

Radon Concentrations in Canned Liquid Juice

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ABSTRACT

This study was performed at University of Kufa, Iraq, using canned liquid juice samples found in Iraqi markets due to the absence of environmental contamination from radionuclides emitting ^{222}Rn concentrations using RAD-7 detectors. The annual effective dose (AED) of ^{222}Rn was estimated for children and adults from the ingestion of canned liquid juice samples. The estimated concentrations of ^{222}Rn in unit (mBq/L) ranged from 35.4 to 249.1, with an average of $77.880.24 \pm 15.42$. It also shows that the AED values for children and adults in (nSv/y) ranged from 19.11 to 134.48 with an average of 43.31 ± 8.32 and from 22.67 to 159.55 with an average of 51.39 ± 9.88 , respectively. All estimated results of ^{222}Rn concentrations for juice samples were lower than the natural limits provided by the WHO and the European Union Commission to the public (0.5 and 1 Bq/L, respectively). Therefore, there are no health hazards from drinking juice sold in Iraq markets.

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INTRODUCTION

Significant damage can be done at the cellular level because of the ionizing radiation exposure. However, given that alpha and beta radiation are generally categorized as non-penetrating radiation, only localized damage may result from direct exposure to these forms of radiation. One example is radiation burns to the skin [1,2]. Humans on earth are constantly subjected to radiation this way. There are two types of radiation sources that can be classified as follows: natural and man-made radiation [3]. Gamma rays and neutrons are more intense compared to alpha and beta particles, while being able to do specific harm to the body [4].

Inert gas has the potential to migrate through solids and mix with air, then accumulating in enclosed spaces or areas where airflow is limited to which large concentrations of radon gas can reach the human respiratory tract when breathing [5,6]. Radon (^{222}Rn) hazard to human health lies in the nature of Kamal ambient air. It is a heavy elements that can possibly harm the respiratory tract when it reaches the lung wall, potentially causing lung cancer [7,8]. The radiological influence of soil fertilizer uses is attributable to the internal

irradiation of the respiratory organ by alpha particles, short-lived radon-thoron progeny, and the body's external irradiation through radionuclide-emitting gamma rays. ^{222}Rn is carcinogenic to human and responsible for natural radiation exposure to human [9,10]. It exists on air, water, and soil, with the main source came from soil. While radon gas has always been present in the atmosphere, its contribution to radiation exposure to human has risen in recent years [11]. Radon emanates from uranium, a naturally occurring mineral that exists in rocks and soil. Radon is the second leading cause of lung cancer mortality in the United States [12]. Several researches investigated the calculation of the radon concentration levels in liquid samples [13-17]. The goal of this work is to analyze the content of ^{222}Rn radionuclide in several liquid canned juices (made in different countries) commonly consumed in Iraq using alpha spectroscopy (RAD-7).

EXPERIMENTAL METHODS

Concentration of radon gas is analyzed in fifteen canned juice samples most commonly sold in Iraq. The samples are listed in Table 1. Most of canned food and liquid samples are not produced locally in Iraq. Samples were packed at a constant volume of 0.25 liters, so they can be used

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with RAD-7 detector (DURRIDGE Company, Inc.-Bedford, MA, U.S.A.) (see Fig. 1). The experimental method meets the standard adopted for Radon-in-water measurement [14-17].

Table 1. Information about canned liquid juice samples

No.	Sample code	Sample Name	Origin
1	J1	Blue Dana	Kuwait
2	J2	Jeehan	Jordan
3	J3	Ogarit	Syria
4	J4	Raubi	Lebanon
5	J5	Mizo	Saudi Arabia
6	J6	Rayaheen	Iraq
7	J7	Original	Saudi Arabia
8	J8	Rauch	Austria
9	J9	Sunfor	Kuwait
10	J10	Kazouza	Lebanon
11	J11	Balkan	Bulgaria
12	J12	Lafi	Jordan
13	J13	Sirma	Turkey
14	J14	Rani	Saudi Arabia
15	J15	Serene	Jordan

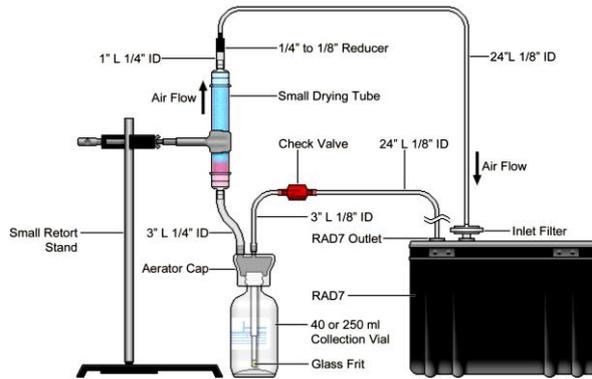


Fig. 1. RAD-7 experimental set-up [18-20]

RAD-7 detector consists of semiconductor materials. Essentially, it consists of a cell filled in regularly. This cell is filled with air by means of a small pump that draws air into the cell at each pre-selected interval at which the radon or ²¹⁸Po may decay so that it can be counted while the process is repeated. Technically, the RAD-7 system is based on a solid state detector in its operation. The silicon ion detector converts the radiation into electric signal through the semiconductor material. One of the advantages of solid-state detectors is that they can discern the intensity of the incoming alpha radiation electronically. Many radionuclides, such as ²¹⁸Po, can be detected with an energy of 6.00 MeV or ²¹⁴Po of 7.69 MeV [18].

The AED based on the ingestion of juice was calculated according ICRP. The annual effective dose (E_d) can be determined by Eq. (1) [21]:

$$E_d = A_c A_i C_f \quad (1)$$

where A_c is ²²²Rn concentration in juice samples (Bq/L), A_i is annual intake in unit (L/y) and C_f is the conversion factor in unit (Sv/Bq). The conversion

factor is 5.9 and 3.5 nSv/Bq for children and adults, respectively, in accordance to UNSCEAR2000 report [22].

RESULTS AND DISCUSSION

Results were obtained from fifteen canned liquid juice samples collected from the market of Al-Najaf, as shown in Table 2. In sample j7 (originally made in Saudi Arabia) the highest concentration of ²²²Rn was found, accounted for 249.1 mBq/L. The lowest ²²²Rn concentration are found in samples j10 and j11, with concentration of 35.4 mBq/L (Kazouza made in Lebanon and Balkan made in Bulgaria). For all samples analyzed, the mean value was 80.24 mBq/L with standard error of 15.42 mBq/L. The difference in the ²²²Rn concentration results for canned liquid juice samples may be due to the original composition of materials and water for the ingredients of the test samples. The average value of ²²²Rn is higher in Saudi Arabia than in any other country. It can be noted from Table 2 along with Fig. 2. Compared with WHO standard and EU Commission of Drinking Water, the ²²²Rn concentrations of liquid canned juice in the current study were found to be lower than WHO limit at 0.5 bq/L [23] and the EUC limit 1 bq/L [24].

Table 2. Results of ²²²Rn concentrations canned liquid juice samples

No.	Sample code	²²² Rn concentrations (mBq/L)
1	J1	124.8
2	J2	106.5
3	J3	71.2
4	J4	178.2
5	J5	71
6	J6	71.2
7	J7	249.1
8	J8	35.5
9	J9	35.6
10	J10	35.4
11	J11	35.4
12	J12	47.46
13	J13	35.6
14	J14	53.4
15	J15	53.3
Average±S.E		80.24±15.42

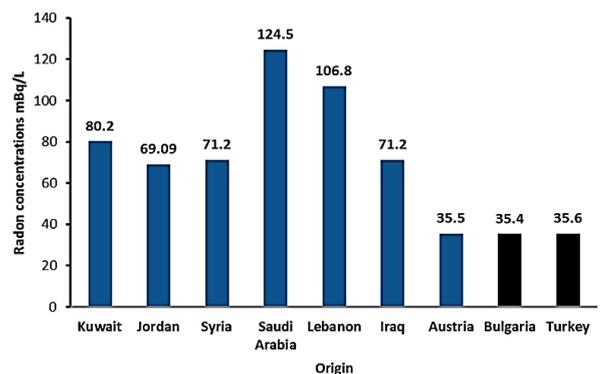


Fig. 2. Comparison the average value of ²²²Rn concentrations in different counties of present study

Table 3 reveals AED when children and adults consume the canned liquid juice. Table 3 indicates that AED in children ranges between 19.11 nSv/y and 134.48 nSv/y, averaging for 43.31 ± 8.32 nSv/y. Meanwhile, AED in adults ranges between 22.67 nSv/y and 159.55 nSv/y, with an average of 51.39 ± 9.88 nSv/y.

Table 3. AED in children and adult

Sample code	AED (nSv/y)	
	Children	Adults
J1	67.37	79.93
J2	57.49	68.21
J3	38.44	45.60
J4	96.20	114.14
J5	38.33	45.48
J6	38.44	45.60
J7	134.48	159.55
J8	19.16	22.74
J9	19.22	22.80
J10	19.11	22.67
J11	19.11	22.67
J12	25.62	30.40
J13	19.22	22.80
J14	28.83	34.20
J15	28.77	34.14
Average \pm S.E	43.31 ± 8.32	51.39 ± 9.88

Table 3 and Fig. 3 indicate that the AED in adult samples are higher than that in the children samples. The high intake rate is responsible for this greater dose. The obtained data show that in all samples of vegetable and fruit juices, the AED is lower than the 1 mSv/year allowable limit recommended by the ICRP [25]. It is therefore possible to assume that ^{222}Rn concentration in samples of canned juices were small, and there were no health risks when consumed in Iraq or elsewhere by various age groups.

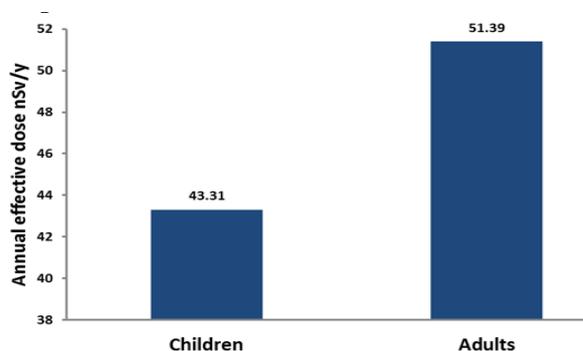


Fig. 3. Compare the average of AED in children and Adults age group.

CONCLUSION

The concentrations of ^{222}Rn in canned liquid juices were measured using RAD-7 detection

technique. The measured concentrations of ^{222}Rn were found to be lower than the recommended WHO and EUC values at 0.5 Bq/L and 1 Bq/L respectively. The values of AED in all samples are less than the allowed maximum level of 1 mSv/y. It can be concluded that drinking from the liquid canned juices studied pose no health risks to the consumer.

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