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Measurement the natural radioactivity of Sheep meat samples from Karbala governorate

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ABSTRACT

In this paper, the measurement of natural radioactivity in Sheep meat samples from different regions of Karbala governorate by using (Na(Tl)) detector. The results of measurements have shown that the specific activity and the determination of some other related parameters such as (Ra_{eq} , H_{in}, I_{γ}, I_{α}, D_{γ}, Eff dos and AGDE). In fourteen four sheep meat samples by using NaI(Tl) detector. The results have shown that, the mean specific activity of (^{40}K, ^{238}U and ^{232}Th) which were (6.813±1.82 Bq/kg, 3.865±1.033 Bq/kg and 1.02±1.03), respectively, were found to be less than the recommended values of specific activity given by (UNSCEAR, 2000).

***Keyword*:** Natural radioactivity, HPGe detector, Soil samples, Wassit governorate

1. INTRODUCTION

The physiological behavior of uranium compounds depends mainly on their solubility. Soluble uranium is regulated because of its chemical toxicity, while insoluble (less soluble) uranium is regulated by its radiological properties. But because of its slow absorption through the lungs and the long retention time in the body tissues, its primary damage will be to its radiological damage (risk of cancer death) to internal organs rather than the risk of significant chemical damage to the renal system [1].

When ingested, uranium might be concentrated within the bone; it increases the probability of bone cancer, or in the red bone marrow (leukemia). Uranium also resides in soft

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tissues including gonads increasing the probability of genetic health effects including the berth defects [2].

Due to all what is mentioned above, there are many outstanding signs and symptoms that may result from uranium (some of them based upon animal studies) as a systemic chemical toxicant such as headaches, cold sweat, hypertension, anemia, diarrhea, insomnia, bronchitis, renal disorder (may increase the infectious diseases), focal necrosis of the liver, lymph nod fibrosis, loss of the body weight, low birth weight, skeletal abnormalities, and others [3].

The aim of the present work is to measurement the specific activity of (^{238}U, ^{232}Th and ^{40}K), and Values of the hazard indices (Ra_{eq} , H_{in},I_{γ} , I_{α} D_{γ}, EFF dos and AGDE) for all sheep meat samples studied, by using (NaI (Tl)) with a crystal detector of (3"×3").

2. SAMPLES COLLECTION AND PREPARATION

We have collected different meat samples of Karbala governorate and imported meat products from Karbala's markets. The origins of the imported meat products are: Iran, Turkey, India, Tanzania, Vietnam, and Brazil. In order to follow the human food chain we have collected samples of local and imported animal's feed. Cut the meat and cook it with a pressure cooker until the meat is cooked well and dry it with the electric oven. After this process, it is exposed to the sunlight for a period of one or two days. We have used a grinding vessel to grind the dried meat into small pieces and then crush it. We have put the prepared meat in marinelli beakers and then achieve the gamma spectroscopy measurements. The feed of sheep is composed of bran and barley, sometimes the crushed nuclei of dates are added. After preparing the feed we put it in marinelli beakers and then we can achieve the gamma spectroscopy measurements.

The Figure (1) shows the preparing of the sheep meat samples.

Figure 1. Preparing the sheep meat samples.

NaI (Tl) detector

We have used a scintillation detector NaI (Tl) gamma spectroscopy system, crystal dimension of (3"× 3"), SCIOIX model 51S51, Germany origin. Figure (2) shows the crystalline detector Na (Tl) with photomultiplier tube.

Figure 2. Detector position in the shielding.

Activity Concentration

Since all the elements of radioactive chains effective in the case of late balance so it is possible to calculate the concentration of an element in the series in terms of the concentration of another element, it has been the focus of effectiveness of a Potassium-40, Bismuth-214 related to the Uranium-238 series, and Thallium-208 related the Thorium series in all sheep meat samples, and then the concentration of Potassium-40 account radioactive nuclide (1460 keV) can be effective concentration is calculated by the following equation [4]:

$$A = \frac{NET}{\varepsilon * I_\gamma * m * t} \quad .... \qquad (1)$$

where:

A : activity concentrations of the sample units Bq/kg,

ε : Energy efficiency,

m : mass of sample units kg,

t : time measurement (3600 sec.).

Radiation hazard indices

1) Radium Equivalent

Radium equivalent calculation from the following equation [5]:

$$Ra_{eq}(\mathrm{Bq/kg}) = A_U + 1.43A_{Th} + 0.077A_K \qquad (2)$$

where A_U, A_{Th}, A_k activity concentration of a series of Uranium and a series of Thorium and Potassium, respectively, in the equation (2) Assume that (10 Bq/kg) of Uranium and (7 Bq/kg) of Thorium and (130 Bq/kg) of Potassium produces an equal dose of radiation [6].

2) Absorbed Dose Rate

The total rate of the absorbed dose in the air is calculated in terms of the concentrations of (^{238}U, ^{232}Th and ^{40}K), through the following equation [6]:

$$D_\gamma = 0.462A_{Ra} + 0.604A_{Th} + 0.0417A_K \qquad (3)$$

3) The Annual Effective Dose

The annual effective dose rate outdoor in air can be estimated using the absorbed dose and take into account two factors; conversion factor of 0.7 $Sv \cdot Gy^{-1}$ and the occupancy factor for outdoor 0.2. The annual effective dose equivalent outdoor ($AEDE_{out}$) in unit of $\mu Sv \cdot yr^{-1}$ is given by the following formula [7].

$$E_{out}(\mathrm{mSv/y}) = D\,(\mathrm{nGy.h^{-1}}) \times 10^{-6} \times 8760(\mathrm{h/y}) \times 0.20 \times 0.7(\mathrm{SvGy^{-1}}) \qquad (4)$$

where the 8760 refers to the number of hours a year. The global average annual effective dose is 0.48 mSv.

4) External Hazard Index

The external guide is a hazard assessment of the risk of natural gamma radiation, is calculated from the following equation [8].

$$H_{ex} = \frac{A_{Ra}}{370} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \leq 1 \qquad (5)$$

where this factor must be less than one , if equal to or greater than one indicates the presence of radiation risk.

5) Activity Concentration Index (I_γ), ($I\alpha$):

The activity index (I_γ) and Alpha index ($I\alpha$) was calculated by using the following equation [8]:

$$I_\gamma = \frac{A_U}{300} + \frac{A_{Th}}{200} + \frac{A_K}{3000} \qquad (6)$$

$$I\alpha = \frac{A_{Ra}}{200} \tag{7}$$

6) Internal Hazard Index

The internal exposure is caused by the inhalation of radon gas and daughters which can be expressed in terms of the internal hazard index and calculates by the following equation [9]:

$$H_{in} = \frac{A_{Ra}}{185} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \le 1 \tag{8}$$

and this factor must be less than the one to be within the allowable universally border [11-12].

3. RESULTS AND CONCLUSIONS

Gamma-ray spectrum of one of the studied sheep samples is shown in Figure (3). It's clear the photopeck of the three detected radionuclides. Each of them was distinguished by a color different from the others as well as from the total spectrum. The specific activities of the detected radionuclides with codes of the samples besides the maximum, minimum, mean, standard errors and the word wide mean are shown in Table (1).

Table 1. The specific activities of the sheep meat samples.

No.	Code	^{40}K (Bq/kg)	Uranium series ^{214}Bi (Bq/kg)	Thorium series ^{208}Tl (Bq/kg)
1	**SDL1**	**21.077**	**8.147**	**1.590**
2	**SD2**	**1.775**	**4.541**	**0.553**
3	**SRL3**	**0.780**	**8.805**	**1.364**
4	**SPL4**	**0.820**	**1.576**	**0.330**
5	**SBRL5**	**4.487**	**4.033**	**1.036**
6	**SBRL6**	**1.916**	**3.542**	**3.671**
7	**SBCL7**	**B.D.L**	**1.383**	**0.063**
8	**SBAL8**	**1.417**	**0.178**	**0.646**
9	**SBGL9**	**0.303**	**1.366**	**0.040**
10	**SBWL10**	**7.485**	**8.395**	**2.297**

11	SVL11	6.114	3.805	0.382
12	SLL12	14.925	B.D.L	0.202
13	SHL13	12.286	4.168	0.168
14	SKL14	22.003	4.166	1.902
Max		22.003	8.805	3.671
Min.		0.000	0.000	0.040
Mean±S.E.		6.813±1.82	3.865±1.033	1.02±1.03
Worldwide mean [10]		400	35	30

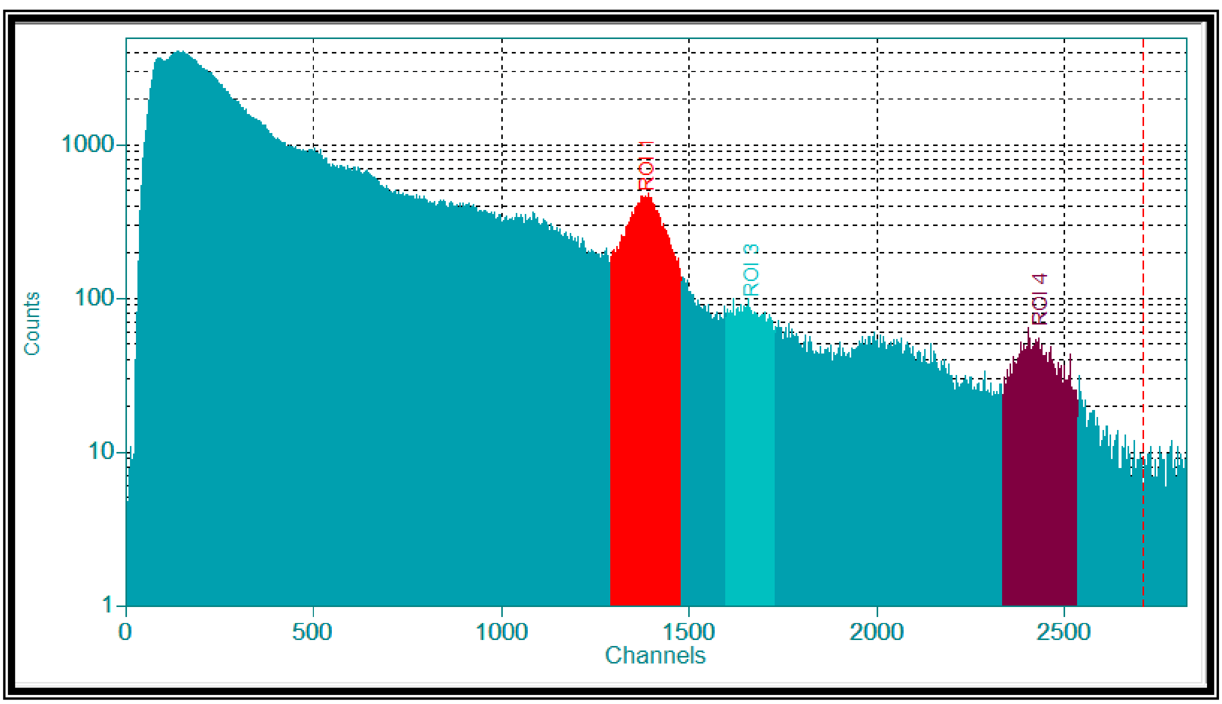

Figure 3. Specific activity of (^{40}K, ^{238}U, and ^{232}Th) for SBCL8 sample

It is clear that the highest value of (^{40}K), in sheep meat samples, the highest value of specific activity of (^{40}K) was found in SKL14 sample which was equal to (22.003 Bq/kg), while the lowest value of specific activity of (^{40}K) was found in SBCL7 sample which was equal to B.D.L, with a mean value of (6.813±6.2 Bq/kg).

For specific activity of (^{238}U), in sheep meat samples, the highest value of specific activity of (^{238}U) was found in SRL3 sample which was equal to (8.805 Bq/kg), while the lowest value of specific activity of (^{238}U) was found in SLL12 sample which was equal to (B.D.L Bq/kg), with a mean value of (3.865±2.1 Bq/kg).

For specific activity of (^{232}Th), in sheep meat samples, the highest value of specific activity of (^{232}Th) was found in SBRL6 sample which was equal to (3.671 Bq/kg), while the lowest value of specific activity of (^{232}Th) was found in SBGL9 sample which was equal to (0.040 Bq/kg), with a mean value of (1.02±0.8 Bq/kg).

The present results have shown that values of specific activity for (^{40}K, ^{238}U and ^{232}Th), respectively, in all sheep meat samples studied were less than the recommended for the specific activity given by (UNSCEAR, 2000).

Radiation hazard indices

Fourteen of the suitable radiation hazard indices were be calculated in this study depending on the results of the specific activities of the sheep meat samples. Table (2) summarizes the results obtained for radiation hazard indices (Raeq, Hin, Iɣ, Iα DƔ, Eff dos and AGDE). From Table (2) it can be noticed that, the highest value of radium equivalent activity was found in SBWL10 sample which was equal to (12.256 Bq/kg), while the lowest value of Ra_{eq} was found in SBAL8 sample, which was equal to (1.211 Bq/kg), with a mean value of (5.84±3.3 Bq/kg).

The highest value of internal hazard index was found in SBWL10 sample which was equal to (0.056), while the lowest value of H_{in} was found in SBAL8 and SLL12 samples which was equal to (0.004), with a mean value of (0.026±0.01). Also from Table (2), it can be noticed that, the highest value of activity concentration index was found in SDL1 sample which was equal to (0.042), while the lowest value of $I_{ɣ}$ was found in SBAL8 sample which was equal to (0.004), with a mean value of (0.02±0.01).

The highest value of Alpha index in the studied samples was found in SRL3 sample which was equal to (0.044), while the lowest value of (I_{α}) was found in SLL12 sample which was equal to (0.000), with a mean value of (0.019±0.01).

The highest value of absorbed gamma dose rate was found in SDL1 samples which was equal to (5.630 nGy/h), while the lowest value of $D_{Ɣ}$ was found in SBAL8 sample which was equal to (0.543 nGy/h), with a mean value of (2.7±1.5 nGy/h). For annual effective dose rate, the highest value of annual effective dose rate was found in (SDL1 and SBWL10) samples which was equal to (0.007 mSv/y), while the lowest value of EFF dos was found in (SPL4, SBCL7, SBAL8, SBGL9 and SLL12) samples which was equal to (0.001 mSv/y), with a mean value of (0.003±0.001 mSv/y).

The highest value of annual effective dose equivalent was found in (SDL1 and SBWL10) samples which was equal to (0.038 mSv/y), while the lowest value of AGDE dos was found in (SBAL8 and SBAL8) samples which was equal to (0.004 mSv/y), with a mean value of (0.018±0.01 mSv/y).

4. CONCLUSIONS

The present results have shown that values of hazard indices for (Raeq, Hin, Iɣ, Iα DƔ, Eff dos and AGDE), respectively, in all sheep meat samples studied were less than the recommended for the hazard indices given by (UNSCEAR, 2000).

Table 2. The hazard indices [Ra_{eq}, H_{in}, I_{γ}, I_{α} D_{γ}, EFF dos and AGDE] for the all sheep meat samples.

No.	Code	Ra_{eq} (Bq/kg)	H_{in}	I_{γ}	I_{α}	D_{γ} ($nGy \cdot h^{-1}$)	Eff dose ($mSv \cdot y^{-1}$)	AGDE ($mSv \cdot y^{-1}$)
1	SDL1	12.043	0.055	0.042	0.041	5.630	0.007	0.038
2	SD2	5.469	0.027	0.018	0.023	2.516	0.003	0.017
3	SRL3	10.816	0.053	0.036	0.044	4.948	0.006	0.033
4	SPL4	2.111	0.010	0.007	0.008	0.967	0.001	0.007
5	SBRL5	5.860	0.027	0.019	0.020	2.694	0.003	0.018
6	SBRL6	8.939	0.034	0.030	0.018	3.996	0.005	0.027
7	SBCL7	1.474	0.008	0.005	0.007	0.678	0.001	0.005
8	SBAL8	1.211	0.004	0.004	0.001	0.543	0.001	0.004
9	SBGL9	1.446	0.008	0.005	0.007	0.668	0.001	0.004
10	SBWL10	12.256	0.056	0.040	0.042	5.617	0.007	0.038
11	SVL11	4.822	0.023	0.015	0.019	2.250	0.003	0.015
12	SLL12	1.439	0.004	0.002	0	0.748	0.001	0.005
13	SHL13	5.355	0.026	0.015	0.021	2.542	0.003	0.017
14	SKL14	8.580	0.034	0.024	0.021	4.023	0.005	0.028
Max.		12.256	0.056	0.042	0.044	5.630	0.007	0.038
Min.		1.211	0.004	0.004	0.000	0.543	0.001	0.004
Mean ±S.E.		5.84 ±1.56	0.026 ±0.01	0.02 ±0.01	0.019 ±0.07	2.7 ±0.72	0.003 ±0.001	0.018 ±0.005
World wide mean [10]		370	≤1	≤1	≤1	55	1	0.3

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