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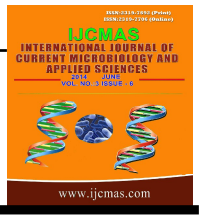

Original Research Article

Determination of agriculture soil primordial radionuclide concentrations in Um Hablayn, north Jeddah west of Saudi Arabia

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A B S T R A C T

Twenty samples of the highly fertilized soil from Wadi Um Hablayn north Jeddah of Saudi Arabia were analyzed by XRD spectroscopy for the chemical and mineral compositions. The results show that, the major constituents are Quartz and Albite. Minor of Clinochlore, Microcline, Pargasite, and Tremolite occur in soils, also trace minerals are present. The activity concentration of radionuclides, such as ^{238}U, ^{226}Ra, ^{232}Th, and ^{40}K were measured by –ray spectroscopy using HPGe detector. The average concentrations in Bq/kg dry weight of determined radionuclides (^{238}U, ^{226}Ra, ^{232}Th, ^{235}U, and ^{40}K) were 74.95, 44.87, 54.59, 03.79, and 2652.30 respectively. The activity concentration average in Bq/kg dry weight of ^{238}U / ^{226}Ra ratio was1.58 (it is about 1.03 in UNSCEAR, 2000). $Ra_{eq,}$ dose rate, annual effective dose, and hazard indices (H_{ex} and H_{in}) average values were 337.58 Bq/ kg, 169.73 nGy /h, 0.21 mSv , 0.912, and 1.040 respectively . The high concentrations of radioelements and their ratios were due to extensively phosphate fertilizers applied in this area. The gamma doses and the hazard indices were found to be high in this area, which means that it is not safe for the environment. The results of the present study were discussed and compared with the results of similar investigations and internationally recommended values.

Keywords

Wadi Um Hablayn. natural radioactivity in soil. Phosphate fertilizers

Introduction

Radionuclides (uranium, radium, thorium, and potassium) are found naturally in soil. The amount of radioactivity in soil depends upon the type and at different levels of the soil of each different geological region. It is important to study the distribution and specification of the encountered radioelements and their impact on the environment. Uranium, thorium, and their decay products are radionuclides that represent a potential risk to human health due to the emission of ionizing radiation (E Aassy Ibrahim E., et al, 2011). The subject of natural radioactive contamination gained considerable public importance because they are the largest contributors to radiation doses received by human beings (Nasim Akhter, et al, 2005). Measurement of natural radioactivity in rocks and soils is very important to determine and monitor the amount of change of the natural background activity with time for environmental

protection. (Najam Laith A., et al, 2011). Over the last decades, the land reclamation and agriculture activities in Saudi Arabia and other countries have been widely expanded. Therefore, the usage of chemical fertilizers is increased (such as phosphate fertilizers) to increase crop production and to improve the properties of the nutrient-deficient lands. Negative effect of phosphate fertilizers is the contamination of cultivated lands by naturally occurring radioactive materials (NORM) (Khater Ashraf E.M., AL-Sewaidan H.A., 2008).

The aim of this study is to measure the natural radioactivity contents, annual effective radiation dose, and external radiation hazard indices in the surface soils of Wadi Um Hablayn . In this valley, the manufacturer fertilizers contain phosphates were used to cultivate and increase the fertility of soil. The data generated in this study will provide base line values of natural radioactivity in soils and may be useful for studies on this issue.

Analytical technique

Study area

Jeddah, the largest city of the Kingdom of Saudi Arabia stands on the eastern shore of the Red Sea. Jeddah Governorate comprises three distinct geomorphological zones; the Red Sea and shore features, the coastal plain, and coastal hills and pediments. The last zone forms a basin that lies east of Jeddah. The drainage in this area consists of a large number of Wadi (valley), from north to south and all of these systems drain towards the Red Sea. One of them is Wadi Um Hablayn, it is a valley, bounded by relatively steep banks, which in the rainy season becomes a watercourse. Its center lies at a latitude of 21.72778 and longitude of 39.25111and it has an elevation of 52 meters above sea level. (Mohammed H.T. Qari, 2009). The amount of rain falling annually does not exceed than the 120 mm on Jeddah Wadies, this water is used to irrigate farms spread in this area. With the increase in population and the need for more agricultural production turned attention to the use of purified water in the irrigation these valleys to cultivate and increase the fertility of soil using manufacturer fertilizers contain phosphates, which affect negatively on agricultural soils as a result of the melting of fertilizers in the soil and erosion on the surface, in addition to pollution water, air and living organisms at high concentrations.

Sample Collection and Measuring Methods

Soil samples were collected from 20 points at selected area (Latitude 210 42’ 0” N - Longitude 390 16’ 0” E) during April 2012. Each sample was taken from a depth of 5 - 10 cm at a randomly chosen point within the site of Wadi Um Hablayn, north Jeddah west of Saudi Arabia as shown in figure (1). The samples were ground and sieved through a sieve of 1-mm mesh to remove gravels as well as plant root and leaves. They were dried to 95°*C* for 24 hours in order not to lose the volatile polonium or cesium. The dried fine grained samples were packed in polyethylene Marinelli beaker, sealed off, and stored for 2 to 4 months to reach the secular equilibrium between 226Ra and 228Ra nuclides and their progenies. The dried soil samples were analyzed by XRD model Burker XR-D D8 Advance for the chemical and mineral compositions. Then, soil samples were Analyzed for the activity of natural radionuclides using the gamma spectrometer based on Canberra Hyper Pure Germanium detector "HPGe" coaxial detector with relative efficiency of 20% and FWHM 4.2 keV at 1461 keV. Genie 2000 basic spectroscopic software was installed in

the computer for data acquisition and analysis. The system was calibrated for energy and absolute efficiency. The lowest limits of detection were determined to be 0.33, 0.27, and 2.31 for 226Ra, 232Th, and 40K respectively, the measurements were done for a time period of 82,800 seconds. An empty polyethylene Marinelli beaker was placed in the detection system, for the time period between 20-24 h, in order to collect the background count rates. Then, each sample was measured during an accumulating time between 20 -24 h.

Calculations

The activity of 238U cannot be directly determined, the short half–life gamma-emitting daughter nuclide (234Th) in equilibrium with 238U was used for activity determined from the 63.3(4.10%) keV photopeak. Gamma-ray lines of energies 295.09 (18.50%), 351.87 (35.80%), 609.31 (44.79%), 1120.27 (14.80%), and 1764.49 (15.36 %) keV resulting from the decay of daughters 214 Pb and 214Bi radionuclides were used to determine the activity concentrations of 226 Ra which it is in secular radioactivity equilibrium with its short half–life daughters; the gamma-ray lines at 338.32 (11.25%), (911.16 (26.60%), 968.97 (16.17%), 583.10 (30.11%), and 2614.48(35.34%) kev from the decay of short half–life daughters 228Ac and 208Tl were used to determine the activity concentrations of 232Th respectively (since there is secular radioactivity equilibrium in 232Th series).

The gamma-ray line 143.80 (11.00%) was used to determine the activity concentrations of 235U, while the 1460.80 (11.00%) transition was used to determine the activity concentrations of 40K. Determination of activity concentrations in Bq/kg dry weight was calculated using the equation (1) (Amrani D., Tahtat M., 2000).

$$\mathbf{A = \frac{C}{m\,\beta\,\varepsilon}} \qquad \mathbf{(1)}$$

Where: C is the net peak area of specific gamma ray energy (count per second). m is the mass of the samples in (kg) is the transition probability of gamma-decay. is the detector absolute efficiency at the specific gamma-ray energy. Exposure to radiation has been defined in terms of the radium equivalent Raeq Bq/kg which is calculated from equation (2) (Tufail *et al.*, 2006).

Raeq = CRa +(CTh x 1.43) + (CK x0.077) (2)

Where: CRa, CTh and CK are the concentrations in Bq/kg dry weight for radium, thorium and potassium respectively. The total air absorbed dose rate (nGy/h) in the outdoor air at 1 m above the ground due to the activity concentrations of 226Ra, 232Th and 40K (Bq/ kg) dry Weight was calculated using the equation (3) (UNSCEAR, 2000; Veiga *et al.*, 2006).

D (nGy/h) = 0.462CRa + 0.604CTh +0.0417CK (3)

Where: CRa, CTh, and CK are the specific activities (concentrations) of 226Ra, 232Th and 40K in Bq /kg dry weight respectively.
The annual effective dose equivalent D eff (mSv/ y) in air was calculated using the values of the absorbed dose rate by applying the dose conversion factor of 0.7 Sv/Gy and the outdoor occupancy factor of 0.2 (people spend about 20% of their life outdoor) the Annual Effective Dose (in mSv/y) received by population can be calculated using equation :

Deff (mSv/y) = D (nGy/h) ×8,766 h × 0.7(Sv/Gy)× 0.2 ×10-6 (4)

Where: D (nG/h) is the total air absorbed dose rate in the outdoor. 8,766 h is the number of hours in 1 year. 10-6 is conversion factor of nano and milli. To limit

the annual external gamma-ray dose to 1.5 Gy for the samples under investigation, the external hazard index (Hex) is given by the equation (5) (Ibrahim *et al.*, 2011).

Hex =CRa 370 +CTh 259 + CK 4810 (5)

The internal exposure to 222Rn and its radioactive progeny is controlled by the internal hazard index (Hin), which is given by the equation (6) (Nada, 2003)

Hin = CRa /185 + CTh / 259 + CK / 4810 (6)

Results and Discussion

XRD Analysis

Soil mineralogy is determined routinely because of its strong influence on soil behavior, its use in soil classification, and its relevance to soil genetic processes. Soils commonly contain primary minerals, which are formed from magma and provide insight into characteristics such as parent material provenance, uniformity, and weathering rates. Soils also contain secondary minerals, which are formed from weathering processes, and may have crystallographic characteristics that strongly influence the physical and chemical properties of soils. X-ray diffraction (XRD) is the technique most heavily relied on in soil mineralogical analysis.

X-ray diffraction is a technique that provides detailed information about the atomic structure of crystalline substances. It is a powerful tool in the identification of minerals in rocks and soils (Harris W., White G. N., 2007). In the present study,the XRD results indicate that the main constituents (Major) of these samples are quartz (SiO2) and Albite (NaAlSi3O8). Small amount (Minor) of Clinochlore ((MgFe2+)5Si3Al2O10(OH)8), Microcline (KAlSi3O8), Pargasite (NaCa2Mg3Fe2+ Si6Al3O22(OH)2), and Tremolite (Ca2Mg5 (Si8O22)(OH)2) occur in soils. Other minerals (Trace) are present as well. The mineral constituents of 20 samples analyzed by XRD spectrometer are shown in Table 1. Table 2 represents the mineral chemical composition and its description.

Gamma Analysis

Table 3 illustrates the specific activities in Bq/.kg dry weight of the natural radionuclides (238U, 226Ra, 232Th, 235U and 40K) and the Activity concentration ratios 238U/226Ra in the samples. Activity concentrations of 238U found to be ranged from 48.02 to 115.74 Bq/kg with an average value of 74.95 Bq/kg. Activity concentrations of 226Ra varied from 39.92 to Bq/kg with an average value of 44.87 Bq/kg. The 232Th activity concentrations ranged from. 46.93 to 68.31Bq/kg with an average value of 54.59Bq/kg. Activity concentrations of 235U (in samples 6, 7, and 12 only) ranged from 02.34 to 06.07Bq/kg with an average value 03.79 of Bq/kg. While the activity concentrations of 40K ranged from 2555.67to 2976.81Bq/kg with an average of 2652.30Bq/kg. Sample No. 6 has the highest values of 238U, 226Ra and 232Th, while Sample No. 11 has the highest value of 40K.

Activity concentration values of 238U in all samples were high than that in the soil of 226Ra and 232Th. This is refer to some of the alteration processes led to the increase of uranium concentrations during weathering, alterations, and due to using the manufacturer fertilizers contain phosphates in this area. The activity concentration ratios 238U/226Ra for the measured samples ranged from 1.01 to 1.96 with an average of 1.58 (The average value of 238U/226Ra in UNSCEAR, 2000 report is about 1.03). This ratio can be used as an indicator of the relative occurrence of these radionuclides.

Samples1 and 7 with 238U/226Ra ratios were around unity, which means that the uranium migration-in and migration-out is nearly the same. Most of the samples (18 samples) with238U/226Ra ratio more than unity may be attributed to extensively phosphate fertilizers applied in this area, therefore uranium contents were found to be increased.

Hazard indices

Table 4 gives the radium equivalent (Raeq), in addition to the dose rate (D), the annual effective dose (Deff), the external and internal hazard indices (Hex and Hin). Raeq values ranged between 309.25 to 369.02 Bq/ kg, with average value of 337.58 Bq/ kg. These values are relatively high but the estimated average value of Raeq in the present work is lower than the recommended maximum value of 370 Bq/ kg (UNSCEAR, 2000). The γ-radiation absorbed dose rate (D) in air at a height of about 1 m above the ground varied from 155.77 to 183.51 nGy /h with average value of 169.73 nGy /h, which is higher by a factor of 2.83 than the world's average value of 60 nGy/h. Results for the annual effective dose (Deff) ranged from 0.19 to 0.23 mSv with an average of 0.21 mSv, while the world wide average of annual effective dose is approximately 0.07 mSv. The external hazard index (Hex) ranged from 0.835 to 0.997 with an average value of 0.912.

The internal exposure to 222Rn and its radioactive progeny is controlled by the internal hazard index (Hin), which ranged from 0.951 to 1.156 with an average value of 1.040. Hex and Hin must not exceed the limit of unity for the radiation hazard to be negligible. In this study, the calculated average values of external and internal hazard indices were near and higher than unity, which it means that this area is not safe for the environment. The results were not in agreement (higher than) with the average worldwide limits.This refer to the addition in excessive rate of the inorganic phosphate fertilizers accompanied with the natural radioactivity nuclides in these areas. Table 5 compares the values of 238 U, 232Th, 40K, and Raeq in the worldwide agricultural soils with those determined in the present study. It is found that, in the present study, the value of 238U was higher than that All other countries. 226Ra average value almost matched those of Northern Jordan, Vojvodina, and Vietnam. 232Th average value matched those of Vojvodina, and Vietnam. However, the average values of 40K of Saudi Arabia and Jeddah were in the highest range that All other countries.

In comparison, Raeq value was high for the present study but less than that Malaysia. Table 6 shows the average Hazard Indices of the primordial radionuclides in the worldwide agricultural soils. Absorbed dose rate (D (nGy/h) follows as Malaysia Jeddah Saudi Arabia India Bathinda India Amritsar VIETNAM UNSCEAR, for Jordan and Riyadh,(D (nGy/h) is less than the world's average value of 60 nGy/h. The effective dose rates (Deff mSv/y) for all samples were not exceed the recommended value 1 mSv, but the values of the external hazard index (Hex) was higher than unity for Malaysia and the internal hazard index (Hin) was higher than unity for the present work. Hence, these two countries pose much health hazard the population and not safe for the environment.

The activity concentrations of radionuclides of 238U, 226Ra, 232Th, and 40K were measured by gamma-ray spectrometry system for surface soil samples collected from Wadi Um Hablayn, north Jeddah west of Saudi Arabia. In this study, it is found that the value of uranium was higher than that all other comparable countries.

Table.1 The mineral constituents of 20 samples analyzed by XRD spectrometer

Sa. No.	MAJOR	MINOR	TRACE
1	Quartz Albite	Clinochlore, Microcline, Pargasite	Augite, Biotite, Calcite, Halite, Magnetite, Saponite
2	Quartz Albite	Clinochlore, Microcline	Augite, Biotite, Calcite, Halite, Magnetite, Pargasite Saponite
3	Quartz Albite	Clinochlore, Microcline	Augite, Biotite, Calcite, Halite, Magnetite, Pargasite Saponite,
4	Quartz Albite	Clinochlore,Microcline, Pargasite	Biotite , Calcite, Diopside , Halite, Magnetite , Saponite
5	Quartz Albite	Clinochlore, Microcline	Augite, Biotite, Calcite, Halite, Magnetite, Pargasite Saponite
6	Quartz Albite	Clinochlore, Microcline	Biotite , Calcite, Diopside , Halite, Magnetite , Saponite , Tremolite
7	Quartz Albite	Clinochlore, Microcline, Pargasite	Augite , Biotite , Halite , Magnetite,Saponite
8	Quartz Albite	Clinochlore,Microcline, ,Pargasite	Augite, Biotite, Calcite, Halite, Magnetite, Pargasite, Saponite,
9	Quartz Albite	Clinochlore,Microcline, Tremolite	Augite, Biotite, Calcite, Halite, Magnetite, Saponite
10	Quartz Albite	Clinochlore,Microcline, Pargasite	Augite, Biotite, Calcite, Halite, Magnetite, Saponite
11	Quartz Albite	Clinochlore, Microcline	Biotite , Calcite, Diopside , Halite, Magnetite , Saponite, Pargasite
12	Quartz Albite	Clinochlore,Microcline, Pargasite	Augite, Biotite, Calcite, Halite, Magnetite, Saponite
13	Quartz Albite	Clinochlore,Microcline, Pargasite	Biotite , Calcite, Diopside , Halite, Magnetite , Saponite
14	Quartz Albite	Clinochlore,Microcline, Pargasite	Augite, Biotite, Calcite, Halite, Magnetite, Saponite
15	Quartz Albite	Clinochlore,Microcline,	Augite, Biotite, Calcite, Halite, Magnetite, Saponite, Tremolite
16	Quartz Albite	Clinochlore,Microcline,	Augite, Biotite, Calcite, Halite, Magnetite, Pargasite, Saponite,
17	Quartz Albite	Clinochlore,Microcline, Tremolite	Biotite , Calcite, Diopside , Halite, Magnetite , Saponite
18	Quartz Albite	Clinochlore,Microcline, Pargasite	Augite, Biotite, Calcite, Halite, Magnetite, Saponite
19	Quartz Albite	Clinochlore,Microcline, Pargasite	Augite, Biotite, Calcite, Halite, Magnetite, Nontronite
20	Quartz Albite	Clinochlore,Microcline, Pargasite	Biotite , Calcite, Diopside , Halite, Magnetite , Montmoril

Table.2 The mineral chemical composition and its description, (Leet *et al*., 1982, and Mineral Data, *2012)*

MINERAL	CHEMICAL COMPOSITION	DESCRIPTION
Albite	NaAlSi3O8	Sodium Plagioclase feldspar. Magmatic and pegmatitic rocks. Opalescent variety, moonstone.
Augite a pyroxene	(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)2O6	Ferromagnesian silicate. Basic igneous and metamorphic rocks.
Biotite Black mica	K(MgFe2+)3AlSi3O10(OH, F)2	Granitic rocks. Forms a series with phlogopite
Calcite	CaCo3	Calcium Carbonate. Found in Sedimentary, igneous, and metamorphic rocks.
Clinochlore	(MgFe2+)5Si3Al2O10(OH)8	Contact, hydrothermal, and regional metamorphism of mafic minerals
Diopside	CaMg(Si2O6),	Basic and ultrabasic igneous and metamorphic rocks
Halite	NaCl	Marine or continental Evaporite deposits
Magnetite	Fe3+2Fe2+O4	Common accessory mineral in igneous and metamorphic rocks. Strongly magnetic known as lodestone.
Microcline	KAlSi3O8,	Granitic pegmatites, hydrothermal and metamorphic rocks
Montmorillonite	NaCaAl2Si4O10(OH)2(H2O)10	A very soft phyllosilicate group of minerals form in microscopic crystals, forming a clay, absorp water and exand.
Nontronite	NaFe3+2Si3AlO10(OH)24(H2O)	It is the iron(III) rich member of the smectite group of clay minerals.
Pargasite	NaCa2Mg3Fe2+Si6Al3O22(OH)2	Lime green, prismatic crystals or Blocky, dark green crystals.
Quartz	(SiO2)	Valid Species Prehistoric.
Saponite	CaNa(MgFe2+)3Si3AlO10(OH)2•4 (H2O)	Amygdaloidal cavities in basalts.
Tremolite	Ca2Mg5(Si8O22)(OH)2	Contact metamorphism of Ca rich rocks.

Table.3 The activity concentrations Bq/.kg dry weight of the ^{238}U, ^{226}Ra, ^{232}Th, ^{235}U, ^{40}K and Activity concentration ratios $^{238}U/^{226}Ra$ for the measured samples

Sample No.	^{238}U	^{226}Ra	^{232}Th	^{235}U	^{40}K	$^{238}U/^{226}Ra$
1	48.02 0.47	45.52 0.28	61.04 0.13	ND	2815.28	1.06
2	68.95 0.41	43.32 0.09	58.84 0.09	ND	2884.50 0.08	1.59
3	72.65 0.43	39.92 0.08	52.27 0.08	ND	2647.98 0.06	1.82
4	92.35 0.45	53.61 0.12	62.42 0.14	ND	2665.28 0.06	1.72
5	94.82 0.43	49.32 0.14	56.93 0.12	ND	2829.70 0.09	1.92
6	115.74 0.45	59.00 0.13	68.31 0.16	06.01 0.07	2757.57 0.06	1.96
7	50.86 0.44	50.21 0.18	52.42 0.10	02.34 0.06	2871.53 0.08	1.01
8	65.26 0.42	49.70 0.07	51.04 0.10	ND	2606.15 0.07	1.31
9	70.18 0.41	50.21 0.18	53.69 0.13	ND	2920.56 0.07	1.40
10	96.04 0.41	49.70 0.10	49.89 0.11	ND	2699.90 0.09	1.93
11	67.72 0.44	50.26 0.13	56.58 0.04	2976.81 0.11	1.35	
12	60.33 0.42	40.34 0.10	58.63 0.06	03.01 0.07	2689.80 0.09	1.50
13	73.88 0.44	42.43 0.09	46.97 0.07	ND	2731.63 0.10	1.74
14	52.95	46.37 0.13	52.29 0.07	ND	2676.82 0.06	1.14
15	80.03 0.43	42.96 0.12	48.60 0.05	ND	2555.67 0.08	1.86
16	91.12 0.43	49.17 0.11	57.10 0.19	ND	2852.78 0.07	1.85
17	72.65 0.42	48.67 0.09	46.93 0.09	ND	2738.84 0.05	1.49
18	77.57 0.41	48.16 0.08	57.04 0.06	ND	2748.73 0.15	1.61
19	67.72 0.40	48.73 0.07	48.76 0.07	ND	2735.94 0.07	1.39
20	80.03 0.42	43.36 0.08	52.02 0.07	ND	2652.30 0.06	1.85
Range	**48.02-115.74**	**39.92**	**46.93-68.31**	**02.34-06.07**	**2555.67-2976.81**	**1.01-1.96**
Average	**74.95 0.43**	44.87 0.16	**54.59 0.08**	**03.79 0.07**	**2752.89 0.08**	**1.58**

Table.4 Radium equivalent activity, dose rate, annual effective dose, external and internal indices for the studied samples.

Sample No.	Raeq q/kg)	D (nGy/h)	Deff mSv/y)	Hex	Hin
1	349.58	175.30	0.215	0.944	1.067
2	349.57	175.84	0.216	0.944	1.061
3	318.56	160.44	0.197	0.860	0.968
4	348.10	173.61	0.213	0.940	1.085
5	348.62	175.17	0.215	0.941	1.075
6	369.02	183.51	0.225	0.997	1.156
7	346.28	174.60	0.214	0.935	1.071
8	323.36	162.47	0.199	0.873	1.008
9	351.87	177.41	0.218	0.950	1.086
10	328.94	165.68	0.203	0.888	1.023
11	360.38	181.53	0.222	0.973	1.109
12	331.30	166.21	0.204	0.895	1.004
13	319.93	161.88	0.199	0.864	0.979
14	327.26	164.63	0.202	0.884	1.009
15	309.25	155.77	0.191	0.835	0.951
16	350.49	176.17	0.216	0.947	1.079
17	326.67	165.04	0.203	0.882	1.014
18	341.38	171.32	0.210	0.922	1.052
19	329.12	166.05	0.204	0.889	1.020
20	321.98	162.05	0.199	0.869	0.987
Range	**309.25-369.02**	**155.77- 183.51**	**0.191-0.225**	**0.835-0.997**	**0.951-1.156**
Average	**337.58**	**169.73**	**0.208**	**0.912**	**1.040**

Table.5 Average activity concentrations in Bq/ kg of the primordial radionuclides and Raeq in the worldwide agricultural soils

Location	**238U Bq/ kg**	**^{226}Ra** Bq/ kg	**232Th Bq/ kg**	**40K Bq/ kg**	**Raeq Bq/ kg**	**Reference**
Vojvodina	51.56	39.04	53.00	554.00	-----	I. Bikit, et al(2005)
Riyadh, Saudi Arabia	---	14.50	11.20	225.00	---	A. S. ALAAMER (2008)
Saudi Arabia	---	75.00	23.00	2818.00	283.00	Khater and ALSewaidan (2008)
Northern Jordan	49.90	42.50	26.70	291.10	103.10	AlHamarneh and Awadallah (2009).
India Bathinda	57.53	55.67	92.75	377.04	217.33	Mehra, ana Singh (2011)
India Amritsar	50.61	54.45	78.31	301.80	189.67	Mehra, ana Singh (2011)
Malaysia	---	138.20	175.40	681.90	372.91	Musa, et al. (2011)
VIETNAM	---	42.77	59.84	411.93	160.06	Huy, et al. (2012)
Jeddah Saudi Arabia	74.95	44.87	54.59	2752.89	337.58	Present Work
Worldwide	---	35.00	30.00	400.00	370.00	UNSCEAR, (2000)

Table.6 Average Hazard Indices of the primordial radionuclides in the worldwide agricultural soils.

Location	**D (nGy/h)**	**Deff mSv/y)**	**Hex**	**Hin**	**Reference**
Riyadh, Saudi Arabia	23.3	0.14	0.13	---	A. S. ALAAMER (2008)
Northern Jordan	51.50	0.06	0.28	0.39	AlHamarneh and Awadallah (2009).
India Bathinda	97.47	0.12	---	---	Mehra, ana Singh (2011)
India Amritsar	85.04	0.10	---	---	Mehra, ana Singh (2011)
Malaysia	202.04	0.23	1.19	----	Musa, et al. (2011)
VIETNAM	71.72	0.54	0.43	---	Huy, et al. (2012)
Jeddah Saudi Arabia	169.73	0.208	0.912	1.040	Present Work
Worldwide	60	0.070	1	UNSCEAR, (2000	

Fig.1 Location Map of the Collected Samples

The radium, thorium, and potassium contents exceeded of ranges the average worldwide. Raeq average value was high for the present study but less than that value identified by UNSCEAR (2000). Absorbed dose rate (D (nGy/h) was higher than the world's average value of 60 nGy/h. The effective dose rate (Deff mSv/y was not exceed the recommended value 1 mSv. For the present work, the average value of the external hazard index (Hex) was less than unity and the average value of internal hazard index (Hin) was higher than unity. These data show that the activity concentration of naturally occurring radionuclides in soil samples were high. In the Kingdom of Saudi Arabia, the use of fertilizers especially phosphate fertilizer in large extent have affected radionuclides concentration, potassium containing fertilizers are the one of the cause of presence of high activity of 40K in soil. Phosphate Fertilizers are used in excessive rate in the Kingdom due to their relatively low cost and the need for more agricultural land. The application of these fertilizers has the effect of an accumulation of radio activity in soils that can be harmful for the population and the production. The enhancement of radioactivity in agricultural land can be controlled for the use of Phosphate Fertilizers.

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