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Natural radioactivity in common biscuits samples in Iraq

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ABSTRACT

Babies in Iraq and other nations frequently ingest biscuits, constituting a significant dietary group. In this work, gamma spectroscopy was used to assess long-lived gamma emitters in children's biscuits. Furthermore, radiation hazard indices, such as the yearly effective dose for children, the representative gamma level index, and the radium equivalent activity, were estimated. Ten examples were collected from the Iraqi market, representing a range of origins. The average specific activities for 238U, 232Th, and 40K were 11.174**,** 16.314, and 206.57 Bq/kg, respectively, but the internal hazard index and the average of the radium equivalent activity and the internal hazard index were 0.1662 and 50.382 Bq/kg, respectively. The total average annual effective dose from consumption by children and infants is estimated to be 1.47 and 1.2 mSv, respectively. All samples in this investigation had values for a specific activity, radiation hazard indices, and yearly effective dose that were lower than the global median values for all categories; as a result, these values were determined to be safe.

Keywords: *Natural, Common, Average, Examples*

INTRODUCTION

The extended half-lives of the primordial radionuclides have allowed them to persist since their origin. They continue to decay in order to reach a stable state and release ionizing radiation in varying amounts [1]. Work with radioisotopes is associated with the two primary forms of external and internal radiation exposure. External dangers are created when radiation from an external source enters the body and produces an ionizing radiation dose. These exposures may be caused by neutrons, alpha particles, beta particles, gamma rays, or X-rays; they depend on the radiation's kind and energy. When an uptake takes place through ingestion, i nhalation, or skin contact, radioactive elements can be deposited in the body [2, 3]. Doses taken orally (internal source) are caused mainly by the radionuclides in food of the 238U and 232Th family and by the element 40K. and water to drink. Due to their vast variety of flavors, extended shelf life, and relatively inexpensive price, biscuits are a common food item many enjoy [4]. They are created with flour, shortening, leavening, milk, water, and other ingredients. Natural radionuclides in food consumed in various regions of the world have been explored in international studies [5, 6, 7, 8, 9, 10]. Regarding contaminated goods, the Fukushima nuclear catastrophe has generated much anxiety.

It is critical to compare doses derived from naturally occurring radionuclides, the study's emphasis, with doses produced from artificial radionuclides [11, 12, 13].

In this investigation, we looked at the radioactivity of the biscuits that newborns, kids, and adults in Iraq ate. We sought to ascertain the levels of naturally occurring radionuclide activity in biscuit samples found in Iraqi markets. We also sought to calculate radiation hazard indices and yearly effective doses from biscuit eating across different age groups.

METHOD AND MATERIALS

Ten samples of biscuits were bought from diverse regions of the central Euphrates governorates in Iraq. These samples are of different origins, and after collecting the samples, each sample was crushed separately, sifted, dried, and then kept in thermal bags. They are arranged as shown in Table. 1

TABLE 1: Types and origins of the Biscuit samples

Code of Samples	Name of samples	Country of Origin
B1	Original Cream Crackers	Malaysia
B2	Digestive	Iran
B3	Digestive Original	Turkey
B4	Petit Beurre	Iran
B5	Classic Biscuit	Iraq
B6	Petit Beurre Biscuit	Turkey
B7	Petit Beurre Tea Biscuit with Milk	Turkey
B8	Finger Biscuit	Turkey
B9	Digestive Oats Orange	Spain
B10	Lotus Biscoff	Belgium

TABLE 2: The conversion factors

Age Group	Annual Effective Dose (nSv/y)		
	238U(226Ra)	232Th	40K
Adults (over 17 y)	280	230	6.2
Children (10) y	800	290	13
Infant (1) y	980	450	42

To achieve a consistent weight, they were maintained moisture-free in an oven. One case day ensured geometric uniformity about the detector, and then the particular net weights were recorded and measured using a highly sensitive digital weighing scale (60.01%). To allow for secular equilibrium between 222Rn and its parent 226Ra in the uranium chain, the Marinelli beakers were closed with PVC tape and maintained for about a month before counting [14]. Each sample's gamma spectrum was recorded by a NaI (Tl) detector (crystal volume 3 by 3 in). [7.6 by 7.6 cm]) and a 4096-channel PC-based multichannel analyzer that was processed using Maestro-32 software (Ortec, Oak Ridge, TN). The samples were placed in the detector, and 18,000 seconds of measurements were made. Our conclusions were derived from the gamma rays released by the progenies of 226Ra and 232Th, which are in secular equilibrium with them, whereas 40K was determined directly from its 1,460 keV gamma line case day (208 Ti). Count rates and activity levels for each identified photopeak and nuclide were determined. Equation 1 provides the specific activity (in Bq/kg), A Ei, of a nuclide having a peak at energy E [15]:

$$A_{Ei} = \frac{N_P}{t_c \times I_\gamma(E_\gamma) \times \varepsilon(E_\gamma) \times M} \quad (1)$$

where NP is the number of peaks determined in a particular peak area adjusted for background peaks of an energy Ei, and ε(Eγ) is the energy efficiency of the detection rate E, tc is the counting lifetime, Iγ (Eγ is how many gammas this nuclide emits during each disintegration during a transition with energy E, and here M is the observed sample's mass in the unit of kilograms. Radiation indices were calculated for the internal hazard index (IHI) and the radium equivalent activity (Raeq) (Hin). Moreover, the yearly effective dosage, D, was computed for the different age groups. Distribution of 226Ra, 232Th, and 40K in the location is not uniform; consequently, concerning radiation exposure, radioactivity is characterized in terms of Ra \seq (Bq/kg) to compare the specific activities of ingredients containing varying quantities of 226Ra, 232Th, and 40K [16, 17]:

$$\mathrm{Ra_{eq}} = A_{\mathrm{Ra}} + 1.43A_{\mathrm{Th}} + 0.077A_{\mathrm{K}}$$
(2)

where ARa, ATh and AK are the concentrations of specific activity for 226Ra,232Th and 40K in (Bq/kg), respectively. The index may be used to compare the particular activity of materials with varying concentrations of 226Ra, 232Th, and 40K. Internal 222Rn exposure and its radioactive offspring are governed by the Hin, as defined by equation 3 [18, 10]:

$$H_{\mathrm{in}} = \frac{A_{\mathrm{Ra}}}{185} + \frac{A_{\mathrm{Th}}}{259} + \frac{A_{\mathrm{K}}}{4{,}810}$$
(3)

The maximum value of Hin should be less than unity for the safe use of a material in the construction of a house [19]. Equation 4 is used to compute the yearly effective dosage from biscuit intake [3]

$$D = A \times E \times I \qquad (4)$$

where A is the concentration of radionuclide's activity (Bq/kg), E is the factor of dose conversion (Sv/Bq), and I is the yearly intake of the sample (kg/year).

According to the International Commission on Radiological Protection categories [20], the values of E (Table 2) are adult, child (10 years old), and newborn (1 year old). Based on the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) [3], the values of I are instead assumed to be 140, 90, and 45 kg/year, respectively, for the age categories of adult, child, and newborn.

RESULT AND DISCUSSION

The specific activity (Bq/kg) for 226Ra, 232Th, and 40K in Biscuit samples is presented in Table. 3 for ten biscuit samples from several markets in the middle of Iraq were taken and compared to the global median values reported by UNSCEAR in 2000 [3]. The red and green colors indicate the maximum and minimum values of the specific activity, respectively.

TABLE 3: Specific Activity (Bq/kg) in Biscuit samples

Sample Code	Specific Activity (Bq/kg)		
	226Ra	232Th	40K
B1	16.93±0.92	10.95±0.66	200.31±2.83
B2	5.98±0.55	19.8±0.89	227.41±3.02
B3	8.04±0.64	13.57±0.73	244.29±3.13
B4	18.84±0.97	25.16±1	141.25±2.38
B5	11.1±0.75	12.46±0.7	204.04±2.86
B6	18.28±0.96	10.24±0.64	215.86±2.94
B7	11.11±0.75	18.06±0.85	180.78±2.69
B8	13.56±0.83	20.56±0.9	232.62±3.05
B9	4.62±0.48	13.41±0.73	235.43±3.07
B10	3.01±0.39	18.93±0.87	183.71±2.71
Average	11.147±0.724	16.314±0.797	206.57±2.868

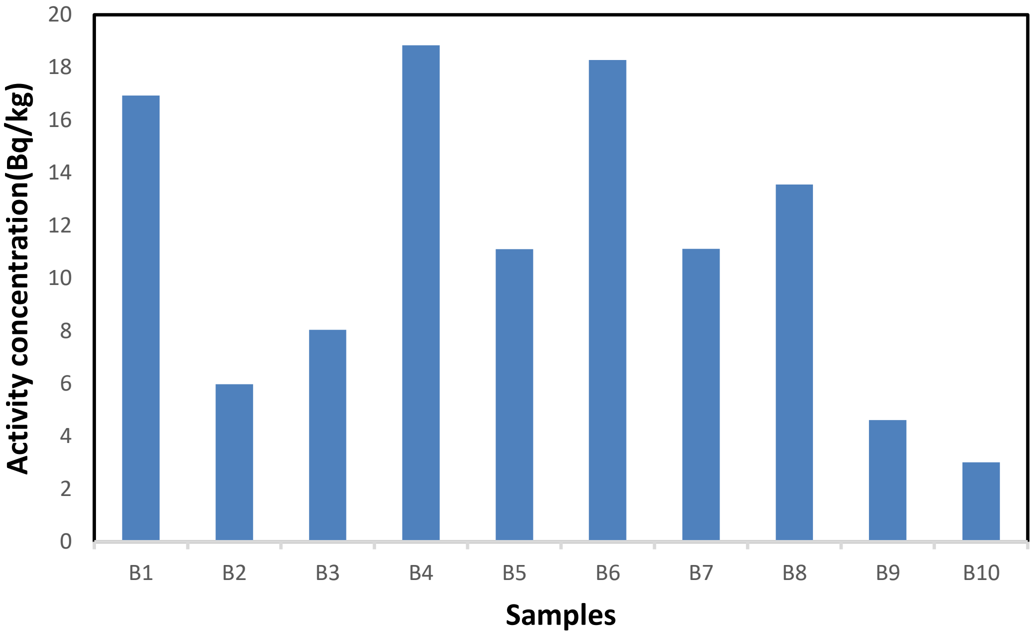

FIG 1: Activity concentration of 226Ra in Biscuit samples.

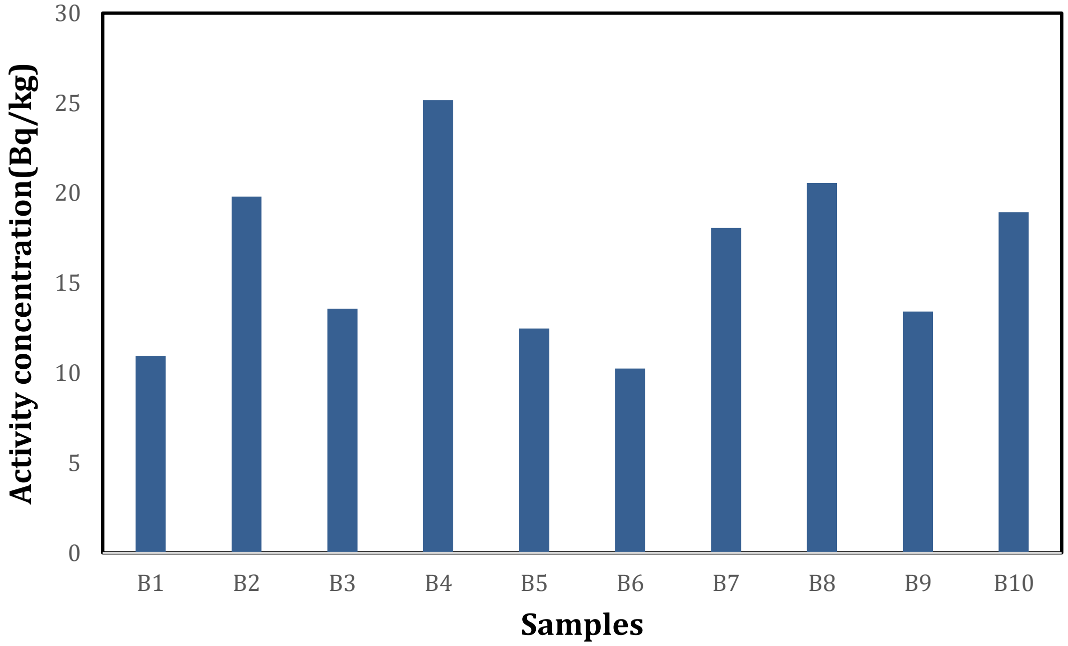

FIG 2: Activity concentration of 232Th in Biscuit samples.

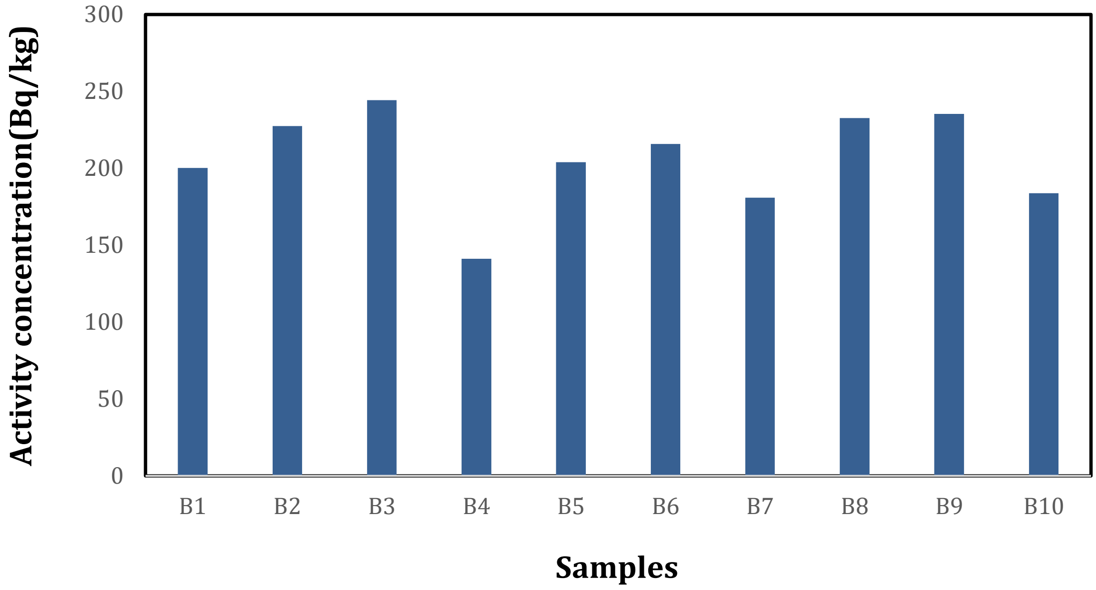

FIG 3: Activity concentration of 40K in Biscuit samples.

TABLE 4: Radium equivalent activity and internal hazard index in Biscuit samples

Sample code	Raeq(Bq/kg)	Internal Hazard Index
B1	48.012	0.1754
B2	51.805	0.1561
B3	46.255	0.1466
B4	65.695	0.2283
B5	44.629	0.1505
B6	49.544	0.1832
B7	50.856	0.1674
B8	60.873	0.2010
B9	41.924	0.1257
B10	44.226	0.1276
Average	50.382	0.1662

The specific activities of 226Ra and 232Th varied from 3.01±0.39to 18.84±0.97 Bq/kg (average, 11.147±0.724 Bq/kg) and from 10.24 ±0.64 to 25.16 ±1 Bq/kg (average, 16.314±0.797 Bq/kg), respectively, while the specific activity of 40K varied from 141.25 ±2.38 to 244.29± 3.13Bq/kg (average, 206.57± 2.868 Bq/kg). Table 4 shows the Raeq and Hin values of 226Ra, 232Th, and 40K in the samples of biscuits. The Hin was evaluated using equation 3 for each sample; it varied from 0.1257 in sample B9 to 0.2283in sample B4, with an average value of 0.1662. The total annual effective dose (mSv) for children and infants, calculated using equation 4, is presented in Table. 5 shows. For children and babies, the average values of the total yearly effective dose equivalent caused by the specific activity levels of 226Ra, 232Th, and 40K were determined to be 1.47 and 1.2 mSv, respectively, as shown in Fig. 4.

TABLE 5: Total annual effective doses from biscuit samples consumed by children and infants.

Sample code	Total annual effective dose (mSv)	
	Child	Infant
B1	1.739	1.332
B2	1.213	1.089
B3	1.219	1.084
B4	2.178	1.59
B5	1.363	1.117
B6	1.836	1.405
B7	1.483	1.187
B8	1.785	1.442
B9	0.958	0.916
B10	0.926	0.860
Average	1.47	1.202

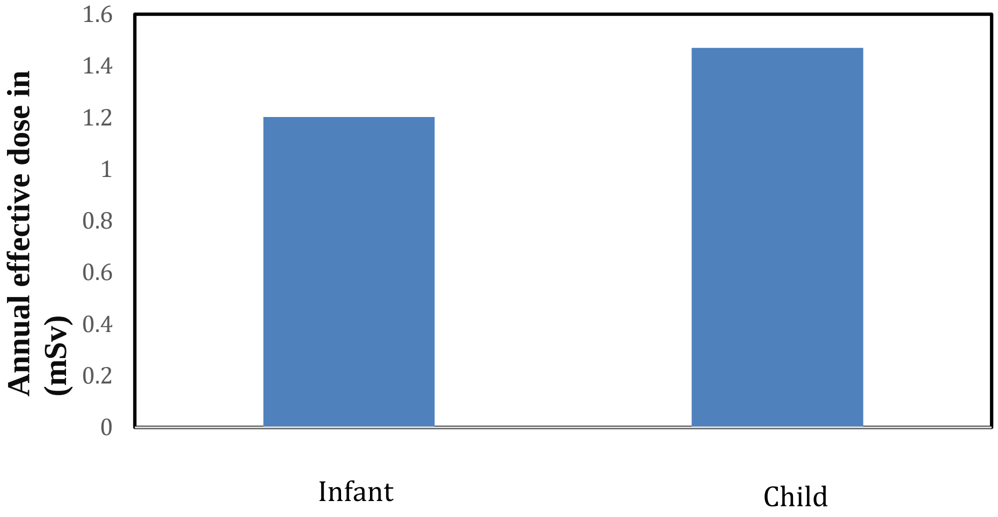

FIG 4: The average annual effective doses from consumption of biscuit samples for children and infants.

CONCLUSION

In this study, we found the highest percentage of radioactivity for uranium in sample B4, thorium in sample B4, and potassium B3, and the lowest percentages in samples B10, B6, and B4, respectively. In any case, all sample values are within the internationally permissible level. The radium equivalent and the internal risk coefficient reached the highest values in the B4 and B4 samples. Also, all values are considered within the internationally permissible range. The specific activity of radionuclides 226Ra, 232Th, and 40K was measured using gamma-ray spectroscopy on samples of several varieties of biscuits that are commonly consumed. In Iraq, people of all ages drink it. These radionuclide-specific activity concentrations in samples were smaller than those described by UNSCEAR. As a result, we may conclude that the radionuclide levels in the samples of biscuits investigated are safe for typical intake by adults, children, and babies. Furthermore, the radiation hazard indices were below the global standard thresholds deemed acceptable for radioactive dangers. The average yearly effective doses from consuming all three natural radionuclides by adults, children, and babies were determined to be within the average annual consuming radiation dose from natural sources. As a result, the overall average yearly effective dosage was significantly below the level for radiological safety set by the international commission on radiological protection and the world health organization.

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