Study the Health risk of Radioisotopes in different samples of salt in markets of Iraq.

Shaymaa Awad Kadhim alshebly*, Azhar S.Alaboodi, Ahmed Muhsen Hassan, Rusul Mohammed alkhafaji and Asmahan Asaad Muhmood

Physics Department, Faculty of Science, University of Kufa , Najaf, Iraq.

* shaymaa.alshbely@uokufa.edu.iq

Abstract. Eleven samples of salt were collected from local markets in Iraq for the purpose of identifying which types were more radioactive and the radiation efficacy of the external hazard index, outdoor absorbent dose, internal hazard index and indoor absorbed dose and Radium equivalent activity (Raeq) also finding an effective dose due to ingestion where the maximum value of a specific uranium activity was recorded in sample S4, which was (32.138Bq/kg). The lowest value was recorded in sample S8, which was (4.432 Bq/kg). It should be noted that sample S8 is Turkish origin specific activity of 232Th, the highest value was (12.456Bq/kg) recorded in sample S9, while the lowest value was (1.426 Bq/kg) and recorded in sample S7. Also calculate Effective dose Dose(Sv/y) by using equation (7) for 40K was 10.088 Sv/y, 226Ra was 1.152 Sv/y and 232Th was 1.660 Sv/y.

Keyword: Effective dose due to ingestion, external hazard index, outdoor absorbed.

Introduction

Potassium (K) is silver – white metal and soft so that it can be cut by a knife. K is an important element in the soil and feasts extensively in nature and there in nearly all plant and animal tissues [1]. In the earth's crust is the seventh in profusion either in the oceans is considered the sixth element. K found in mineral waters and seawaters and in many of the major kinds of alloys, particularly metal ones[2]. K is an essential nutrient in plants as an important feature of the lush soil. In the case of abridged its concentration in the soil, one must be used manure (especially triple fertilizers NPK) in order to get a good plant growth[3]. In man K represents an important feature in the diet and in the growth and upkeep of the body. K is essential in transfer water with normal quantities between the cells throughout the body and its fluids [4]. K plays a key part in the response of nerves to rouse muscle reduction. It is also essential to uphold the good work on the functions of the cardiovascular, where it theaters as the electric key and that a lot of people taking it in the form of capsules or tablets or salt form. People use sodium chloride (NaCl) in the eating, but those who hurt from high blood pressure, increases the NaCl salt leads to increase their high blood pressure and thus heart attack or stroke may be happened[5]. Therefore, physicians are counseled to use potassium chloride (KCl) salt, which does not lead to a increase in a high blood pressure. On average, the adult human body covers up to 140 grams of K, and this rate differs rendering to body weight and muscle mass. Man's ingest about 3.3 grams of K per day through food, drink and excrete almost the same quantity[6].

The element of K contains of three isotopes [7]: potassium – 39 (39K), which is the most stable and peer profusion (93.26%), potassium – 41 (41K), a stable isotope also represents the second in abundance (6.73%), and the third isotope is potassium – 40 (40K), which has very small abundance (0.0118%) [8]. 40K signifies the only one radioactive of the three potassium isotopes, which emit beta particles of maximum energy of 1.33 MeV with rate 89 % from total emission, while the other part of the emission is gamma rays with energy 1.46 MeV. The half-lifetime of 40K is 1260 million years[9], a relatively long lifetime and therefore, is used by many of the geophysics in the dating calculation of the rocks and even in the approximation of the age of the archaeologies as is the circumstance of the 14C isotope[10].

K is one of the most sensitive metals in nature, and that a number of compounds that have many commercial use[11]. For example, potassium permanganate, the color purple, is used as an
antibacterial and germicidal. Potassium iodide is used, which is fast solubility in water, in photography. It is also used in medicine to treat rheumatism and overactive thyroid glands[12]. Again, as an example, solid white potassium carbonate uses to produce glass and soft soap. With nitrogen and phosphorus, potassium chloride is used throughout the manure industry to produce the important tri manure (KPN Fertilizer) which is very important for plant growth[13].

K is a naturally happening radioactive isotope and can lead to health dangers, both internal and external. For external hazards, 40K can emit gamma ray with energy of 1.46 MeV; therefore, the exposure could be a source of great concern. Either in the body (internal exposure), and in addition to gamma rays, beta particles, which are 89 % of the total radiations, they have significant health risks. The ionizing radiation (beta or gamma) of 40K could affect the health caused by cell damage and thus the probability of cancer incidence may be increased[14]. The ingestion is the most common type of exposure but has risk coefficients less than inhalation. In addition to this internal exposure, 40K could give external exposure. For example, if we assume that 100,000 people are constantly exposed to a thick layer of soil has 40K concentration of 1 pCi/g, then, 4 from these 100,000 people will die from cancer resulting from this exposure[15]. Daily intake of potassium element: 3.3 grams. Amount of potassium element in body: 140 grams (1.5 pCi/g or 55 Bq/kg of body weight) Typical K-40 activity in body: 0.1 uCi. This means that there are over 200,000 atoms of K-40 that decay in the body each minute! Typical K-40 activity in soil: 10 to 20 pCi/g[16].

Material and Methods

Eleven different potassium salt samples were collected from suppliers, which are available in markets and natural radioactivity for K radionuclides have been measured. The natural activity of potassium salt was measured using a γ-ray spectrometer system. The spectrometer consists of a NaI(Tl) “3 X 3” Massy detector, the Preamplifier, High-Voltage power supply, Amplifier and Multi-Channel-Analyzer (MCA). The surrounding of the sample cup was shielded by lead in order to shield from other background γ sources. The energy calibration of the detection system was done using radioactive sources of 137Cs and Co which emit 662 and 1170, 1333 keV respectively. After calibration of the detection system, the background and real measurement have been done for 18000 s duration.

A typical γ-ray spectrum for salt sample is related to the interested radionuclide of 40K is clearly seen. Calculations

For each individual isotope, the specific activity in Bq/kg units was calculated by using the equation (1) [17].

\[
\mathcal{A}_n = \frac{(C_n - C_b)}{\epsilon_{\gamma} I_{\gamma} m_n} \quad (1)
\]

where \(\mathcal{A}_n\) is the specific activity of each radionuclide in Bq/kg, \(C_n\) the count rate in cps for a sample, \(C_b\) the count rate in cps for background, \(\epsilon_{\gamma}\) and \(I_{\gamma}\) are detection efficiency and emission probability of γ-ray, \(t\) is the counting time and \(m_n\) is the mass of the sample in kg[18].

The distribution of 40K, 226Ra and 232Th nuclei in rocks and soil are not uniform, so a common factor was used to compare its combined radiological effects. This factor is called the Radium equivalent activity (\(\mathcal{R}_{aeq}\)). As proposed by the Organization of Economic Cooperation and Development, the permissible Radium equivalent activity values for safe use should be less than 370 Bq/kg. Equation (2) was used to calculate the radium equivalent activity (\(\mathcal{R}_{aeq}\)) [19].

\[
\mathcal{R}_{aeq} = \mathcal{A}_{Ra} + 1.43 \mathcal{A}_{Th} + 0.077 \mathcal{A}_K \quad (2)
\]

Where \(\mathcal{A}_{Ra}, \mathcal{A}_{Th}\) and \(\mathcal{A}_K\) are the specific activity of 226Ra, 232Th and 40K respectively.

The external (\(\mathcal{H}_{ex}\)) and internal (\(\mathcal{H}_{in}\)) hazard indices were calculated using Equations (3) and (4) [20].

\[
\mathcal{H}_{ex} = \frac{\mathcal{A}_{Ra}}{370} + \frac{\mathcal{A}_{Th}}{259} + \frac{\mathcal{A}_K}{4610} \quad (3)
\]

\[
\mathcal{H}_{in} = \frac{\mathcal{A}_{Ra}}{185} + \frac{\mathcal{A}_{Th}}{259} + \frac{\mathcal{A}_K}{4610} \quad (4)
\]

If the calculated values of indices are greater than unity, Radioactivity may cause harm to the population.

Equation (5) was used to calculate the outdoor dose (\(\mathcal{D}_{out}\)) [19], and the average value is 51 nGy/h as recommended by the UNSCEAR (2000) report.

\[
\mathcal{D}_{out} = 0.462 \mathcal{A}_{Ra} + 0.604 \mathcal{A}_{Th} + 0.0417 \mathcal{A}_K \quad (5)
\]

While the indoor absorbed dose rate for salt samples was calculated by using equation (6) [18].

\[
\mathcal{D}_{in} = 0.929 \mathcal{A}_{Ra} + 1.11 \mathcal{A}_{Th} + 0.08 \mathcal{A}_K \quad (6)
\]

The recommended value of indoor absorbed dose rate is 70 nGy/h [20]. Effective dose due to ingestion

Effective dose is a useful concept that enables the radiation doses from different radionuclides and from different types and sources of radioactivity to be added. Estimates of the radiation induced health effects associated with intake of radionuclides in the body are proportional to the total dose
delivered by the radionuclides while resident in the various organs. Radiation doses ingested are obtained by measuring radionuclide activity in foodstuffs (Bq kg-1) and multiplying these by the masses of food consumed over a period of time (kg d-1 or kg y-1). A dose conversion factor (Sv Bq-1) can then be applied to give an estimate of ingestion dose. Thus, the ingested dose is given by [21]

\[ Dose(Sv/y) = \text{Concentration (Bq/kg)} \times \text{Annual intake (kg/y)} \times \text{DCF (Sv/Bq)} \]

Where DCF is the standard dose conversion factor. For the high use of salt in our daily lives, we must consider the ratio of radioisotopes to the threshold of attention to human life.

Results and Discussion

The specific activity values calculated for the eleven samples of salt were listed in Table 1.

Table 1 The specific activity of 226Ra, 232Th and 40K of salt Available in Iraqi local markets.

| Name of sample | Origin | Sample code | Specific Activity (Bq/kg) |
|----------------|--------|-------------|--------------------------|
| solti          | Saudi Arabia | S1          | 4.161±0.812              |
| Zer            | Turkey   | S2          | 11.840±0.507             |
| American Garden Alathary | United States of America | S3          | 25.711±0.677             |
| Normal         | Iraq     | S4          | 32.138±1.116             |
| Nawras         | Iraq/Iraq Slemansi | S5          | 28.079±0.541             |
| Bahman 2       | Iran     | S6          | 13.870±0.338             |
| Altunsa        | Turkey   | S7          | 26.387±0.575             |
| Hello          | Saudi Arabia | S8          | 4.432±0.710              |
| Soorin         | Iran     | S9          | 7.849±0.609              |
| Chtoura Field  | Lebanon  | S10         | 6.529±0.474              |
|                |          | S11         | 9.405±0.643              |

From Table 1 we can see that the values of 226Ra specific activity for the salt samples in this study ranged between the maximum and minimum values. The maximum value of a specific uranium activity was recorded in sample S4, which was (32.138 Bq/kg). The lowest value was recorded in sample S8, which was (4.432 Bq/kg). It should be noted that sample S8 is Turkish origin.

As for the specific activity of 232Th, the highest value was (12.456 Bq/kg) recorded in sample S9, while the lowest value was (1.426 Bq/kg) and recorded in sample S7. In this study, all specific activity values of salt samples measured for uranium and thorium nuclei were significantly lower than the worldwide average recommended by UNSCAER.

The measurements of the specific activity of the 40K nucleus varied between a maximum value of (3864.1 Bq/kg) in sample S9 and a minimum value of (420 Bq/kg) in sample S7. The samples have specific activity values of 40K higher than the worldwide average value (420 Bq/kg) recommended by the UNSCAER.

Table 2 shows the calculated values of external hazard index, outdoor absorbed dose, internal hazard index and indoor absorbed dose. The maximum values of these factors were (0.873), (177.755 nGy/h), (0.894) and (231.082 nGy/h) respectively. While the minimum values were (0.145), (26.914 nGy/h), (0.177) and (34.988 nGy/h) respectively. The calculated mean values were (0.385), (76.759 nGy/h), (0.425) and (99.787 nGy/h) respectively.
Table 2. Calculated values of hazard indices for salt samples which is Available in Iraqi local markets.

| sample code | Ra eq (Bq/kg) | Hex | Dout (nGy/hr) | Hin | Din (nGy/hr) |
|-------------|---------------|-----|---------------|-----|--------------|
| S1          | 115.2         | 0.311 | 63.12         | 0.322 | 82.06        |
| S2          | 28.07         | 0.145 | 26.91         | 0.177 | 34.98        |
| S3          | 28.48         | 0.181 | 33.76         | 0.250 | 43.89        |
| S4          | 45.87         | 0.251 | 46.32         | 0.338 | 60.22        |
| S5          | 33.08         | 0.278 | 53.29         | 0.354 | 69.28        |
| S6          | 16.08         | 0.449 | 90.82         | 0.486 | 118.0        |
| S7          | 28.50         | 0.244 | 46.83         | 0.316 | 60.88        |
| S8          | 9.914         | 0.270 | 54.79         | 0.282 | 71.23        |
| S9          | 25.73         | 0.873 | 177.7         | 0.894 | 231.0        |
| S10         | 22.97         | 0.833 | 169.9         | 0.851 | 220.9        |
| S11         | 26.75         | 0.157 | 29.63         | 0.183 | 38.52        |
| max         | 115.2         | 0.873 | 177.7         | 0.894 | 231.0        |
| min         | 9.914         | 0.145 | 26.91         | 0.177 | 34.98        |
| Average     | 38.91         | 0.385 | 76.75         | 0.425 | 99.78        |

Also calculate Effective dose Dose(Sv/y) by using equation (7) for 40K was 10.088 Sv/y, 226Ra was 1.152 Sv/y and 232Th was 1.660 Sv/y.

Conclusions
A salt samples in the markets of Iraq has a significant increase in potassium concentrations. As for uranium and thorium, their concentrations are low in this samples compared with other countries in the world. This may be due to the large quantities of water that are used to prepare salt in the origin country. All values of hazard indices are less than the permissible limits. Concentrations are different between the three radioisotopes. Therefore, when we observe that a radiant element in a sample is less, we see a different component. Therefore, it is proposed to conduct a comprehensive and comprehensive study at the country level for the purpose of identifying the best types of salt in terms of radiation.

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