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THE NATURAL RADIOACTIVITY DISTRIBUTION AND RADIATION HAZARD IN HONEY BEES SAMPLES

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Abstract

We establish baseline measurements for radioactivity concentration in the honey samples collected from the Iraq's provinces. The work focused on the naturally occurring of radiation associated with ^{226}Ra and ^{232}Th natural decay chains naturally occurring radionuclide 40K in 16 honey samples collected from different region from Iraq. Two honey samples were found to be elevated of ^{226}Ra concentration. Notably The mean values of activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K for the full cohort of samples were found to be (27.18, 33.18 and 1027.6) Bq/Kg, respectively. These values lie within the expected range relative to the world average values in honey samples.

Key words: NaI (Tl) detector, natural radioactivity, Annual Effective Dose, honey samples.

Introduction

Iraq, occupies a total area of 437072.00 km², is a country in Western Asia, bordered by Turkey to the north, Iran to the east, Kuwait to the southeast, Saudi Arabia to the south, Jordan to the southwest and Syria to the west. (Knoll, 2000). In the present study (16) samples were chosen as fair distribution in Iraq cities. The regions were determined using (GIS) as shown .we chose honey bees to study because Honey is one of the most important food and pharmaceutical products rich in sugars, which consist of monoclonal sugars, yeast, amino acids, vitamins and minerals. Honey is made from the nectar of flowers collected by bee workers from various flowers and spread in the surrounding areas where the bees are raised. Nectar through a series of micro-digestion to honey, stored in hexagonal eyes sealed with wax covers, so during these processes reduce moisture to a liquid rich in sugars,and the honey has two main qualities that benefit the human based on them; the first medicine and the second food, as the honey contains inside the sugar materials of various kinds. As honey is made by bees by collecting the workers for the nectar of flowers spread here and there, this nectar turns into a liquid of sugar, where the nectar undergoes several processes, including partial digestion, in addition to reducing the moisture, and after extraction of diabetes collected in hexagonal eyes, These eyes are covered with wax, and this process is intended to provide food for all bees in the cell. (Salgado *et al.,* 2012). Humans, animals and plants are directly exposed to radiation through the process of external exposure to radioactive material deposited on the ground, or as a result of the inhalation of suspended radioactive materials in the atmosphere and transported by dust storms to long distances and different directions. The indirect way of receiving radiation is through food and water containing radioactive material. Some radioactive isotopes cause soil and plants to enter the human body or animal through the food chain. The radioactive material is transferred from the soil to the plant tissues by the roots or adsorption. Leaf pathway through the metabolic processes carried out in the paper (A-Taie, 2001). To estimate the biological impact on humans, the calculation of radiation doses from radioactive materials, their propagation pathways and their mitigation factors in the environment is required by natural phenomena such as wind, precipitation, soil nature, terrain, evaporation rate and degrees the heat. Knowing how

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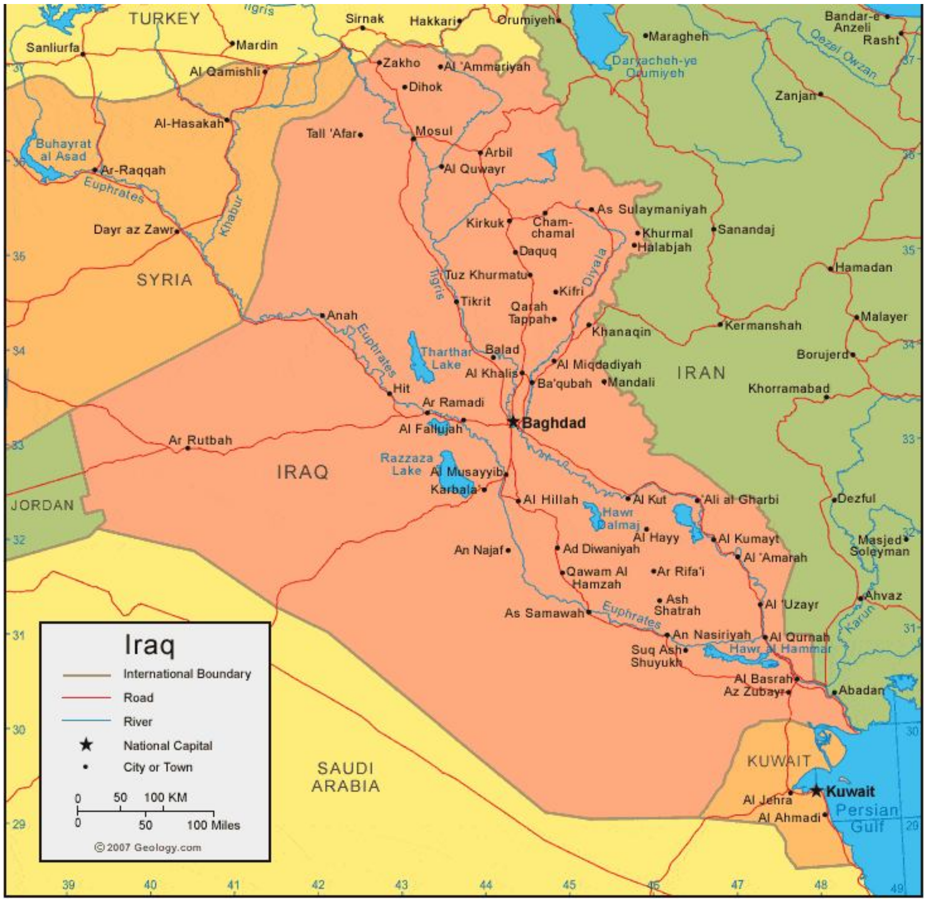

Fig. 1: Map of Iraq Province

soil and plant factors and environmental conditions affect the transmission of radionuclides is essential to reducing their risk to humans. As a result of intensive field studies following the Chernobyl accident, it is possible to estimate the risks of using any radioactive contamination by using programs and ready-made models to estimate the amount of each radioactive nucleus absorbed through the gastrointestinal tract using data related to the food nature, its components, Of the region, and the effect of weather conditions. (Salgado *et al.,* (2012). From here we see that through the level of sedimentation in the soil, the rate of human nutrition, that is, the amount of food consumed by the individual with the radioactive counterpart and its balance with its biotic environment.

Experimental details

The specific radiation activity of gamma rays to measure based on the high penetration strength using counting and electronic analysis used in the detection consisting of an array of detectors of nuclear radiation sodium iodide system Restaurant thallium NaI(TI) and the supplier of the company (Alpha Spectra, Inc.-12I12 / 3) provider is a multi-channel analyzer (MCA) (ORTEC -Digi Base) that contains a 4096 channel connecting unit called ADC (Analog to digital Convertor) Sabharwal *et al.,* (2008) helps the analyst to convert the next pulse into digital numbers, though nuclear measurements and analysis done by a computer software called (MAESTRO-32) as shown in fig. 2 (a) and (b).

(a) (b)

Fig. 2(a,b): The gamma spectroscopy detection system used in the present study.

In this study, gamma ray measurement system associated with the NaI(Tl) Scintillator detector 3"×3", he samples were measured for a counting time of 14400 second, and samples were mass (0.25kg). This system consists of a primary amplifier, a chief amplifier, a high voltage and a multi-channel analyzer. This system is connected to a computer to operate, read the measurement and analyze the results. The honey samples to be measured in a marnelly plastic crystal detector and a pot of lead Beaker to decrees of background.

The concentration of radiation activity of ^{40}K, ^{226}Ra and ^{232}Th in the honey samples was calculated (Specific Activity) using a gamma ray spectrum using the Eq. (1) (Mahur *et al.* (2008).

$$Specific\ Activity\left(Bq.Kg^{-1}\right)=\frac{Area/T-B.G}{l_5\%\varepsilon\%m} \quad (1)$$

where :Area; net area under the photo peak position.

m: mass of sample unit (Kg).

The absorbed dose rate (nGy/h) is calculated using Eq.(2), (Mahur *et al.,* 2008).

$$D(nGy/h) = 0.462A_{Ra} + 0.604A_{Th} + 0.0417A_K \quad (2)$$

where 0.461, 0.604 and 0.0417 nGy/h /Bq kg^{-1} are the conversion factors of ^{226}Ra, ^{232}Th and ^{40}K, respectively (Sabharwal *et al.,* 2008; Mahur *et al.,* 2008).

Calculation Radium equivalent activity (Ra_{eq}) of the Eq.(3) (Shakir *et al.,* 2012):

$$Ra_{ea} = A_{ra} + 1.43A_{Th} + 0.077A_K \quad (3)$$

where A_k, A_{Th}, A_{Ra} is the qualitative effectiveness of a series of uranium and thorium series and potassium, respectively. Where the highest value of Ra_{eq} must be less than the allowable limit internationally (370 $Bq.Kg^{-1}$) as (tab.1).

To calculate the risk of radiation gamma index is used Eq(4). (Mahur *et al.,* 2008):

$$I_\gamma = \frac{A_{Ra}}{150}+\frac{A_{Th}}{100}+\frac{A_K}{1500} \quad (4)$$

To calculate the risk of alpha index is used Eq(5). (Shakir *et al.,* 2012):

$$I_\alpha = \frac{A_{Ra}}{200} \quad (5)$$

The external risk guide (H_{ex}) is to assess the risk of natural gamma radiation, is calculated by Eq.(6) (Shakir *et al.,* 2012).

$$H_{ex} = \frac{A_{Ra}}{370}+\frac{A_{Th}}{259}+\frac{A_K}{4810}\le 1 \quad (6)$$

where A_U, A_{Th} and A_K, are the radioactivity concentrations in $Bq.Kg^{-1}$ of ^{226}Ra, ^{232}Th and ^{40}K .respectively (tab.1). The value of this index must be less than one for the radiation hazard to be negligible if equal to or greater than one indicates the presence of radiation risk (International Commission on Radiological Protection, 1993).

Internal exposure (H_{in}) is due to inhalation of radon and his counterpart, can be calculated by using Eq.(7) (Mahur *et al.,* 2008; Shakir *et al.,* 2012) The value of this index must be less than one for the radiation hazard to be negligible UNSCEAR, (2008) as tabulated in Table 1.

$$H_{in} = \frac{A_{Ra}}{185}+\frac{A_{Th}}{259}+\frac{A_K}{4810}\le 1 \quad (7)$$

Results and Discussion

From Tabel 1 Spectrum of gamma radiation emitted from the radioactive elements (^{226}Ra,^{232}Th,^{40}K) of the samples under study for a period of 14400 seconds. We was calculated the concentration of the radiation activity of these elements and t was found that the concentration of radioactivity of these elements ranged between (44-5) Bq/Kg, (162-10)Bq/Kg and (1607-137)Bq/Kg. with an average (27.18, 33.18 and 1027.6) Bq/Kg, respectively. The concentration of radiation activity in the current study does not pose a risk because it is within the internationally

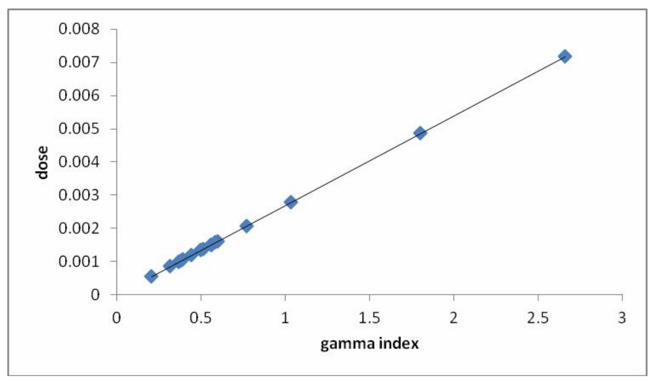

Fig. 3: Shows the relationship between the absorbed dose D(nGy/h) and the gamma risk index (I_γ)

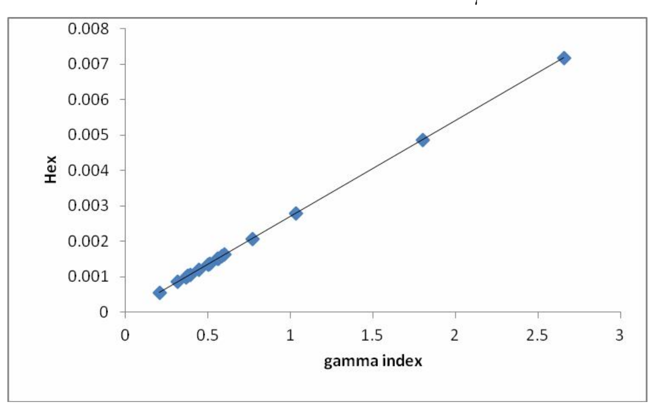

Fig. 4: Shows the relationship between (I_γ) and the external risk level H_{ex}

Table 1: Specific activities of radionuclides, rate absorbed dose, hazard indices and seriousness index of samples.

Sampl	Activity Concentration (Bq/kg)			Ra_{eq} (Bq/Kg)	Dose rate D (nGy/h)	seriousness index		Hazard Index	
	^{226}Ra	^{232}Th	^{40}K			alpha index(I_α)	gamma index (I_γ)	External ($H_{ex} \le 1$)	Internal ($H_{in} \le 1$)
1	38	44	348	0.76	0.2	0.0003	0.005	0.002	0.0022
2	5	12	156	0.2	0.06	0.000004	0.001	0.00055	0.00058
3	14	17	748	0.36	0.12	0.0001	0.0026	0.0009	0.0016
4	28	16	217	0.31	0.1	0.0002	0.0022	0.0008	0.001
5	10	38	137	0.59	0.18	0.000009	0.004	0.0016	0.0017
6	38	16	708	0.39	0.13	0.0004	0.0028	0.001	0.0012
7	14	23	1647	0.55	0.19	0.00013	0.0042	0.0015	0.0015
8	32	54	1458	1.02	0.3	0.0003	0.007	0.0027	0.0029
9	5	13	1505	0.37	0.13	0.000004	0.003	0.001	0.001
10	34	162	1607	2.65	0.8	0.00032	0.018	0.007	0.007
11	37	25	1027	0.56	0.18	0.00035	0.0041	0.0015	0.0017
12	42	18	1398	0.51	0.17	0.0004	0.0038	0.0013	0.0016
13	33	10	1420	0.56	0.19	0.00022	0.0043	0.0016	0.0017
14	25	23	1025	1.8	0.5	0.00033	0.013	0.0048	0.005
15	44	52	1602	0.42	0.14	0.00021	0.0032	0.0011	0.0013
16	36	18	1439	0.49	0.17	0.00031	0.0037	0.0013	0.0015

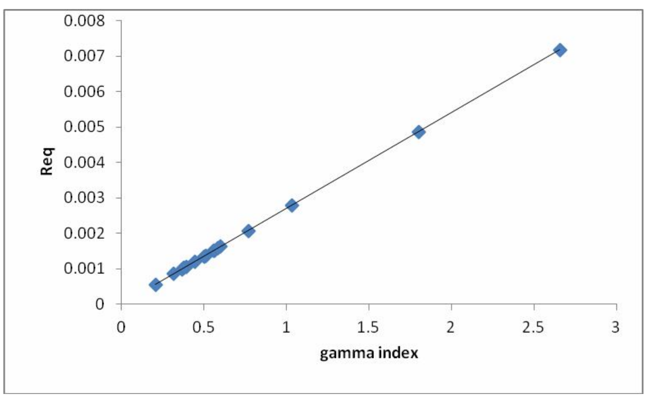

Fig. 5: Shows the relationship between the radium equivalents Ra_{eq} and (I_γ)

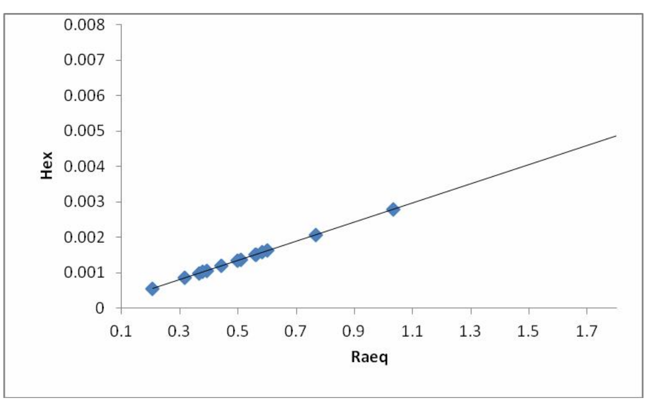

Fig. 6: Shows the relationship between Ra_{eq} and H_{ex}.

permissible values (UNSCEAR, 2008), Which identified concentrations of ^{226}Ra (32)Bq/Kg radium, ^{232}Th (45) thorium, and ^{40}K(412) potassium., The rate of absorbed dose was also (0.22) nGy/h, It was also calculate Raeq, Iγ, Iα, Hin and Hex are shows that the values of the variables above are less than internationally permissible limits, It was also calculate Raeq, Iγ, Iα, Hin, Hex. shows that the values of the variables above are less than internationally permissible limits, It was found that the values of the variables above are below the limits allowed globally. The Figs. 3, 4, 5 and 6 shows the relationship between (Iγ, D), (Iγ, Hex), (Iγ, Hin), (Iγ, Raeq), (Raeq, Hex) and we found that the relationship between them is Extrusive.

Conclusions

The environmental monitoring of natural background radiation using Sodium Iodide NaI(Tl) detector revealed the distribution of the natural radiation levels in all the honey samples measured. From the obtained result, one could see that the distribution was not uniform. Also artificial radionuclide was not detected in any of the measured samples. The obtained results confirm some conclusions as below:

1- The present work has shown that the radioactivity concentration of ^{40}K, ^{232}Th, ^{226}Ra are generally acceptable in comparison with the worldwide average.

2- Since the radiation levels were within permissible limits, thus the radioactive hazard is low for human beings UNSCEAR, (2000) in these samples.

3- Specific activity of ^{40}K is much higher than that of ^{232}Th and ^{226}Ra.

4- The results of the present work demonstrate that the gamma absorbed dose rate of samples varies appreciably from one sample to another due to the variation of ^{40}K,^{232}Th,

5- The estimated average absorbed dose rates in air for the studied area are below or comparable with world average (0.22 nGy/h).

6- All average values of annual indoor and outdoor effective dose were lower than the permissible limit.

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