Measuring the Pollution Level with Uranium and Radon in the Soil of Some Areas Inside Baghdad University Campus-AL-Jadiriyah

Farah Faris Kaddoori[1*], Basim Khalaf Rejah[1], Wijdan Thamer Fzaa[2]

Abstract

In present study, the technique was used, including nuclear track detector type (CR-39), for appreciative concentrations uranium and radon in soil samples from Baghdad University Campus-AL-Jadiriyah utilizing a prolonged -term with a solid-state nuclear path sensor, a technique for charged particles has been developed., the radon concentrations, effective dose rate and uranium concentrations have measured in soil samples. Eight various venues from soil Baghdad University Campus have appointed. The results indicated variant values about uranium and radon concentrations, the average value for radon gas, effective dose rate and uranium concentrations was found to be 281.59 Bq/cm^3, 7.09 mSv/y and 0.01 Bq/mm^{-2} respectively. All results appeared that concentrations for radon and uranium in soil are infra the permitted limit from (ICRP) agency which are 1100 Bq/m^3 and 11.7 (mg. Kg^{-1}) ppm respectively. All results were comparison with the domestic and worldwide results.

Key Words: Radon Concentration, Uranium Concentration, Can Technique.

DOI Number: 10.14704/nq.2021.19.7.NQ21086 **NeuroQuantology 2021; 19(7):72-77**

Introduction

Radon Rn-222 is one of the noble gases naturally radiating the alpha particles, it is created by the disintegration of physical occurs radionuclide ^{226}Ra, where is in turn is a disintegration result in the uranium chains. As radon originates from the dissolution of radium, it is released through air or water which has follicles between the soil and the boulder substances. Emanation and conveyance are the two ways through which radon is emitted through soil. The two apparatuses impacted from many agents, involving the attributes for the soil (Nusseif *et al*, 2020: Faheem *et al* 2008). When radon inhalation into the lungs it disintegrations by emission α – particle that is induced ionization damaged when it strikes the lung tissue. Moreover, that damaged induced lung carcinoma (Guo *et al* 1993).

The half-life for ^{222}Rn is (3.82 d) which is prolonged sufficient that provide it for posted during the soil and entry the atmospheric, therefore, arriving the mortal environmental (Kumar *et al* 2016). The important of measuring natural radioactivity in the soil for several scholars around the world had caused to a global survey for the last two contracts, therefore, it is quite significant to measure the natural radioactivity in the soil for the identify the quantity of vary for normal backlinks behavior related with time reason or infusion radioactive (Mohammed *et al* 2017). Physical radioactivity varies significantly from one type of soil to another.

Corresponding author: Farah Faris Kaddoori
Address: [1]Department of Physics, College of Science for Women, University of Baghdad, Baghdad, Iraq; [2]Al-Nahrain Non Renewable Energy Research Center, Iraq.
[1*]E-mail: farahfaris84@gmail.com
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Received: 14 May 2021 **Accepted:** 18 June 2021

The Radionuclide are existed in the environmental and soil, as physically occurrence elements and as product of nuclear technologically, uranium defines as one of these radionuclides (Bashair and Raad 2016). Uranium is one of the minerals naturally present from time immemorial. And by the volcanic lava it was deposited on the ground, then it was disbanded by rain water. All the isotopes for uranium are radioactive, so it is necessary there to have quantity under control (Malik *et al* 2019). The abundance and isotopes of uranium identify its effectiveness in the natural radioactivity of uranium. By emitting alpha particles, uranium is decomposed to be a non-radioactive lead. The new radionuclides contribute about seven times to the formation of total natural radioactivity in the soil from that available in uranium itself. These new radionuclides are called a decay chain. Uranium is the closest source of radium and radon in soils and rocks. Radon is known to be a major contributor to background radiation and it's the uranium strain. Radon can escape from the ground because it is a gas. The amount of exposure to various radon concentrations supports on the number of agents, involving the quantity of uranium in the soil (Nidhala *et al* 2019: Sahoo 2009) The accumulated uranium has a multiplier effect because of the radioactive and chemical properties. Therefore, taking large quantities of uranium and its decay products has very malicious influence on humans (Dyck 1979). An endangering of about 0.1 $mg.Kg^{-1}$ of body weight of soluble physical uranium results in a chemical corrupt to the kidneys (Malik *et al* 2019). To calculate the concentration of natural uranium in the soil, a CR-39 detector was used. This detector has many advantages, including high sensitivity, euphoria, and accuracy in detecting alpha particle elements, although their concentration is very small. The paths of the alpha particles are observed by means of a microscope through the etching process (Abojassim *et al* 2017: Basim *et al* 2019). The present research aims to measure and study the radioactivity for radon concentrations, the equivalent dose percentage, as a consequence of it and concentration for uranium in the eight soil samples from Baghdad University Campus- AL-Jadiriyah using α – particle emission registrations that are emitted from natural radon and uranium in sensor of nuclear paths (CR-39). The calculating for natural radon gas and uranium concentrations is essential to inquiry the concentration in causing diverse diseases, particularly lung cancer due to expansion of its deployed in the soil, building materials and groundwater.

Materials and Methodology

Using uranium dosimeter techniques, the measurements natural radioactivity elements of were made with solid-state nuclear track detector (SSNTD) technique. The alpha particles related from uranium and radon gas with its derivatives were detected by a CR-39 detector. As some of these particles, upon reaching the detector, are left corrode (or used leave tracks). As well as, the average uranium and radon concentrations is proportional to the number of paths. Eight samples of soil were collected from separate sites from the University of Baghdad complex, as it shows in Fig.1.

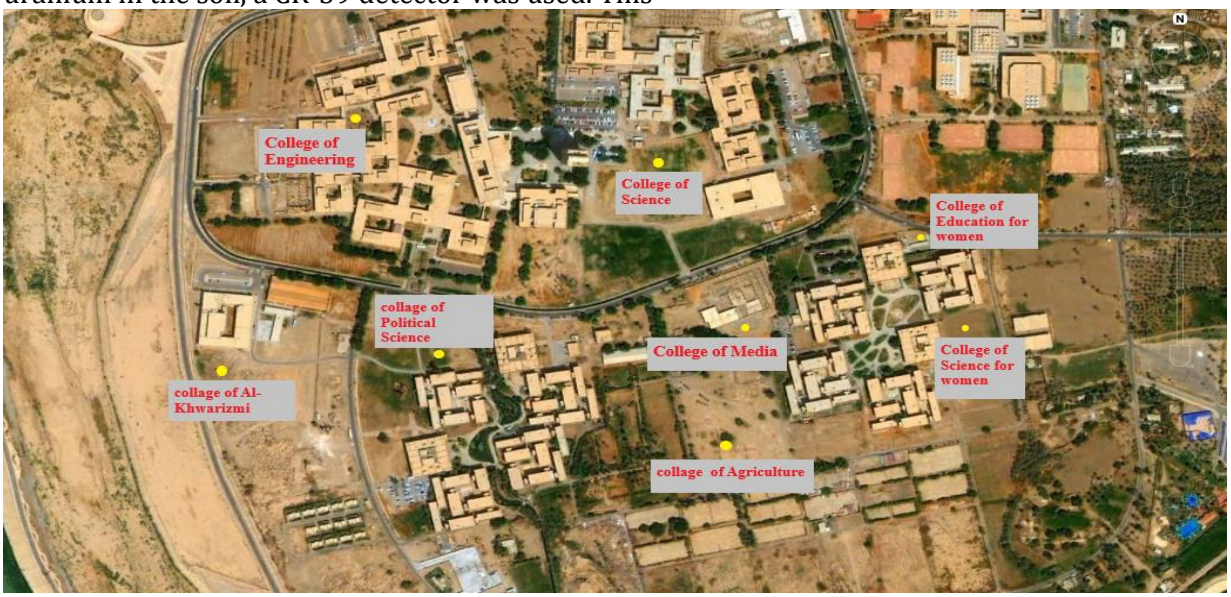

Figure 1. Google earth map appearing the location of the study area

These samples milled, dried, crushed, sieved by 2mm mesh, 140 grams of each samples were placed inside a cylindrical plastic container faced the CR-39 path detector. Each cup container is 7cm heights and 6.5cm in diameter and contains (1×1) cm square of CR-39 nuclear track detector as it shows in Fig.2. Then it is left for 30 days.

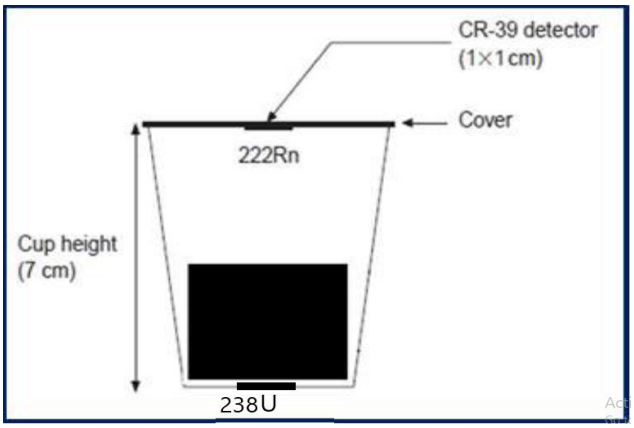

Figure 2. The geometry of both the radon and uranium dosimeters used in the investigation is depicted in a graphic picture.

After one month, the CR-39 detectors were eliminated and etched used NaOH in the normal state of 6.25 N and heated under 70 ° C in a water bath for 6 hours to reveal the paths. CR-39 detectors were washed and left to dry, and paths were calculated with a 400-x magnification

The following relationship Eq. (1) was used to determine the concentration of the paths (ρ) in the specimens (Faiz *et al* 2014: Amalds *et al* 1989).

$$\text{Tracks density (p)} = \frac{Average\ number\ of\ track}{Area\ of\ field\ view} \quad (1)$$

To measure the level of radon gas C_{Rn} in a soil sample, the utilized detectors for surface density ρ of tracks was in (track/cm$^{2)}$ and using Eq. (2) (Abdalsattar and Elham 2016: Somogi *et al* 1986).

$$C_{Rn} = \frac{p}{Kt} \quad (2)$$

while t is the day irradiation period as well as K was its correction constant, and is the proportion of the path intensity to radon gas level (track/cm2) for each (Bq. day / m3). In general, most radon gases values measured in residence or even in the outside air are stated in picocuries values for liter of air (pCi / liter) as well as SI terms including Becquerel for cubic meter (Bq / m3), while radon is reported in girls in Laboure rates (WL), that is obtained by Eq (3) (Ruwiadah *et al* 2017).

$$C_p\ (WL) = \frac{F*CRn}{3700} \quad (3)$$

F has been the equilibria operator, which is recommended to have F = 0.4 (Ruwiadah *et al* 2017).

Eq. (4) relates the yearly effective dosage equivalence, E (WLM.y-1), to the radon concentrations C_{Rn} inside a soil specimen. (Ruwiadah *et al* 2017: Abd-Elmoniem *et al* 2014):

$$E\ (WLMy^{-1}) = \frac{F*t*CRn}{170*3700} \quad (4)$$

While C in Bq /m^3, and 170 numbers for hours per working month.

For radon gas exposure, the effective dose equivalents was appreciated used a conversion operator G of 6.3(mSv.WLM^{-1}) given by Eq. (5) (UNSCEAR 2010: ICRP 1987).

$$E_{ff} = G * C_{Rn} \quad (5)$$

The concentrations of Uranium were calculated in soil samples using Eq. (6):

$$C_x = \frac{Px}{Slop} \quad (6)$$

The slope constitute relationship between track density ρs and standard concentration for the Uranium as shown in Fig.7 (Qureshi *et al*, 2017: Al-Baidhani 2006).

Results and Discussion

The results of the track density, radon concentration, the equilibrium equivalent ^{222}Rn concentration EEC, the Annual Effective Dose E_{ff} and track density, concentration for uranium, for eight soil samples from Baghdad University campus are presented in (Table 1).

The average value for the concentrations of ^{222}Rn in soil samples was 281.59 Bq/cm^3. The highest value concentration of ^{222}Rn was 340.17 Bq/cm^3 found in College of Engineering sample while the minimum value concentration was 195.87 Bq/cm^3 in collage of Al-Khwarizmi sample as shown in Fig 3.

The average value of equilibrium equivalent concentration EEC for ^{222}Rn was 112.63 Bq/cm^3. Computed values for EEC appeared that the highest value was 136.06 Bq/cm^3 in College of Engineering sample, and the least value is 98.97 Bq/cm^3 in College of Education for women sample. The results appeared that the radon concentration which is emanating from the soil doesn't relies on concentration of radium ^{226}Ra only.

The average value of the represented WLM/Y for ^{222}Rn concentrations in soil samples was to be 1.568. The highest value was 1.895 in College of Engineering sample while the least value was 1.091 existed in collage of Al-Khwarizmi sample. For the annual effective dose E_{ff} the extremely value was

8.57 mSv/y in College of Engineering and the least value was 4.93 mSv/y in collage of Al-Khwarizmi while the average value was 7.09 mSv/y. Fig.4 appears the relationship between radon concentration in Bq/kg and effective dose rate Eff in mSv/y resultant from it which is an excellent correlation. In other words, the magnitude for raise and decrease for radon gas concentrations result to a raise and reduce equivalent dose rate resultant derived it. Fig. 5 shows the relation between ELC and radon concentration in Bq/m^3. The average value of ELC for all soil samples was 4262.56. The highest value was 5149.22 in College of Engineering while the minimum value was be 2964.93 in collage of Al-Khwarizmi. Moreover, this variation in the values sample is because of disparities of the naturally of soil samples.

The results of the present research show that, the values for radon gas concentrations are least than the standard limits 1100 Bq/m^3 depending on (UNSCEAR 1993). This is an obvious connotation that radon radiation activity is agreeable compared to other studies (Farid *et al* 2014: Korany *et al* 2013: Abbas 2013).

Fig. 6 shows the variation values for uranium concentrations in the soil samples, which is differ from one sample to another. The maximum concentration for uranium in soil samples was existed in College of Science which is 0.017 Bq/mm^{-2}, while the minimum value concentration was existed in College of Science for women and College of Education for women which was 0.005 Bq/mm^{-2} with an average value of 0.01 Bq/mm^{-2}.

The concentrations of uranium values in the present study remain within the permitted worldwide limit as the permissible limit is lower than 11.7 ppm UNSCEAR (UNSCEAR 1993).

All the results obtained from this study are in agreement with the previous studies (Bashair and Raad 2016:Malik *et al* 2019).

Table 1. Results of the radon concentration, EEC, WL, E (WLM/Y), E_{ff}, ELC and uranium concentration in soil samples

S. code	Location	ρ Track/cm^2	C_{Rn} Bq/cm^3	EEC	WL	WLM/Y	E_{ff}	ELC	ρ Track/mm^2	C_U Bq/mm^{-2}
1	College of Science for women	66	327.28	130.91	0.035	1.823	8.24	4954.06	55.5	0.005
2	College of Education for women	49.9	247.44	98.97	0.026	1.378	6.23	3745.57	55.5	0.005
3	Collage of Agriculture	61.3	303.97	121.59	0.032	1.693	7.66	4601.27	59.2	0.006
4	Collage of Political Science	60.3	299.01	119.6	0.032	1.665	7.53	4526.21	65.3	0.006
5	Collage of Al-Khwarizmi	39.5	195.87	78.34	0.021	1.091	4.93	2964.93	121.4	0.012
6	college of Media	52.8	261.82	104.73	0.028	1.458	6.59	3963.25	131	0.013
7	College of Engineering	68.6	340.17	136.06	0.036	1.895	8.57	5149.22	154.8	0.015
8	College of Science	55.9	277.19	110.87	0.029	1.544	6.98	4195.94	171.1	0.017
Average		56.78	281.59	112.63	0.03	1.568	7.09	4262.56	101.72	0.01

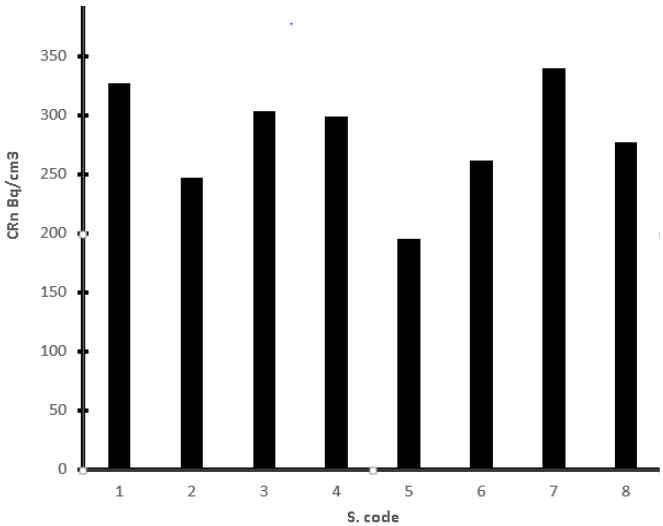

Figure 3. Radon concentrations in Bq/cm^3 in soil samples in all location

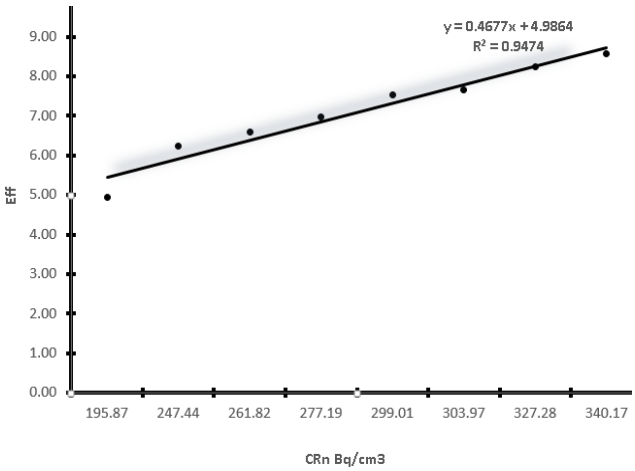

Figure 4. Eff and radon levels C_{Rn} in Bq/cm3

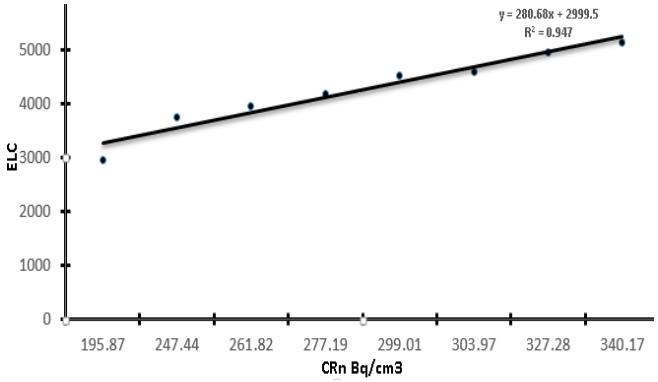

Figure 5. The relationship of ELC and radon concentrations C_{Rn} in Bq/cm^3

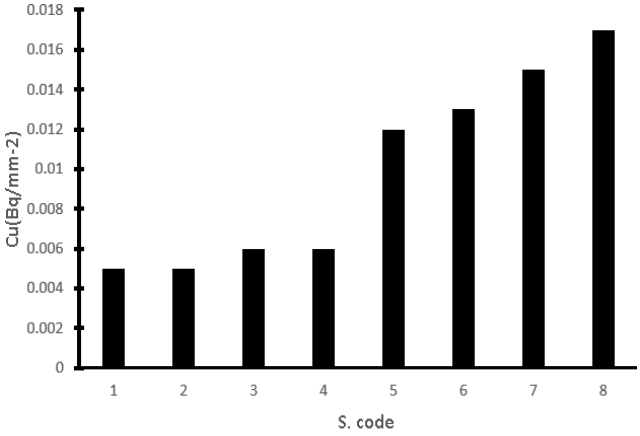

Figure 6. Uranium concentrations in Bq/mm^{-2} in soil samples for all locations.

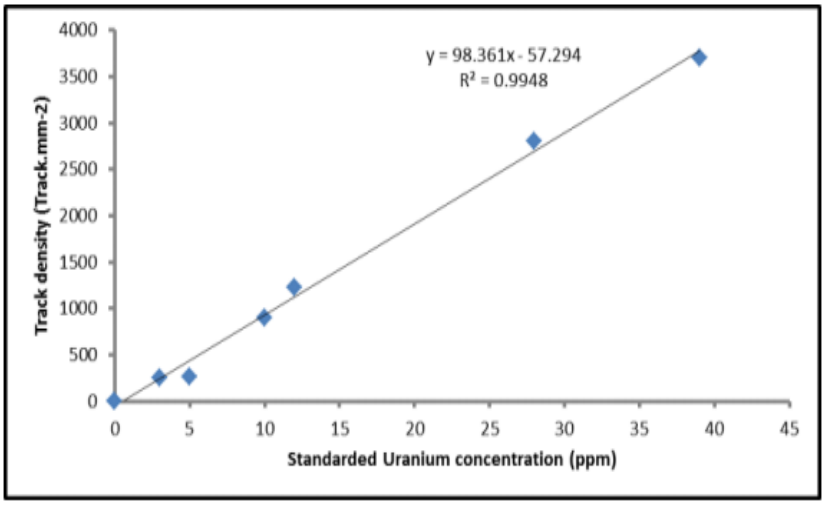

Figure 7. The relationship between track density and standard Uranium concentrations for geologist soil specimens. Followed Qusy [21] and Al-Baidhani [22].

Conclusion

The results of the current work give a supplementary database on soil for Radon and uranium concentrations level in Baghdad university campus- AL-Jedidiah. The obtained values for radon and uranium concentrations were divergent within the soil samples for the current study. The registered values for radon and uranium concentrations were least than the standard limits. A linear relation was following the measured radon gas and annual dose that is efficient. The average value for radon ^{222}Rn and uranium ^{238}U concentrations in soil samples was 1100 Bq/m^3 and 11.7 ppm respectively. The average value for WLM/Y of radon ^{222}Rn concentrations for all soil samples set was identified to be 1. 568. The maximum value was 1.895 in college of engineering and the lowest value was 1.091 in collage of Al-Khwarizmi. The average value for calculated ELC of radon ^{222}Rn was 4262.56, the highest value was in college of Engineering and least value was 2964.93 in collage of Al-Khwarizmi. Hence the area under investigation is secured from health hazards and radiological risks due to radon and uranium concentration in the soil. It is recommended that no residence building in region have high concentrations for radon and uranium from prohibit exposure to radiation that performs to cancer morbidity.

Declaration of Competing Interest: There is no conflict of interest.

References

Abojassim A, Fares A, Abbas M. Determination of effective radium content and Uranium for the soap and the detergent powder samples in Iraq. *Current Pediatric Research* 2017; 21(3): 485-489.

Amalds O, Custball H, Nielsen A. Cs137 in Montarq Soils. *Health Physics* 1989; 57(6): 955-958.

Abdalsattar K, Elham M. Measurement of Radon Concentration and the Effective dose Rate in the Soil of the City of Karbala, Iraq. *Journal of Radiation and Nuclear Applications* 2016; 1(1): 17-23.

Abd-Elmoniem AE, Mohammed YS, Mohammed KS, Sumaia SM. Radium and radon exhalation studies in some soil samples from Singa and Rabak Towns, Sudan using CR-39. *International Journal of Science and Research (IJSR)* 2014; 3(11): 632-637.

Al-Baidhani A. Determination of the Radioactivity in Soil and Water in Baghdad, Karbala and Basrah Samples. *M.Sc. Thesis. Al-Nahrain University, College of science* 2006.

Abbas JA. Determination of Radon Concentration and the Annual Effective dose in Karbala University Campus, Karbala, Iraq. *Karbala journal of medicine* 2013; 6(1): 1591-1599.

Saied BM, Al-Khafaji RM, Al-Bayati AT. Measurement of Uranium Concentration in the Soil Samples by Using Solid State Nuclear Track Detectors (SSNTDs). *International Journal of Scientific Research in Science and Technology* 2016; 2(4): 130-135.

Basim R, Haitham A, Wassan F, Farah FK. Measurement the concentrations of radon and Thoron and Their Progeny in the Air Sample of Al – Haswaa City in babylon Province. *In Journal of Physics: Conference Series* 2019; 1178(1): 012001.

Dyck W. Application of Hydro Geochemistry to the Search of Uranium. *Economic Geology* 1979; 31: 489-510.

Khan FM, Gibbons JP. *Khan's the physics of radiation therapy*. Lippincott Williams & Wilkins 2014.

Farid M. Indoor radon in dwellings of Jeddah city. Saudi Arabia and its correlations with the radium and radon exhalation rates from soil. *SAGE* 2014.

Faheem M. Radon exhalation and its dependence on moisture content from samples of soil and building materials. *Radiation Measurements* 2008; 43(8): 1458-1462.

Guo Q, Shimo M, Ikebe Y, Minato S. The study of thoron and radon progeny concentrations in dwellings in Japan. *Radiation Protection Dosimetry*, 1992; 45(1-4): 357-359.

ICRP. Lung cancer risk from indoor exposures to radon daughters. International commission on Radiological Protection (1987), A report of a task group of the ICRP publication 50, *Oxford: Pergamon Press*.

Kumar A, Kaur M, Sharma S, Mehra S. A study of radon concentration in drinking water samples of Amritsar city of Punjab (India). *JRPR* 2016; 39(1): 13-19.

Korany KA, Shata AE, Hassan SF, Nagdy MSE. Depth and seasonal variations for the soil radon-gas concentration levels at Wadi Naseib Area, southwestern Sinai, Egypt. *Journal of Physical Chemistry & Biophysics* 2013; 3(4): 1-6.

Mohammed RS, Ahmed RS. Estimation of excess lifetime cancer risk and radiation hazard indices in southern Iraq. *Environmental Earth Sciences* 2017; 76(7): 303.

Kheder MH, Azeez HN, Slewa MY, Zaker TA. Determination of Uranium Contents in Soil Samples in Al-Hamdaniya Region Using Solid State Nuclear Track Detector CR-39. *Al-Mustansiriyah Journal of Science* 2019; 30(1): 199-204.

Nusseif A, Mkhaiber A, Abdaljali R. Evaluating Radon Level in Imported Milk using CR-39 Detector. *NeuroQuantology* 2020; 18(4): 01-04.

Kadim NH, Rejah BK, Mahdi RT, Khalaf AM. Radium and uranium concentration in some plants in Iraq. *In Journal of Physics: Conference Series* 2019; 1178(1): 012022.

Qureshi A, Kakar M, Akram M, Khattak U, Tufail, M, Mehmood K. Radon concentrations in coal mines of Baluchistan. Pakistan. *Journal of Environmental Radioactivity* 2017; 48(2): 203-209.

Ruwiadah TM, Basim KR, Asael KM. Radon Concentration and the Annual Effective Dose in the Soil Samples of the Midland Refineries Company Doura Baghdad Iraq. *International Journal of Science and Research* 2017; 6(8): 1513-1516.

Sahoo K, Measurement of uranium and its isotopes at trace levels in environmental samples using mass spectrometry, Indian. *Journal of Physics* 2009; 83(6): 787-797.

Somogyi G, Hafez AF, Hunyadi I, Toth-Szilagyi M. Measurement of exhalation and diffusion parameters of radon in solids by plastic track detectors. *International Journal of Radiation Applications and Instrumentation. Part D. Nuclear Tracks and Radiation Measurements* 1986; 12(1-6): 701-704.

UNSCEAR United Nations Scientific Committee on the effect of Atomic Radiation. Source, Effect, and Risks of Ionizing Radiation Report to the general Assembly with Scientific Annexes, *United Nations, New York* A 2010.

UNSCEAR United Nations Scientific Committee on the effect of Atomic Radiation. Sources, Effect, and Risks of Ionizing Radiation, Report to the general Assembly with Scientific Annexes, *United Nation* 1993.

Li X, Zhang H, Cui L, Zhu L, Liu J, Du H, Wang C, Fang S. Hereditary coproporphyria presenting with weakness and photosensitive rash: A case report and literature review. *NeuroQuantology* 2018; 16(6): 899-903.