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RESEARCH ARTICLE

RADON EXHALATION RATE IN SURFACE SOIL OF GRADUATE'S VILLAGES IN WEST NILE DELTA, EGYPT, USING CAN TECHNIQUE

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ABSTRACT

Radionuclides distribution and radiation levels are important to assess the potential hazard of radiation exposure. Radon concentration and exhalation rate from surface soil were carried out in totally thirty points with different locations of Graduate's Villages West Nile Delta, Egypt. Radon concentration and radon exhalation rate were measured using Can technique with CR-39 detector. The average values of radon concentrations ranged from 236.34 to 717.78 Bqm^{-3} and area exhalation rate from 0.28 to0.86 Bqm^{-2}h^{-1}. The obtained results can be used as reference information to assess any changes in the radioactive background level due to geological processes in the investigated area.

INTRODUCTION

Terrestrial radiation is due to various radioactive nuclides that are present in soil, water, air and their abundance changes depending on the geological and geographical features of region. The external exposure is caused by gamma rays emitted mainly by radionuclides of uranium ^{238}U and thorium ^{232}Th decay series as well as potassium ^{40}K. The internal exposure is caused by radon (^{222}Rn and ^{220}Rn) and its short-lived decay products. Radon is an alpha emitter that may be easily inhaled and its descendants may be deposited in tissues of the respiratory tract (UNSCEAR, 2000). The most important isotope of radon is ^{222}Rn, which belongs to the ^{238}U series, since its short-lived progenies are the major contributor to lung dose. Most of the radioisotopes are alpha emitters, so when they are ingested or inhaled, they significantly contribution to the radiation dose that people receive (IAEA, 2003). Radon is radioactive noble inert gas and very mobile gaseous daughter of uranium ^{238}U which is found in all rocks and soil (Misdaq *et al*., 2000). Radon emanates from soil and rock, which is also the main source of radon in the atmosphere. The concentration of atmospheric ^{222}Rn, therefore, depends on the rate of diffusion from the ground and diffusion in the air (Rahman *et al*., 2009). The most important mechanism of exposure is the inhalation of the short-lived decay products of the principal isotope, ^{222}Rn, with indoor air. Concentrations of ^{222}Rn and its progeny are usually higher in indoor air than in outdoor air (UNSCEAR, 1993). When radon gas is inhaled, densely ionizing alpha particles emitted by deposited short- lived decay products of radon ^{218}Po and ^{214}Po can interact with biological tissue in the lungs leading to damage and causes lung cancer (WHO, 2009).

The Graduate's Villages location are in the north of Wadi El Natrun, south of Damanhur city, west of Tanta city and east of El Nasr canal (Alexandria city) .The area is crossed by a very important two roads, Cairo-Alexandria Desert road and Wadi El Natrun- El Aamein road. The area is limited by latitudes (30° 47' 2.8" and 30° 38' 8.89") and longitudes (30° 46' 37.6" and 30° 05' 36.3") as showing in Table (1).

The present work is aiming to determine the radon concentrations and radon exhalation rate in the soil samples from Graduate's Villages, West Nile Delta, Egypt. In order to detect any harmful radiation that would affect radioactivity background levels this, can be used to assess the indoor radiological hazards to human health and determination of radioactivity level in cultivated land.

MATERIALS AND METHODS

Thirty soil samples were collected from 18 villages of Graduate's Villages. The samples were measured using Can

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technique to determine the values of radon concentration and exhalation rate with CR-39 detector. The soil samples are crushed to a grain size 1 mm and placed into samples containers. All samples were dried in air for four days and dried in oven at 110°C for 5hr. The samples were minced, sieved by 1-mm mesh, and weighted. The samples were carefully sealed for 60 days in cylindrical containers made from a good kind of plastic with dimensions of 9 cm in diameter and 16 cm in depth. Each sample container was capped tightly to an inverted cylindrical plastic cover as shown in (Fig.1). A piece of CR-39 of 700 µm thickness (American Technical Plastic, Inc.) detector of area 1.5 cm x1.5 cm fixed at the bottom center of the inverted plastic cover. During the exposure time of α-particles from the decay of radon and their daughters bombard the CR-39 detector in the air volume of the cylindrical containers. After the irradiation period, the detectors were collected and chemically etched in NaOH solution 6.25N at 70°C for 7 hr (Al-Jarallah *et al*., 2008; Hafez *et al*., 2011). After etching the CR-39 detectors were washed in distilled water and then dipped for few minutes in a 5 % acetic acid solution and washed again with distilled water and finally air dried. The track density was determined by using optical microscope (Kumar *et al*., 2003) which calibrated before usages. The background of CR-39 track detector was counted by optical microscope and subtracted from the count of all detectors (Abo-Elmagd *et al*., 2006). The value of radon concentration in (Bqm^{-3}) at secular equilibrium is given by the following equation:

$$C_{Rn} = \frac{\rho}{\eta T} \quad (1)$$

Where, C_{Rn} is radon concentration (Bqm^{-3}), ρ is the track density (track cm^{-2}), T is the exposure time (day) and η is the calibration coefficient of CR-39 nuclear track detectors obtained from the experimental calibration 0.22 tracks $cm^{-2}day^{-1}/Bqm^{-3}$ of radon, respectively (Hafez *et al*., 2001). Radon exhalation rate from different sand samples was calculated from the relation:

$$E_A = \frac{CV\lambda}{A[T + \frac{1}{a}(e^{-\lambda t} - 1)]} \quad (2)$$

Where, E_A is the surface exhalation rate in ($Bqm^{-2}h^{-1}$), C is the integrated radon exposure in ($Bqm^{-3}h$), λ is the decay constant of radon (h^{-1}), V is the effective volume of the can (m^3), A is the area covered by the can (m^2) and T is the exposure time (Laith *et al*., 2013).

$$E_M = \frac{CV\lambda}{M[T + \frac{1}{a}(e^{-\lambda t} - 1)]} \quad (3)$$

Where, E_M is the mass exhalation rate in ($Bqkg^{-1}h^{-1}$) and M is the mass of sample (kg) (Laith *et al*., 2013; Kakati, 2014). The annual absorbed dose rate equivalent due to the activity in the soil was calculated using the following equation:

$$D_{Rn} = C_{Rn}.\ D.\ H.\ F.\ T \quad (4)$$

Where, C_{Rn} (Bqm^{-3}) is the measured mean radon activity concentration in air, F (0.4) is the indoor equilibrium factor. T is the indoor occupancy time (8760) hr, H is the indoor occupancy factor (0.4) and D is the dose conversion factor (9 x10^{-6} mSv h^{-1} / Bqm^{-3}) (Maged, 2006; Nsiah *et al*., 2011). The annual effective dose in ($mSvy^{-1}$) was calculated according to the following equation:

$$H_E = D_{Rn}.W_R.W_T \quad (5)$$

Where D_{Rn} is annual absorbed dose, W_R is radiation weighting factor for alpha particles equal 20 and W_T is tissue weighting factor for the lung 0.12 (UNSCEAR, 2000; Nsiah *et al*., 2011). The working levels given using the following equation:

$$WL = \frac{C.F}{3700} \quad (6)$$

Where, C is radon concentration in Bqm^{-3} and F is the equilibrium factor for radon has been taken as 0.4 as suggested by (Mamta *et al*., 2011). The radium concentration in soil samples was calculated using the following relation:

$$C_{Ra} = \frac{\rho h A}{\eta M T_e} \quad (7)$$

Where C_{Ra} is the radium content in (Bq kg^{-1}), h is the distance between the detector and the top of the sample and T_e is the effective exposure time in (hr) (Sarma, 2013).

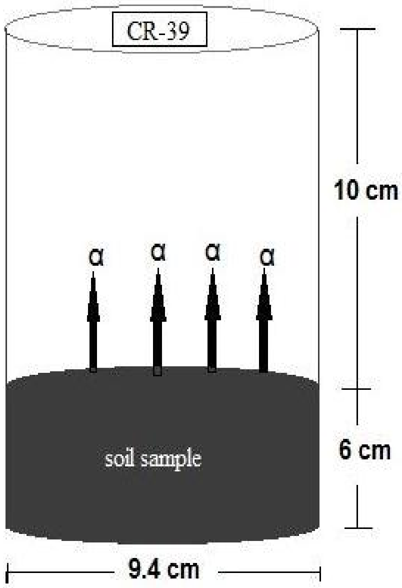

Figure1 Cylindrical containers of the sample

RESULTS AND DISCUSSIONS

The samples types and locations of the Graduate's Villages were determined as shown in table 1. The values of radon concentration in (Bqm^{-3}), area exhalation rate in ($Bqm^{-2}h^{-1}$), mass exhalation rate in ($BqKg^{-1}h^{-1}$) and radium concentration in ($BgKg^{-1}$) as shown in table 2.

Table 4, gives the average values of radon concentration (C_{Rn}), surface exhalation rate (E_A), mass exhalation rate (E_m) and radium concentration (C_{Ra}). The average values of radon concentrations are ranged from 236.34 to 717.78 Bqm^{-3}, area exhalation rate from 0.28 to 0.86 $Bqm^{-2}h^{-1}$, mass exhalation rate from 1.06 to 13.40 $mBqKg^{-1}h^{-1}$ and the average values of radium concentrations varied from 12.70 to 40.20 $BqKg^{-1}$.

Table 1 The samples types and locations of the Graduate's Villages

No.	Village name	Type	Latitude	Longitude
1	Najeeb Mahfooz	Sand	30° 46' 36.7"	30° 17' 36.7"
2		Sand	30° 46' 37.6"	30° 46' 37.6"
3	Ali Ebn Abi Talib	Sediment	30° 44' 50"	30° 15' 36"
4		Sand	30° 44' 45"	30° 15' 63"
5	El Shaarawi	Sand	30° 44' 45"	30° 44' 44"
6	Abd El Muneem Reyad	Sand	30° 42' 14.7"	30° 20' 6.41"
7		Sand	30° 41' 50.5"	30° 19' 13.2"
8	Village 107	Sand	30° 39' 8.7"	30° 19' 49"
9		Clay	30° 39' 8.7"	30° 19' 49"
10	El Shaer	Clay	30° 39' 8.89"	30° 19' 50.2"
11		Clay	30° 38' 8.89"	30° 18' 50.2"
12	El Gazaalee	Clay	30° 40' 51.7"	30° 21' 6.15"
13		Clay	30° 45' 8.17"	30° 21' 8.70"
14	Muhammad Refaat	Clay	30° 45' 8.17"	30° 20' 8.99"
15		Clay	30° 45' 8.34"	30° 20' 59.8"
16		Clay	30° 45' 10"	30° 19' 28"
17		Clay	30° 45' 29"	30° 19' 44"
18	Imam Hussein	Clay	30° 43' 8.55"	30° 21' 55.8"
19		Clay	30° 44' 8.34"	30° 20' 59.8"
20		Sludge	30° 44' 8.34"	30° 20' 59.8"
21	Ahmad Ramee	Sediment	30° 43' 39.5"	30° 23' 6.24"
22		Sand	30° 43' 7.8"	30° 23' 6.64"
23	El Shaeshaee	Clay	30° 41' 9.84"	30° 14' 16"
24	Ahmad Shawqi	Clay	30° 40' 9.82"	30° 09' 33.5"
25	Abu Bakir El Sideeq	Clay	30° 40' 9.14"	30° 08' 21.7"
26	Abdl Adeem Abul Ataa	Clay	30° 40' 8.15"	30° 06' 35.9"
27	Taha Hussein	Clay	30° 41' 8.02"	30° 05' 36.3"
28	19 Luhoom	Clay	30° 46' 0.6"	30° 11' 16.3"
29	Jeneklees	Clay	30° 47' 12.8"	30° 10' 48.8"
30	Tawfeeq El Hakeem	Clay	30° 46' 29.1"	30° 13' 43.2"

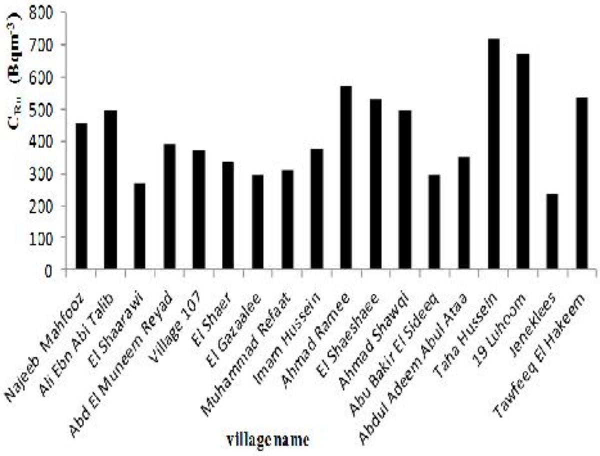

Figure2. The relation betwwen village name and radon concentration (C_{Rn}) for the soil samples .

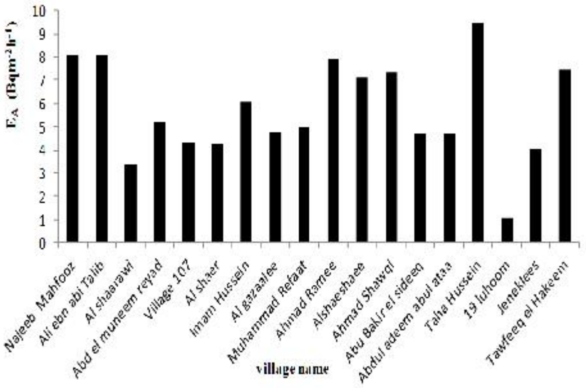

Figure 3. The relation betwwen village name and area exhalation rate (E_A) for the soil samples .

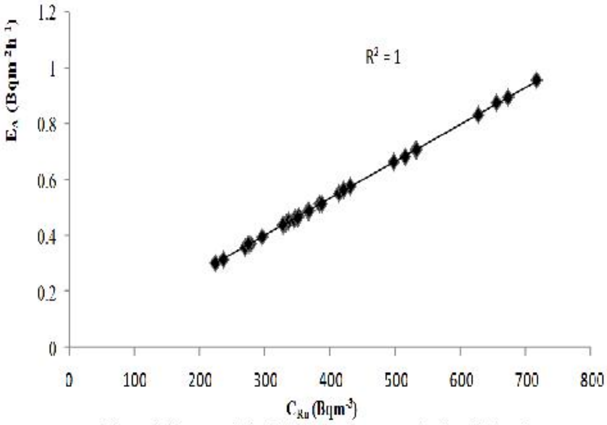

Figure 4. The correlation between radon concentration (C_{Rn}) and area exhalation rate (E_A) for the soil samples.

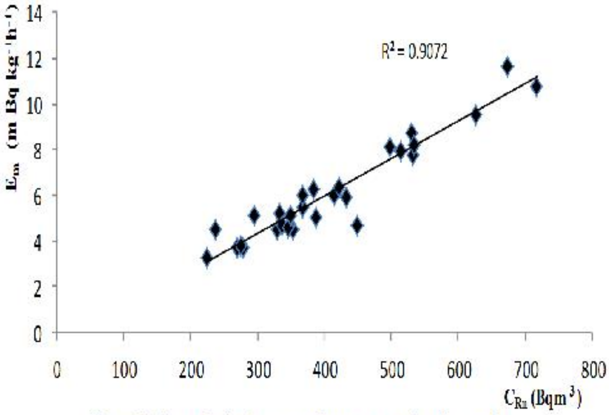

Figure 5. The correlation between radon concentration (C_{Rn}) and mass exhalation rate (E_m) for the soil samples.

Table 2 Radon concentration, area exhalation rate, mass exhalation rate and radium concentration

Sample	C_{Rn} (Bqm^{-3})	E_A ($Bqm^{-2}h^{-1}$)	E_m ($mBqkg^{-1}h^{-1}$)	C_{Ra} ($Bqkg^{-1}$)
1	531.21 ± 17.04	0.70 ± 0.02	8.76 ± 0.16	30.30 ± 0.96
2	384.05 ± 14.46	0.51 ± 0.01	6.31 ± 0.13	21.80 ± 0.82
3	656.51 ± 18.93	0.87 ± 0.02	10.60 ± 0.17	74.40 ± 2.14
4	333.72 ± 13.48	0.44 ± 0.01	5.19 ± 0.12	17.90 ± 0.72
5	270.22 ± 12.19	0.35 ± 0.01	3.68 ± 0.11	12.70 ± 0.57
6	414.09 ± 15.07	0.55 ± 0.02	5.99 ± 0.14	20.70 ± 0.75
7	367.09 ± 14.16	0.48 ± 0.01	5.51 ± 0.13	18.30 ± 0.73
8	352.87 ± 13.86	0.46 ± 0.01	4.47 ± 0.13	16.10 ± 0.60
9	386.74 ± 14.54	0.51 ± 0.01	5.00 ± 0.13	17.30 ± 0.64
10	346.81 ± 13.78	0.46 ± 0.01	4.64 ± 0.13	16.00 ± 0.63
11	328.80 ± 13.40	0.43 ± 0.01	4.49 ± 0.12	15.50 ± 0.63
12	224.85 ± 11.06	0.29 ± 0.01	3.26 ± 0.10	11.30 ± 0.55
13	336.96 ± 13.56	0.44 ± 0.01	4.71 ± 0.12	16.30 ± 0.65
14	328.25 ± 13.40	0.43 ± 0.01	4.65 ± 0.12	42.00 ± 1.71
15	345.15 ± 13.71	0.45 ± 0.01	4.63 ± 0.12	16.00 ± 0.63
16	279.01 ± 12.34	0.37 ± 0.01	3.73 ± 0.11	12.90 ± 0.57
17	432.19 ± 15.37	0.57 ± 0.02	5.93 ± 0.14	20.50 ± 0.72
18	367.64 ± 14.16	0.48 ± 0.02	6.00 ± 0.13	20.70 ± 0.79
19	275.73 ± 12.27	0.36 ± 0.02	3.81 ± 0.11	13.20 ± 0.58
20	421.25 ± 15.15	0.56 ± 0.02	6.33 ± 0.14	21.80 ± 0.78
21	514.81 ± 16.81	0.68 ± 0.02	7.94 ± 0.15	27.40 ± 0.89
22	626.96 ± 18.48	0.83 ± 0.02	9.56 ± 0.17	33.00 ± 0.97
23	532.86 ± 17.04	0.70 ± 0.02	7.81 ± 0.16	26.90 ± 0.86
24	497.85 ± 16.51	0.66 ± 0.02	8.09 ± 0.15	27.90 ± 0.92
25	295.97 ± 12.72	0.39 ± 0.01	5.16 ± 0.12	17.80 ± 0.76
26	350.13 ± 13.86	0.46 ± 0.01	5.15 ± 0.13	17.80 ± 0.70
27	717.78 ± 19.84	0.95 ± 0.02	10.80 ± 0.18	37.40 ± 1.03
28	672.91 ± 13.71	0.89 ± 0.01	11.70 ± 0.12	40.20 ± 0.81
29	236.34 ± 11.36	0.31 ± 0.01	4.50 ± 0.10	15.50 ± 0.74
30	533.41 ± 17.04	0.70 ± 0.02	8.21 ± 0.16	28.30 ± 0.90

Table 3 The working level, annual absorbed dose and annual effective dose

Sample	mWL	D ($mSvy^{-1}$)	H_E ($mSvy^{-1}$)
1	57.40 ± 1.84	6.70 ± 0.21	16.01 ± 40.89
2	41.50 ± 1.56	4.84 ± 0.18	11.62 ± 34.70
3	71.00 ± 2.04	8.28 ± 0.23	19.90 ± 45.43
4	36.10 ± 1.46	4.21 ± 0.17	10.10 ± 32.35
5	29.20 ± 1.32	3.41 ± 0.15	8.18 ± 29.25
6	44.80 ± 1.63	5.22 ± 0.19	12.53 ± 36.16
7	39.70 ± 1.53	4.63 ± 0.17	11.11 ± 33.98
8	38.10 ± 1.50	4.45 ± 0.17	10.70 ± 33.26
9	41.80 ± 1.57	4.88 ± 0.18	11.70 ± 34.89
10	37.50 ± 1.49	4.37 ± 0.17	10.50 ± 33.07
11	35.50 ± 1.45	4.15 ± 0.16	9.95 ± 32.16
12	24.30 ± 1.19	2.84 ± 0.13	6.81 ± 26.54
13	36.40 ± 1.46	4.25 ± 0.17	10.20 ± 32.54
14	35.50 ± 1.45	4.14 ± 0.16	9.94 ± 32.16
15	37.30 ±1.48	4.35 ± 0.17	10.44 ± 32.90
16	30.20 ± 1.33	3.52 ± 0.15	8.40 ± 29.61
17	46.70 ± 1.66	5.45 ± 0.19	13.08 ± 36.88
18	39.70 ± 1.53	4.64 ±0.17	11.12 ± 33.98
19	29.80 ± 1.33	3.48 ± 0.15	8.34 ± 29.44
20	45.50 ± 1.64	5.31 ± 0.19	12.75 ± 36.36
21	55.70 ± 1.82	6.49 ± 0.21	15.58 ± 40.34
22	67.80 ± 2.00	7.91 ± 0.23	18.98 ± 44.35
23	57.60 ± 1.84	6.72 ± 0.21	16.13 ± 40.89
24	53.80 ± 1.78	6.28 ± 0.20	15.07 ± 39.62
25	32.00 ± 1.37	3.73 ± 0.16	8.96 ± 30.52
26	37.90 ± 1.50	4.42 ± 0.17	10.59 ± 33.26
27	77.60 ± 2.14	9.05 ± 0.25	21.72 ± 47.61
28	72.70 ± 1.48	8.49 ± 0.17	20.37 ± 32.90
29	25.60 ± 1.23	2.98 ± 0.14	7.15 ± 27.26
30	57.70 ± 1.84	6.73 ± 0.21	16.14 ± 40.89

From the obtained results we find that the values of radon concentrations in Taha Hussein village higher than the other villages but in Jeneklees village has a low value. (Fig. 2), shows the comparison between the values of radon concentrations.

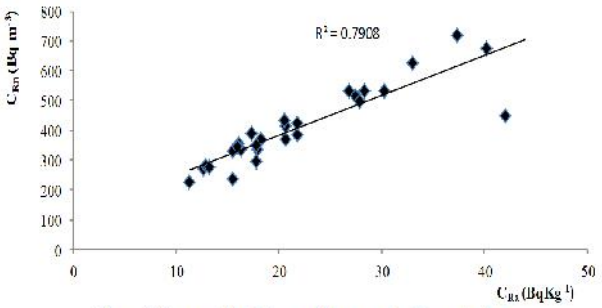

Figure 6. The correlation between radium concentration and radon concentration for the soil samples

Also (Fig. 3) gives the comparison between the average values of surface exhalation rates for the investigated areas. The correlation coefficient between the average values of radon concentration and the average values of surface exhalation rate equal R^2 = 1. This is a good correlation as shown (Fig. 4), but the correlation coefficient between radon concentration and mass exhalation rate is equal R^2 = 0.95 as shown in (Fig.5). The correlation coefficient between the average values of radium concentrations in ($Bqkg^{-1}$) and radon concentration in (Bqm^{-3}) is equal (R^2 = 0.79) as shown in (Fig.6). The calculated values of working level (WL), annual absorbed dose rate (D) and annual effective dose rate (H_E) were given by table 3. The average values of working level varied from (25.55 to 77.59) mWL, the average values of annual absorbed dose rate from 2.98 to 9.05 $mSvy^{-1}$ and annual effective dose rate from 7.15 to 21.72 $mSvy^{-1}$ as shown in Table 5. The annual effective dose larger than the normal background level of 1.10 $mSvy^{-1}$ as quoted by (UNSCEAR, 2000). The comparison between the average values of the annual absorbed dose rate for the investigated areas is given by (Fig.7).

Table 4 The average values of radon concentration, area exhalation rate, mass exhalation rate and radium concentration

No.	Village name	C_{Rn} (Bqm^{-3})	E_A (Bqm^{-2}h^{-1})	E_m (mBqkg^{-1}h^{-1})	C_{Ra} (Bqkg^{-1})
1	Najeeb Mahfooz	457.63 ± 15.25	0.55 ± 0.01	8.06 ± 0.14	26.05 ± 0.89
2	Ali Ebn Abi Talib	495.11 ± 16.54	0.60 ± 0.01	13.40 ± 0.14	19.75 ± 0.78
3	El Shaarawi	270.22 ± 12.05	0.32 ± 0.01	3.24 ± 0.11	12.70 ± 0.66
4	Abd El Muneem Reyad	390.59 ± 14.36	0.47 ± 0.01	5.22 ± 0.13	19.50 ± 0.57
5	Village 107	369.80 ± 13.74	0.44 ± 0.01	4.30 ± 0.13	16.70 ± 0.81
6	El Shaer	337.81 ± 13.56	0.42 ± 0.01	4.21 ± 0.12	15.75 ± 0.66
7	El Gazaalee	296.68 ± 13.44	0.35 ± 0.01	6.09 ± 0.11	13.80 ± 0.58
8	Muhammad Refaat	312.08 ± 12.65	0.37 ±0.01	3.80 ± 0.13	22.85 ± 0.69
9	Imam Hussein	374.20 ± 14.85	0.45 ± 0.02	4.99 ± 0.13	18.56 ± 0.59
10	Ahmad Ramee	570.88 ± 17.95	0.69 ± 0.02	7.94 ± 0.11	30.20 ± 0.61
11	El Shaeshaee	532.86 ± 17.56	0.64 ± 0.02	7.09 ± 0.16	26.90 ± 0.86
12	Ahmad Shawqi	497.85 ± 16.81	0.60 ± 0.02	7.34 ± 0.15	27.90 ± 0.92
13	Abu Bakir El Sideeq	295.97 ± 12.25	0.35 ± 0.01	4.69 ± 0.12	17.80 ± 0.76
14	Abdl Adeem Ataa	350.13 ± 13.12	0.42 ± 0.01	4.67 ± 0.13	17.80 ± 0.70
15	Taha Hussein	717.78 ± 19.69	0.86 ± 0.02	9.48 ± 0.18	37.40 ± 1.03
16	19 Luhoom	672.91 ± 13.48	0.81 ± 0.01	1.06 ± 0.12	40.20 ± 0.81
17	Jeneklees	236.34 ± 11.55	0.28 ± 0.01	4.08 ± 0.10	15.50 ± 0.74
18	Tawfeeq El Hakeem	533.41 ± 17.81	0.64 ± 0.02	7.46 ± 0.16	28.30 ± 0.90

Table 5 The average values of working level, annual absorbed dose rate and annual effective dose rate

No.	Village name	mWL	D (mSvy^{-1})	H_E (mSvy^{-1})
1	Najeeb Mahfooz	49.42 ± 1.65	5.77 ± 0.20	13.81 ± 38.25
2	Ali Ebn Abi Talib	53.53 ± 1.95	6.24 ± 0.19	15.00 ± 38.95
3	El Shaarawi	29.21 ± 1.32	3.41 ± 0.15	8.18 ± 29.25
4	Abd El Muneem Reyad	42.22 ± 1.47	4.92 ± 0.18	11.82 ± 28.91
5	Village 107	39.00 ± 2.01	4.66 ± 0.17	11.20 ± 41.56
6	El Shaer	36.52 ± 1.58	4.26 ± 0.16	10.22 ± 31.24
7	El Gazaalee	32.07 ± 1.51	3.74 ± 0.21	8.98 ± 45.55
8	Muhammad Refaat	33.73 ± 2.11	3.93 ± 0.23	9.42 ± 30.90
9	Imam Hussein	40.45 ± 1.95	4.72 ± 0.18	11.32 ± 27.22
10	Ahmad Ramee	61.71 ± 1.55	5.90 ± 0.17	14.16 ± 40.88
11	El Shaeshaee	57.60 ± 1.84	6.72 ± 0.21	16.13 ± 40.89
12	Ahmad Shawqi	53.82 ± 1.78	6.28 ± 0.20	15.07 ± 39.62
13	Abu Bakir El Sideeq	31.99 ± 1.37	3.73 ± 0.16	8.96 ± 30.52
14	Abdl Adeem Ataa	37.85 ± 1.50	4.42 ± 0.17	10.59 ± 33.26
15	Taha Hussein	77.59 ± 2.14	9.05 ± 0.25	21.72 ± 47.61
16	19 Luhoom	72.74 ± 1.48	8.49 ± 0.17	20.37 ± 32.90
17	Jeneklees	25.55 ± 1.23	2.98 ± 0.14	7.15 ± 27.26
18	Tawfeeq El Hakeem	57.66 ± 1.84	6.73 ± 0.21	16.14 ± 40.89

Table 6 The comparison between the obtained results and the published data in different countries

Country	C_{Rn} (Bqm^{-3})	E_A (Bqm^{-2}h^{-1})	H_E (mSvy^{-1})	C_{Ra} (mBqkg^{-1})	References
Egypt	4383 – 6297	0.23 – 0.33	0.136-0.145	0.24-0.25	(Abel-Ghany, *et al* 2009)
Egypt	36.98- 576.18	0.03-0.47			(El-Farrash, *et al* 2012)
Iraq (Kurdistan)	156.30			2.76- 0.9	(Asaad and Mohamad, 2010)
Iraq (Basrah)	616.6	0.417			(Khodier and Abdul, 2014)
Saudi (Jazan)	55.56–275.79	18.72	1.52		(Zarrag *et al*., 2012)
Turkey	270 - 3319	0.02 – 0.47			(Oktay and Dogru, 2006)
India (Kashmir)				6.43 - 18.89	(Feroz and Sajad, 2014)
Algeria	160-285				(Belafrites, 2008)
Ghana	270 - 123				(Peter *et al.*, 2012)
Iraq (Samawah)	492		3.54	31.80	(Almayahi *et al.*, 2014)
India		0.54-0.88	0.04- 0.06		(Barooda *et al.*, 2013)
India (Haryana)	21 - 113				(Kant *et al.*, 2009)
India (Dadri)	222.50 - 673.60	0.08 - 0.24	0.011		(Mamta *et al.*, 2010)
India		0.6		0.014	(Zubair *et al*., 2012)
India (Assam)	81.20 – 277.70	0.34 - 1.86			(Kakati, 2014)
India	998 - 2198				(Pooja and Rishi, 2014)
Egypt (Fayoum)		4.40		14.92	(Abo-Elmagd *et al*., 2009)
Egypt	236.34 -717.78	0.29- 0.95	6.8-21.7	11.3-74.4	The Present work

From the figure we find that the values of annual absorbed dose rate in Taha Hussein village higher than the other villages but in Jeneklees village has a low value.

CONCLUSION

The main aim of this study was to determine radon concentration and exhalation rate in the soil samples using solid state nuclear track detectors. The average values of radon concentrations are ranged from 236.34 to 717.78 Bqm^{-3} and surface exhalation rate from 0.28 to 0.86 Bqm^{-2}h^{-1}. The measured values of radon concentration and exhalation rate generally in the recommended limit by (UNSCEAR, 2000). The investigation of radionuclides distribution and radiation levels of such materials is important to assess the potential hazard of radiation exposure for those working in the investigated area.

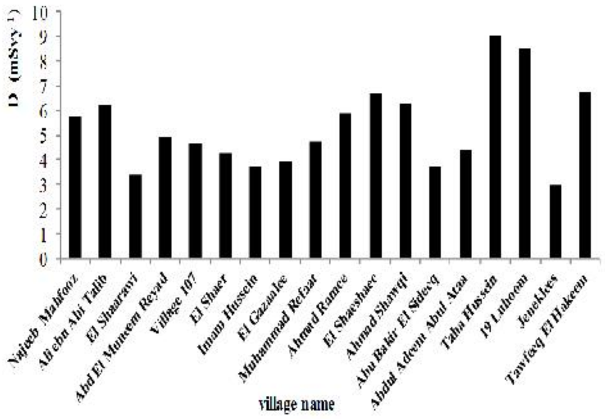

Figure 7. The relation betwwen village name and annual absorbed dose rate (D) for soil samples

The obtained results can be used as reference information to assess any changes in the radioactive background level due to geological processes in the investigated area. Most of the indoor radon values lie in the range of action levels from 200 to 600 Bqm^{-3} (ICRP, 1990; Singh *et al*., 2004**)**. The average values of radon concentrations in the soil samples are lower than the recommended limit 800 Bqm^{-3} which, reported by (WHO, 1993).The obtained experimental results were agreement with the published data by other workers in the different countries as shown in table 6.

References

Abo-Elmagd M., Mansy M., Eissa H.M. and El-Fiki M.A. 2006.Major parameters affecting the calculation of equilibrium factor using SSNTDs measured track densities. Radiat. Meas., 41, 235-240.

Abo-Elmagd M., Marie H. K. and Basha A. M., 2009. Passive measurements of effective radium content and radon exhalation rates in soil and water samples from the Fayoum depression, Egypt. Isotope and Rad. Res., 41(2) 463- 469.

Al-Jarallah M. I. and Rehman F., 2003. Indoor radon measurements in dwellings of four Saudi Arabian cities. Radiat. Meas., 36, 445-448.

Asaad H. Ismail and Mohamad S. Jaafar., 2010. Hazard assessment of radon exhilaration rate and radium content in the soil samples in Iraqi Kurdistan using passive and active detecting methods. World Acad. Sci. Eng. and Techn., 4, 609-612.

El-Farrash A. H., Yousef H. A.and Hafez A.F., 2012. Activity concentrations of ^{238}U and ^{232}Th in some soil and fertilizer samples using passive and active techniques. *J. Radiat. Meas*., 47, 644 - 648.

Hafez A. F, El-Farrash A.H, and Yousef H. A., 2011. Determination of radon concentration in some environmental samples using Cup Technique. *Journal of Environmental Sciences*, 40 (4), 535- 548.

Hafez, A.F., Hussein A.S. and Rasheed N.M., 2001. A study of radon and thoron release from Egyptian building materials using polymeric nuclear track detectors. Appl. Radiat. Isot., 54, 291-298.

IAEA, 2003. Extent of Environmental Contamination by Naturally Occurring Radioactive Material (NORM) and Technological Options for Mitigation, Technical Reports Series No. 419, IAEA, Vienna.

ICRP, 1990. Recommendations of the International Commission on Radiological Protection, Radiation Protection, Elmsford, NY: Pergamon Press, Inc., Publication (60), 1990.

Kakati R. K., 2014. Radon exhalation rate of soil and indoor radon concentration of various places of Karbi Anglong District of Assam. *Journal of Applied physics*, 6 (4), 13-16.

Kumar R., Scngupta D. and Prasad R., 2003. Natural radioactivity and radon exhalation studies of rock samples from Surda copper deposits in Singh Hun Shear zone. Radiat. Meas., 36, 551 - 553.

Laith A. Najam, Nada F. Tawfiq and Rana Hesham Mahmood., 2013. Radon concentration in some building materials in Iraq using CR-39 track detector. *International Journal of Physics*, 1 (3), 73-76.

Maged A. F., (2006). Radon concentrations in elementary schools in Kuwait. H. Phys., 90 (3), 258-262.

Mamta Gupta, Mahur A. K, Ssonkawade R. G, Verma K. D., and Rajendra Prasad, 2010. Measurement of radon activity, exhalation rate and radiation dose in fly ash samples from NTPC Dadri, India. *India Journal of pure and Applied Physics*, 48, 520-523.

Mamta Gupta, Mahur A. K., Sonkawade and Verma K. D. 2011. Monitoring of indoor radon and its progeny in dwellings of Delhi using SSNTDs. Advances in Applied Science Res., 2 (5), 421- 426.

Misdaq M. A., Merzouki A., Elabboubi D., Aitnouh F. and Berrazzouk S., 2000. Determination of radon equivalent alpha dose in different human organs from water ingestion using SSNTD and dosimetric compartmental models. *J. Radioanal. Nucl. Chem*., 245(3), 513-520.

Nsiah-Akoto I., Fletcher J .J., Oppon O. C., and Andam A. B., 2011. Indoor radon levels and the associated effective dose rate determination at dome in the greater Accra Region of Ghana. *Research Journal of Environmental and Earth Sciences*, 3(2), 24-30.

Rahman S. U., Rafique M., and Matiullah Anwar J. 2009. Radon measurement studies in workplace buildings of the Rawalpindi region and Islamabad capital area, Pakistan. Build Env., 45(2) 421-426.

Sarma H. K., 2013. Radon activity and radon exhalation rates from some soil samples by using SSNTD. *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, 2, 5024- 5029.

Singh Surinder and Prasher Sangeeta, 2004. The etching and structural studies of gamma irradiated induced effects in CR-39 plastic track recorder. Nucl. Instr. Meth. Phys. Research B, 222, 518-524.

UNSCEAR, 1993. Sources and Effects of Ionizing Radiation, United Nations Scientific Committee on the Effects of Atomic Radiation, Report, New York, 1993.

UNSCEAR, 2000. Sources and effects of ionizing radiation, Report to the General Assembly with scientific annexes. United Nations, New York, Vol., I, 2000.

WHO, 1993. Guidelines for drinking water quality. World Health Organization, Vol., 2, Geneva, 1993.

WHO, 2009. Handbook on Indoor Radon and A public health perspective. World Health Organization, 2009.

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