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# NATURAL RADIOACTIVITY MEASUREMENTS IN SOIL AND DATES SAMPLES FROM GROVES OF THE SHATT AL-ARAB IN BASRAH GOVERNORATE

**RANA A.ABED[1], JABBAR H. JEBUR[2]**

*1,2Physics Department, College of Education for Pure Sciences, University Of Basrah, Basrah, Iraq*

E-mail:-rana.kafajy@gmail.com (**Rana Azeez Abed** )

## ABSTRACT

Natural radioactivity of ($^{226}$Ra, $^{238}$U, $^{232}$Th, $^{40}$K), in Soil and Dates samples calculated from shatt Al-arab in Basra govermente were measured using gamma ray spectroscopy with NaI (Tl).

The results showed that the specific activity of ($^{226}$Ra, $^{238}$U, $^{232}$Th, $^{40}$K (Bq/kg)) in Soil ranges from (1.02, 0.27, 0.45, 219.19) Bq/kg to (11.21, 2.73, 2.77, 389.51) Bq/kg and Dates ranged from (0.58, 0.21, 0.36, 140.20) Bq/kg to (6.57, 1.74, 2.58, 273.66) Bq/kg respectively. The radium equivalent in Soil samples ranged from (11.84) to (40.4) Bq/kg and in Date samples ranged from (13.41) to (25.37) Bq/kg. The annual effective dose equivalent AEDEin in Soils samples ranged from (0.01) - (0.09) µSv/y and for Date samples ranged from (0.03) to (0.07) µSv/y. The results of the internal and external hazard index in Soil and Dates samples were all lower than the value of the global limit.

**Keywords:** Soil and Dates radioactivity, Sodium iodide NaI(Tl) , activity concentrations, Effective Radium.

## 1. INTRODUCTION

This study aims to find the values of specific activity concentration and radiological hazards of the natural radioactive radio nuclides ($^{226}Ra$, $^{238}U$, $^{232}Th$, $^{40}K$) present in Soil and Dates samples taken from the study area located on the Shatt al-Arab from the south of Basra to the north and from west to east.

The presence of Gamma rays and the radiation of charged particles was a reason for the evolution of life on Earth. Therefore, radiation is one of the conditions of life and biological development. However, it is certain that ionizing radiation is harmful to life and biological systems [1].

Studies of natural radiation background are of great importance because it is the main source of exposure to human kind. The presence of natural radioactive material (NORM) on Earth's surface depends on the geological structure of the Soil as well as on rocks. This system is very important in order to understand some of the changes in nature and geographical location [2]. Naturally occurring food materials and processed products have radionuclides of the three most commonly known radioactive series: Uranium-radium series, Thorium Series and $^{40}K$ isotopes. The presence of natural occurring radioactive material (NORM) in the terrestrial composition of the natural background is dependent on the geological composition of the Soil and rocks. Therefore, systematic and accurate measurements of the radioactivity level in Soils are essential for understanding changes in the natural radiation background as a function of geographical location and time [3]. The contaminated Soil works as a source of radionuclides that lead to contamination of all agricultural products. Likewise, the contaminated Soil used in the protected bots can add to the pollution of vegetables very significantly [4]. Rain water, wind and snow are also early indicators of radioactive contamination. In some places drinking water and rain water can be significant pathways of short lived radionuclides, e.g. radioiodine, to man or animals. Drinking water and household water are potentially important pathways, directly or through their use in food preparation and processing, although dilution, time delays and water treatment can reduce the contamination levels markedly. The water used for irrigation purposes or consumed by livestock can be a source of radionuclides in foods. Likewise, seawater is a polluted source of seafood (fish, shellfish, algae). For this reason, the water of streams, sub-rivers, and lakes can be considered a source of contamination of vegetables grown on its banks. Accordingly, during the growing season, it is necessary to carefully obtain plant samples in the early stages of repercussions, which can be green vegetables an important pathway for short-lived radionuclides [5].

The assessment of general dose rates and health risks as well as maintaining a record of reference data to document the possible change in environmental radioactivity caused by humans in the future with regard to nuclear activities came the importance of this study and great interest throughout the world in studying terrestrial radioactivity to carry out radioactive characterization of Soil and food [6].

Therefore, when taking samples from cultivated areas, it is of the utmost importance to know the amount of natural radiation present and compare it with the radiation background in that region which is gaining other importance with its geographical location as it is located on a waterway that is connected to the outside world and is characterized by the phenomenon of tides. Since radioactive contamination is transmitted through Soil and water to vegetables and palm trees, it became necessary for this study to be a database for the amount of natural radiation in the studied area and its impact on palm groves and their fruits. The above causes make it is necessary for baseline study such as this to determine the basic radioactivity levels which will serve as reference data for future studie.

The area under study was divided into four sections, the first in the north of Basra Governorate (Medina, Qurna, Al Shafi, Al Dair, Al Hartha and Karma Ali), the second south of Basra (Al Wafood Street, Umm Al-Naaj, Al-Ouja, Al-Siba, Al-Fadaghia, Dora and Mamer), the third that is located east of Shat Al Arab and includes (Al-Kubasi, Al-Hawtah and Bab Jalei) The fourth, which is located to the west of the Shatt Al-Arab, includes (Al-Brjisia, Al-Zubair Petrochemicals, Umm Qasr and Safwan) as shown in the figure (1,2). The importance of this study is due to the fact that the study area is one of the agricultural and residential areas in Basrah Governorate.


Figure (1) :Sketched Geological Map of Iraq Showing the Study Area [7].

## 2. SAMPLE COLLECTION AND PREPARATION:

A total of 20 surface Soil samples at (5 cm) depth level was collected from the areas indicated in Figure (2) [8]. Likewise, 20 samples of Dates were collected from the same marked regions. After transporting the samples to the laboratory, all Soils samples were dried at (80 °C) for two hours, pulverized, homogenized, and sieved through sieve (75µm). The sieved Soil samples were weighed and stored in 1.4 litter Marinalli beakers. These plastic beakers are well sealed for one month to allow secular equilibrium of $^{226}$Ra with its decay products in the uranium series transferred for radio nuclide analysis [9]. The collected Soil samples were analyzed using a passively shielded Sodium Iodide (NaI) detector detector 3x3 inch with a 1024 channel computer analyzer USX supplied by Spectrum Technique Company, The detector is employed with lead shielding, (4 cm) thickness, which reduced the background. The detector was calibrated using standard sources of $^{137}$Cs (peak 661.5 keV) and $^{60}$Co (peaks 1173, 1333 keV). The detector, based on high-resolution gamma and an energy resolution of (%8 keV) for the 661.5 keV gamma transition of $^{137}$Cs the efficiency calibration was achieved using eight standard sources including the calibration sources. The system was running freely, for (2 h) live time, to evaluate the background spectrum. The Marinalli beaker container sample was placed over the detector for counting.


Figure (2): the Geological Map of Study Area [8].

## Experimental details

Activity concentration Ai of radio nuclides in each sample was measured for a time period of 7200 seconds, taken to represent this parameter for the environmental radionuclide's has been calculated using the relation (1) [10]. One of the sample spectrum shown in figure (4).

$$A_i = \frac{Net\ count}{\varepsilon \times I_\gamma \times M \times t} \qquad (1)$$

Where ε is efficiency in percentage of the detector for that energy. $I_\gamma$ Is Gamma-rays intensity in percentage, M is the mass of the sample in kg and t is the counting time of the measurement in second. For calculation of the activity concentrations of natural radionuclide's, one has to recognized the belong city of each peak according to gamma decay of each isotope [11]. The activity concentration of $^{226}Ra$, is calculated from the weighted average concentration of gamma ray lines lines; 295 keV (19.2%), 352 keV (37.1%), 609 keV (46.1%), 1120 keV (15%) and 1760 keV (15.4%). The determination of existence of $^{232}Th$ was achieved by 338 keV (12%), 911 keV(29%), 964 keV (5.05%) and 969 keV (17%). The case of $^{238}U$ is recognized by 1001 keV (83%), 766 keV (29%) and 2204 keV (5%). For $^{40}K$, this directly determined using 1460 keV(10%) peak.

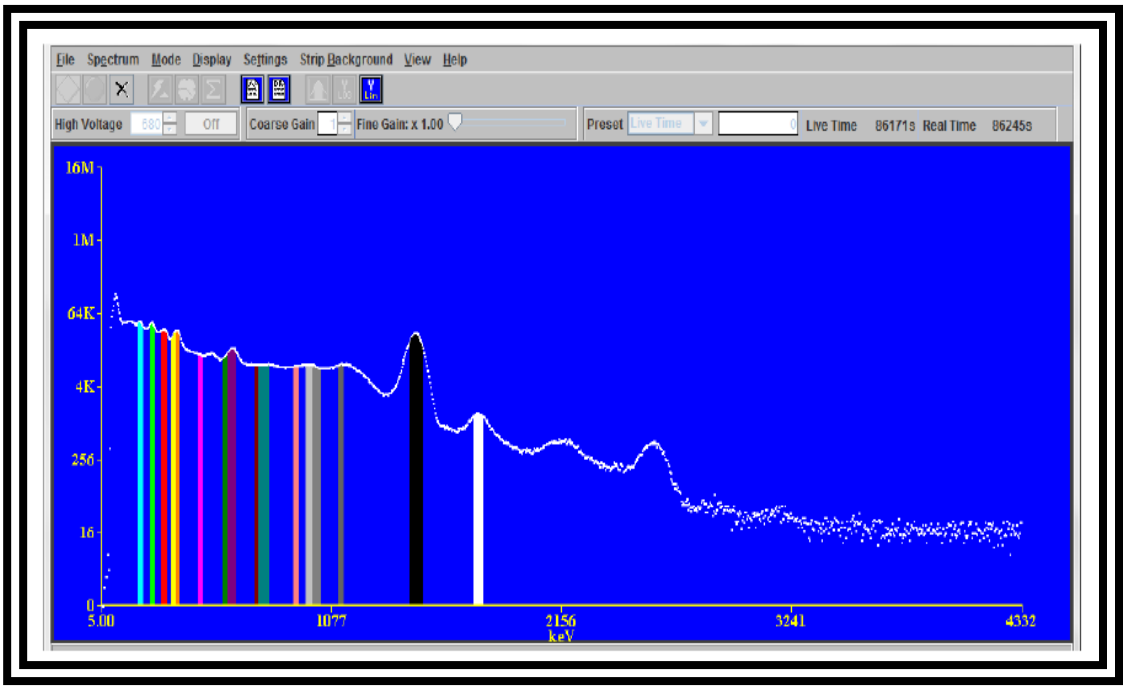


Figure (3): The NaI(Tl) spectrum of sample number 5 (Dates), where most of the peaks are clearly visible. The color represents the area under the peak of interest.

## GAMMA DOSE RATE

The average dose absorbed in the outside air of the Gamma rays emitted from the natural radioisotopes present in the Soil and at a height of one meter from the ground level can be calculated from the concentrations of the elements of $^{226}Ra$, $^{232}Th$, $^{40}K$) in the Soil, Dates or distress, assuming neglecting other radioactive nuclei such as ($^{137}Cs$, $^{90}Sr$, $^{235}U$) In the contribution to the radiation background values, the dose rate (D) of the absorbed gamma in the outdoor air and at a height of meters above the ground level can be calculated from the following equation [12]:

$$D\left(\frac{nGy}{h}\right) = \sum A_x\, C_x = 0.0417 A_k + 0.462 A_{Ra} + 0.606 A_{Th} \qquad (2)$$

The maximum allowable absorbed dose rate is (55 nGy/h) [13].

## RADIUM EQUIVALENT ACTIVITY

The radium equivalent activity ($Ra_{eq}$) which is used to evaluate the hazards associated with materials containing ($^{226}Ra$, $^{132}Th$, $^{40}K$) calculated by assuming (370 Bq/ kg) for radium-226 or (260 Bq/kg) for thorium-232 or (4810 Bq/kg) Potassium-40, which produces the same dose rate for Gamma. Radium Equivalent (Bq $kg^{-1}$ ) [12]:

$$Ra_{eq} = A_{Ra} + 1.43A_{Th} + 0.077A_K \qquad (3)$$

The published maximal permissible $Ra_{eq}$ is (370 Bq $kg^{-1}$) [13].

## EXTERNAL HAZARD INDEX

External hazard represent an assessment of the risks resulting from natural gamma radiation. The main objective of this indicator is to determine the radiation dose for the permissible dose of the permissible dose of 1mSv / y, the external risks is [12]:

$$H_{ex} = \frac{A_{Ra}}{370} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \leq 1 \qquad (4)$$

The external hazard caused by gamma rays corresponds to a maximum radium equivalent activity of Raeq = (370 Bq/kg) for the substance.

## INTERNAL HAZARD INDEX

The internal hazard Index has a value of less than one radiation risk that can be negligible. Inhaling alpha particles emitted from the short-lived radionuclides radon ($^{222}Rn$ , the daughter product of $^{226}$ Ra) and thoron ($^{220}Rn$, the daughter product of $^{224}$ Ra) which is considered to be a threat to the respiratory system, that its internal risk value is given by the following relationship [12]:

$$H_{in} = \frac{A_{Ra}}{185} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \leq 1 \qquad (5)$$

## THE ANNUAL EFFECTIVE DOSE RATE

In order to calculate the annual effective dose rate in the air, the conversion factor from the absorbed dose in the air to the effective dose received by the adult must be taken, the conversion factor value is 0.7 $SvGy^{-1}$ for environmental exposure to moderate energy gamma rays (UNSCEAR. 1993 and UNSCEAR 2000) The annual effective dose equivalent is given by [12]:

$$AEDE_{oo}\left(\frac{\mu Sv}{y}\right) = D\left(\frac{nGy}{h}\right)x8760\left(\frac{h}{y}\right)x0.2x0.7\left(\frac{Sv}{Gy}\right)x10^{-3} \qquad (6)$$

Note that the outdoor occupancy coefficient is 0.2

In the case of indoor measurement, the internal occupancy factor is 0.8 and equation (5) becomes as follows:

$$AEDE_{in}\left(\frac{\mu Sv}{y}\right) = D\left(\frac{nGy}{h}\right)x8760\left(\frac{h}{y}\right)x0.8x0.7\left(\frac{Sv}{Gy}\right)x10^{-3} \qquad (7)$$

The global average effective dose of (AEDE) for inward and outward gamma radiation from Earth is 0.560 mSv/ year [13].

## RESULTS AND DISCUSSION

The specific activity concentration of radioactive natural elements ($^{226}Ra$, $^{238}U$, $^{232}Th$, $^{40}K$) in the Soil and Dates samples taken from the study area were calculated by equations (1) and included in Tables 1, 2.

Table (1) the specific activity (Bq/Kg) of radium, thorium and potassium contents in Soil sample.

| S.N | Regain | $^{226}$Ra Bq/kg | $^{238}$U Bq/kg | $^{232}$Th Bq/kg | $^{40}$K Bq/kg |
|---|---|---|---|---|---|
| 1 | Medina | 3.94±0.010 | 1.42±0.38 | 0.51±0.32 | 257.87±16.74 |
| 2 | Qurna | 7.05±0.072 | 1.62±0.52 | 2.7±1.91 | 245.42±15.93 |
| 3 | Al-Shafi | 6.37±0.021 | 2.02±0.52 | 0.55±0.33 | 278±18.04 |
| 4 | Al-Dair | 3.7±0.040 | 0.92±0.71 | 0.89±0.64 | 343.82±22.31 |
| 5 | Al-Hartha | 1.17±0.010 | 0.63±0.20 | 0.69±0.48 | 228.91±14.88 |
| 6 | Karma Ali | 4.35±0.022 | 1.07±0.32 | 0.64±0.44 | 300.84±19.52 |
| 7 | Al-Wafood Street | 7.41±0.071 | 2.22±0.72 | 2.1±1.49 | 389.51±25.28 |
| 8 | Umm Al-Naaj | 2.3±0.021 | 0.72±0.22 | 1.66±1.16 | 240.67±15.62 |
| 9 | Al-Ouja | 1.24±0.022 | 0.49±0.17 | 0.54±0.39 | 321.2±20.85 |
| 10 | Al-Siba | 6.92±0.071 | 1.22±0.41 | 0.45±0.32 | 326.63±21.2 |
| 11 | Al-Fadaghia | 8.17±0.081 | 2.3±0.77 | 1.72±1.23 | 327.53±21.26 |
| 12 | Al-Dora | 1.36±0.011 | 0.46±0.12 | 1.08±0.67 | 219.19±14.22 |
| 13 | Al-Mamer | 2.27±0.032 | 0.75±0.42 | 2.77±2.02 | 362.14±23.5 |
| 14 | Al-Zubair Petrochemicals | 1.54±0.012 | 0.54±0.14 | 1.16±0.71 | 230.95±14.9 |
| 15 | Al-Brjisia | 11.21±0.052 | 2.73±0.80 | 0.54±0.35 | 247.69±16.07 |
| 16 | Safwan | 1.76±0.013 | 0.68±0.22 | 0.79±0.53 | 220.32±14.3 |
| 17 | Umm Qasr | 1.07±0.006 | 0.62±0.17 | 0.88±0.56 | 284.78±18.48 |
| 18 | Al-Kubasi | 2.7±0.012 | 0.85±0.24 | 1.65±1.06 | 311.47±20.21 |
| 19 | Al-Hawtah | 1.02±0.003 | 0.27±0.08 | 0.61±0.41 | 335.9±21.8 |
| 20 | Bab Jalei | 9.09±0.041 | 2.59±0.76 | 0.86±0.57 | 281.39±18.26 |
| Max. | | 11.21±0.081 | 2.73±0.80 | 2.77±2.02 | 389.51±25.28 |
| Min. | | 1.02±0.003 | 0.27±0.08 | 0.45±0.32 | 219.19±14.22 |
| Ave. | | 4.23±0.031 | 1.21±0.39 | 1.14±0.78 | 287.71±18.67 |

Table (2) the specific activity (Bq/Kg) of radium, thorium and potassium contents in Dates samples.

| N.S | Regain | $^{226}$Ra Bq/kg | $^{238}$U Bq/kg | $^{232}$Th Bq/kg | $^{40}$K Bq/kg |
|---|---|---|---|---|---|
| 1 | Medina | 1.43±0.021 | 0.24±0.08 | 2.58±1.900 | 151.55±9.84 |
| 2 | Qurna | 1.62±0.022 | 0.28±0.09 | 1.13±0.831 | 163.09±10.58 |
| 3 | Al-Shafi | 2.26±0.031 | 0.47±0.16 | 0.74±0.540 | 190.25±12.38 |
| 4 | Al-Dair | 5.59±0.070 | 1.09±0.37 | 0.54±0.391 | 140.02±9.09 |
| 5 | Al-Hartha | 6.57±0.081 | 1.34±0.46 | 0.73±0.520 | 183.91±11.93 |
| 6 | Karma Ali | 3.94±0.050 | 0.62±0.21 | 0.51±0.361 | 218.96±14.21 |
| 7 | Al-Wafood Street | 1.43±0.021 | 0.22±0.07 | 0.71±0.510 | 156.08±10.13 |
| 8 | Umm Al-Naaj | 1.04±0.010 | 0.55±0.19 | 1.68±1.183 | 165.12±10.72 |
| 9 | Al-Ouja | 1.73±0.021 | 0.37±0.12 | 1.55±1.091 | 167.39±10.86 |
| 10 | Al-Siba | 3.83±0.040 | 0.82±0.22 | 2.48±1.745 | 193.4±12.55 |
| 11 | Al-Fadaghia | 1.69±0.020 | 0.23±0.08 | 1.48±1.041 | 217.15±14.09 |
| 12 | Al-Dora | 2.52±0.031 | 0.42±0.14 | 1.32±0.928 | 208.55±13.53 |
| 13 | Al-Mamer | 1.54±0.021 | 0.21±0.07 | 1.23±0.864 | 209.46±13.59 |
| 14 | Al-Zubair Petrochemicals | 0.58±0.011 | 0.58±0.19 | 1.87±1.313 | 223.48±14.50 |
| 15 | Al-Brjisia | 1.59±0.010 | 0.33±0.11 | 1.16±0.814 | 214.66±13.93 |
| 16 | Safwan | 1.64±0.010 | 0.35±0.11 | 1.88±1.319 | 273.66±13.93 |
| 17 | Umm Qasr | 2.57±0.021 | 1.59±0.42 | 1.21±0.848 | 264.65±13.47 |
| 18 | Al-Kubasi | 2.15±0.020 | 0.39±0.13 | 1.15±0.805 | 140.24±9.10 |
| 19 | Al-Hawtah | 0.66±0.005 | 1.15±0.37 | 0.36±0.252 | 180.96±11.74 |
| 20 | Bab Jalei | 1.72±0.012 | 1.74±0.56 | 0.38±0.266 | 144.77±9.41 |
| Max. | | 6.57±0.077 | 1.74±0.56 | 2.58±1.900 | 273.66±14.50 |
| Min. | | 0.58±0.003 | 0.21±0.07 | 0.36±0.252 | 140.02±9.09 |
| Ave. | | 2.31±0.024 | 0.65±0.21 | 1.24±0.875 | 190.37±11.98 |

In Table (1) the specific activity of $^{226}Ra$ in all Soil samples in the study area range between the minimum value (1.02±0.003 Bq/kg) to the maximum value (11.21±0.081 Bq/kg) with an average value of (4.23±0.031 Bq/kg).

The specific activity concentration of $^{238}U$ has a range between (0.27±0.08 Bq/kg) to (2.73±0.80 Bq/kg) with the mean value of (1.21±0.39Bq/kg).

The specific activity of Thorium range between a minimum value (0.45±0.32 Bq/kg) to a maximum value (2.77±2.02 Bq/kg) with an average value of (1.14±0.78 Bq/kg).

These values are all within the permissible limits (50 Bq/kg) (UNSEAR prediction).

The potassium values range from a minimum value (219.19±14.22 Bq/kg) to a maximum value (389.51±25.28 Bq/kg) with an average value of (287.71±18.67 Bq/kg), which is less than the world average value of (400 Bq/kg) [14].

The concentration and distribution of these radioactive isotopes are not equal in all regions of the world due to the difference in the geological structure of the regions and some local standards. Which is less than the world average value of (400 Bq/kg) [15].

Table 2, The specific activity concentration of radioactive natural elements ($^{226}Ra$, $^{238}U$, $^{232}Th$, $^{40}K$) in the Dates samples taken from the same study area are shown in Table 2, the specific activity of $^{226}Ra$ ranged between (0.58±0.003 Bq/kg) to (6.57±0.077 Bq/kg) with an average (2.31±0.024 Bq/kg), for uranium Between (0.21±0.07 Bq/kg) to (1.74±0.56 Bq/kg) with an average (0.65±0.21 Bq/kg), for thorium between (0.36±0.252 Bq/kg) to (2.58±1.900 Bq/kg) with an average value of (1.24±0.875 Bq/kg), for potassium between (140.02±9.09 Bq/kg) to (273.66±14.50 Bq/kg) with an average value of (190.37±11.98 Bq/kg).

Figures 4 and 5 show the distribution of radioactivity concentrations (Bq / kg) For $^{226}Ra$, $^{238}U$, $^{232}Th$, and $^{40}K$ for samples measured for both Soil and Dates respectively, it is noted that the level of concentrations of radioactive potassium is much higher than other radioactive elements measured in the samples, but within the permissible limits according to the recommendations of international organizations such as.

Tables (3, 4) represent the absorbed dose values (D$\frac{nGy}{h}$), the radium equivalent activity $Ra_{eq}$, External Hazard Index ($H_{ex}$), internal hazard Index ($H_{ex}$), annual effective dose equivalent **(**$AEDE_{oo}\left(\frac{\mu Sv}{y}\right)$) **(**$AEDE_{oo}\left(\frac{\mu Sv}{y}\right)$)

Table (3): The radium equivalent, external hazard, absorbed dose and annual effective dose equivalent for Soil samples from the study area.

| S.N | Regain | $Ra_{eq}$ Bq kg$^{-1}$ | $H_{ex}$ | $H_{in}$ | D nGy/h | $AEDE_{in}$ $\frac{\mu Sv}{y}$ | $AEDE_{Out}$ $\frac{\mu Sv}{y}$ |
|---|---|---|---|---|---|---|---|
| 1 | Medina | 24.56 | 0.07 | 0.08 | 12.90 | 0.06 | 0.02 |
| 2 | Qurna | 19.10 | 0.05 | 0.05 | 10.33 | 0.05 | 0.01 |
| 3 | Al-Shafi | 28.56 | 0.08 | 0.09 | 14.87 | 0.07 | 0.02 |
| 4 | Al-Dair | 31.45 | 0.08 | 0.09 | 16.59 | 0.08 | 0.02 |
| 5 | Al-Hartha | 19.83 | 0.05 | 0.06 | 10.15 | 0.05 | 0.01 |
| 6 | Karma Ali | 28.44 | 0.08 | 0.09 | 14.95 | 0.07 | 0.02 |
| 7 | Al-Wafood Street | 40.41 | 0.11 | 0.13 | 20.94 | 0.01 | 0.03 |
| 8 | Umm Al-Naaj | 23.20 | 0.06 | 0.07 | 12.10 | 0.06 | 0.01 |
| 9 | Al-Ouja | 32.53 | 0.09 | 0.09 | 17.44 | 0.09 | 0.02 |
| 10 | Al-Siba | 32.72 | 0.09 | 0.01 | 17.09 | 0.08 | 0.02 |
| 11 | Al-Fadaghia | 35.86 | 0.01 | 0.12 | 18.48 | 0.09 | 0.02 |
| 12 | Al-Dora | 19.79 | 0.05 | 0.06 | 10.43 | 0.05 | 0.01 |
| 13 | Al-Mamer | 34.07 | 0.09 | 0.01 | 17.79 | 0.09 | 0.02 |
| 14 | Al-Zubair Petrochemicals | 20.98 | 0.06 | 0.06 | 11.05 | 0.05 | 0.01 |
| 15 | Al-Brjisia | 31.06 | 0.08 | 0.11 | 15.84 | 0.08 | 0.02 |
| 16 | Safwan | 11.84 | 0.05 | 0.06 | 10.47 | 0.05 | 0.01 |
| 17 | Umm Qasr | 24.26 | 0.07 | 0.07 | 12.90 | 0.06 | 0.02 |
| 18 | Al-Kubasi | 29.04 | 0.08 | 0.09 | 15.23 | 0.07 | 0.02 |
| 19 | Al-Hawtah | 27.76 | 0.07 | 0.08 | 14.85 | 0.07 | 0.02 |
| 20 | Bab Jalei | 31.94 | 0.09 | 0.11 | 10.46 | 0.08 | 0.02 |
| Max. | | 40.41 | 0.11 | 0.13 | 20.94 | 0.09 | 0.03 |
| Min. | | 11.84 | 0.01 | 0.01 | 10.15 | 0.01 | 0.01 |
| Ave. | | 27.37 | 0.07 | 0.08 | 14.24 | 0.07 | 0.02 |

Table (4): The radium equivalent, external hazard, absorbed dose and annual effective dose equivalent for Dates samples from the study area.

| S.N | Regain | $Ra_{eq}$ Bq $kg^{-1}$ | $H_{ex}$ | $H_{in}$ | D nGy/h | $AEDE_{in}$ $\frac{\mu Sv}{y}$ | $AEDE_{Out}$ $\frac{\mu Sv}{y}$ |
|---|---|---|---|---|---|---|---|
| 1 | Medina | 16.78 | 0.05 | 0.05 | 8.54 | 0.04 | 0.01 |
| 2 | Qurna | 15.79 | 0.04 | 0.05 | 8.23 | 0.04 | 0.01 |
| 3 | Al-Shafi | 18.00 | 0.05 | 0.05 | 9.44 | 0.05 | 0.01 |
| 4 | Al-Dair | 17.15 | 0.05 | 0.06 | 8.75 | 0.04 | 0.01 |
| 5 | Al-Hartha | 21.77 | 0.06 | 0.08 | 11.15 | 0.05 | 0.01 |
| 6 | Karma Ali | 21.53 | 0.06 | 0.07 | 11.26 | 0.06 | 0.01 |
| 7 | Al-Wafood Street | 14.47 | 0.04 | 0.04 | 7.60 | 0.04 | 0.01 |
| 8 | Umm Al-Naaj | 16.15 | 0.04 | 0.05 | 8.78 | 0.04 | 0.01 |
| 9 | Al-Ouja | 16.84 | 0.05 | 0.05 | 8.72 | 0.04 | 0.01 |
| 10 | Al-Siba | 22.26 | 0.06 | 0.07 | 11.33 | 0.06 | 0.01 |
| 11 | Al-Fadaghia | 20.53 | 0.06 | 0.06 | 10.74 | 0.05 | 0.01 |
| 12 | Al-Dora | 20.46 | 0.06 | 0.06 | 10.66 | 0.05 | 0.01 |
| 13 | Al-Mamer | 19.43 | 0.05 | 0.06 | 10.19 | 0.05 | 0.01 |
| 14 | Al-Zubair Petrochemicals | 23.15 | 0.06 | 0.07 | 11.96 | 0.06 | 0.01 |
| 15 | Al-Brjisia | 19.77 | 0.05 | 0.06 | 10.38 | 0.05 | 0.01 |
| 16 | Safwan | 25.37 | 0.07 | 0.07 | 13.29 | 0.07 | 0.02 |
| 17 | Umm Qasr | 24.68 | 0.07 | 0.07 | 12.96 | 0.06 | 0.02 |
| 18 | Al-Kubasi | 14.59 | 0.04 | 0.05 | 7.54 | 0.04 | 0.01 |
| 19 | Al-Hawtah | 15.10 | 0.04 | 0.04 | 8.07 | 0.04 | 0.01 |
| 20 | Bab Jalei | 13.41 | 0.04 | 0.04 | 7.06 | 0.03 | 0.01 |
| Max. | | 25.37 | 0.07 | 0.08 | 13.29 | 0.07 | 0.02 |
| Min. | | 13.41 | 0.04 | 0.04 | 7.06 | 0.03 | 0.01 |
| Ave. | | 18.86 | 0.05 | 0.06 | 9.83 | 0.05 | 0.01 |

From Table (3), the lowest value of radium equivalent activity $Ra_{eq}$ (Bq/kg), in Soil samples was (11.84) Bq/kg and the highest value (40.41) Bq/kg with an average value of (27.37) Bq/kg.

As for Table 4, its lowest value of radium equivalent activity $Ra_{eq}$ (Bq/kg), in Dates samples taken from the same study area is (13.41) Bq/kg and the highest value (25.37) Bq/kg with an average value of (18.86) Bq/kg.

The above results show that the average effective radium equivalent activity $Ra_{eq}$ (Bq/ kg), in the study area in Basra Governorate is lower than the global average of radium equivalent activity of (370 Bq/Kg) [4, 15].

The lowest value of the absorbed dose rate D (nGy/h) in Soil samples is (10.15) and the highest value (20.94) with an average value of (14.24), while in Date samples the lowest value of the absorbed dose rate (7.06) and the highest value (13.29) with an average value of (9.83) that the above results show The absorbed dose rate in the study area in Basrah Governorate is less than the global average (55 nGy/h) [4, 15].

Tables (3) and (4) also show that the lowest value of the annual effective dose equivalent $(AEDE)_{oo}$ (μSv/y)) for external exposure in Soil samples is (0.01) and the highest value (0.03) with an average value of (0.02), while the lowest value in Date samples is (0.01) and the highest value (0.02) and with an average value of (0.01), these results show that the annual effective dose rate for external exposure in Soil and Date samples is less than the global average of (0.07 mSv/y).

The lowest value of the annual effective dose equivalent (AEDE)in (μSv/y) for internal exposure in Soil samples is (0.01) and the highest value (0.09) with an average value of (0.07), and in Dates samples was the lowest value (0.03) and the highest value (0.07) and an average value (0.05), The results show that the average annual dose for internal exposure in these samples from the study area in Basra Governorate is less than the global average of (0.5 mSv/y) . [4, 15]

As for the lowest value of the external hazard Index (Hex), in the Soil samples is (0.01) and the highest value (0.11) with an average value of (0.07), in Date samples, the lowest value is (0.04) and the highest value (0.07) and an average value (0.05).

As for the lowest value of the internal hazard Index (Hin) in Soil samples it is (0.01) and the highest value (0.13) with an average value of (0.08), and in Date samples the lowest value is (0.04) and the highest value (0.08) and an average value (0.06).

The above results show that the average internal and external hazard index for both samples (Soil and Dates) taken from the study area is less than the global average. Figures (1) shows the levels of radioactive hazard indicators in Soil and Date models taken from the study area in Basra Governorate.

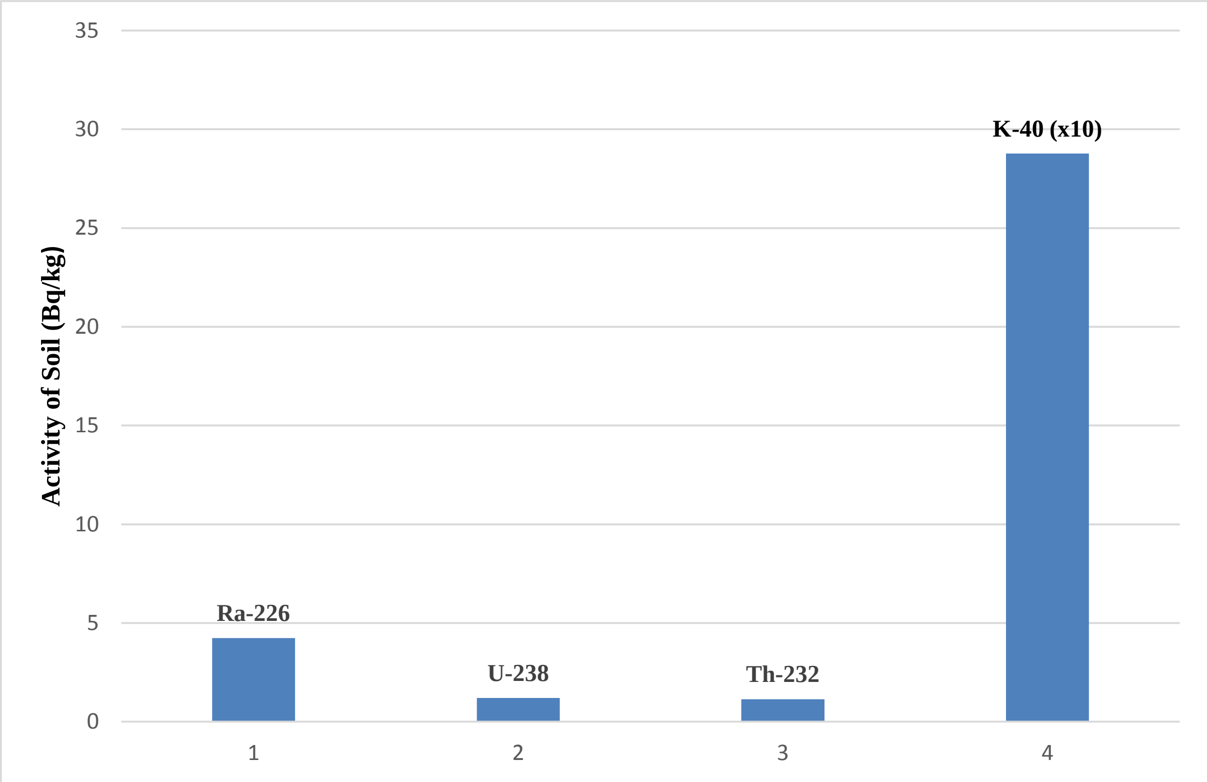


Figure 4: The activity average in the Soil samples of (Ra-226, U-238, Th-232 and K-40) in (Bq/kg).

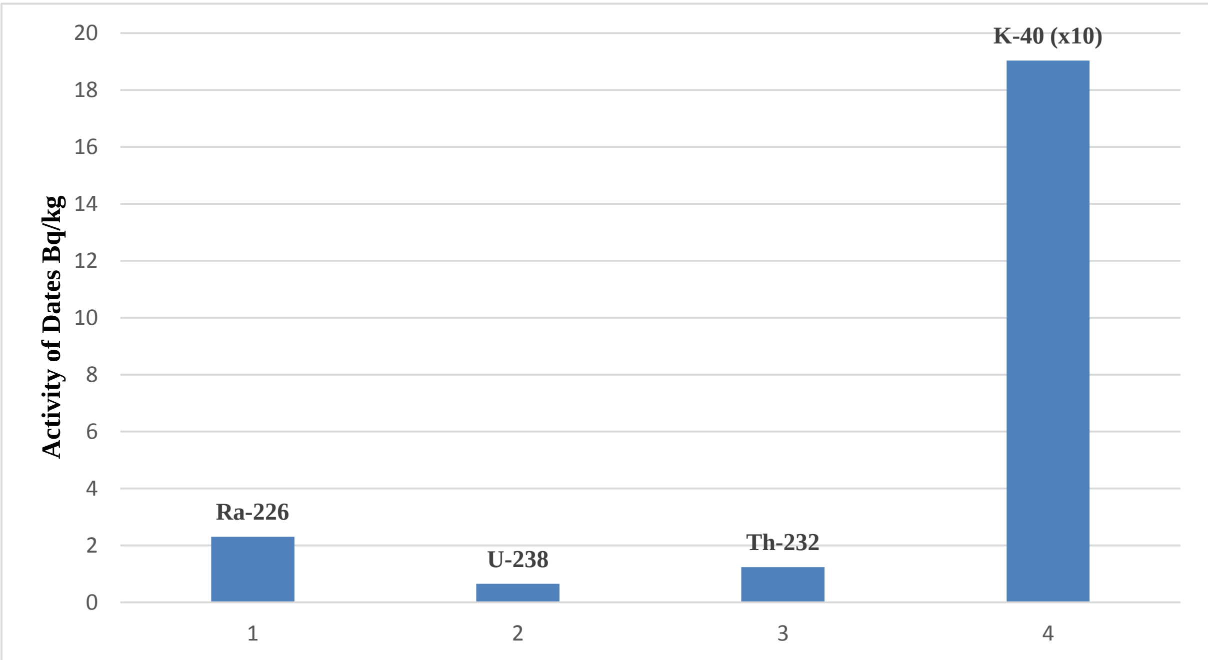


Figure 5: The activity average in the Dates samples of (Ra-226, U-238, Th-232 and K-40) in (Bq/kg).

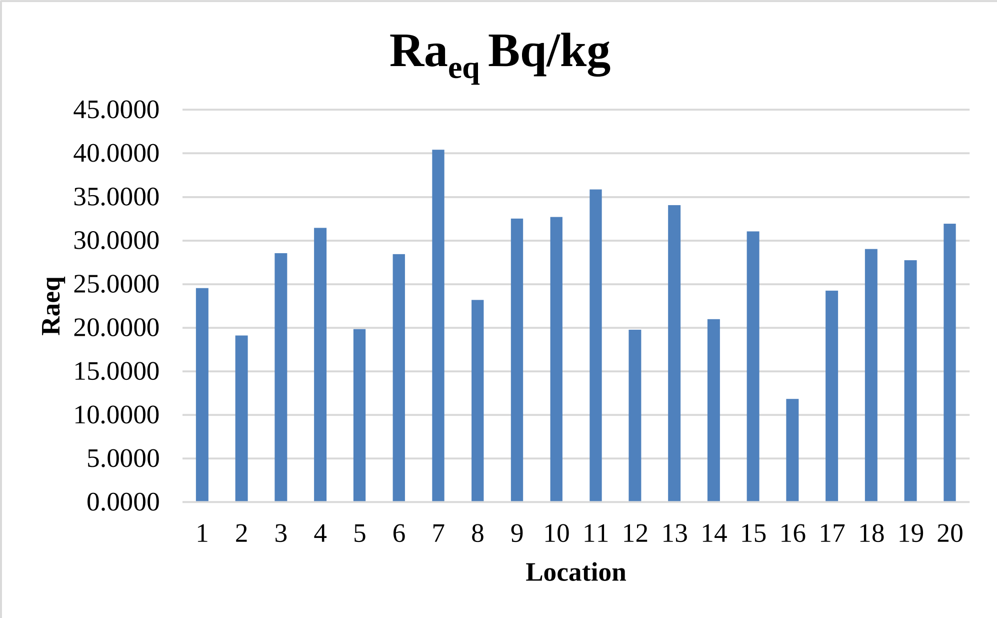


Figure 6: The distribution of $Ra_{eq}$ in Bq/kg in Soil samples for various Locations.

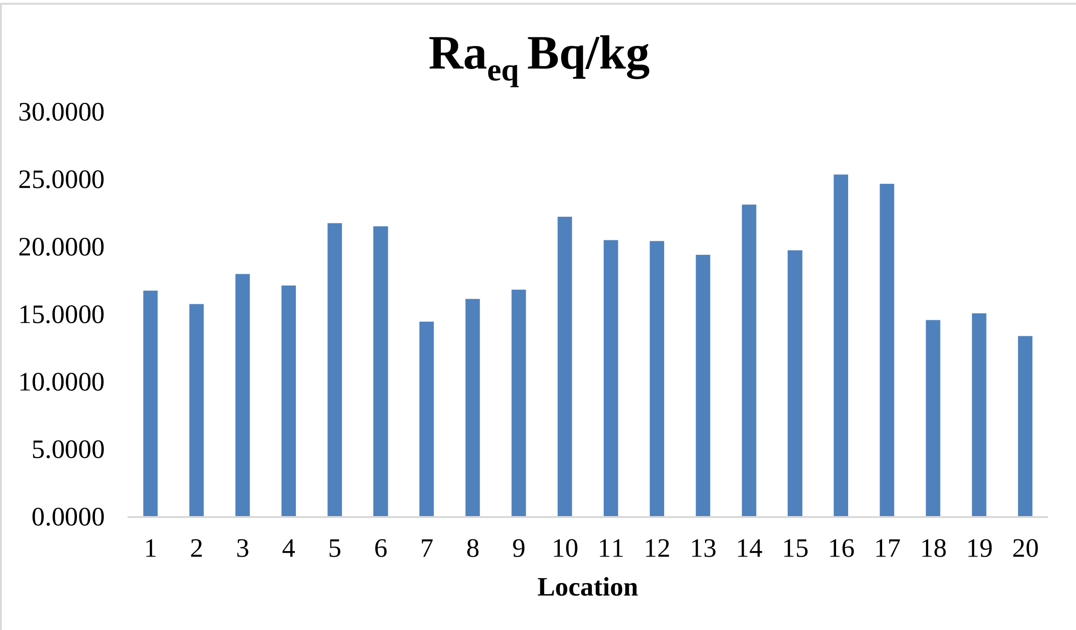


Figure 7: The $Ra_{eq}$ in Bq/kg in Date samples for various Locations.

## CONCLUSION

The specific activity concentration levels of radium for uranium and thorium are lower than the global values recorded at 35 Bq / kg [UNSCEAR 2000] [15]. And also the values of potassium are lower than the values recorded by (UNSCAR 2000) of 400 Bq / kg.This difference is due to the nature of the Soil, the tidal phenomena, and the excessive use of chemical fertilizers in agriculture, whose use varies from one farmer to another.The current results revealed that the samples taken from the study area (Soil, Dates) are safe with regard to the health effect, and therefore it is necessary to monitor this area and check the food items continuously grown in the future.

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# قياس النشاط الإشعاعي الطبيعي في نماذج التربة والتمور من بساتين شط العرب في محافظة البصرة

رنا عزيز عبد[1]، جبار حافظ جبر[2]

1. 2 قسم الفيزياء، كلية التربية للعلوم الصرفة، جامعة البصرة، العراق

E-mail:-rana.kafajy@gmail.com (**Rana azeez abed** )

**الخلاصة:**

تم قياس النشاط الإشعاعي الطبيعي لـ ($^{226}Ra$, $^{238}U$, $^{232}Th$, $^{40}K$)، في عينات التربة والتمور المأخوذة من شط العرب في محافظة البصرة بإستخدام مطيافية أشعة كاما Na(Tl).

أظهرت النتائج أن الفعالية النوعية لـ ($^{226}Ra$, $^{238}U$, $^{232}Th$, $^{40}K$)، في التربة تتراوح بين (1.02، 0.27، 0.45، 219.19 Bq/kg) إلى (11.21، 2.73، 2.77، 389.51 Bq/kg)، وفي التمور تراوحت بين (0.58، 0.21، 0.36، 140.20 Bq/kg) إلى (6.57، 1.74، 2.58، 273.66 Bq/kg) على التوالي. وتراوح فعالية الراديوم المكافئ في نماذج التربة بين (11.84) و(40.4) Bq/kg، وفي نماذج التمر تتراوح من (13.41) إلى (25.37) Bq/kg. تراوحت الجرعة المكافئة المؤثرة السنوية $AEDE_{in}$ في نماذج التربة بين (0.01) – (0.09) µSv/y، وفي نماذج التمر تراوحت بين (0.03) و(0.07) µSv/y. وكانت نتائج معامل الخطر الداخلي والخارجي في نماذج التربة والتمور جميعها أقل من قيمة الحد العالمي.

**الكلمات المفتاحية:** النشاط الإشعاعي الطبيعي للتربة والتمور، تراكيز الفعالية، الراديوم الفعال، يوديد الصوديوم NaI(Tl).