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THE ANNUAL EFFECTIVE DOSE FOR SOME FOOD CROPS SAMPLES USING ALPHA TRACK DETECTOR

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ABSTRACT

Radon gas arrives the indoors from different sources and very important in human life because it is harmful on the human population. Radon concentrations were measured in some crops samples from the local market by Suez government, Egypt, using alpha track detector from the type of CR-39. The values of the annual effective dose varied from 1.94 - 1.21mSvy^{-1}. The obtained results indicate that the values of annual effective dose lower than the recommended limit of ICRP. We conclude that there is no health hazard due to radon gas, when used in eating of the food crops samples in this study. This work will help to provide an important database about the radiation hazard from food crops, which used in our houses.

Keyword

Radon, Crops, CR-39, Effective dose, Food.

INTRODUCTION

Radon is a radioactive gas comes from natural decay of uranium decay series that is found in nearly all rocks, soils, and water [1]. When radon gas is inhaled, densely ionizing alpha particles emitted by depositing decay products of radon (^{218}Po and ^{214}Po) can interact with biological tissue in the lungs leading to DNA damage [2]. Radon is radioactive isotopes and its half-life of 3.82 days. The subseries decays of radon decays into many short lived daughter progeny among which ^{218}Po and ^{214}Po are very high alpha emitter [3].

However, it is not the radon itself, but the alpha particles produced during the decay process and the highly radioactive daughter products that are considered as environmental health hazard. People exposed to radon have confirmed that radon in homes represents a serious health hazard. The main health risk associated with long-term, elevated exposure to radon is an increased risk of developing lung cancer, which depends on the radon concentration and exposure time [4]. When an individual spends time in an atmosphere that contains radon and its decay products. In addition, the organs, including the kidney and the bone marrow, may receive low doses [5]. If an individual drinks water in which radon is dissolved, the stomach will also be exposed [6]. There are different methods for measurement of radon gas and its decay products, which are classified according to their sampling adopted procedures. Passive technique is more suitable for the measurement of radon [7]. SSNTD's are widely used in detecting radon and considered to be most used devices for radon concentration measurements. CR-39 plastic track detector was used for the evaluation of radon concentration in different types of crops samples [8]. The radionuclides present in the environment are transferred to plant uptake from soil through the roots. When food crops are grown in the contaminated soil, the activity is shifted from the soil to the roots and then shoots. At the end, activity is transferred to the human diet [9]. The radioactive elements can be transferred into plants along with the nutrients via minerals uptake which accumulate in various parts and reach edible portions [10]**.** Since all crops samples contain various amounts of natural radionuclides, and those radionuclides are sources of radon, then the knowledge of the natural radioactivity of crops are important to determine population exposure to radiations [11]. Traders monopolize food and stored for a long time, this is leading to radon exhalation, which harmful to health and nutrients in Egyptian homes, which consumption every day. This work aimed to measure radon concentration in food crops samples (lentil, cumin, anise, black pepper, coriander and other crops) collected from a local market in Suez Governorate, Egypt. This data will provide an important database about the radiation hazard from crops, which used in our houses.

MATERIALS AND METHODS

Fifteen samples from food crops samples like (lentil, cumin, anise, black pepper, coriander, bean, fenugreek, fennel, cowpea, kidney beans, chickpeas, wheat flour, wheat grains, corn flour, and rice) were collected randomly from local market in Suez Governorate, Egypt and it is the most popular used in food. Radon concentration in crops samples were measured using passive technique based on CR-39 detectors. Some samples were washed, dried in air and dried in oven at 60˚C for suitable time [12], to eliminate absorbed moisture and obtain actual dry weight. The samples were minced, crushed by using a blender (except the flour), sieved and carefully sealed for 40 days in plastic containers with diameter 8 cm and depth 16 cm. Before use, containers were washed with dilute hydrochloric acid and rinsed with distilled water and assigned a code specific to each individual sample.

A piece of CR-39 detector with an area of (1.5 × 1.5) cm^2 was fixed by double stick tape at the bottom of the cover of the container. After irradiation, the detectors were collected and etched in 25% of NaOH solution at 70˚C for 8 hr [13]. After etching, the detectors were washed in distilled water and dipped in a 5 % acetic acid. After this the detector washed by distilled water and dried in air. The tracks density was counted using an optical microscopic (magnification of 640x) [14]. Background of CR-39 track detectors was calculated and subtracted.

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Radon concentration determines using the following relation:

$$\rho = K. C_{Rn} .T \quad (1)$$

Where, P: track density (track cm^{-2}), C_{Rn} :radon concentration (Bqm^{-3}), T :exposure time (day) and K :calibration factor of CR-39 (tracks cm^{-2}day^{-1}/Bqm^{-3}) [15]

$$E = \frac{CV\lambda}{A(1-e^{-\lambda t})} \quad (2)$$

Where, E: surface exhalation rate (Bqm^{-2}h^{-1}), C: concentration of radon (Bqm^{-3}), λ: decay constant of radon (h^{-1}), V: effective volume of the container (m^{3}), A: sample surface area (m^{2}) and t: irradiation time [16 - 17]. Annual effective dose rate (H) in mSvy^{-1} due to inhalation of radon in indoor air, was calculated according to the following equation:

$$H\ (mSvy^{-1}) = C_{Rn} .D.F.\ T.\ R \quad (3)$$

Where, F (0.4) is the indoor equilibrium factor. T is the indoor occupancy time (hr), R is the indoor occupancy factor (0.8) and D is the dose conversion factor (9 x10^{-6} mSv h^{-1}/ Bqm^{-3}) [18-19 -20].

RESULTS AND DISCUSSION

The results of radon concentrations, surface exhalation rate, and annual effective dose for food crops samples were presented in **Table 1**. Chickpeas have the highest value of radon concentration 116.94 Bqm^{-3}, while the lowest value was found in bean 30 Bqm^{-3}. But the value radon exhalation rate ranged from 7.08 to 2.91 Bqm^{-2}h^{-1}, and the values of annual effective dose ranged from 1.94 to 1.21 mSvy^{-1}. Comparison between the values of radon concentration of the food crops samples was given by **Figure 1,** from this figure we find that the sample number 9 has a high value but sample number 2 has a lowest value of radon concentration. All values of radon concentration lower than the natural limits of public (400 Bqm^{-3}) given by ICRP [21]. The variation of radon concentration levels for food crops refer to the wide variations in the geological formation of soil and the type of composition of soil material used during construction. Also the distribution of radionuclides in different parts of the plant depends on the chemical characteristics and several parameters of the plants and soil. Measurement of radon exhalation rate is a good indicator for the radon present in the crops samples. The data obtained show that the radon exhalation rate varies linearly with the radon concentration as shown in **Figure 2**, which gives a good positive correlation (R^2=1). **Figure 3** shows the correlation relation between the values of radon concentration and annual effective dose of the samples, where the correlation coefficient equal (R^2= 0.98), this is a good correlation because the values of annual effective dose depend on the values of radon concentration. The present work was compared with those listed in **Table 2** are lower than those reported in the literature for different crops samples and the results of the radon concentration are in good agreement with this literature.

Table 1. The values of radon concentration, radon exhalation rate and the annual effective dose of the samples

Sample No.	Name	C_{Rn*} (Bqm^{-3})	E (Bqm^{-2}h^{-1})	H (mSvy^{-1})
1	Rice	48.05	2.91	1.21
2	Bean	30.00	1.81	0.76
3	Lentil	69.02	4.18	1.74
4	kidney beans	35.97	2.18	0.91
5	Cowpea	54.02	3.27	1.36
6	Flour	35.97	2.18	0.91
7	Fenugreek	45.00	2.72	1.35
8	Wheat	76.94	4.66	1.94
9	Chickpeas	116.94	7.08	2.95
10	Black pepper	50.97	3.09	1.29
11	Anise	49.03	2.97	1.24
12	Coriander	58.05	3.51	1.46
13	Cumin	66.94	4.06	1.69
14	Fennel	61.94	3.75	1.56
15	Corn	60.97	3.69	1.54

*The percentage of error in radon concentration equal 5%

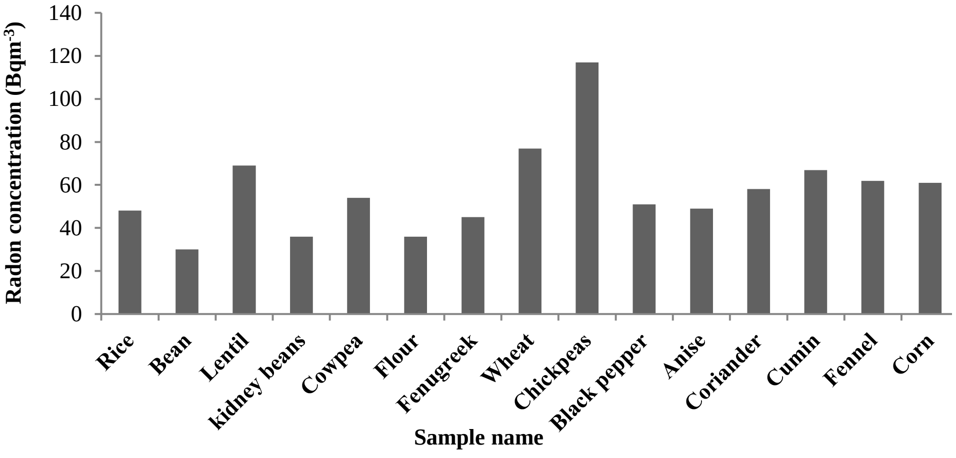

Figure 1. The comparsion between the values of radon concentration of crops samples

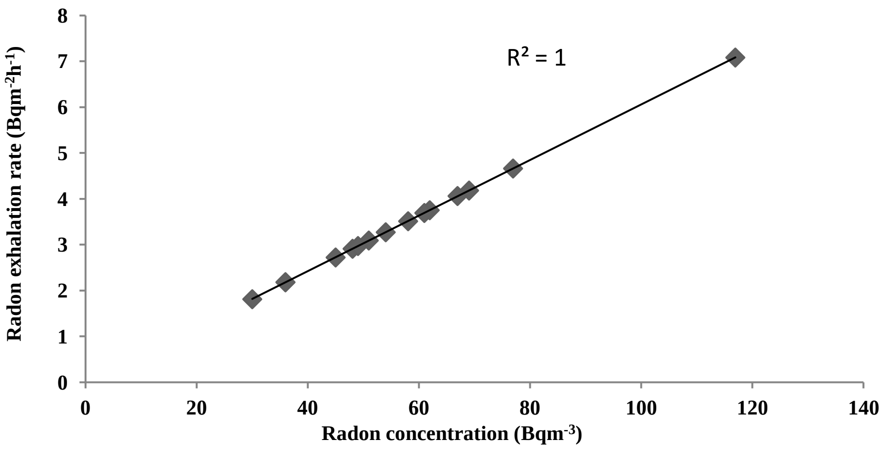

Figure 2. The correlation relation between radon concentration and exhalation rate

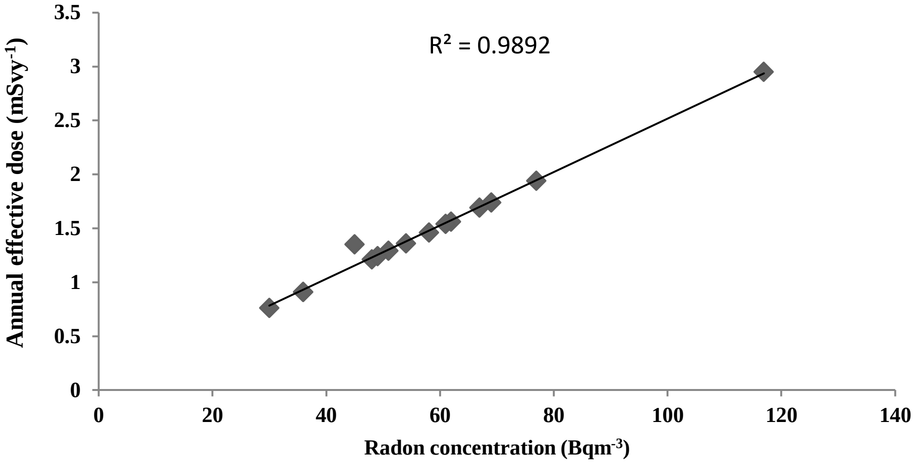

Figure 3. The correlation relation between radon concentration and annual effective dose

Table 2. The comparison between our results and the others

Countries/Org.	Sample name	C_{Rn} (Bqm^{-3})	References
WHO		100	[4]
ICRP		400	[21]
ICRP (action level)		200-600	[22]
Iraq	Bean	24.17	[23]
	Rice	45.63	
	Wheat	81.24	
	Flour	37.71	
	Kidney bean	137.39	
	Chick bean	151.90	
Egypt	Bean	30	The present work
	Rice	48.05	
	Wheat	76.94	
	Flour	35.97	
	Kidney bean	35.97	
	Chickpeas	116.94	

CONCLUSION

We study radon concentration for crops in Suez Governorate in order to get on its impact on the health of the Egyptian people residing in Suez Governorate. The results showed that radon concentrations in crops samples were ranged between (30 -116.94) Bqm^{-3}. The present values of indoor radon levels found in corps samples are lower than the reference level (400 Bqm^{-3}), which recommended by ICRP [21].

And lower than the action levels range (200-600) Bqm^{-3} ICRP [22], and also lower than level 100 Bqm^{-3}, which recommended by WHO [4]. The radon distribution in the crops samples vary from sample to another this refer to the type plant Composition. The annual effective dose ranged between (1.91 to 1.21) is found less than the lower limit of the action level (3 mSvy^{-1}) recommended by ICRP [21]. And also the values of annual effective dose are lower than the worldwide average radiation dose of 2.4 mSvy^{-1} and low the range of (3-10) mSvy^{-1} recommended by ICRP [21]. General public in terms of the radiological hazard, as well as the finding of this work will help in establishing a baseline of radioactivity exposure to the general public from ingestion of this type of food crops. We conclude that there is no health hazard due to radon gas, when used in eating of the crops samples in this study.

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