Measurement of the natural radiological activity of soil samples of some general education schools in Al-Qadisiyah Governorate

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Abstract

Right now, specific radioactivity of soil chose from Diwaniya Governorate was estimated. Ten samples of this soil were gathered. These samples were from some general education schools, where the samples were taken from diversified sites. to define the specific activity from the radioactivity ^{232}Th, ^{238}U and ^{40}K, Iodide sodium system activated with Thallium 3"×3" had been used for this aim , finally for Thorium ^{232}Th ranged between (BLD-14.652) Bq.kg^{-1}, average (5.334) Bq.kg^{-1}. for Uranium ^{238}U, it is ranged between (BLD-26.187) Bq.kg^{-1}, average (8.364) Bq.kg^{-1}, where the result showed that radio activity of potassium ^{40}K ranged between (346.823-536.704) Bq.kg^{-1} with a rate of (450.482) Bq.kg^{-1}, The radium equivalent values ranged between (33.951-68.194) Bq.kg^{-1}, average (50.68) Bq.kg^{-1}, the absorbed dose rate in air ranged between (18.386- 33.995) nGy.h^{-1}, average (25.962) nGy.h^{-1}, External hazard index ranged through (0.091-0.184), average (0.136), Internal hazard index ranged through (0.091-0.226), average (0.159). activity concentration index ranged between (0.293-0.538), average (0.409), the observed results were below the International recommended limits.

Keywords: Radiation, Radioactive contamination, Na reagent (Tl), Effective annual dose.

1 - Introduction

Radioactivity was found out in 1896 by the scientist Henri Beckerle, where it was found that Uranium salt emits a strong radiation.in all Time and even in the dark. Where This radiation penetrated paper wrappers and thick silver foil and was affected by photographic plates ,This phenomenon radioactivity [1,2], The concentration of radioactive isotopes in a soil were a course for radioactivity to people and is an indicator of radioactive assembling in environment [2]. Naturalist sources of radiation are cosmic radiation and earth radiation (naturally radiation), the approximates of the half life time of a radionuclide found in land stratum asymptotic to the age of the Earth ,at that point the radionuclide is primordial [3] . it was present from the earliest starting of the earth [4]. Inventories of primordial radionuclides are essentials segment of the normal foundation level of radioactivity in nature. the concentration of the natural nuclides^{238}U ,^{232}Th ,and their daughter items and ^{40}K, existing in the soil and rocks which is a relies upon the local geology of each part on the planet are causes diversity of dosages [5]. A few region are have high natural background in light of

the fact that in these regions levels of Uranium and their decay items in soil and rock , high establishment radiation zones, as a result of places geography , and geochemical activities it, due to arises levels of terrestrial radiation [4].

2 - Material and Method

2.1. Study area

Al-Qadisiyah is an Iraqi governorate. The total area is 8153.The samples were collected from city center of Al-Qadisiyah as shown in figure (1). By picking 10 schools Governmental from the center of Al-Qadisiyah city (i.e Khadija, Al-azhar Al-sharif, Qutibah, Al-zaytoon, Al-markaziah, Baghdad, Al-fajr Al-jadid, Dhat Al-sawari , Al-Rusafi, Altafawuq), as shown in table (1).

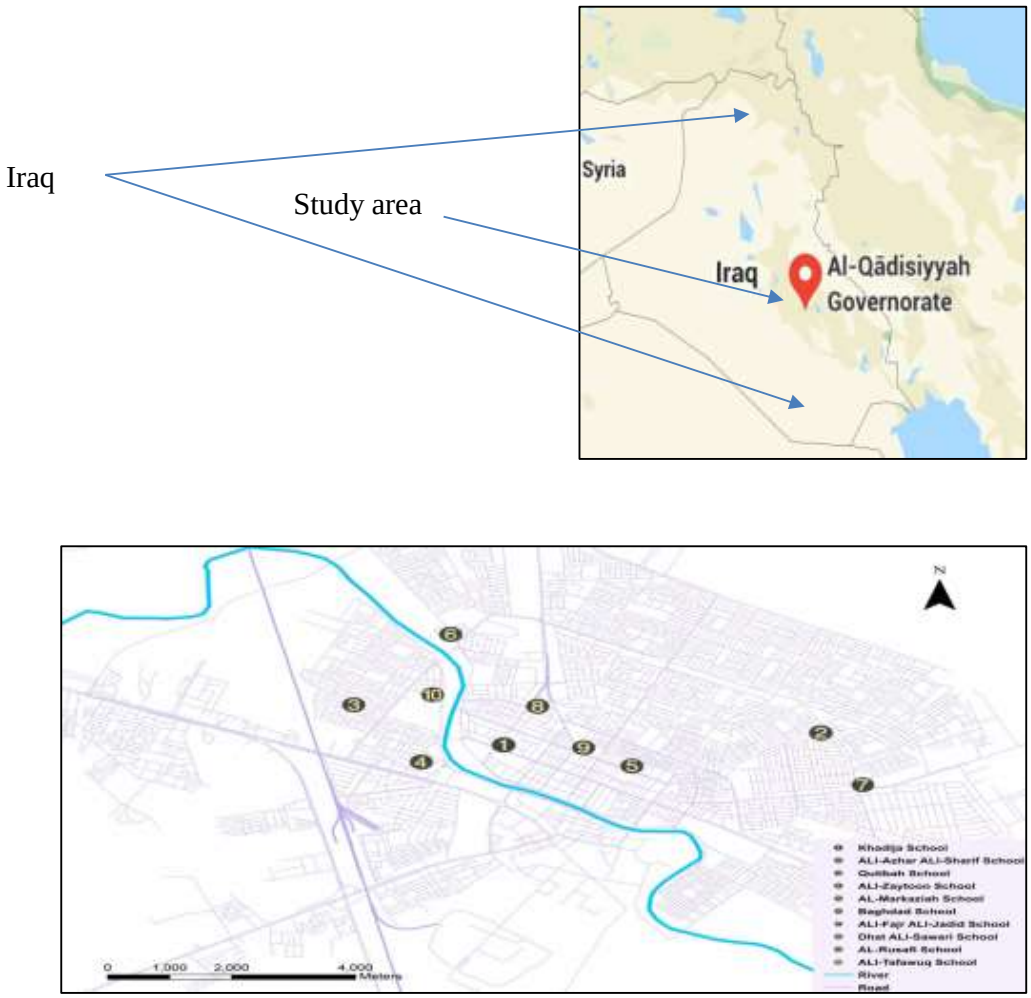

Figure (1) map of Al- Qadisiyah /Iraq with sampling site

Table (1) Numbers, codes, Names and Locations of the collected samples in Al-Qadisiyah Province

S of No.	S of code	Schools name	Locations
1	R1	Khadija	Aleuruba
2	R2	Al-azhar Al-sharif	Al-wahduh Al-thania
3	R3	Qutibah	Um Khayl

4	R4	Al-zaytoon	Um AL-khayl
5	R5	Al-markaziah	Al-fadhiliah
6	R6	Baghdad	Al-wihda Al-thalitha
7	R7	Al-fajr Al-jadid	Al-wihda Al-thalitha
8	R8	Dhat Al-sawari	Nisan 7 Street
9	R9	Al-Rusafi	Al-fadhiliah
10	R10	Altafawuq	Um AL-khayl

2.2. Experimental Procedures

In this study, the natural radiation of soil samples was studied in some Diwaniyah schools which were randomly collected. beforehand estimation tests are exsiccated in a broiler at a temperature of 60 Cº for 72 h, every last one of the example filled and tight in a nearby PVC compartment and it was spared about one month and a half period to Let the radioactive balance between the daughter products of radon (^{222}Rn), thoron (^{220}Rn) and their shorter-lived decay products be allowed. was used 0.5 kg of soil is per sample. These samples are taken from a depth of approximately 10 centimeter. They were estimated by using Gamma spectrometer with scintillation detector NaI(Tl) from SPECTRUM TECHNIQUES, INC.USA. the sample is put vis-à-vis over the detector for 18000 sec(five hours), the contribution of the radiological background is subtract from the peak area of the measured sample [6], Because of the accuracy of NaI(TI) reagent in detecting vanishing gamma energies that did not separate the peak well..hence, the estimating of the activity focuses is accessible at high energies as that secure in our outcomes from gamma beam emitted the series of^{238}U (the gamma line 1765 keV for ^{214}Bi) and ^{232}Th (the gamma line 2614 keV for ^{208}Tl) which are equilibrium together with them, however ^{40}K was assessed directly by means of its gamma line of 1460 keV [7,8].

3 - Calculation of activity

The samples were placed on the detector to calculate the specific activity for each sample, the net area under the corresponding peaks in the energy spectrum was computed by subtracting count due to background sources from the net area of a certain peak using MAESTRO-32 data analysis package. The background spectrum measured by using Empty 1 L polyethylene plastic container in the detector and counting at the same time for the sample measurements .The specific activity of each radionuclide is can be calculated using the following equation [7,8].

$$Ac = \frac{C - BG}{\varepsilon I_{\gamma} M t} \dots\dots (1)$$

where Ac is the specific activity, C is the area under the specified energy peaks, BG is background, ε is the efficiency of the detector , Iγ the transition probability for emitted gamma ray , m weight of samples in (kg) and t the time for collected in (sec)

4 - Calculation of Hazard indices

The specific efficacy of Uranium, Thorium, and Potassium, the Radium equivalent, average dose absorbed in air, and external and internal risk factors as well as the coefficient of effectiveness for the studied models were calculated as following:

4.1.Radium equivalent activity (Ra_{eq})

Distribution of ^{232}Th, ^{238}U and ^{40}K in environment is not orderly, for this regard to exposure for radiation , the radioactivity has been defined in terms of radium equivalent activity (Ra_{eq}) in Bq.kg^{-1} [9].

$$Ra_{eq} = A_U + 1.43\,A_{Th} + 0.077\,A_K \ldots\ldots (2)$$

Where A_U , A_{Th} and A_K are specific activity concentration in (Bq.kg^{-1}) of ^{238}U ^{232}Th and ^{40}K, respectively. The indexes are important to compare at the specific activity of materials containing various concentrations of ^{238}U ^{232}Th and ^{40}K [10].

4.2.Gamma Dose Rate (D)

The total dose rate D in the air (outdoors) from distribution of commonly the 226Ra, 232Th and 40K in the soil 1 meter above sea level was estimated by the following equation [11,12].

$$D = 0.462A_U + 0.604A_{Th} + 0.042A_K \ldots\ldots (3)$$

Where D, the dose rate in (nGy.h^{-1}) and A_U , A_{Th} and A_K are the concentrations each of ^{233}U,^{232}Th and ^{40}K respectively [13]**.**

4.3.Representative level index (Iγr)

orderly to check whether the sample meets the dosage criterion limits, Another radiation risk index, level index Iγ employed to assess the degree of γ-radiation peril related for the radionuclides in examined samples is characterized as follow [12,13]

$$I_\gamma = {A_U}/{150} + {A_{Th}}/{100} + {A_K}/{1500} \ldots\ldots (4)$$

The annual dose was associated with an index Iγr of excessive external gamma radiation by surface material. Values of index I ≤1 agree to 0.3 mSv.y^{-1}, while I ≤ 3 agree to 1 mSv.y^{-1}. Thus, the movement fixation list is important to utilize just as a screening apparatus for portray materials which may be see to use as covering material. As indicated by this portion measure, materials with I ≤ 3 must be deflect [12].

4.4.External hazard index (H_{ex})

Equation (5) calculate The external hazard index (H_{ex}), as following [12,13]

$$H_{ex} = {A_U}/{370} + {A_{Th}}/{259} + {A_K}/{4810} \ldots\ldots (5)$$

4.5.Internal hazard index (H_{in})

The inner exposure to ^{222}Rn and its radioactive progeny was given from this risk ,and given by this equation [10,11]

$$H_{in} = {A_U}/{185} + {A_{Th}}/{259} + {A_K}/{4810} \ldots\ldots (6)$$

for the safe utilization of all material, index (Hin) ought to be less than unity to give safe level to the radiation.

Table (2) Activity Concentration in (Bq.kg^{-1}) ^{232}Th, ^{238}U and ^{40}K in soil samples investigated in this study

Sample code	Specific activity (Bq.**k**g^{-1})		
	^{232}Th	^{238}U	^{40}K
R1	12.961±1.103	5.084±1.137	430.415±10.914
R2	1.127±0.325	26.187±2.580	387.512±10.356
R3	BLD	BLD	440.933±11.047
R4	BLD	8.898±1.504	536.704±12.188
R5	2.911±0.522	12.712±1.797	393.048±10.430
R6	1.784±0.409	4.576±1.078	527.570±12.084
R7	14.652±1.173	8.644±1.482	501.275±11.779
R8	4.696±0.664	9.152±1.525	346.823±9.797
R9	6.762±0.796	8.390±1.460	523.695±12.039
R10	8.453±0.891	BLD	416.852±10.741
Low.	BLD	BLD	346.823±9.797
Hig.	14.652±1.173	26.187±2.580	536.704±12.188
Ave.	5.334±0.588	8.364±1.256	450.482±11.137
BLD = not detected			

The concentration of ^{238}U, ^{232}Th and ^{40}K in soil samples are compared with other values reported in other countries as shown in table 3. The comparisons are indicated the activity concentration of ^{238}U was found to be lower than in other countries, except for Cyprus, Iraq/Basra. On the other hand, the activity concentration of ^{232}Th was observed to be lower than in other countries, except Cyprus. Whilst, the activity concentration of ^{40}K was found to be more than in other countries, except for India, Pakistan. .in fact we found the concentration of ^{238}U, ^{232}Th were less than the world average Except ^{40}K .The results indicated that the concentration varied from country to country due to the differences in the geological nature of the soil

Table(3) Comparison of specific activity of soils samples in Iraq and other countries of the world

Country	Activity concentration Bq.kg^{-1}			Reference
	^{2238}U	^{232}Th	^{40}K	
Pakistan	20.9	42.6	550	[14]
India	34.03	90.71	765.35	[15]
Cyprus	7.1	5	104.6	[16]
Iraq/Basra	1.35	10.16	360.5	[17]
Saudi Arabia	11,3	6,7	153,8	[18]
Ghana	13.6	24.2	162.1	[19]
Turkey	17.9	30.7	448.7	[20]
Egypte	22.3	12.2	158.2	[21]
Nigeria	8.42	10.28	337.08	[22]
Iraq, Ghammas	15.780	8.596	393.012	[23]
Vietnam	42.77	59.84	411.93	[24]
Iraq, Al-Qadisiyah	8.3	5.3	450.4	Present work
World (average)	35	30	400	[25]

Table (4) Radium equivalent activity, absorbed dose rate, external hazard index, internal hazard index, and gamma index for soil samples consumed in this study

Sample code	Radium equivalent ($Bq.kg^{-1}$)	absorbed dose rate ($nGy.h^{-1}$)	Hazard Index		Activity concentration index (I_γ)
			Internal ($H_{in} \leq 1$)	External ($H_{ex} \leq 1$)	
R1	56.761	28.346	0.153	0.167	0.450
R2	57.637	28.957	0.155	0.226	0.444
R3	33.951	18.386	0.091	0.091	0.293
R4	50.224	26.491	0.135	0.159	0.417
R5	47.140	24.071	0.127	0.161	0.375
R6	47.751	25.222	0.128	0.141	0.400
R7	68.194	33.995	0.184	0.207	0.538
R8	42.537	21.607	0.114	0.139	0.339
R9	58.384	29.913	0.157	0.180	0.472
R10	44.185	22.632	0.119	0.119	0.362
Low.	33.951	18.386	0.091	0.091	0.293
Hig.	68.194	33.995	0.184	0.226	0.538
Ave.	50.680	25.962	0.136	0.159	0.409

So as to demonstrate the state of variation in the rate of specific effectiveness, for thorium-232, Uranium-238 and Potassium-40, the relationship between the specific quality values in $Bq.kg^{-1}$ see figure (2).

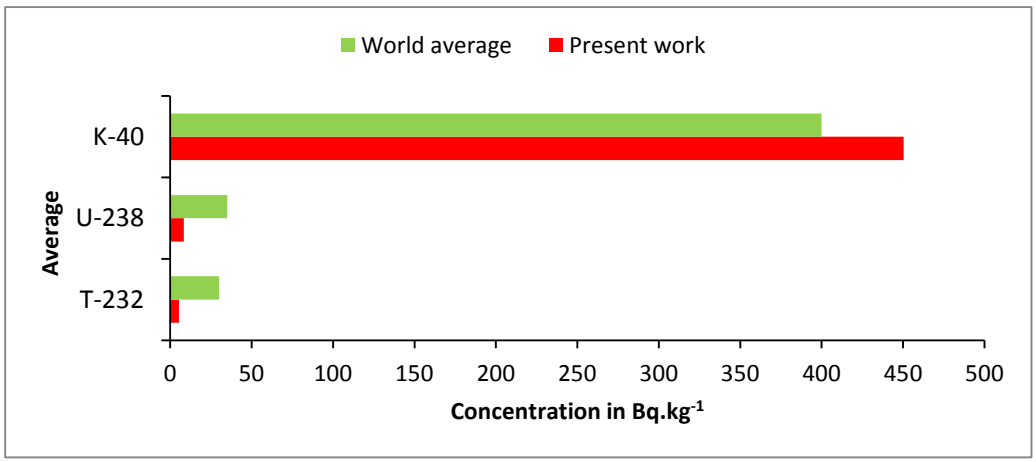

Figure (2) concentrations in soil samples

5 - Discussion and conclusions

Discussion of the results studied in the light of the global standards for the specific efficacy of potassium, uranium and thorium in public education schools, and comparing them with the internationally tolerable results with a presentation of the main conclusions we have reached.

For ^{232}Th ^{238}U and ^{40}K radionuclides, the specific activity values for (10) soil samples are tabulated in table 2 and figure 2 they have been found in the range from (BLD to 14.652) $Bq.kg^{-1}$ with an average (5.334) $Bq.kg^{-1}$, from (BLD to 26.187) $Bq.kg^{-1}$ with an average of (8.364) $Bq.kg^{-1}$ and (346.823 to 536.704) $Bq.kg^{-1}$ with an average (450.482) $Bq.kg^{-1}$ for ^{232}Th, ^{238}U and ^{40}K separately. The outcome shows that all values of ^{232}Th, ^{238}U and ^{40}K

specific activity for all samples are in the world average (30 Bq.kg^{-1} for ^{232}Th, 35 Bq.kg^{-1} for ^{238}U and 400 Bq.kg^{-1} for ^{40}K). [25,26].

Also Ra_{eq} values change from (33.951 to 68.194) Bq.kg^{-1} with average value of (50.680) Bq.kg^{-1}, as shown in table 4 at that point can see the Ra_{eq} values for all samples are lower than the recommended values 370 Bq.kg^{-1} [25,26]. The Absorbed dose rate in air ranged between (18.386 to 33.995) nGy.h^{-1}, average (25.962) nGy.h^{-1}, See table 4.

while (Hex), (Hin) and (Iγr) for the 10 soil samples index tabulated in table 4 , External hazard index (H_{ex}) range from (0.091 to 0.184) with an average (0.136) and Internal hazard index (H_{in}) range from (0.091 to 0.226) with an average (0.159). Representative level Gamma Dose (I_{γ}) extend from (0.293 to 0.538) with an average (0.409) External and internal risk and gamma activity concentration were less than unity indicated by the Radiation Protection [26]. The values of the Radium equivalent activity and annual effective dose have been less than world average for ^{40}K It was found that the specific efficacy of ^{40}K takes varying values from one site to another, so it was observed that there is an increase in the Potassium nucleus concentration in some regions, due to its contamination with wastewater, and other wastes that are thrown in the area where the isotope concentration increases (^{40}K), but Results were higher than internationally allowed limits Bq.kg^{-1} (400). The values of the Radium equivalent activity and annual effective dose was less than the world average Except ^{40}K. External and internal hazard and gamma activity concentration (representative level index) indexes were lower than unity [27].

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