Location**	**^{226}Ra (Bq/kg)**	**^{232}Th (Bq/kg)**	**^{40}K (Bq/kg)**
P1	Salvia verticillata	Ağaç Köprü Village	3.74	<MDA	526.96
P2	Melissa officinalis	Ağaç Köprü Village	48.02	<MDA	430.85
P3	Artemisia absinthium	Ağaç Köprü Village	7.40	<MDA	293.57
P4	Achillea filipendulina	Ağaç Köprü Village	4.18	<MDA	597.24
P5	Umbilicus erectus	Ağaç Köprü Village	18.74	<MDA	240.89
P6	Marrubium astracanicum	Ağaç Köprü Village	28.63	<MDA	171.47
P7	Echium italicum	Mutki	45.21	<MDA	786.27
P8	Hyoscyamus niger	Güroymak	24.50	<MDA	129.80
P9	Tanacetum abrotanifolium	Tatvan Han Elmalı Village	14.32	<MDA	366.58
P10	Lallemantia peltata	Campus of University	23.20	<MDA	271.17
MDA			0.28	0.51	5.11
Min. value			3.74	<MDA	129.80
Max. value			48.02	<MDA	786.27
Average			21.79	<MDA	381.48

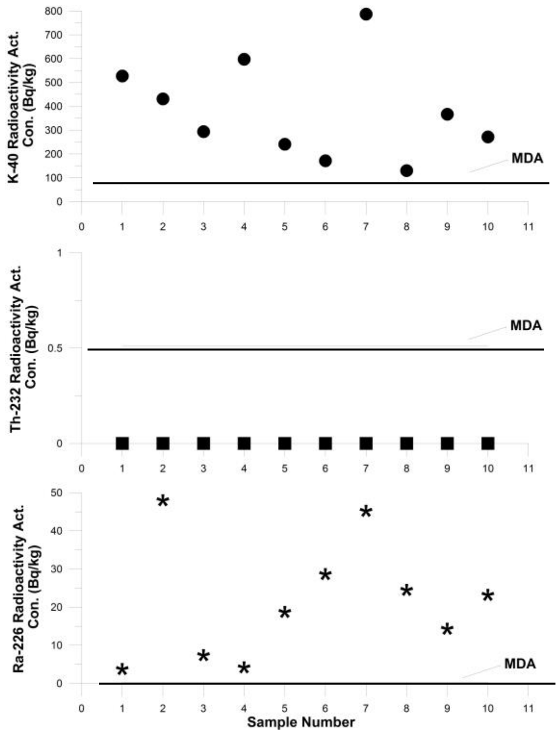

FIG. 1. Change of values of radioactivity concentration.

Although the habitat of plants in Ağaç Köprü village are same, plant samples in here have different radioactivity levels. The reason for it can be features of chemical, physical and biological of plants, for example, the radioisotope absorption feature of plant, etc.

TABLE II. The comparison with other some studies.

Location	Plant species	^{226}Ra (Bq/kg)	^{232}Th (Bq/kg)	^{40}K (Bq/kg)	References
Nigeria	Medicinal	25.02	35.09	171.72	10
South India	Medicinal	6.34	5.05	1895.25	14
Brazil	Medicinal	15.85	4.35	-	15
Nigeria	Vegetable	8.75	20.13	263.88	16
South India	Leaf	4.37	<MDA	2136.00	17
Malaysia	Rice	4.15	3.04	272.23	18
Bitlis	Medicinal	23.64	<MDA (<0.51)	319.94	This study

4. CONCLUSION

In this study, 10 different kinds of medicinal and aromatic plant samples have been analyzed for the determination of their natural radio-isotope levels. We can conclude the following:

1. The values of ^{226}Ra, ^{232}Th and ^{40}K radioactivity concentration are normal level in comparison with other same studies in literature (Table 2).
2. The radioactivity values of plant are changed according to the location, the geological structure, the plant species, and the chemical features of plant, water etc.

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