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Calculation of radioactivity levels for various soil samples of Karbala - Najaf road (Ya- Hussein) / Iraq

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Abstract

Ya- Hussein an outer road that links the governorates of Najaf and Karbala / Iraq , the soil on this road is a sandy desert . The study was conducted to calculate the radioactivity and the risk indicators for this soil, because this study is of great importance due to the contribution of many factors to increasing the concentrations of radionuclides as they are transported through the soil then to humans and endanger their lives. We have estimated ^{226}Ra, ^{232} Th and ^{40} K concentrations in the paper, with their radiological risks in 15 soil sample types gathered from road Ya - Hussein / Iraq, investigated by using gamma ray spectrometry detector NaI (Tl). The result showed the soil sampling concentrations of ^{226}Ra, ^{232}Th, and ^{40} K were there an average among 17.386±1.327 , 15.889±0.556 and 553.269±4.997 with unit (Bq.kg^{-1}) respectively . Likewise ($\mathcal{H}_{in}$; $\mathcal{H}_{ex}$) hazard indices , total annual effective dose which was below the internationally recommended limits and excess life-time cancer risk (ELCR) were calculated (0. 793*10^{-3}) was lower than the worldwide value. All parameters were statistically studied, and the correlation between the parameters studied was calculated, Pearson's correlation and (P value) among the variables .The correlation between gamma index (Iγ) and Alpha index (I$_\alpha$) was strong, positive and direct ,where it was statistically significant (p-value $<$ 0.05) . The studied area is considered safe and the samples are free from radiation safety threats then the soil does not pose a health risk in this road .Thus this study can be considered as a baseline for future studied on the studied area.

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Key Words :soil, radionuclide, hazard index ,annual effective dose, Iraq.

1.Introduction

Humans are either exposed to ionizing radiation from natural sources or of man-made materials all the way through their lives. Hence knowledge of concentrations of radionuclides and emissions of environmental radionuclides are essential for ensure the level and concentration of radiation exposure

at rates which are acceptable[1]. Normal radionuclides exist in all human environments stuff for the earth, water , air, food and even our own body contain radioactive elements which occur naturally. The main sources of ionizing radiation in soil are the long-lived as ^{226}Ra, ^{232} Th and ^{40} K and their decay series [2]. Analysis of these radionuclides in soil is an important part of the environmental monitoring program. These natural radioactive sources are the major contributors to the largest contributor of the radiation doses received by humanity [3]. In view of the importance of the topic and its direct effects on human health, many studies were conducted in Najaf and other Iraqi cities, for example Study of concentrations of radionuclides in agricultural soil in the Ghammas region of Iraq using gamma ray spectrometry detector NaI(Tl) [4]. Estimation of concentrations of radionuclides in agricultural soil from different region of Najaf / Iraq [5] .Long-lived gamma-ray measurement in soil samples collected from city central of Al-Diwaniyah, Iraq [6].In another study, the risk of cancer(ELCR) due to radiation and risk indicators was estimated in Abu Al-Khasib and Al-Dayr in Basrah Governorate, southern Iraq [7]. Natural radioactivity was calculated for forty two soil samples from religious and archaeological sites in Najaf governorate/ Iraq, were measured by using(3 "x 3") NaI(Tl) detection[8]. Radiation sources make up nearly natural sources of radiation include nearly 80% radiation exposure to world population. Existing radionuclides both natural or manmade, in the ecosystem radionuclides, can be taken by animals and plants and will enter through the food chain into the human body [9]. In general, there are natural radionuclides in the soil and their chains, such as Thorium series and Uranium chain, which affect human health directly or indirectly. The external exposure to the natural radionuclides depends on the geological and geographical conditions of the region and this explains the difference in the concentrations of these radionuclides and their effect in every region of the world[10]. Therefore, measurements of natural radioactivity in soils and radiation doses have most Interest from the researchers who led surveys nationwide around the world .Therefore, as soil, the concentrations must be carefully measured to predict any potential danger to humans .The primary purpose of this study is to determine the natural specific activity, and to estimate the radiation hazard indices namely radium equivalent activity (R_{aeq}), representative level index ($I\gamma$),(I_α) absorbed dose rate (D_{in}, D_{out}), effective dose rate (D_{eff}), external hazard index (H_{ex}) , internal hazard index (H_{in}) ,Pearson's correlation , P-value and the risk cancer in soil samples in Ya- Hussein road.

2.Methodology

2.1.Study area .Samples were taken from Ya- Hussein road ,15 samples were collected from this road, the starting point from the city of Najaf to north towards Karbala . The distance between one sample and another is 250 meters as shown in figure (1). This road was chosen because of its importance as it is considered a road a major, link between the two cities is usually used as a passage for pedestrian crossing at religious occasions, where people spend about two months each year on this road to perform religious rituals and set up camps so that the citizen is exposed to the soil of the area directly.

2.2.Sample Collection and Preparation .This study was conducted on 15 soil samples collected from Ya - Hussein road Al-Najaf -Karbala / Iraq. To determine the concentration of radionuclides in the soil, samples were immediately brought to the laboratory for preparation and storage of samples. Each sample was passed through a sieve with a mesh to produce particle sizes less than 0.8 mm thus obtaining a homogeneous sample powder with a weight of one kilogram, placing the samples in a tightly closed plastic container, then storing them separately for 30 day to allow a radiative equilibrium between ^{226}Ra and then ^{232}Th and short-lived degradation products[11]. Radionuclides of ^{226}Ra, ^{232} Th and ^{40}K were measured in soil samples using a NaI (Tl) gamma ray spectrometer detector.

2.3.Statistical Analysis. Statistical descriptions were performed using SPSS for Windows, standard version 20.0. analysis of the data was carried out by frequency distributions (Pearson

correlation) to assess the statistical significance in all parameters measured in the soil samples.

2.4.Gamma spectrum analysis. The concentration of radioisotopes present in the soil such as and [226]Ra, [232] Th and [40] K were determined using the gamma ray spectroscopy technique on the high ability of this radiation to penetrate different materials. This spectrometer consists of a NaI(Tl) luster detector with crystal dimensions (3"x 3"), supplied by Alpha spectra, Inc.-12I12/ 3, and equipped with a multi-channel analyzer (MCA) (ORTEC-Digi base) with a range of 4096 channel connected to ADC (analog to digital converter), through the interface. Measurements and spectroscopy are calculated using the MAESTRO -32 software on a windows computer.

2.5. Efficiency and Energy Calibrations (ε). The purpose of efficiency calibration is to find a relationship between energy and the maximum peak energy efficiency of gamma ray spectroscopy system, and that was done using standard calibration sources ([22]Na, [54]Mn , ^{60}Co and ^{137}Cs) as shown in figure(2), from the international energy agency where it was used to derive the energy calibration curve and find out the efficacy of the detector NaI (Tl) gamma - ray spectrometer detector with high accuracy and that is absolutely necessary to determine levels of radioactivity in soil samples using the relationship[4]:

$$\varepsilon = \frac{CPS}{A_t * I_\gamma} * 100\% \qquad\qquad \dots\dots\dots\dots\dots (1)$$

Where(CPS) is counts per second, (A_t) presents activity of the source, and (I_γ) is gamma - ray intensity per decay.

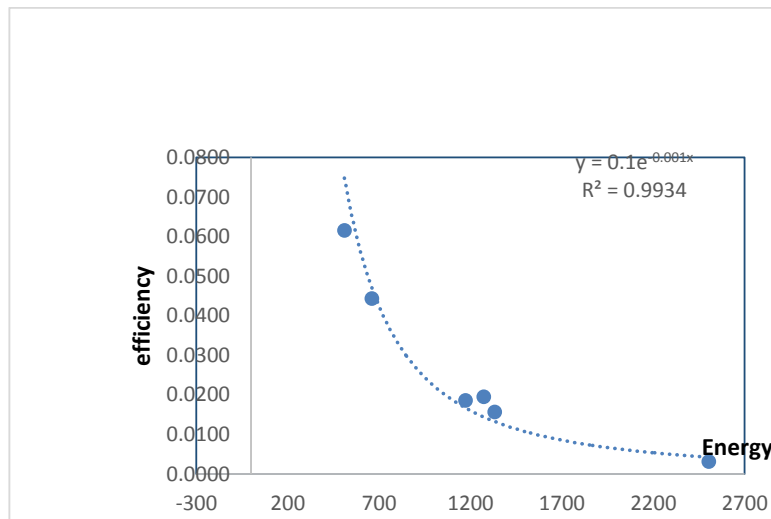Figure (1) : A map showing the locations of sampling for Ya- Hussein road

Figure (2) Shows the relationship between energy and efficiency

3.Calculation Of Concentration of Radionuclide and Hazard Indices

3.1. 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[12] :

$$A_n = \frac{(C_n - C_b)}{t \varepsilon_\gamma I_\gamma m_s} \qquad (2)$$

whereA_n: is the specific activity of each radionuclide in(Bq.kg^{-1}), C_n: the count rate in CPS for sample, C_b: the count rate in CPS for background, t: is the checking time , ε_γ and I_γ are detection efficiency and emission probability of γ:ray , m_s :is the mass of the sample in (Kg).

*3.2.Hazard Indices .*the relationship between natural radionuclides Can be determined [226]Ra,[232] Th and [40] K and the risks resulting from them by a set of indicators. In this study, excess life-time cancer risk (ELCR) and nine hazard indicators were calculated as follows:

3.2.1.The radium equivalent : activity (Ra$_{eq}$)it is used to describe gamma output from different mixtures of Radium, Thorium and Potassium in substances. It was calculated from the following equation[13]:

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

Where $A_{Ra} . A_{Th} A_K$ are activity concentrations of [226]Ra, [232]Th and [40]K, respectively.

3.2.2.The internal (H_{in}) and external (H_{ex}) hazard indices :there are calculated by equations(4) and(5) [13]:

$$H_{in} = \frac{A_{Ra}}{185} + \frac{A_{Th}}{259} + \frac{A_K}{4810} …………………… (4)$$

$$H_{ex} = \frac{A_{Ra}}{370} + \frac{A_{Th}}{259} + \frac{A_K}{4810} …………………… (5)$$

values of $(\mathcal{H}_{in})$, $(\mathcal{H}_{ex})$ Should be less than unity in order not to pose a threat of the population.

3.2.3.The outdoor dose ($\mathcal{D}_{out}$). is calculated from the following equation and the average value is 59 (nGy.h^{-1})as mentioned by the UNSCEAR (2000B) report [14].

$$\mathcal{D}_{out} = 0.462\mathcal{A}_{Ra} + 0.604\mathcal{A}_{Th} + 0.0417\mathcal{A}_K \dots \dots \dots \dots (6)$$

3.2.4.The indoor absorbed dose($\mathcal{D}_{in}$).for the soil samples is calculated by using formula(7) [14].

$$\mathcal{D}_{in} = 0.92\mathcal{A}_{Ra} + 1.1\mathcal{A}_{Th} + 0.08\mathcal{A}_K \dots \dots \dots (7)$$

The recommended value of indoor absorbed dose rate is 84 (nGy.h^{-1}).

3.2.5.Alpha index(I_α). The excess alpha radiation because of the Radon inhalation originating from the soil samples was assessed through alpha index, also it was little than one. Alpha index (I_α) was calculated as follow [4, 15]:

$$I_\alpha = \frac{\mathcal{A}_{Ra}}{200} \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (8)$$

3.2.6.gamma index($I\gamma$) .This indicator was used to calculate the risk arising from Gamma radiation associated with radioactive natural nuclei (^{238}U, ^{232}Th and ^{40}K) in the studied samples and calculated from the following equation [4]:

$$I_\gamma = \frac{\mathcal{A}_{Ra}}{150} + \frac{\mathcal{A}_{Th}}{100} + \frac{\mathcal{A}_K}{1500} < 1 \dots \dots \dots \dots \dots \dots \quad (9)$$

Its value must be less than one in order not to present any risk to human health.

3.2.7.The annual effective dose(D_{eff}). Equivalent from outdoor terrestrial gamma radiation was [16]:

$$D_{eff} = \text{Outdoor dose(nGy. h}^{-1} \text{) * 0.7(Sv .Gy}^{-1}\text{) * 8760(h y}^{-1}\text{) *0.2} \quad \dots (10)$$

While for indoor exposure, by using an occupancy factor of 0.8, the annual effective dose equivalent was:

$$D_{eff1} = \text{Indoor dose (nGy. h}^{-1}\text{) * 0.7 (Sv.Gy}^{-1}\text{) * 8760 (h.y}^{-1}\text{)} \times 0.8 \quad \dots (11)$$

4.Excess Life-time Cancer Risk (ELCR)

The risk of cancer due to radiation effects which is called excess lifetime cancer risk (ELCR) can be calculated from the following equation [17].

$$ELCR = AEDE * LS * RF \dots \dots \dots \dots (12)$$

AEDE: The Annual Effective Dose Equivalent.

LS: is a mean life span for adult (50 years).

By offsetting these variables we will get the (ELCR) of ^{226}Ra, ^{232}Th and ^{40}K in the soil samples .The value of risk factor (RF) for stochastic effects in the population is 0.05 per Sievert as recommended by ICRP [18].The average annual committed effective dose for the measured in soil in this study (0.317 mSv.y^{-1}), that used to estimate the risk of cancer for an adult person using the equation (12) which gives a risk factor of ($0.793*10^{-3}$). The estimated values are significantly less than the ICRP cancer risk of (1.45×10^{-3}) This indicates that the soil in this road is safe and has no negative effects on human health [19] .

4.Results and Discussion

Concentrations of radionuclide ^{226}Ra, ^{232}Th and ^{40}K were measured for fifteen samples from the soil taken from Ya-Hussein road using a detector NaI (Tl). From table(1),we have found that the concentration of ^{226}Ra is in the sample S12 as high as possible, in the sample S01 the lowest possible and at the rate of 17.386 ±1.327 (Bq.Kg^{-1}) as for the concentration of ^{232}Th has the largest value at the site S07 and the lowest value at the site S01 and the rate of 15.889±0.556 (Bq.Kg^{-1}) while the concentration of ^{226}Ra, ^{232}Th are less than the permissible limits globally. The concentration of ^{40}K is higher than the permissible limits globally average value (420 Bq.kg^{-1}) recommended by the UNSCAER at all locations of studied samples except for sample S01 where equal to 298.088±4.164 (Bq.Kg^{-1}), it represents the lowest value and also less than the permissible limits, while the maximum value is at the sample S03 and reaches 682.304±5.664 (Bq.Kg^{-1}) either the average Potassium concentration in this study is 553.269±4.997 (Bq.Kg^{-1}) and is considered high .The reason could be that the soil in this road is sandy and it is known that sandy soil is characterized by the presence of organic materials in addition to solid waste and the reason may be the release of Potassium during the adsorption process from the surface and edges of the silica layer, as well as this region is characterized by burying very large quantities of food residue, each These reasons led to a high concentration of Potassium in this road .In order to compare the radionuclide concentrations in soil samples, the ratios were used to provide a simple explanation of the relationship between these concentrations. The ratios of (^{232}Th - ^{226}Ra) in table (2) show that ^{232}Th concentrations are lower than ^{226}Ra, concentrations at a rate of 0.9138±0.420 but both are lower than ^{40}K concentrations due to the large increase in Potassium concentration. also, the ratio between the concentrations of (^{40}K - ^{226}Ra) and (^{40}K - ^{232}Th) is slightly close together in soil samples 31.821±3.784, 34.819±9.016 respectively, which confirms the difference between ^{40}K concentration and ^{226}Ra, ^{232}Th concentrations , where the ratios of (^{232}Th - ^{226}Ra),(^{40}K - ^{226}Ra) and (^{40}K - ^{232}Th) were higher than average world UNSCEAR2000 .

From table(3), we find that the highest values of $\mathcal{R}a_{eq}$, I_{γ} in Sample S07 with an average 82.710±2.508, 0.643±0.017 (Bq.Kg^{-1}) respectively , but the highest Iα value is found in Sample S12 with an average 0.086±0.006 (Bq.Kg^{-1}) but the lowest $\mathcal{R}a_{eq}$, I_{γ}, and Iα values in Sample S01, the reason may be the location of this sample near the center of Najaf city, so the reason could be the low level of Potassium depending on the reasons mentioned above.. All values for these three indicators were less than the permissible limit, note that the relationship between I_{γ} and Iα is shown in figure (3).

According to table (4), the minimum value of outdoor and indoor absorbed dose , outdoor and Indoor annual effective dose, external and internal hazard indexes are at sample S01, while the maximum value is at sample S07, and the reason for this is that the location of this sample is approximately the middle of the studied area, where it is far from the city and its rough sandy soil and salinity ratio it is very high.

Table (5) shows the relationship between analysis of laboratory data as radionuclide concentrations and hazard indicators for the studied soil samples. Where we found Pearson's correlation was very direct strong relation and positive between the concentrations of ^{226}Ra, ^{232}Th and ^{40}K nuclides and $\mathcal{R}a_{eq}$, where it was statistically significant (p-value < 0.05) it turns out that there is a strong statistical

significance. While Pearson's correlation showed significant strong positive correlations (1.000**, p value 0.00) for each outdoor and indoor absorbed dose , outdoor and indoor annual effective dose. This correlation among variables indicates to not significant correlations (P = 0.900) were found between (^{232}Th-^{226}Ra)and (^{40}K-^{226}Ra)While An inverse relationship and there is no statistical significance between (^{40}K-^{232}Th) , (^{232}Th-^{226}Ra) (0.035 ,P value 0.900) Pearson's correlation showed significant middle positive correlations (1.000**, p value <0.001) for (^{40}K-^{232}Th)and (^{40}K-^{226}Ra). Pearson correlation showed significant strong positive correlations (1 to 0.999**, p value 0.00o) for external and internal hazard indexes with outdoor and indoor absorbed dose , outdoor and indoor annual effective dose .finally Pearson's correlation showed great strong positive (0.853 **, p value 0.000) and there is strong statistical significance between I$_\gamma$and Iα.

Table1. The concentration of ^{226}Ra, ^{232}Th and ^{40}K in the soil samples under study

ID	^{232}Th(Bq.Kg^{-1})	^{226}Ra(Bq.Kg^{-1})	^{40}K(Bq.Kg^{-1})
S01	7.928±0.442	10.064±1.207	298.088±4.164
S02	15.913±0.555	20.484±1.420	515.573±4.914
S03	19.011±0.621	17.594±1.397	682.304±5.664
S04	18.559±0.602	18.163±1.397	664.673±5.219
S05	16.337±0.621	19.797±1.397	575.157±4.997
S06	14.849±0.621	13.948±1.255	616.028±5.025
S07	19.322±0.630	21.005±1.633	682.914±5.358
S08	15.988±0.527	19.892±1.349	558.748±5.108
S09	15.828±0.489	16.221±1.255	522.681±4.636
S10	13.681±0.546	12.148±1.160	462.652±4.720
S11	14.595±0.546	17.618±1.397	514.268±4.942
S12	17.241±0.583	23.278±1.302	607.976±5.164
S13	14.990±0.536	15.700±1.349	575.074±5.025
S14	16.233±0.508	16.245±1.089	452.324±4.886
S15	17.862±0.517	18.636±1.302	570.576±5.136
Ave.	15.889±0.556	17.386±1.327	553.269±4.997
Max.	19.322±0.630	23.278±1.633	682.914±5.664
Min.	7.9284±0.442	10.064±1.089	298.088±4.164
worldwide[20]	30	35	420

Table2. The ratio of ^{226}Ra, ^{232}Th and ^{40}K in the soil samples under study

ID	The ratio of specific activity of ^{226}Ra, ^{232}Th and ^{40}K		
	^{232}Th - ^{226}Ra	^{40}K - ^{226}Ra	^{40}K - ^{232}Th
S01	0.787±0.366	29.618±3.448	37.597±9.410
S02	0.776±0.391	25.169±3.279	32.398±8.846
S03	1.080±0.444	38.778±4.053	35.889±9.113
S04	1.021±0.431	36.594±3.736	35.813±8.661
S05	0.825±0.444	29.052±3.577	35.205±8.041
S06	1.064±0.495	44.165±4.485	41.485±8.688
S07	0.919±0.386	32.511±3.279	35.343±8.493
S08	0.803±0.390	28.089±3.784	34.946±9.688
S09	0.975±0.390	32.221±3.694	33.021±9.469
S10	1.126±0.495	38.083±4.067	33.815±8.642
S11	0.828±0.390	29.188±3.537	35.235±9.049
S12	0.740±0.448	26.117±3.965	35.263±8.846
S13	0.954±0.397	36.627±3.723	38.362±9.363
S14	0.999±0.466	27.843±4.485	27.863±9.041

S15	0.958±0.397	30.615±3.943	31.942±9.918
Ave.	0.9138±0.420	31.821±3.784	34.819±9.016
Max.	1.126±0.495	44.165±4.485	41.485±9.688
Min.	0.740±0.448	25.169±3.279	27.863±8.041
Worldwide[20]	0.86	11.43	13.33

Table3. Radiation hazard Indices of Gamma and Alfa rays in the soil Samples under study

| ID	$\mathcal{R}a_{eq}$(Bq.Kg^{-1})	I_{γ}(Bq.Kg^{-1})	Iα(Bq.Kg^{-1})
S01	44.354±2.161	0.345±0.015	0.050±0.005
S02	82.939±2.593	0.639±0.018	0.102±0.007
S03	97.318±2.722	0.762±0.019	0.087±0.006
S04	95.882±2.660	0.749±0.749	0.090±0.006
S05	87.446±2.670	0.678±0.018	0.098±0.006
S06	82.616±2.530	0.652±0.018	0.069±0.006
S07	101.22±2.948	0.788±0.020	0.105±0.008
S08	85.779±2.497	0.664±0.020	0.099±0.006
S09	79.102±2.312	0.614±0.017	0.081±0.006
S10	67.337±2.304	0.526±0.016	0.060±0.005
S11	78.088±2.558	0.606±0.018	0.088±0.006
S12	94.747±2.534	0.732±0.017	0.116±0.008
S13	81.417±2.504	0.637±0.017	0.078±0.006
S14	74.288±2.192	0.572±0.015	0.081±0.005
S15	88.114±2.438	0.683±0.017	0.093±0.006
Ave.	82.710±2.508	0.643±0.017	0.086±0.006
Max.	101.22±2.948	0.788±0.020	0.116±0.008
Min.	44.354±2.161	0.345±0.015	0.050±0.005
Worldwide[20]	370	< 1	< 1
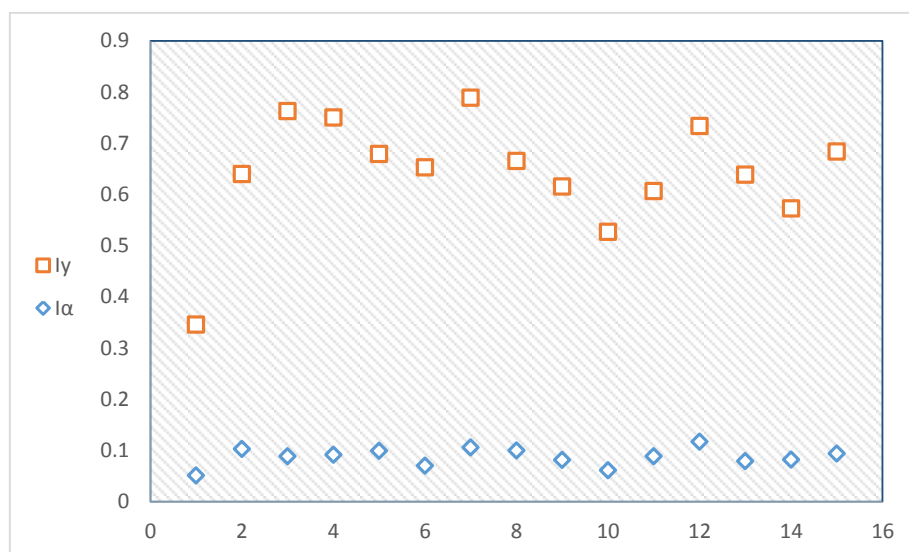
Figure3. Comparison between Gamma and Alfa Rays in the soil Samples

<div align="center">Table4.Hazard indices in the soil sample under study</div>

ID	Outdoor Absorbed Dose (nGy. h^{-1})	Indoor Absorbed Dose (nGy.h^{-1})	Outdoor annual effective dose equivalent (mSv y^{-1})	Indoor annual effective dose equivalent (mSv y^{-1})	H_{ext}	H_{int}
S01	22.363±0.987	29.0730±1.284	0.027±0.001	0.142±0.006	0.119±0.005	0.146±0.009
S02	41.451±1.185	53.886±1.541	0.050±0.001	0.264±0.007	0.223±0.007	0.279±0.010
S03	49.437±1.251	64.268±1.627	0.060±0.001	0.315±0.007	0.262±0.007	0.310±0.011
S04	48.622±1.219	63.209±1.585	0.059±0.001	0.310±0.007	0.258±0.007	0.308±0.010
S05	44.000±1.222	57.200±1.589	0.0539±0.001	0.280±0.007	0.236±0.007	0.289±0.010
S06	42.275±1.163	54.95±1.512	0.051±0.001	0.269±0.007	0.223±0.006	0.260±0.010
S07	51.125±1.345	66.463±1.749	0.062±0.001	0.326±0.008	0.273±0.007	0.330±0.012
S08	43.104±1.145	56.035±1.488	0.052±0.001	0.274±0.007	0.231±0.006	0.285±0.010
S09	39.880±1.059	51.844±1.377	0.048±0.001	0.254±0.006	0.213±0.006	0.257±0.009
S10	34.138±1.059	44.380±1.377	0.041±0.001	0.217±0.006	0.181±0.006	0.214±0.009
S11	39.298±1.170	51.088±1.521	0.048±0.001	0.250±0.007	0.210±0.006	0.258±0.010
S12	47.496±1.164	61.745±1.514	0.058±0.001	0.302±0.007	0.255±0.006	0.318±0.010
S13	41.356±1.147	53.762±1.492	0.050±0.001	0.263±0.007	0.219±0.006	0.262±0.010
S14	37.133±1.011	48.273±1.315	0.045±0.001	0.236±0.006	0.200±0.005	0.244±0.008
S15	44.317±1.119	57.613±1.455	0.054±0.001	0.282±0.007	0.237±0.006	0.288±0.010
Ave.	41.733±1.150	54.253±1.495	0.051±0.001	0.266±0.007	0.223±0.006	0.270±0.010
Max.	51.125±1.345	66.463±1.749	0.062±0.001	0.326±0.008	0.273±0.007	0.330±0.012
Min.	22.363±0.987	29.073±1.284	0.027±0.001	0.142±0.006	0.119±0.005	0.146±0.008
Worldwide[21]	59	84	0.07	0.41	< 1	< 1

<div align="center">Table4.Pearson Correlation and P-value for all parameters studied</div>

Laboratory data

Variables	Correlations	^{226}Ra	^{232}Th	^{40}K	$\mathcal{R}a_{eq}$
^{226}Ra	Pearson Correlation	1	0.752**	0.634*	0.810**
	P value		0.001	0.011	0.000
^{232}Th	Pearson Correlation	0.752**	1	0.883**	0.956**
	P value	0.001		0.000	0.000
^{40}K	Pearson Correlation	0.634*	0.810**	1	0.958**
	P value	0.001	0.000		0.000
$\mathcal{R}a_{eq}$	Pearson Correlation	0.810**	0.956**	0.958**	1
	P value	0.000	0.000	0.000	

Variables	Correlations	$\mathcal{D}_{out}$	$\mathcal{D}_{in}$	D_{eff}	D_{eff1}
$\mathcal{D}_{out}$	Pearson Correlation	1	1.000**	1.000**	1.000**
	P value		0.000	0.000	0.000
$\mathcal{D}_{in}$	Pearson Correlation	1.000**	1	1.000**	1.000**
	P value	0.000		0.000	0.000
D_{eff}	Pearson Correlation	1.000**	1.000**	1	.999**
	P value	0.000	0.000		0.000
D_{eff1}	Pearson Correlation	1.000**	1.000**	.999**	1
	P value	0.000	0.000	0.000	

Variables	Correlations	^{232}Th-^{226}Ra	^{40}K-^{226}Ra	^{40}K-^{232}Th	

^{232}Th-^{226}Ra	Pearson Correlation	1	0.822**	0.035
	P value		0.000	0.900
^{40}K-^{226}Ra	Pearson Correlation	0.822**	1	0.596*
	P value	0.000		0.019
^{40}K-^{232}Th	Pearson Correlation	.035	0.596*	1
	P value	0.900	0.019	

Variables	Correlations	$\mathcal{H}_{ex}$	$\mathcal{H}_{in}$
$\mathcal{H}_{ex}$	Pearson Correlation	1	.993**
	P value		0.000
$\mathcal{H}_{in}$	Pearson Correlation	.993**	1
	P value	0.000	
D$_{eff1}$	Pearson Correlation	.999**	.988**
	P value	0.000	0.000
D$_{eff}$	Pearson Correlation	.999**	.989**
	P value	0.000	0.000
$\mathcal{D}_{out}$	Pearson Correlation	.999**	.988**
	P value	0.000	0.000
$\mathcal{D}_{in}$	Pearson Correlation	.999**	.988**
	P value	0.000	0.000

Variables	Correlations	I_{α}	I_{γ}
I_{α}	Pearson Correlation	1	0.853**
	P value		0.000
I_{γ}	Pearson Correlation	0.853**	1
	P value	0.000	

**high significant of correlation at the level (0.01)(2-tailed) , also *correlation is significant at the level (0.05)level(2-tailed).

Conclusions.

After obtaining information about the levels of natural radioactivity and understanding the behavior of these radionuclides in the soil of Ya-Hussein road, it was found that the values mentioned in this paper are within the normal level of radiation and less than the average global value. Likewise, the effective dose in the soil of this road falls within safety limits except for the potassium concentration, which is higher than the values recommended by[22].This data can be considered as a baseline when making population exposure estimates in this road. Pearson's correlation is strong and statistically significant in all comparisons except (^{40}K-^{232}Th) , (^{232}Th-^{226}Ra).Finally   the ELCR is lower than average world. UNSCEAR2000B[21] This study is considered exceptional and preliminary for this region   and   can   be   adopted   in   the   future   for   research   in   this field.

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