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Investigation of Radon Concentration effects from Smoking Cigarette available in Basra Market, and Lung Cancer Risk

Abdul Ridha Hussian Subber[1] , Munaf Qasim Jaber[2] and *Waleed Hameed AL-Mosuwi* [3]
1)Al-Kenooze University College, Basra, Iraq
Email: abdulredha@kunoozeu.edu.iq
2) Marine Sciences Centre, University of Basra, Basra, Iraq
3) Ministry of Environment Directorate of Protection and Improvement of Environment Southern Area ,Iraq, Basra
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Abstract

The combination of smoking, secondhand smoke, and radon exposure from tobacco results in an especially serious health risk. The risk of lung cancer due to indoor radon exposure can be decreased with current technology. Radon may be the second cause of lung cancer due to smoking, the synergistic effect between radon and tobacco smoke. People who inhale tobacco smoke are exposed to higher concentrations of radioactivity due to radon gas and its decay products. To investigate whether the cigarette tobacco itself is a potential source of indoor radon, the levels of radon and thoron from radioactive decay were measured in tobacco samples of 28 different brands in the local market using CR-39 Solid State Nuclear Track Detectors (SSNTDs) and Sealed Can technique. The results showed that the ^{222}Rn and ^{220}Rn concentrations in cigarette tobacco samples ranged from 91.7 to 492.8 Bqm^{-3}. The radon radioactivity concentrations that emerged from all investigated 28 samples were significantly higher than the background level and WHO recommendations level in some aspects. The annual effective dose from the use of these tobacco and the lung cancer cases per year per million persons were calculated for all samples.

Keywords: Radon gas, CR-39, Can technic, Tobacco, Lung cancer.

* *Corresponding author.*. E-mail address: abdulredha@kunoozu.edu.iq

1. Introduction

For a healthy environment, it is important to carry out a routine measurement of radioactive radon gas concentration in outdoor and indoor environments. Radon is a natural, colorless, odorless radioactive gas with three natural isotopes, actinone ^{219}Rn, thoron ^{220}Rn and radon ^{222}Rn, and it is the main natural source of radiation on Earth. Rocks, soil, and water naturally contain radon due to the presence of uranium in trace concentrations as well as its immediate parent and because of the radioactive decay of radium[1-2]. Radon gas can be found everywhere in the Earth's crust and it easily crosses from the ground into the air and plant-like tobacco leaves. Indoor radon concentrations mostly depend on local geology, hygrometry, meteorological conditions as well as the level of ventilation and occupancy, especially smokers [3-6]. Radon is an unstable radionuclide that disintegrates through short-lived decay products before eventually reaching the end product of stable lead. The solid short-lived decay products of radon are responsible for most of the hazards posed by participation in human lungs. Lung cancer is the most commonly occurring cancer in men and the third most commonly occurring cancer in women. The fertilizers that tobacco farmers use to increase the size of their tobacco leaves contain the naturally-occurring radionuclide radium and its decay products. As the plant grows, the radon from fertilizer, along with naturally-occurring radon in surrounding soil and rocks, transfer into and on the plant and are later included in tobacco products made from these plants [EPA]. Radon's decay product, polonium-210, carries the most risk according to the European Union (EU) Directive, establishing basic safety standards for protection against the dangers that may result of exposure to ionizing radiation, radon concentrations in houses less than 300 Bq/m3 are considered acceptable and the individual risk of some illness is negligible [7]. Indoor radon varies with the time of the year, from hour to hour, from day to day, and from season to other. Smoking Cigarette increases the indoor radon concentration and the inhalation of smoke, due to the release of radon and its progeny hidden in tobacco leaves and many other chemical materials and this has an effect on both active and passive smokers. Smoking cigarettes greatly increases the chance of developing lung cancer due to exposition to radon and radon progeny inside the breathing system. Each year approximately 10%-25% of lung cancer death in the world are attributed to indoor radon [8]. Radon is the number one cause of lung cancer among non-smokers, according to EPA estimates [9]. Overall, radon is the second leading cause of lung cancer. Radon is responsible for about 21,000 lung cancer deaths every year. About 2,900 of these deaths occur among people who have never smoked. It has been observed that tobacco smoking increases the risks of radon-induced lung cancer [10]. Each year 1.35 million new cases are diagnosed, which represents more than 12% of all the new cancer cases. Furthermore, smoking is responsible for 1.18 million deaths from cancer (17.6% of the world total), of which 21,400 are lung cancers from secondhand smoking. Radon is a class A carcinogen and the second leading cause of lung cancer [11].

The work presented here aims at shedding lighter on the radiological health hazards due to cigarette tobacco smoking in Iraq and specially especially in Basra governorate. The concentrations of radon, thoron, and their daughters in cigarette tobacco have been determined using CR-39 solid-state nuclear track detectors (SSNTDs). The annual effective dose equivalent from use of these tobaccos is computed. The exhalation rates of both ^{222}Rn and ^{220}Rn in cigarette tobacco samples have been determined using integrated radon exposure. In addition, the difference between indoor radon in smoke-free and smoke-rich environments are also investigated.

2. Materials and Methods

Twenty-eight tobacco samples for a different brand of local and imported cigarette were collected from local markets in Basra Governorate Iraq. Samples of tobacco were isolated from their covered papers and filters, each weighted about (20 g) of pure tobacco. Samples were dried by exposing them to the sunlight during the daytime for two days in summer to get rid of the moisture, then ground and sieved. These fixed amounts of tobaccos samples were put in the bottom of a heavy plastic can 11 cm in height and 7 cm in diameter [12]. The detectors were cut into a piece of 1.5cm × 1.5 cm and placed on the bottom of the top cover of the containers, using a scotch double-sided foam tape, to allow the irradiation process with radon-222 only to take place [13]. The well-sealed can is shown in figure 1. The cans were completely sealed and left for about 90 days in room temperature to allow the radium reach to equilibrium with radon. This step was necessary to ensure that the radon gas is confined within the sample. At the end of exposure, the CR39 detectors were immediately removed from the cans and

stored inside the chamber until the end of the experiment. The detectors were etched with 6.25N NaOH at 70° C for 7 h..The detectors were then washed many times by double distilled water and dried with smooth tissue papers. The numbers of tracks due to alpha particles interaction are counted by the means of an optical microscope 400X.

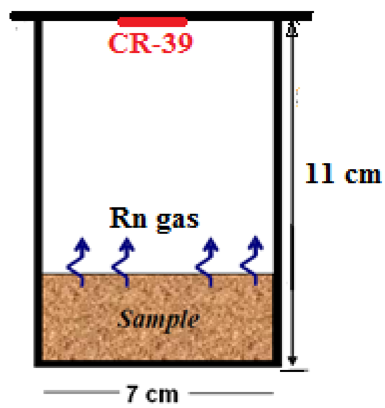

Figure 1. The hard plastic cylinder used as radon irradiator

3.Theoretical consideration

Radon gas concentration is given by [14]

$$A_{Rn} = \frac{\rho}{tK} \quad (1)$$

where ρ is track density in Tr/cm^2 , t exposure time in the day and K the calibration factor in Tr/cm^2.day / Bq.m^{-3}. The value of K will depend on the height and radius of the measuring can. The track density and radon gas activity was obtained through a calibration factor of K=0.2857±0.01431 Tr cm^{-2} d^{-1} per Bq m^{-3} according to the relation [15]

At the equilibrium state, the final activity of radon exhalation from each sample inside the can is given by [16-18]

$$E_{ex} = \frac{AV\lambda/S}{T+(e^{-\lambda T}-1)/\lambda} \quad (2)$$

where E_x is exhalation rate in unit Bq $m^{-2}.d^{-1}$, A is integrated exposure measured by the detector in unit Bq m^{-3} d, λ is radon decay constant, T, the exposure time, V the volume of the can, and S is the surface area covered by the can.

The radon exhalation rate in terms of mass is calculated from the relation;

$$E_M = \frac{AV\lambda/M}{T+(e^{-\lambda T}-1)/\lambda} \qquad (3)$$

where E_M expressed in Bq $kg^{-1}h^{-1}$ and M is the mass of the sample.

The effective radium content in the sample could be calculated from;

$$A_{Ra} = \frac{\rho hS}{KMt} \qquad (4)$$

where ρ is track density recorder, h distance between the detector and sample, S surface area of sample and t exposure time.

The annual effective dose (AED) in terms of (mSv/y) units was obtained using the relation [19-21]

$$\text{AED (m Sv/y)} = A_{Rn} \times F \times H \times T \times D \qquad (5)$$

The annual effective dose equivalent to potential alpha energy E_p is given to the following formula:

$$E_p\left(\frac{mSv}{y}\right) = 2.21 \times 10^{-3}\, n\, F\, A_{Rn} \qquad (6)$$

where n is occupation number estimated as n=0.8 indoor and n=0.2, is radon equilibrium factor estimated as F=0.41 and A_{Rn} is the measured radon gas concentration. The time T is the number of hour in a year, (T=8760 h/y), and (D) is the dose conversion factor which is equal to [9×10-6 (m Sv) / (Bq.h.m-3)]. The lung cancer cases per year per million people (CPPP), was obtained using the relation [21, 22]

$$\text{(CPPP)} = \text{AED} \times (18\times10^{-6}\ mSv^{-1}.y) \qquad (7)$$

In the present work radon concentrations, were measured in different for 28 different brands of tobacco cigarettes in the Iraqi market. Table 1 summarizes the results obtained in the present work for radon gas concentrations in brand tobacco cigarettes in the Iraqi market.

To measure the background three empty cans with detectors were used for ninety days also and their average track number was subtracted**.**

4- Results and Discussion

Different origin fertilizers have been collected from local positions and listed in table 1 with their ID. The tracks density made by radon gas on CR39 fixed on top of the chamber for 90 days is listed in the same table. The minimum value for track density is 2830 Tr/cm^2, and the maximum value is 15212 Tr/cm^2. Equation (1) has been used to calculate radon concentrations in tobacco samples, according to the measured calibration factor 0.2857±0.01431 $Tr\ cm^{-2}\ d^{-1}$ per $Bq\ m^{-3}$. Radon concentrations were

measured in 28 different imported brands of tobacco cigarettes in the Basra market.it is found that the minimum concentration was 91.7∓24.8 Bg/m^3, in tobacco originating from Turkey, while the maximum value was 492.8∓128.1Bq/ m^3in tobacco imported from Iran. The radon-induced lung cancer risks for most of the brands of tobacco cigarette in the Basra market was found to vary from 1.2 people per million to 6.4 person per million.

The highest value of exposure to radon progeny (area exposure rate) was found in GR with an estimated value of 0.436 $Bq\ m^{-2}.d^{-1}$ in Iranian tobacco, while the lowest value of was found in to be 0.081 $Bq\ m^{-2}.d^{-1}$1 , in Turkish tobacco, with the average value of 0.258 $Bq\ m^{-2}.d^{-1}$. The remaining results of the samples were within allowable limits of the recommended values. The radon exhalation rates, mass exhalation rate, and effective radium activity in tobacco collected from the local market were also calculated and presented in the table with their minimum, maximum, and average values shown in the same table. The effective radium content in the samples was calculated using equation (4). It is found that the minimum content is 0.277 and the maximum value is 1.487, and they are within the recommended level of EPA.

Table 1. The type of tobacco and their origin together with the masses and track density produced by irradiate CR39 track detector for 90 days

Sample No	Sample cod	ρ in Tr/cm²	Radon conc.in Bq/m³	E(A) Bq m⁻².d⁻¹	E(M) Bq kg⁻¹h⁻¹	Ra	AED mSv/y	Cancer per Million
1	Sumer	8255	267.4∓70.1	0.236	6.09	0.807	0.194	3.5
2	Marlboro	10279	333.0∓87.0	0.294	7.59	1.005	0.241	4.3
3	Gauloises	6073	196.7∓51.9	0.174	4.48	0.594	0.143	2.6
4	Gauloises	8451	273.8∓71.7	0.242	6.24	0.826	0.198	3.6
5	Bon	5759	186.5∓49.3	0.165	4.25	0.563	0.135	2.4
6	Aspen	9021	292.2∓76.5	0.258	6.66	0.882	0.212	3.8
7	Aspen 1	8078	261.7∓68.6	0.231	5.96	0.789	0.190	3.4
8	Aspen 2	9513	308.1∓80.6	0.272	7.02	0.930	0.223	4.0
9	Mastar 1	5955	192.9∓50.9	0.171	4.39	0.582	0.140	2.5
10	Master 2	9277	300.5∓78.6	0.266	6.85	0.907	0.218	3.9
11	Oscar 1	8255	267.4∓70.1	0.236	6.09	0.807	0.194	3.5
12	Oscar 2	8746	283.3∓74.2	0.250	6.45	0.855	0.205	3.7
13	Gitanes	7921	256.6∓67.3	0.227	5.85	0.774	0.186	3.3
14	Five star	5641	182.7∓48.3	0.161	4.16	0.551	0.132	2.4
15	Graven	7370	238.8∓62.7	0.211	5.44	0.720	0.173	3.1
16	Afaair	7469	241.9∓63.5	0.214	5.51	0.730	0.175	3.2
17	Miami	9316	301.8∓79.0	0.267	6.87	0.910	0.219	3.9
18	Royale	6289	203.7∓53.7	0.180	4.64	0.615	0.148	2.7
19	Pine	10456	338.7∓88.5	0.299	7.72	1.022	0.246	4.4
20	Kent	9296	301.1∓78.8	0.266	6.86	0.909	0.218	3.9
21	Roth.	13954	452.0∓117.7	0.400	10.30	1.364	0.328	5.9
22	local	13365	432.9∓112.7	0.383	9.86	1.306	0.314	5.6
23	local	13168	426.6∓111.1	0.377	9.72	1.287	0.309	5.6
24	Iran	10692	346.3∓90.4	0.306	7.89	1.045	0.251	4.5
25	Iran	15212	492.8∓128.1	0.436	11.23	1.487	0.357	6.4
26	Ter	2830	91.7∓24.8	0.081	2.09	0.277	0.066	1.2
27	Ter	8962	290.3∓76.0	0.257	6.61	0.876	0.210	3.8
28	Arbil	12303	398.6∓103.9	0.352	9.08	1.202	0.289	5.2
min			91.7∓24.8	0.081	2.09	0.277	0.066	1.2

max	492.8∓128.1	0.436	11.23	1.487	0.357	6.4
Av	291.5∓76.3	0.258	6.64	0.879	0.211	3.8

4. Conclusion remarks

Samples taken from 28 brands of tobacco used in Basrah governorate were analyzed for radon concentration and exhalation rates and radium effective mass, using the passive method of CR-39. Tobacco samples of many types of cigarette brands is found to be within the range of recommended values of radon concentration. The present results show that the radon gas concentration in some samples is below the allowed limit by (the International Commission of Radiation Protection) (ICRP) agency. While other samples have a high radon concentration and consequently more smokers and ex-smokers increases a significant risk to human health, leading to an increased risk for lung cancer. T

his study may help to limit the exposure to chemical and radiation from tobacco products uses by others.

References

1. UNSCEAR, 2006 United Nations Scientific Committee on the Effects of Atomic Radiation, Report of UNSCEAR to the General Assembly, United Nations, New York, USA.,111–125.
2. International Commission on Radiological Protection Statement on Radon ICRP Ref 00/902/09, (2009).
3. Zeeb, H. Shannoun, F. WHO handbook on indoor radon: a public health perspective, WHO Press, World Health Organization: Geneva, Switzerland, 2009; 1–94.
4. Branco, P.T, Nunes, R.A.O.; Alvim-Ferraz, M.C.M.; Martins, F.G.; Sousa, S.I.V. Children's Exposure to Radon in Nursery and Primary Schools. Int. J. Env. Res. Pub. He. 2016, 13, 386.

5. Antão, A.M. Assessment of Radon Concentrations Inside a High School Building in Guarda (Portugal): Legislation Implications and Mitigation Measures Proposed. Procedia. Earth. Planet. Sci. 2014, 8, 7–12.
6. Llerena, J.J.; Cortina, D.; Durán, I.; Sorribas, R. ^{222}Rn concentration in public secondary schools in Galicia (Spain). J. Environ. Radioactive. 2020, 101, 931–936. Appl. Sci. 2020, 10, 2341 12 of 13
7. Radolic, V.; Vukovic, B.; Stanic, D.; Katic, M.; Faj, Z.; Lukacevic, I.; Planinic, J.; Suveljak, B.; Faj, D.; Lukic, M. National survey of indoor radon levels in Croatia. J. Radioanal. Nucl. Ch. **2006**, 269, 87–90
8. National Academy of Sciences. Biological effects of ionizing radiation (BEIR) VI report: the health effects of exposure to indoor radon. Executive summary. Available at http://www.epa.gov/iaq/radon/beiriv1.html. Accessed February 19, 1998
9. EPA, Environmental Protection Agency, regulations of Rn-220 proposed rules, 1999
10. Abdalsattar, Kareem Hashim1, Fadhil Khaddam Fuliful, Lung Cancer Risk
11. Due to Radon in Different Brand Cigarette Tobacco in Iraqi Market, Asian Journal of Applied Sciences (ISSN: 2321 – 0893) Volume 05 – Issue 03, June 2017, 541
12. Seyed M, Farid,A, A study of the Radon concentration in Tobacco in Jeddah (Saudi Arabia) and associated health effects, *Public Health,* Medical Journal of Islamic World Academy of Sciences 2012, 20:3, 84-93,

12- Ali Farhan Nadir, Abdul R. H. Subber* and Noori H. N. Al-Hashmi, Mathematical Calculation to Find the Best Chamber and Detector Radii Used for Measurements the Range of α-Particle, The International Journal Of Engineering And Science (IJES),V3 Issue 12, 2014 , 48-52

13- Ali Farhan Nadir, Abdul R. H. Subber and Noori H. N. Al-Hashmi, onstruction simple radon chamber for measurement of radon detectors calibration factors, Pelagia Research Library Advances in Applied Science Research, 2015, 6(2):128-131

14- Durrani, S. A., & Ilic, R. (1997), *Radon measurements by etched track detectors,* World Scientific Publishing, Singapore.

15- Juber J. H., Subber A. R., Natural Radon Exhalation Rate from Fertilizer used in Basra Governorate/Iraq, International journal of Physics and researches, 4(6), 1-10, (2014) 16- Abu-Jarad F., J., (1988), *Application of nuclear track detectors for radon related measurements*, Nucl. Tracks Radait. Meas. 15, 525-534

17- Hassan N. M., Hosoda, Iwaoka M., K., Sorimach A, M., Janik C., KranrodS., Sahoo K., Ishikawa T., Yonehara H. Fukushi M and Tokonami S., (2011), *Simultaneous Measurement of Radon and Thoron Released from Building Material Used* , Progress in Nuclear Science and Technology, 1, 404-407.

18- Saad A.F., (2008), *Radium activity and radon exhalation rates from phosphate ores using CR-39 on-line with an electronic radon gas analyzer "AlphaGUARD"*, Radiation Measurements 43 (2008) S463–S466

19- Mowlavi A.,M., Fornasier M.R., Binesh A. and de Denaro M. " Indoor radon measurement and effective dose assessment of 150 apartments in Mashhad, Iran" Environ Monit Assess, Vol.184, pp.1085-1088, (2012) .

20- UNSCAER Appendix I: Epidemiological evaluation of radiation induced cancer; Appendix G: Biological effects of low radiation doses, (2000).

21- Saad A. F, Abdallah R. M. and Hussein N. A, Radon exhalation from Libyan soil samples measured with the SSNTD technique, Applied Radiation and Isotopes, (2013),72, 163-168.

22- Mansour H.H., "Measurement of indoor radon level in Arbil capital by using solid state nuclear track detectors " Radiation measurement, (2005),Vol.40, pp: 544-547.

23- Abdullah, A.A., "Internal and external radiation exposure evaluation amongst selected workers and locations in Iraq" Ph.D. Thesis, University Sains Malaysia, Malaysia (2013).