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# Cancer risk (ELCR) and annual gonadotropin equivalent dose (AGED) in macaroni

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***Abstract*---**Natural radioactivity has attracted a lot of attention in the world due to its crucial role in human safety. macaroni (Macaroni) is a dry, hollow pastry, made from cereals such as wheat, rice and barley. Macaroni is one of the basic and important for human beings, as well as its proven usefulness to the general health of human beings. Therefore, the measurement of natural radioactivity is a critical because of its direct impact on human safety. In this research, quantification has been made of natural radionuclide concentrations using NaI(Tl) gamma-ray spectrometry. The analyses of samples reveal the mean activity concentrations of $^{226}$Ra, $^{232}$Th, $^{40}$K% are found to 4.5E-01±0.071, 4.46±0.163 and 2.14±0.021, respectively. RLI,AUI,IC and Iα were also calculated the values were less than one also estimated annual gonadal equivalent dose (AGED) resulting with an average 302.98±07.59 mSv.y$^{-1}$ where was higher than globally limits. Consumption of macaroni for adult was found (0.035±0.0015) mSv.y$^{-1}$ which less than global studies , while the average value of cancer risk (ELCR) 1.21E-04±0.000005*10$^{-3}$ mSv.y$^{-1}$ Below the international permissible limits. The study can be considered as a basis for future studies on this basic substance in food.

***Keywords*---**Hazard indices, AGED, ELCR, gamma spectroscopy, macaroni food, Iraq.

## Introduction

Environmental samples contain different concentrations of natural radionuclides due to geographic factors, which makes these nuclides scattered throughout the world, including soil, water and food, and the half-lives of these radionuclides are the same as the age of the Earth or greater (about four to five billion years) [1]. The radioactivity present or transmitted through the air and soil may be present in agricultural crops and thus finds its way directly to the human body [2]. Most importantly for the ingestion dose comes from the radionuclides which are, $^{226}$Ra, $^{232}$Th and $^{40}$K and their progeny [3]. One of the most important causes of internal exposure to natural radiation is the ingestion of natural radionuclides while eating and drinking, because the wheat plant (from which pasta is made) is like the rest of the crops that are grown and fed on the minerals in the soil, including radionuclides [4]. The chemical and biological properties of natural radioactive isotopes are similar to their non-radioactive isotopes, and therefore these minerals and elements in food are responsible for building and maintaining the human body, and continuous exposure to them is extremely dangerous to human life. The large amounts of radionuclides deposited during food intake such as ($^{226}$Ra accumulated in human kidneys, $^{232}$Th in liver and skeletal tissues and $^{40}$K in muscle) lead to human health at risk, especially weak immune system [5], so it is necessary to know The effect of these nuclides transmitted during ingestion of foods and drinks [6]. It is difficult to obtain specific statistics on eating pasta because of the different preferred food environments and seasonal foods for most of the population of the world's countries [7]. The effective dose approved by the (United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) in its guidance on the intake of food and water) was 0.3 (mSv.y) [8,9]. This value of the effective dose shall be equal to thirty percent of (1 mSv) as approved by both committees (International Committee on Radiological Protection (ICRP, 1991) and international basic safety standards (International Atomic Energy Agency, 1996) for members of the population [10]. Because the issue is of great importance, many studies have been found in this field, the most important of which was the study of radionuclide concentrations and risk factors for different salt samples in Egypt [11]. This work examines the natural and man-made radionuclides in foodstuffs such as pasta, which is considered one of the favorite foods of most of the world's population [12]. A high-efficiency NaI (Tl) gamma ray spectrometer was used to make the measurements after some samples of different pasta were collected from local markets in Iraq for the purpose of determining the most radioactive species [13]. The determination of the presence of natural radionuclides in some samples of pasta (which is one of the preferred foods for most of the population and of all ages) was one of the most important goals in this study, as well as determining the natural concentrations per unit (parts per million) to estimate the radiation hazard indicators, and the equivalent annual dose Gonadotropin (AGED) and cancer risk (ELCR) in pasta samples.

## Methodology

### Sample Collection and Preparation

This study was conducted on twenty types of pasta used by most of the population and spread in most of the Iraqi local markets, as shown in Table (1). Before measuring the radionuclide concentration in the pasta, the samples were immediately brought to the laboratory for preparation, and grind it to 0.8 mm to obtain Maximum uniformity between sample grains, and dried for 24 hours at a temperature of 100°C. The average weights of the samples were approximately (198 g), the samples were placed in a tightly closed plastic container, and then stored separately for (thirty five) days to reach the radioactive equilibrium between $^{226}Ra$ and then $^{232}Th$ and the short-lived decomposition products [14]. The radionuclides of $^{226}Ra$, $^{232}Th$ and $^{40}K$ were then measured in these samples using a NaI (Tl) gamma ray spectrometer detector.

Table 1. Macaroni samples

| Sample code | Name and Origin of pasta Samples | Sample weight |
|---|---|---|
| Macaroni1 | Alkafeel Makaron- made in Turkey | 383 |
| Macaroni2 | Altunsa Spaghetti- made in Turkey | 495 |
| Macaroni3 | Altunsa Makaron- made in Turkey | 400 |
| Macaroni4 | Tak-Mak- made in Iran | 460 |
| Macaroni5 | Zer-Mak- made in Turkey | 413 |
| Macaroni6 | Macaroni- made in Iraq | 423 |
| Macaroni7 | Samira Macaroni- made in Iran | 420 |
| Macaroni8 | Aldahabi Macaroni- made in Iraq | 511 |
| Macaroni9 | Zülfikar- made in Turkey | 487 |
| Macaroni10 | Rezgul Co. - made in Turkey | 496 |
| Macaroni11 | Nawras- made in Turkey | 518 |
| Macaroni12 | OBA- made in Turkey | 531 |
| Macaroni13 | Divella- made in Italy | 473 |
| Macaroni14 | Madilla- made in Iran | 382 |
| Macaroni15 | La Fonte- made in Indonesia | 487 |
| Macaroni16 | Mak Macaroni- made in Iran | 485 |
| Macaroni17 | Zara Macaroni- made in Italy | 479 |
| Macaroni18 | Korjia- made in Turkey | 386 |
| Macaroni19 | TAT Makarona- made in Turkey | 580 |
| Macaroni20 | Antonio Amato- made in Italy | 474 |

### Gamma spectrum analysis

The concentrations of radioactive isotopes ($^{226}Ra$, $^{232}Th$ and $^{40}K$) present in the pasta samples were calculated using gamma ray spectroscopy technique with a high penetrating ability of different materials. This spectrophotometer consists of a NaI (Tl) luster detector with crystalline dimensions (3" x 3"), fitted by Alpha Spectra, Inc.-12I12/3, and equipped with a multichannel analyzer (MCA) (ORTEC-Digi base) with a range of 4096 connected channels. With an ADC (analog to digital converter), through the interface. Using the MAESTRO-32

program on the computer, which runs on the windows system, the measurements were calculated and the spectroscopic analysis was done. The aforementioned detector was calibrated using standard radioactive sources such as ($^{22}$Na,$^{137}$Cs and $^{60}$Co). The detector was surrounded by a cylindrical shield of lead to protect it and to reach the lowest radiation background.

**Calculation of elemental concentration of Radionuclide and Hazard indices**

**Concentration of Radionuclides**

The radionuclide concentrations of $^{226}$Ra, $^{232}$Th and $^{40}$K were calculated in a unit of

( Bq.kg$^{-1}$) using the equation(1) [15]:

$$A_n = \frac{(C_n - C_b)}{t\varepsilon_\gamma I_\gamma m_s} \quad (1)$$

Since the specific activity of each radionuclide is represented by $A_n$, and the counting rate in the sample's CPS was represented by $C_n$, and the counting rate in the sample's CPS was represented by $C_b$, and the measurement time was t, and the counting efficiency was represented by $\varepsilon_\gamma$, and the probability of gamma-ray emission was represented by $I_\gamma$, and finally the sample mass is represented by $m_s$.

**Hazard Indices**

The relationship between natural radionuclides $^{226}$Ra (parts per million), $^{232}$Th (ppm) and $^{40}$K% and the resulting risks was determined by a set of indicators, therefore; the lifetime risk of cancer (ELCR) and the annual dose were calculated. Gonad equivalent (AACD) and nine risk indicators are as follows:

**Representative level index (RLI)**

To estimate the level of associated gamma radioactivity for the radionuclides as the representative level index, which given by the following expression:

$$RLI = \frac{1}{150} A_{Ra} + \frac{1}{100} A_{Th} + \frac{1}{1500} A_K \quad (2)$$

Whereas, the A radioactivity of each of the three nuclides Ra, Th and K was measured in Bq/Kg unit. This index was used to calculate the risk arising from gamma radiation associated with the natural radioactive nucleus in the approved study samples and calculated from the equation on the activity concentrations of $^{226}$Ra, $^{232}$Th and $^{40}$K [15]. Its value should be less than one so as not to cause any danger to human health.

**Activity Utilization Index (AUI)**

In order to calculation of air dose rates from different groups of three radionuclides which given by the following expression [16]:

$$AUI = f_{Ra}\frac{A_{Ra}}{50} + f_{Th}\frac{A_{Th}}{50} + f_{K}\frac{A_{K}}{500} \qquad (3)$$

Where $f_{Ra}$, $f_{Th}$ and $f_{K}$ are the fractional contribution to the total dose rate in air due to gamma radiation from the actual concentration of $^{226}$Ra , $^{232}$Th and $^{40}$K , respectively [17].

**Concentration index ($I_C$)**

To estimate Gamma activity concentration index $I_C$ (Bq. $Kg^{-1}$), the following equation was relied upon [18].

$$I_c = \frac{A_{Ra}}{300} + \frac{A_{Th}}{200} + \frac{A_{K}}{3000} \qquad (4)$$

**Representative Alpha index (Iα)**

The excess Alpha radiation due to the Radon inhalation originating from the Macaronisamples were assessed through Alpha index, must be little than one. Alpha index ($I_\alpha$) was calculated as follow [15, 19, 20]:

$$I\alpha = \frac{\mathcal{A}_{Ra}}{\mathbf{200}} \qquad (5)$$

**Annual Gonadal Equivalent Dose (AGED)**

Because of its sensitivity to radiation, UNSCEAR attaches great importance to the gonads, bone marrow and bone surface cells. It is known that the bones are affected by the increase in AGED, which in turn affects the bone marrow. AGED destroys red blood cells and replaces them with white blood cells. The annual gonadotropin equivalent dose (AGED) from the activity concentrations of ($A_{Ra}$, $A_{Th,}$ $A_K$) is $^{226}$Ra, $^{232}$Th and $^{40}$K, respectively, and this enables us to calculate the annual gonadotropin equivalent dose for pasta samples [21].

**Annual ingestion dose and Excess lifetime cancer risk**

The annual effective dose of human consumed of the samples due to the intake of $^{238}$U, $^{232}$Th and $^{40}$K in any food product can be determined using the formula of UNSCEAR 2000 where the values calculated in paper[22, 23].

$$\text{AACD (mSv.y-1)} = A_i * C_R * C_F \qquad (6)$$

Where *AACD* is the annual effective dose (Sv), $A_i$ is the concentration of radionuclides in the ingested sample ($Bq.kg^{-1}$), $C_R$ is the annual consumption of flour for adults, it was 3.5 kilograms per year (Iraqi Ministry of Trade) ,the value was 70 kilograms per year. As for Infant less than two years, the annual consumption rate was estimated after a statistic of more than 300 infants, taking into account biscuits, ready-made cereal meals and others, so the annual consumption rate was about 11 kilograms respectively, and $C_F$ is the ingestion

dose coefficient of the radionuclide, which equal for adults (230, 280 and 6.2) with unite *(nSv.Bq$^{-1}$)* for $^{232}$Th ,$^{238}$U, and $^{40}$K, respectively as established by ICRP ,[24, 25]:

The relationship that calculates the lifetime risk of cancer (ELCR) caused by the effects of radiation is as follows [26]:.

$$ELCR = \text{AACD} * LS * RF \qquad (7)$$

Whereas, the average life span (LS): Its value is fifty years for adults and ten years for children. The lifetime risk of cancer of $^{226}$Ra, $^{232}$Th and $^{40}$K can be obtained in the pasta samples by balancing the above variables. The risk factor (RF) for random effects in the population: Its value as recommended by the ICRP is (0.05) per Sievert, and to estimate the incidence of cancer in adults, children and infants in pasta samples, we use equation No. (6).

**Result and Discussion**

The concentration activity ($^{226}$Ra, $^{232}$Th) in unit (ppm) and $^{40}$K% was measured by gamma ray spectrometry (NaI (Tl)) for twenty samples of pasta available in the Iraqi market as shown in Table (2), where the model contained (Zara Macaroni-made in Italy) had the highest activity concentration of nuclides $^{226}$Ra(ppm) and $^{40}$K%, while the model (Macaroni-made in Iraq) had the lowest activity concentration. As for the activity of the maximum concentration of $^{232}$Th (ppm), it was the highest in the model (Macaroni-made in Iraq) and the lowest in the model (Aldahabi Macaroni-made in Iraq). And according to what is recommended internationally, all radionuclide concentration rates and for all models were within the permissible limit

Table 2. Elemental Concentrations (ppm) in Macaroni samples.

| ID(code of sample) | Elemental Concentrations (ppm) | | |
|---|---|---|---|
| | $^{226}$Ra | $^{232}$Th | $^{40}$K% |
| Macaroni1 | 1.8E-01±0.085 | 03.08±0.145 | 1.8E-01±0.019 |
| Macaroni2 | 1.3E-01±0.074 | 28.11±0.089 | 1.3E-01±0.011 |
| Macaroni3 | 3.6E-01±0.091 | 00.21±0.145 | 3.6E-01±0.013 |
| Macaroni4 | 2.3E-01±0.058 | 01.05±0.131 | 2.3E-01±0.016 |
| Macaroni5 | 2.9E-01±0.070 | 02.01±0.146 | 2.9E-01±0.017 |
| Macaroni6 | 9.7E-01±0.159 | 05.39±0.345 | 9.7E-01±0.034 |
| Macaroni7 | 2.9E-01±0.087 | 02.65±0.160 | 2.9E-01±0.019 |
| Macaroni8 | 1.9E-02±0.109 | 00.00±0.159 | 1.9E-02±0.007 |
| Macaroni9 | 1.4E+00±0.154 | 04.69±0.300 | 1.4E+00±0.028 |
| Macaroni10 | 1.9E+00±0.162 | 05.25±0.332 | 1.9E+00±0.031 |
| Macaroni11 | 2.4E-01±0.063 | 04.44±0.139 | 2.4E-01±0.022 |
| Macaroni12 | 7.8E-01±0.051 | 03.89±0.127 | 7.8E-01±0.021 |
| Macaroni13 | 5.3E-01±0.045 | 03.71±0.132 | 5.3E-01±0.023 |
| Macaroni14 | 4.4E-01±0.050 | 04.09±0.152 | 4.4E-01±0.028 |
| Macaroni15 | 3.2E-01±0.035 | 03.42±0.124 | 3.2E-01±0.022 |
| Macaroni16 | 6.3E-02±0.016 | 03.11±0.119 | 6.3E-02±0.022 |

| | | | |
|---|---|---|---|
| Macaroni17 | 1.1E-01±0.020 | 03.30±0.126 | 1.1E-01±0.023 |
| Macaroni18 | 2.6E-01±0.035 | 04.19±0.156 | 2.6E-01±0.028 |
| Macaroni19 | 1.4E-01±0.020 | 02.95±0.108 | 1.4E-01±0.019 |
| Macaroni20 | 3.4E-01±0.036 | 03.64±0.132 | 3.4E-01±0.023 |
| Max. | 1.1E-01±0.020 | 05.39±0.345 | 1.1E-01±0.023 |
| Min. | 9.7E-01±0.159 | 00.00±0.159 | 9.7E-01±0.034 |
| Ave. | 4.5E-01±0.071 | 4.46±0.163 | 4.5E-01±0.071 |
| Worldwide [28] | 1.8 | 9 | 1.5 |

The table 2, values were also compared graphically in the figure 2, to get clearer results when comparing, as we note that the thorium concentration was the highest among the results, knowing that all the values of the radioactive parameters were less than the internationally permissible limit.

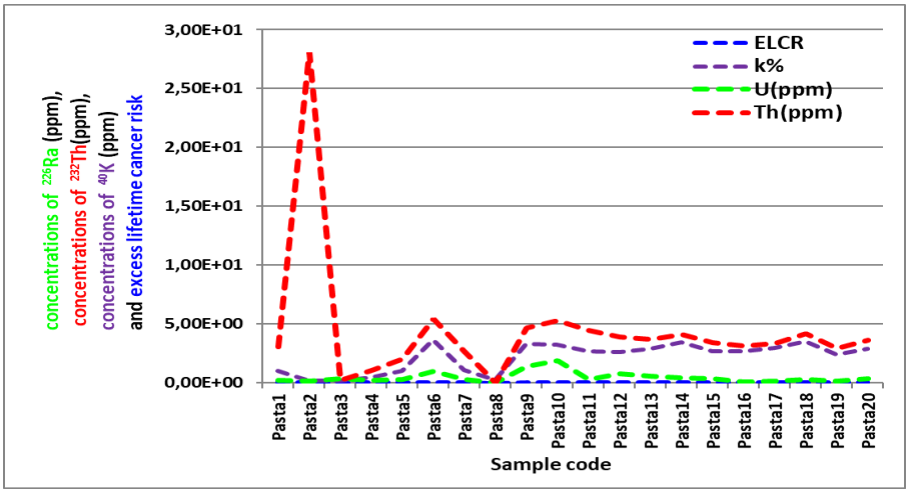


Figure 2. Comparison of elemental concentration of Radionuclides with excess lifetime cancer risk in macaroni Samples

From table (3), we find that the highest values RLI, AUI and $I_C$, in Sample (Macaroni2) and with values 1.154±0.012, 1.400±0.013 and 0.597±0.0060, successively but the lower value of RLI, AUI and $I_C$ was 0.002±0.017, 0.008±0.020 and 0.023±0.0085 in sample (Macaroni8). Also observed the radiological hazard indicters ,the numbers indicted that the average have been to be 0.218±0.017, 0.325±0.017, 0.332±0.0085 for RLI, AUI and $I_c$, respectively. It must also be noted that the highest value for Iα was 1.1E-01±0.0100 in sample (Macaroni10) It is higher than what is permitted worldwide and the lower value was 8.7E-02±0.0095 in sample (Macaroni9) with average 2.8E-02±0.0044. Most of the parameters of the radiological hazard are lower than the recommended level by UNSCEAR2000.

Table 3. Radiological hazard Indices (Representative gamma index, Activity Utilization Index, Concentration index and Representative Alpha index, in the studied Macaroni sample

| ID | RLI | AUI | $I_C$ | $I_\alpha$ |
|---|---|---|---|---|
| Macaroni1 | 0.140±0.017 | 0.198±0.017 | 0.178±0.0085 | 1.1E-02±0.0053 |
| Macaroni2 | 1.154±0.012 | 1.400±0.013 | 0.597±0.0060 | 8.1E-03±0.0045 |
| Macaroni3 | 0.038±0.016 | 0.056±0.018 | 0.039±0.0080 | 2.2E-02±0.0056 |
| Macaroni4 | 0.062±0.014 | 0.089±0.014 | 0.074±0.0068 | 1.4E-02±0.0036 |
| Macaroni5 | 0.106±0.015 | 0.158±0.016 | 0.157±0.0076 | 1.8E-02±0.0043 |
| Macaroni6 | 0.300±0.034 | 0.470±0.036 | 0.532±0.0171 | 6.0E-02±0.0098 |
| Macaroni7 | 0.132±0.018 | 0.190±0.018 | 0.175±0.0088 | 1.8E-02±0.0054 |
| Macaroni8 | 0.002±0.017 | 0.008±0.020 | 0.023±0.0085 | 1.2E-03±0.0067 |
| Macaroni9 | 0.307±0.031 | 0.476±0.033 | 0.499±0.0154 | 8.7E-02±0.0095 |
| Macaroni10 | 0.366±0.033 | 0.552±0.036 | 0.519±0.0167 | 1.1E-01±0.0100 |
| Macaroni11 | 0.200±0.015 | 0.313±0.015 | 0.375±0.0077 | 1.5E-02±0.0039 |
| Macaroni12 | 0.223±0.014 | 0.346±0.013 | 0.379±0.0068 | 4.8E-02±0.0031 |
| Macaroni13 | 0.194±0.014 | 0.316±0.012 | 0.397±0.0069 | 3.3E-02±0.0028 |
| Macaroni14 | 0.202±0.016 | 0.338±0.014 | 0.457±0.0081 | 2.7E-02±0.0031 |
| Macaroni15 | 0.165±0.013 | 0.274±0.011 | 0.364±0.0063 | 2.0E-02±0.0022 |
| Macaroni16 | 0.132±0.011 | 0.229±0.008 | 0.345±0.0054 | 3.9E-03±0.0010 |
| Macaroni17 | 0.143±0.012 | 0.250±0.009 | 0.377±0.0058 | 6.7E-03±0.0012 |
| Macaroni18 | 0.192±0.015 | 0.324±0.012 | 0.458±0.0076 | 1.6E-02±0.0021 |
| Macaroni19 | 0.131±0.010 | 0.221±0.008 | 0.312±0.0050 | 8.6E-03±0.0012 |
| Macaroni20 | 0.176±0.013 | 0.291±0.011 | 0.385±0.0066 | 2.1E-02±0.0022 |
| Max. | 1.154±0.012 | 1.400±0.013 | 0.597±0.0060 | 1.1E-01±0.0100 |
| Min. | 0.002±0.017 | 0.008±0.020 | 0.023±0.0085 | 8.7E-02±0.0095 |
| Ave. | 0.218±0.017 | 0.325±0.017 | 0.332±0.0085 | 2.8E-02±0.0044 |
| Worldwide [29] | < 1 | < 1 | < 1 | < 1 |

From Figure 3 , it is clear that some values of, and in some samples of macaroni, are higher than the permissible limit globally, but the preparation is less than that, so it can be said that it is safe for health also the figure 4 represented the comparison between Alpha index($I_\alpha$) and gamma index(RLI) , that clear was Obviously radiologically safe.

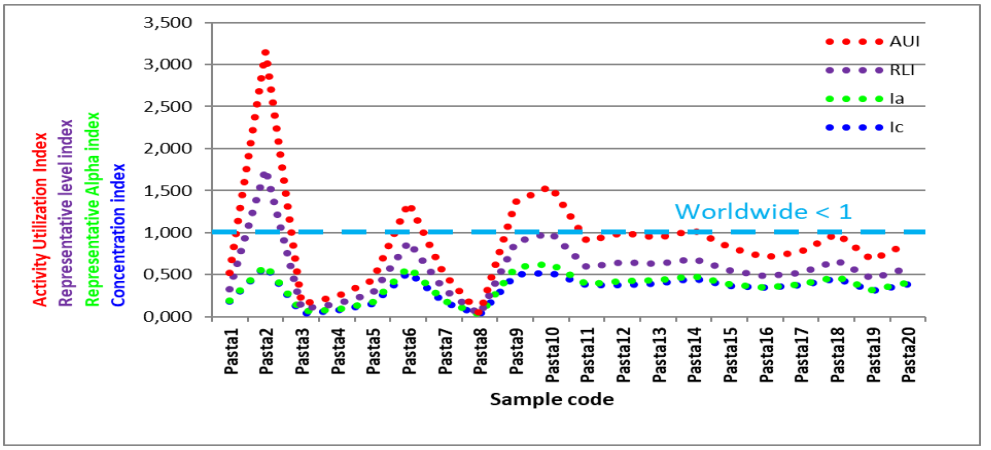


Figure 3. Radiological hazard Indices in macaroni Samples.

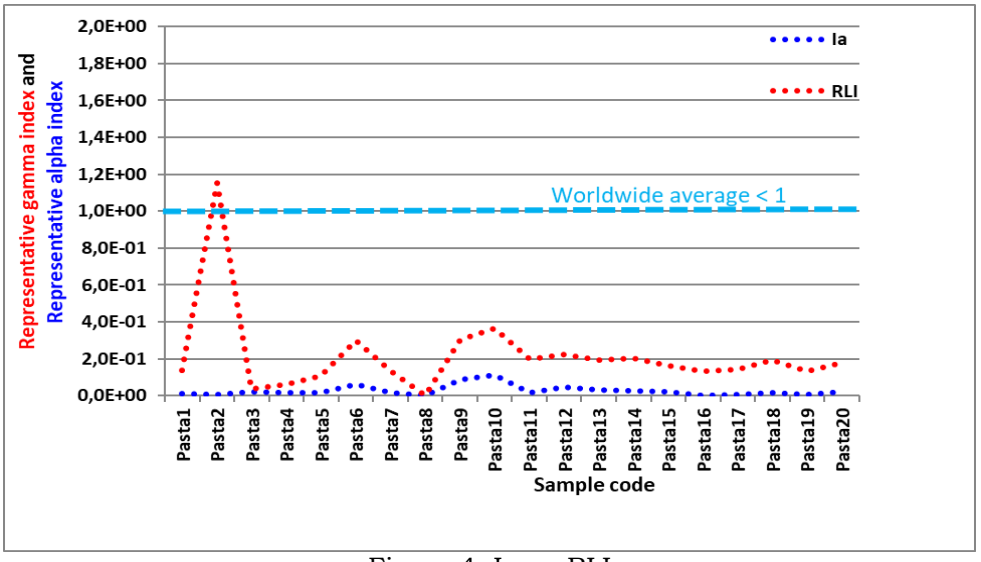


Figure 4. $I_\alpha$ vs. RLI

Table 4. Radiological hazard Indices (Annual Gonadal Equivalent Dose, Average annual committed effective dose and Excess life-time Cancer risk) in the studied Macaroni samples

| ID | AGED*$10^{-3}$ (mSv.$y^{-1}$) | AACD (mSv.$y^{-1}$) | ELCR *$10^{-3}$ |
|---|---|---|---|
| Macaroni1 | 160.53±07.63 | 0.019±0.0016 | 6.73E-05±0.000006 |
| Macaroni2 | 502.04±05.41 | 0.095±0.0013 | 3.32E-04±0.000004 |
| Macaroni3 | 035.70±07.18 | 0.006±0.0017 | 2.21E-05±0.000006 |
| Macaroni4 | 067.48±06.04 | 0.009±0.0012 | 3.16E-05±0.000004 |
| Macaroni5 | 143.82±06.82 | 0.017±0.0014 | 5.92E-05±0.000005 |
| Macaroni6 | 488.69±15.23 | 0.054±0.0033 | 1.90E-04±0.000011 |
| Macaroni7 | 158.67±07.94 | 0.019±0.0017 | 6.75E-05±0.000006 |
| Macaroni8 | 021.98±07.57 | 0.002±0.0019 | 5.97E-06±0.000007 |
| Macaroni9 | 458.67±13.73 | 0.055±0.0030 | 1.92E-04±0.000011 |
| Macaroni10 | 476.13±14.89 | 0.061±0.0033 | 2.15E-04±0.000011 |
| Macaroni11 | 343.72±06.94 | 0.035±0.0014 | 1.24E-04±0.000005 |
| Macaroni12 | 348.59±06.11 | 0.040±0.0012 | 1.39E-04±0.000004 |
| Macaroni13 | 365.73±06.22 | 0.038±0.0011 | 1.33E-04±0.000004 |
| Macaroni14 | 421.42±07.25 | 0.042±0.0013 | 1.46E-04±0.000005 |
| Macaroni15 | 335.73±05.66 | 0.033±0.0010 | 1.17E-04±0.000003 |
| Macaroni16 | 318.50±04.83 | 0.029±0.0007 | 1.02E-04±0.000003 |
| Macaroni17 | 347.59±05.18 | 0.032±0.0008 | 1.12E-04±0.000003 |
| Macaroni18 | 422.63±06.76 | 0.040±0.0011 | 1.42E-04±0.000004 |
| Macaroni19 | 287.38±04.45 | 0.027±0.0007 | 9.58E-05±0.000003 |
| Macaroni20 | 354.63±05.89 | 0.035±0.0010 | 1.24E-04±0.000004 |
| Max. | 502.04±05.41 | 0.095±0.0013 | 1.02E-04±0.000003 |
| Min. | 021.98±07.57 | 0.002±0.0019 | 9.58E-05±0.000003 |
| Ave. | 302.98±07.59 | 0.035±0.0015 | 1.21E-04±0.000005 |

| | | | |
|---|---|---|---|
| Worldwide [29] | $298*10^{-3}$ | 0.48 | 1.45 |

From Table 4, it was noted that the increase in (AGED) may cause negative health complications, especially on the gonads, so it was found that the annual equivalent annual dose of gonadotropins (AGED) of 226Ra, 232Th and 40 K, and its maximum value was found in (Altunsa Spaghetti) equals 502.04 ± 05.41 (mSv.y-1) while the lowest value is 021.98 ± 07.57 (mSv.y-1) in (Aldahabi Macaroni). As recommended by international values, these values are considered safe, the value of Annual Gonadal Equivalent Dose was higher than global recommended limits also for the annual effective dose Same context in samples [21].

Table (4) shows that the model (Mak Macaroni-made in Iran) had the highest value for cancer risk (ELCR), which was (1.02E-04 ± 0.000003) as a result of the daily consumption of pasta by adults, and that the model (TAT Makarona- made in Turkey) had the lowest cancer risk value for pasta (9.58E-05 ± 0.000003). According to the internationally recommended values of cancer risk are less than the permissible limits, therefore; pasta models are considered safe and healthy for consumers.

## Conclousion

In the unit (ppm) of $^{226}$Ra, $^{232}$Th and $^{40}$K%, it was estimated in the current study that their average concentrations in the pasta samples available in the Najaf markets are very low from the point of view of radiation protection, and therefore there are no health concerns or risks to humans. As for the annual gonadotropin equivalent dose (AGED), as recommended internationally, it was higher than the permissible limit. The risk of developing cancer, according to the ICRP of $1.4 \times 10^{-3}$, is also much lower than the permissible limit based on the annual dose limit of 1 (mSv) for the general public, which means, according to the World Health Organization that The average of all samples is safe and humanly safe [20].

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## Conflict of interest

The authors declared no conflict of interest.

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