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Research Article
Study of Radon Levels in Fruits Samples using LR-115 Type II Detector

[1]Heiyam Najy Hady, [2]Ali Abid Abojassim and [1]Zahrah Baqer Mohammed

[1]Department of Physics, Faculty of Education for Girls, University of Kufa, Iraq
[2]Department of Physics, Faculty of Science, University of Kufa, Iraq

Abstract
Background: Radon concentrations in fruits samples collected randomly from local markets in An Najaf, Iraq has been measured. **Materials and Methods:** Two passive detector (LR-115 type II nuclear track detectors) were used to measure the radon concentration in 9 fruit samples, in Iraq. **Results:** The radon concentrations measured by both tracks are found to vary from (18.51 ± 8.28 Bq m^{-3}) to (62.96 ± 15.27 Bq m^{-3}) with a mean value of (37.44 ± 5.09 Bq m^{-3}) and from (37.03 ± 11.71 Bq m^{-3}) to (100 ± 19.24 Bq m^{-3}) with a mean value of (55.55 ± 6.83 Bq m^{-3}), respectively. All values of radon concentrations for samples under study were found to be quite lower than the permissible value of (400 Bq m^{-3}) recommended by (ICRP). **Conclusion:** From radiation protection purpose of read, it had been found that the fruits samples under study don't cause any vital risk for the presence of ^{222}Rn concentration and it's thought of radiologically safe for human consumption.

Key words: ^{222}Rn concentrations, fruits samples, Iraqi markets, LR-115 type II

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Corresponding Author: Ali Abid Abojassim, Department of Physics, Faculty of Science, University of Kufa, Iraq

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The major sources of the key elements which supplies plants are: Air, water and soil[1]. The radio nuclides present in the environment are transferred to plants by two ways first indirect method uptake from soil through roots. When food crops are grown in the contaminated soil, the activity is shifted from the soil to the roots and then in shoots. At the end, activity is transferred to the human diet[2]. The radioactive elements can be transferred into plants along with the nutrients via minerals uptake which accumulate in various parts and reach edible portions[1]. Second, it is direct method absorption through aerial parts of the plants. Presence of radioactivity in plant organs has been reviewed by various workers[2]. The largest natural source of radiation exposure to humans is radon gas, that exist on air, water and soil. Given that radon is always been in the environment, its contribution to human exposure was increased in recent years. Radon's main track is from the ground[3]. Every individual receive an amount of exposure from the naturally occurring radioactivity exists in soil, water, air and food. The ^{222}Rn is generally emitted from uranium, a minerals in rocks and soil; therefore, the radon presents virtually everywhere in the air over the earth[4,5]. The radiological effect of using fertilizers in soil causes internal exposure to the respiratory organs by α-particles, short lived radon-thoron progeny and the external irradiation of the body by γ-rays which are emitted from the radio nuclides. Radon, in fact, is a carcinogenic element to humans and responsible for main natural human radiation exposure[6,7].

Measurement of the radon concentration in food samples were investigated by several studies in countries around Iraq and other countries in the world[8-12].

Alpha (especially radon gas) can enter body in different methods such as air, water and food which it is called "Internal emitters". Fruits take up radiation from the soil environment if grown on soil containing it. In Iraq, there was not clear data base on radon levels in fruit samples despite the wide intake of these kinds of plants using for eating at different age groups. From this point of view, studying radon concentration in food or plants is very important. The aim of this study are to measure the concentrations and specific activity in some samples of fruits using the technique of tracing nuclear detectors (LR-115 type II) that are produced and frequently consumed in Najaf, Iraq. Also, study the effect using two track at same container on the measuring of radon concentrations.

MATERIALS AND METHODS

This part is consist of the experimental setup and calculations for measuring radon concentrations in sample of fruits using solid state nuclear track (LR-115 type II).

Collection and preparation samples: Nine samples were collected randomly from different locations of the An Najaf markets. Fruits samples were chosen for present study since, it is the most popular food to An Najaf and Iraqi people. Different types of fruits samples originating in Iraq, Iran, Egypt and Turkey were collected from several commercial companies that available in Iraqi markets as shown in Table 1. All samples were initially washed many times using water to clean it and to remove all desert sands out of them. After that, they were cut into small pieces and were prepared for measurements by drying in an electric oven at 100°C for 1 day to ensure the removal of moisture and cooled to room temperature in a desiccator. Next, the samples were grounded into a fine powder and sieved using 0.8 mm mesh to obtain a uniform particle size. We coded each sample into a specific code in order to distinguish between it. The samples were sealed in standard marinelli plastic beaker for period of month to have the ^{222}Rn and its short lived daughter products[13] in an equilibrium with ^{226}Ra.

Experimental setup: A LR-115 type II detector with a thickness of (12 μm) used samples of fruits for measuring radon levels. Samples have been put in to the one container technique as shown in Fig. 1. These detectors were placed at the closed top end of a plastic cup of diameter (4 cm), length (7 cm) and volume (130 mL). The number of LR-115 type II detector was 18 pieces where 2 pieces in one container. Each piece was cut in area 1×1 cm^2 and put in the upper part of containers as shown in Fig. 2. A small piece of the LR-115 type II detector was placed in the cylinder cover of each container, while the samples at the container and then sealed for 90 days exposure.

Table 1: Food categories of fruits samples in this study

Name of samples	Code of samples	Country of origin
Rearrange	S1	Iraq
Pomegranate	S2	Iraq
Pear	S3	Iraq
Watermelon	S4	Iran
Apple	S5	Iran
Banana	S6	Egypt
Orange	S7	Egypt
Lemon	S8	Turkey
Apricot	S9	Turkey

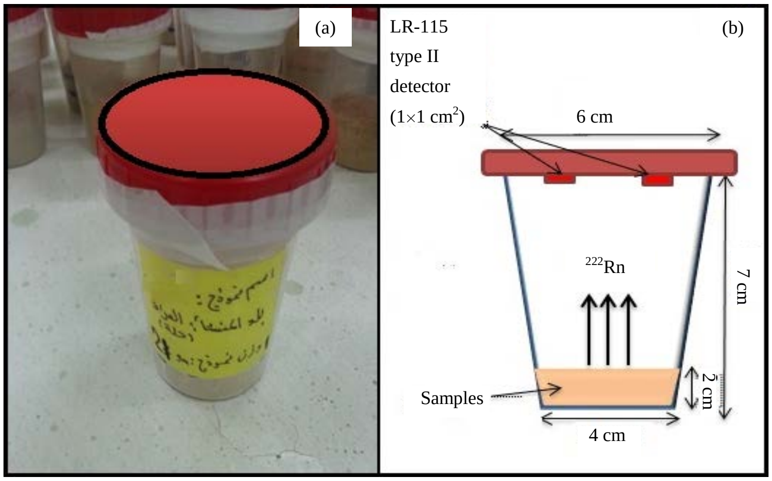

Fig. 1(a-b): Samples in containers

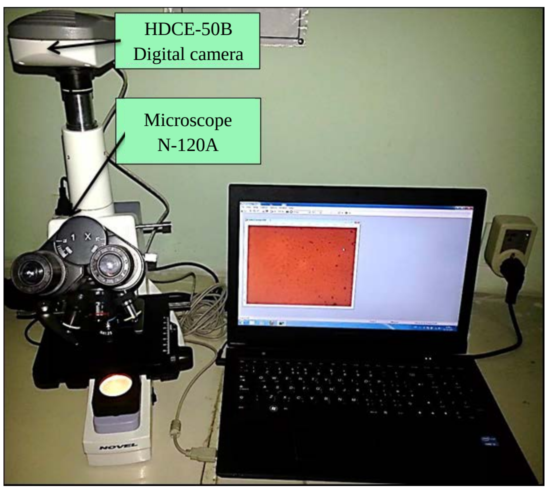

Fig. 2: Optical microscope

The LR-115 type II detector is etched in sodium hydroxide (NaOH) solution of (2.5) normality which is prepared by dissolving 40 g of NaOH in 0.4 L of distilled water.

After preparing the etching solution using magnetic stirrer and it is kept for 24 h until it becomes homogeneous. During this time the detectors are carefully removed from the plastic containers and as possible taking care of keeping the surface of the detectors clean from scratches. Next day detectors were placed in a solution (NaOH) and put pyrex in the water bath and lock it's temperature at (60°C) within 90 min (1.5 h). At last the detectors have been removed from the solution and extensively washed by a distilled water and dried by soft tissue papers. The numbers of tracks, per unit area of samples under study were then counted using an optical microscope (HDCE-50B Digital Camera, System Microscope N-120A) of 400X magnification power as shown in Fig. 2.

Calculation of radon concentrations: Radon concentrations (C_{Rn}) in (Bq m^{-3}) for food (vegetables and fruits) samples have been obtained using the expression[14]:

$$C_{Rn} = \frac{\rho}{K.T} \tag{1}$$

where, ρ is the radon track density (track cm^{-2}) which it is calculated by:

$$\rho = \frac{\text{No.of track}}{\text{Area}}$$

where, area of view, T is the exposure time and K is the calibration factor. The calibration factor in this study for dosimeters exposed for range from (5-30) day to radium-226 (Radon-222 source) of activity 3300 Bq was calculated to be (0.02±0.003) (track cm^{-2})/(Bq day m^{-3}), which agree well within the reported in many studies[15-18].

It can be calculated the activity of radon (A) in (Bq) that it is produced in sample used in this study. Also, it may be calculated the specific activity of radon (C_p) in samples under study in (Bq kg^{-1}) using the following equations[19]:

$$A\ (Bq) = C_{Rn}\ (Bq\ m^{-3}) \times V\ (m^3) \tag{2}$$

$$C_p\ (Bq\ kg^{-1}) = \frac{A}{m} \tag{3}$$

where, m is sample mass (kg) and V is volume of container.

RESULTS AND DISCUSSION

Table 2 and Fig. 3 are presented the results and the compared of radon concentrations in fruits samples using track 1 and 2 in unit (Bq m^{-3}). From Table 2 it is found that, the range of radon concentration varies from (18.51±8.28 Bq m^{-3}) to (62.96±15.27 Bq m^{-3}) with a mean value of (37.44±5.09 Bq m^{-3}) and varies from (37.03±11.71 Bq m^{-3}) to (100±19.24 Bq m^{-3}) with a mean value of (55.55±6.83 Bq m^{-3}), respectively.

Table 2: Radon concentration of fruits samples

	Radon concentration (Bq m^{-3})	
Code of samples	Track 1	Track 2
S1	51.85±13.85	59.25±14.81
S2	37.03±11.71	44.44±12.83
S3	37.03±11.71	44.44±12.83
S4	48.14±13.35	51.85±13.85
S5	25.92±9.790	37.03±11.71
S6	25.92±9.790	100.00±19.24
S7	18.51±8.280	48.14±13.35
S8	62.96±15.27	44.44±12.83
S9	29.62±10.47	70.37±16.14
Average±SD	37.44±5.090	55.55±6.830

Table 3: Average of radon concentrations and specific activity for fruits samples.

Code of samples	Average of radon concentrations (Bq m^{-3})	Average specific activity (Bq kg^{-1})
S1	55.55±14.33	0.25±0.06
S2	40.74±12.27	0.26±0.07
S3	40.74±12.27	0.17±0.05
S4	50.00±13.60	0.32±0.08
S5	31.48±10.75	0.12±0.04
S6	62.96±14.52	0.48±0.11
S7	33.33±10.81	0.25±0.08
S8	53.70±14.05	0.41±0.10
S9	50.00±13.30	0.34±0.09
Average±SD	46.50±3.730	0.29±0.04

Table 3 is presented the results of the average radon concentrations and specific activity in fruits samples in units (Bq m^{-3}) and (Bq kg^{-1}).

Table 3 shows that, the highest value of radon concentrations was (62.96±14.52 Bq m^{-3}) in sample (Banana, made in Egypt, Fig. 4), while the lowest value of of radon concentrations in sample S5 (Apple, made in Iran, Fig. 5) was (31.48±10.75 Bq m^{-3}), with an average (46.5±3.73 Bq m^{-3}).

According to Table 2 and Fig. 3, it is found that the difference between the results of radon concentrations in two tracks. These differences are attributable due to probability interaction the radon gas with solid state nuclear track detectors (LR-115 type II). Then, it can be concluded that it must be using more one detector when the measurement of radon concentrations in any samples to reduce the error in experimental processing.

Data shown in Table 3 indicate that radon concentration in these samples varies from sample to sample, which could be due to the difference in the level of uranium contamination in the soil where the samples are grown or due to the difference in the mechanism of radio nuclides transmission to samples under study. On the basis of our results, it is concluded that there are differences in the degree of

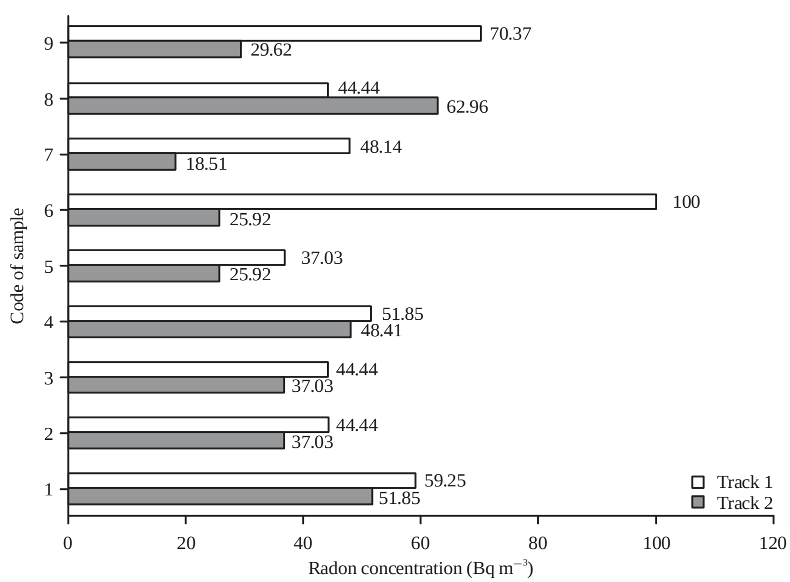

Fig. 3: Compare of radon concentration for two tracks

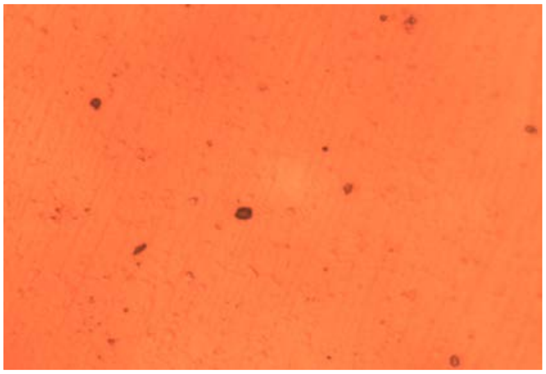

Fig. 4: Number of track in sample S6 (Banana, made in Egypt)

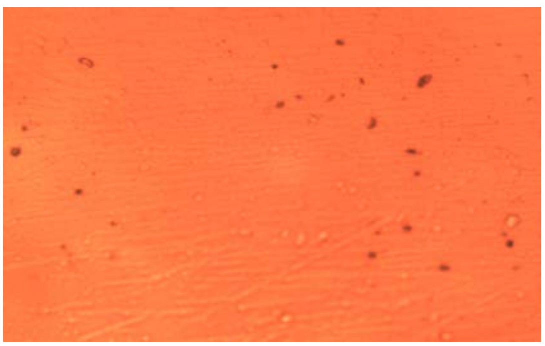

Fig. 5: Number of track in sample S5 (Apple, made in Iran)

translocation of radio nuclides to fruits depending upon physiological characteristics of the fruits and or the radio nuclides itself in addition to the properties of soil and water transportation. Also, it can be seen from Table 3, these values for all samples under study were lower than the natural limits for public (400 Bq m^{-3}) given by the International Commission on Radiological Protection (ICRP)[20]. With regards to radon concentration in various type of foodstuffs a very little amount of data has been published in the literature especially for fruits. Some of these data reported by different researchers in different countries are presented in reference[8,9,12,21].

CONCLUSION

Radon concentrations and the specific activity of An Najaf fruits samples consumed in Iraq have been estimated. The samples, which were collected randomly from different locations of the Iraqi markets. The present study is the first at the national level (in Iraq) to investigate radon concentrations and specific activity in fruits samples . The obtained values of radon concentrations was found to be less than the maximum permissible value of (400 Bq m^{-3}) as per recommendation of (ICRP). Also, it must be used more one SSNTD in same containers, to reduce error in the radon concentrations. At last, there are no health hazards duo to radon gas, when eating of the samples fruits under this study.

REFERENCES

1. Abojassim, A.A., L.A. Al-Alasadi, A.R. Shitake, F.A. Al-Tememie and A.A. Husain, 2015. Assessment of annual effective dose for natural radioactivity of gamma emitters in biscuit samples in Iraq. J. Food Prot., 78: 1766-1769.
2. Robinson, D.S., 1990. Food Biochemistry and Nutritional Value. Longman Scientific and Technical Publisher, New York, USA.
3. Eisenbud, M. and T. Gesell, 1997. Environmental Radioactivity. 4th Edn., Academic Press, USA.
4. L'Annunziata, M.F., 2003. Handbook of Radioactivity Analysis. 2nd Edn., Academic Press, USA., ISBN: 9780080495057, Pages: 1326.
5. BEIRIV., 1999. Health Effects of Exposure to Radon. National Academies Press, Washington, DC., ISBN: 9780309056458, Pages: 516.
6. Ielsch, G., D. Thieblemont, V. Labed, P. Richon and G. Tymen *et al*., 2001. Radon (^{222}Rn) level variations on a regional scale: Influence of the basement trace element (U, Th) geochemistry on radon exhalation rates. J. Environ. Radioactivity, 53: 75-90.
7. Al-Hamidawi, A.A.A., 2015. Monitoring of ^{220}Rn concentrations in buildings of Kufa technical institute, Iraq. Sci. Technol. Nucl. Install. 10.1155/2015/738019.
8. Al-Ani, N.H.K., N.F. Tawfiq and D.H. Ghayb, 2010. Measurement of alpha emitters concentration in tomato fruits using CR-39 plastic track detector. Baghdad Sci. J., 7: 31-35.
9. Oufni, L., N. Manaut, S. Taj and B. Manaut, 2013. Determination of radon and thoron concentrations in different parts of some plants used in traditional medicine using nuclear track detectors. Am. J. Environ. Protect., 1: 34-40.
10. Godaymi, S.A.L. and I.J.M. Al-Khalifa, 2014. Radon and thoron concentrations measurements in local produced and imported dry legumes in Iraqi markets using SSNTDs technique. Int. J. Applied Nat. Sci., 3: 67-74.
11. Hashim, A.K. and L.A. Najam, 2015. Alpha radioactivity in various brands of rice in Iraqi market. Int. J. Environ. Monit. Prot., 2: 70-75.
12. Farhood, A.K., 2015. Assessment of radon concentrations and effective radium content in Samawa desert truffles-Iraq. Pelagia Res. Library Adv. Applied Sci. Res., 6: 131-143.
13. Al-Hamidawi, A.A.A., 2014. Assessment of radiation hazard indices and excess life time cancer risk due to dust storm for Al-Najaf, Iraq. WSEAS Tran. Environ. Dev., 10: 312-319.

14. Hussein, Z.A., M.S. Jaafar and A.H. Ismail, 2013. Measurement of radium content and radon exhalation rates in building material samples using passive and active detecting techniques. Int. J. Sci. Eng. Res., 4: 1827-1831.
15. Eappen, K.P. and Y.S. Mayya, 2004. Calibration factors for LR-115 (type-II) based radon thoron discriminating dosimeter. Radiation Measurements, 38: 5-17.
16. Pundir, A., S. Kamboj and R. Singh, 2014. Estimation of indoor Radon, Thoron and their progeny levels in some dwellings of District Yamuna Nagar of India using SSNTD. Nat. Sci., 12: 94-97.
17. Verma, D. and M.S. Khan, 2014. Assessement of indoor radon, thoron and their progeny in dwellings of bareilly city of northern india using track etch detectors. Rom. J. Phys., 59: 172-182.
18. Duggal, V., A. Rani and R. Mehra, 2014. A study of seasonal variations of radon levels in different types of dwellings in Sri Ganganagar district, Rajasthan. J. Radiation Res. Applied Sci., 7: 201-206.
19. Aziz Naom, H.N., 2002. Determination of uranium in teeth paste by using CR-39 detector. M.Sc. Thesis, University of Mosul, Iraq.
20. ICRP., 1987. Radionuclide Release into the Environment. Pergamum Press, Oxford, New York.
21. Ahmed, A.H. and A.I. Samad, 2014. Measurement of radioactivity levels in daily intake foods of Erbil city inhabitants. J. Zankoy Sulaimania Part A, 16: 111-121.