NORM in Instant Noodles (Indomie) Sold in Iraq
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Abstract

The Radioactivity is invisible, tasteless and not mentioned on food labels, therefore it must be measured the Radionuclides levels in all samples food, we selected the important food that it is widely used in world Instant Noodles. Natural Radioactivity and Some Radiological Parameters of 13 instant noodles samples that available in Iraq supermarkets was determined using Gamma-ray Spectroscopy method. The results showed the range of specific activity for Ra-226 from (2.382 ± 1.128) Bq/kg to (31.918 ± 3.374) Bq/kg with an average (14.98231) Bq/kg, for Th-232 from (1.509 ± 0.297) Bq/kg to (9.269 ± 0.716) Bq/kg with an average (3.4421538) Bq/kg and K-40 from (113.069 ± 6.854) Bq/kg to (392.453 ± 8.482) Bq/kg with an average (234.9235) Bq/kg, while the average results of Radium equivalent activity and Internal hazard indices were (37.99370015 Bq/kg and 0.143116) respectively. All specific activity (Ra-226, Th-232 and K-40) investigated in the noodles samples occurred within the threshold limit of UNSECR, (2000) standard (35, 30 and 400) Bq/kg, also Radium equivalent activity and Internal hazard indices were lower than the worldwide average (370 Bq/kg and 1) respectively. All the samples of fast noodles (Indomie) that are available in the Iraqi market are edible for all people, but caution should be taken for accumulation over the time of this natural radioactivity especially in samples where they appeared near the threshold limit amount.

Keywords: Natural radioactivity; Radiological parameters in food; Food in Iraq markets and instant noodles

Introduction

Natural Radioactivity elements are distributed everywhere in the environment with different concentrations. Their concentrations depend on the local geological condition and they vary from one place to another. It is necessary to monitor the release of radioactivity into the environment in order to provide an appropriate protection for humans [1]. Radionuclides in soil are absorbed by plants and will be available for further redistribution within food chains. These plants may be involved directly in human food [2]. Much work is reported on radioactive food contamination in the environment and its transfer or pathway mechanism to plants, animals and human population [3]. Ingestion of natural radionuclides depends on the consumption rate of food, water and the radionuclide concentrations. Naturally occurring radio nuclides enter the human body mainly by ingestion of primordial radio nuclides and their progeny 40K, 238U and 232Th series. The ingested radio nuclides may be concentrated in certain parts of the body, for example 40K is accumulated in muscles, 238U is in human kidney and lungs, and 232Th is in liver and skeleton tissue [4]. In Iraq, neither surveys of radioactivity in Instant Noodles were carried out nor for concentration of natural and anthropogenic radioisotopes. Therefore, the establishment of radioisotope concentrations will prove meaningful information that contribute to realize the population exposure and to the setting up of original base data, IAEA [5]. Moreover, numerous studies were conducted worldwide to investigate natural radionuclides in consumed food at different parts of the world [6-9]. Instant noodles played a pivotal role in addressing food issues, especially when the world population is anticipated to reach 10 billion by 2050 because it is cheap, tasty, storable and easy to cook [10], therefore studied Instant noodles in all scientific research such as natural radioactivity is important. Because Instant Noodles is popular among all ages, the current study focuses for investigating natural radioactive content in Instant Noodles. Study aim is to estimate radiation hazard indices from consumption of Instant Noodles among various types brand name in Iraqi markets.

Materials and Methods

Samples collection and preparation

Thirteen Instant Noodles samples were collected from some supermarkets that available in Iraq Markets. The collection period between December 2014 to February 2015. To ensure a comprehensive and a wide-spread representation, 13 different brands that originated from 5 different countries were selected (Table 1). Enough quantity of food samples (Instant Noodles) were collected for the analysis and each sample underwent a pre-treatment that consisted of powdering. This step was crucial for achieving a homogeneous state for the sample. Because Instant Noodles come dried, the samples did not undergo any drying process.

Radioactivity measurements

Radioactivity counting: Gamma-ray spectrometer equipment’s is used. It is consists of scintillation detector Na(Tl) of (3×3”) crystal dimension (Model No. 802 series, Canberra Inc., supplied by (Alpha Spectra, Inc.-12112/3), coupled with a multi-channel analyzer (MCA) (ORTEC - Digit Base, Model No. 1104) with range of 4096 channel joined with ADC (Analog to Digital Converter) unit, through interface. Resolution value of the detector is about 7.9% for 0.662 MeV of a 137Cs standard source; therefore it is capable of distinguishing the gamma ray energies considered during these measurements. The detector in this study was calibrated using a set of standard γ-ray 1-μCi active 137Cs, 60Co, 54Mn and 22Na sources. Moreover, it was shielded by a cylindrical lead shield in order to achieve the lowest background level. The relative efficiency for each of the peaks can be calculated with the mentioned energy depending on Np (net peak area (count/ sec) at Eγ), Iγ (intensity of emitted gamma ray (%)) and Af (activity of standard source in (Bq)) by the following equation [11]:

\[ \text{Eff} \times 100\% = \frac{N_p}{I_{\gamma}} \times \frac{A_f}{A_s} \times 100\% \]  

(1)

The samples of Instant Noodles were placed symmetrically on top of the detector and counting for each sample was done for a period of 5 hr (18,000 s). The net area counts under the photo peaks for each radionuclide that was analyzed using the ORTEC Maestro-32 data from the memory of the MCA which subtracts counts due to back-ground
Table 1: Samples investigated in this study.

| No. | Sample Code | Sample Brand | Made Produce |
|-----|-------------|--------------|--------------|
| 1   | S1          | Indomie-Curry | SAUDI ARABIA |
| 2   | S2          | Indomie-Special Chicken Flavor | SAUDI ARABIA |
| 3   | S3          | Superman-Vegetables Flavor | SAUDI ARABIA |
| 4   | S4          | Indomie-Beef Flavor | SAUDI ARABIA |
| 5   | S5          | Superman-Chicken Flavor | SAUDI ARABIA |
| 6   | S6          | Indomie-Tomato Flavor | SAUDI ARABIA |
| 7   | S7          | Chicken Flavor | UNITED ARAB EMIRATES |
| 8   | S8          | Chicken with Onions | UNITED ARAB EMIRATES |
| 9   | S9          | Vegetables Flavor | UNITED ARAB EMIRATES |
| 10  | S10         | Vegetables Flavor | China |
| 11  | S11         | Chicken Flavor | Indonesia |
| 12  | S12         | Noodle-Vegetables Flavor | Italian |
| 13  | S13         | Cup noodles (Pop Mie) | China |

Calculations of radiological parameters: To arrive at a safe conclusion on the health impact of an environment, it is important to assess the gamma radiation hazards to human associated with the food used for eating of Instant Noodles. This is done by calculating the different radiation hazard indices. Radium equivalent activity can be defined on the basis of the preliminary estimation of the quantities of these radionuclides releasing the same gamma ray dose ($^{226}Ra$, $^{232}Th$, and $^{40}K$). Consequently, the following Radium Equivalent Activity ($Ra_{eq}$) of a sample in (Bq/kg) can be evaluated as [15]:

$$Ra_{eq} = C_{Ra} + 1.43C_{Th} + 0.07C_{K}$$

where $C_{Ra}$, $C_{Th}$, and $C_{K}$ are the activity concentrations of $^{226}Ra$, $^{232}Th$, and $^{40}K$ in Bq/kg, respectively. $Ra_{eq}$ activity has been assumed as 370 Bq/kg (10 pCi/g) for $^{226}Ra$, 259 Bq/kg (7 pCi/g) for $^{232}Th$, and 4810 Bq/kg (130 pCi/g) for $^{40}K$.

For the safe use of a material in the construction of dwellings, index $H_{eq}$ should be less than unity.

Results and Discussion

Table 2 shows the specific activity of $^{226}Ra$, $^{232}Th$, and $^{40}K$ of the collected Instant Noodles samples which is Sold in Iraq Supermarkets. The specific activity of radionuclide collected from samples under study from (2.382 ± 1.128) Bq/kg to (31.918 ± 3.374) Bq/kg for $^{226}Ra$, (1.509 ± 0.297) Bq/kg to (9.269 ± 0.716) Bq/kg for $^{232}Th$, and (113.069 ± 6.854) Bq/kg to (392.453 ± 8.482) Bq/kg for $^{40}K$. There is a variation in the specific activity of radionuclides in different Instant Noodles samples, for example (S11) which is China product has lowest $^{226}Ra$ concentration, while (S3) which is SAUDI ARABIA product has the maximum value, (S8) UNITED ARAB EMIRATES product has the lowest $^{232}Th$ concentration of maximum is (S3) SAUDI ARABIA product, and the lowest $^{40}K$ concentration is (S4) which is SAUDI ARABIA product and the maximum is (S2) also SAUDI ARABIA. The results show, (Figures 1-3) that the specific activity of $^{226}Ra$, $^{232}Th$, and $^{40}K$ respectively in all Instant Noodles samples appeared lower than recommended limit of (UNSCEAR, 2000). From the specific activity of $^{226}Ra$, $^{232}Th$, and $^{40}K$ of Instant Noodles samples, the $Ra_{eq}$ and internal radiation hazard is calculated and the results are in (Table 3). The $Ra_{eq}$ is calculated and the value ranges from (15.189) Bq/kg to (67.629) Bq/kg, which is very much lower than the recommended safe limit (370 Bq/kg) by Organization for Economic Cooperation and Development [16]. Also we found the internal hazard index is ranges from (0.052) to (0.268). All the calculated values are lower than the recommended safe limit (1) by Organization for Economic Cooperation and Development [16]. Correlation is a statistical measure for finding the degree of relationship between two or more variables. (Figure 4) shows the correlation between $Ra_{eq}$ and $^{226}Ra$ activity concentrations computed.
Table 2: Specific Activity of radionuclide in Instant Noodles samples.

| No. | Sample Code | Specific Activity in Bq/kg |
|-----|-------------|----------------------------|
|     |             | $^{226}$Ra | $^{232}$Th | $^{40}$K |
| 1   | S1          | 5.686 ± 2.031 | 5.822 ± 0.536 | 273.436 ± 7.734 |
| 2   | S2          | 13.861 ± 2.715 | 1.859 ± 0.255 | 392.453 ± 8.482 |
| 3   | S3          | 31.918 ± 3.374 | 9.268 ± 0.716 | 291.67 ± 8.031 |
| 4   | S4          | 17.693 ± 2.302 | 4.08 ± 0.531 | 113.068 ± 8.584 |
| 5   | S5          | 4.165 ± 1.952 | ----- | 143.181 ± 7.472 |
| 6   | S6          | 5.467 ± 1.852 | 3.599 ± 0.370 | 133.85 ± 7.727 |
| 7   | S7          | 23.506 ± 2.460 | 2.353 ± 0.388 | 252.112 ± 7.806 |
| 8   | S8          | 20.992 ± 2.388 | 1.509 ± 0.297 | 268.21 ± 7.602 |
| 9   | S9          | 26.269 ± 2.101 | 3.258 ± 0.332 | 314.68 ± 7.797 |
| 10  | S10         | 14.704 ± 1.944 | 2.361 ± 0.268 | 318.775 ± 7.21 |
| 11  | S11         | 2.361 ± 1.128 | 1.742 ± 0.297 | 242.173 ± 7.300 |
| 12  | S12         | 8.14 ± 1.447 | 4.785 ± 0.409 | 181.451 ± 4.052 |
| 13  | S13         | 19.988 ± 2.336 | 4.112 ± 0.587 | 128.947 ± 7.850 |

Average 14.982 ± 3.442 ± 234.923 ± 7.572

Table 3: Radiological parameters for Instant Noodles samples.

| No. | Sample Code | Radiological parameters |
|-----|-------------|-------------------------|
|     |             | Ra(eq) (Bq/kg) | Hin |
| 1   | S1          | 35.066032 | 0.110061 |
| 2   | S2          | 46.738251 | 0.163839 |
| 3   | S3          | 67.62983  | 0.268952 |
| 4   | S4          | 32.233636 | 0.134988 |
| 5   | S5          | 15.189937 | 0.052281 |
| 6   | S6          | 20.92002  | 0.071275 |
| 7   | S7          | 46.283414 | 0.188559 |
| 8   | S8          | 43.80204  | 0.175057 |
| 9   | S9          | 55.1583   | 0.219996 |
| 10  | S10         | 42.625905 | 0.15487 |
| 11  | S11         | 23.59381  | 0.069944 |
| 12  | S12         | 28.954277 | 0.100199 |
| 13  | S13         | 35.797079 | 0.150728 |

Average 37.99370015 ± 0.143116

Figure 1: Relation between Specific Activity of $^{228}$Ra with world of maximum allowed by UNSCEC(2000).

Figure 2: Relation between Specific Activity of $^{232}$Th with world of maximum allowed by UNSCEC(2000).

Figure 3: Relation between Specific Activity of $^{40}$K with world of maximum allowed by UNSCEC(2000).

Figure 4: Correlation between radium equivalent activity and specific activity of $^{228}$Ra.

from the Instant Noodles samples. A good correlation between Ra and $^{226}$Ra for the samples in all sampling places. The correlation coefficient between two quantity is $R^2$=0.9153. (Figure 6) shows the correlation between H$_{in}$ and Ra$_{eq}$. A very good correlation between H$_{in}$ and Ra$_{eq}$. The value of correlation coefficient is $R^2$=0.9644.
Conclusions

\(^{226}\text{Ra}, \^{232}\text{Th}\) and \(^{40}\text{K}\) have been measured in Instant Noodles samples that sold in Iraqi Markets using gamma-ray spectroscopy. The activity profiles of the radionuclides have clearly showed low activity for all samples under study. Some Radiological Parameters such as the \(R_{\text{a}}\) and the \(H_{\text{m}}\) were calculated to assess the radiological hazards from eating of Instant Noodles. All the calculated parameters are lower than the recommended safe level. Thus, the result of this work showed that the natural radioactivity in each available noodles samples brands consumed in the Iraqi markets do not pose any health risks or effect of Radioactivity. But in the long term, accumulation of the radioactivity from some samples under study could lead to health issues [17-19].

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