Determining the concentrations of radon and the rate of annual effective dose in some types of drinking water available in the Iraqi markets

Ali A. Al-Hamidawi

Department of Physics, Collage of Science, University of Al-Kufa

E-mail: aliabojassem@yahoo.com

Abstract

In this research, radon concentrations in some types of healthy drinking water samples available in Iraq's market were measured using a technique called Durridge RAD-7-H_2O with closed loop. Then the rate of annual effective dose in human taken this water is determined.

It was found that, radon concentrations in studied samples ranged between 1.2 $Bq.m^{-3}$ to 142 $Bq.m^{-3}$. The results of the radon concentrations and the rate of annual effective dose for drinking water samples were significantly lower than the USEPA and WHO recommended limits that equal 500 Bq/m^3 and 1 mSv/y respectively.

Key words
Radon drinking water, Iraqi markets, RAD-7 detector.

Article info
Received: Jan. 2013
Accepted: Mar. 2013
Published: Apr. 2013

تحديد تراكيز الرادون ومعدل الجرعة السنوية المؤثرة في بعض انواع مياه الشرب الصحية المتوفرة في الاسواق العراقية

علي عبد ابوجاسم الحميداوي

قسم الفيزياء، كلية العلوم، جامعة الكوفة

الخلاصة

في هذا البحث ، تم قياس تراكيز الرادون في نماذج من بعض انواع من مياه الشرب الصحية المتوفرة في الاسواق العراقية باستخدام تقنية (Durridge RAD-7-H_2O) ذات الحلقات المغلقة و تم تحديد معدل الجرعة السنوية المؤثرة على الانسان لنتيجة تناوله هذا الماء.

ووجد إن مدى تراكيز الرادون للنماذج المدروسة يتراوح من 1.2 $Bq.m^{-3}$ إلى 142 $Bq.m^{-3}$، أن نتائج تراكيز الرادون و معدل الجرعة السنوية المؤثرة في نماذج مياه الشرب كانت اقل من المسموح به لمنظمتي USEPA & WHO والتي تساوي 500 Bq/m^{-3} و 1mSv/y على التوالي.

Introduction

Radon is a gas that has no color, odor, or taste and comes from the natural radioactive decay of uranium in the ground. Human exposed to radon by two main sources: radon in the air in home (frequently called "radon in indoor air") and radon in drinking water. Radon can get into the air breathe and into the water used for drinking. Radon is also found in small amounts in outdoor air[1,2]. Breathing radon indoor air can cause lung cancer. Radon gas decays into radioactive particles that can get trapped in lungs when breathe it. As they decay further, these particles release small bursts of energy. This can damage lung tissue and increase chances of developing lung cancer over the course of lifetime. People who smoke have an even greater risk. Not everyone exposed to high levels of radon

will develop lung cancer. However, radon indoor air is the second leading cause of lung cancer. About 20,000 deaths a year in the U.S. are caused by breathing radon indoor air. Only about 1-2 percent of radon in the air comes from drinking water. However breathing radon increases the risk of lung cancer over the course of lifetime. Some radon stays in the water; drinking water containing radon also presents a risk of developing internal organ cancers, primarily stomach cancer. However this risk is smaller than the risk of developing lung cancer from radon released to air from tap water. Based on a National Academy of Science report, EPA estimates that radon in drinking water causes about 168 cancer deaths per year: 89% from lung cancer caused by breathing radon released to the indoor air from water and 11% from stomach cancer caused by consuming water containing radon [3-5]. Not all drinking water contains radon. If drinking water comes from a surface water source, such as a river, lake, or reservoir, most radon that might be in the water will be released into the air before reaching water supplier or home. Radon is only a concern if drinking water comes from underground, such as a well that pumps water from an aquifer, though not all water from underground sources contains radon. Many people realize that the quality of drinking water is not ideal. Maybe it's the taste or odor. Perhaps it's the various chemicals in the water (some are added on purpose and some are from pollution). Some people think that the dissolved minerals in the water are good and others think they're bad. There are some scientists modernly using RAD-7 detector to measure concentration of radon water. R.K. Somashekar et al. in (2010)[6] studied the distribution of radon ^{222}Rn activity concentration in groundwater samples and their annual effective dose exposure in the Varahi and Markandeya command areas. Radon measurement was made using Durridge RAD-7 radon-in-air monitor, using RAD H_2O technique with closed loop aeration concept. A. R. Subber et al. in(2011) [7] studied the methods to measure radon in in surface, underground water and oil-produced water separated from oil in Basra Governorate in Iraq using fast electronic techniques RAD-7 and the passive method by using the solid state nuclear track detectors CR39 and L115-II. And H. Al Zabadi et al. (2012) [8] used RAD-7 detector for measuring the concentration of radon for drinking water supplies in Palestine. The aim of this study was determined the important radioactive element radon in healthy drinking water, because several factors such as increases used it and availability in markets different types.

Sampling and assays

Water samples were taken from Iraq market (Iraq samples). Radon concentrations in these samples were measured with RAD-7 an electric radon detector connected to RAD-H_2O accessory (Durridge Co,USA, 2010) for a period of one month . Figure (1) shows the schematic diagram of RADH_2O .In the setup of RAD-7 detector was used for measuring radon in water by connecting it with a bubbling kit which enables to degas radon from a water sample into the air in a closed loop. A sample of water was taken in a radon – tight reagent bottle of 250 mL capacity connected in a close circuit with a zinc sulphide coated detection chamber which act as scintillator to detect alpha activity and a glass bulb containing calcium to absorb the moisture, air was then circulated in a close circuit for a period of 5-10 min until the radon was uniformly mixed with the air and the resulting alpha activity was recorded and it directly gives the radon concentration.

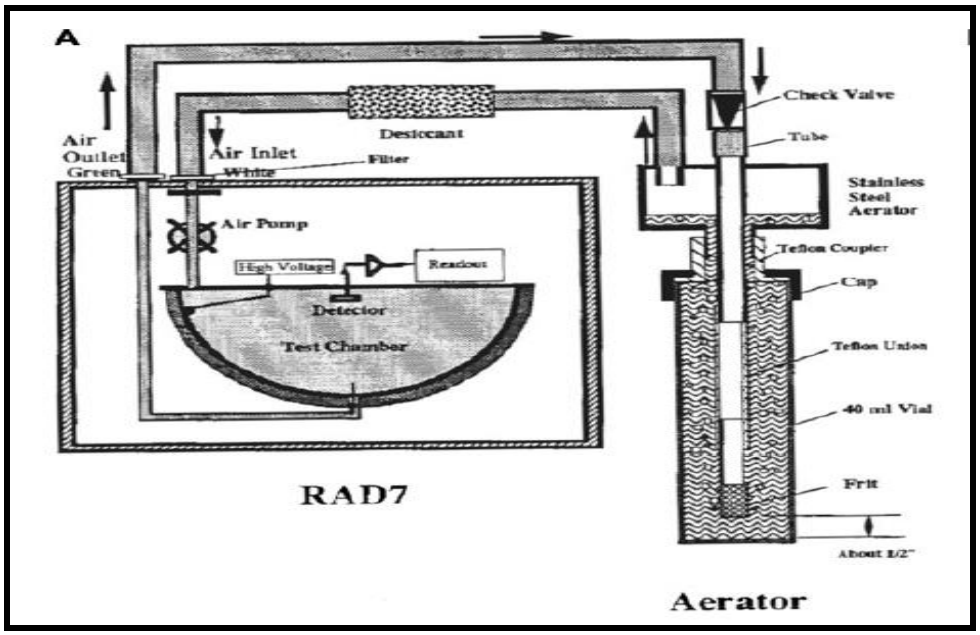

Fig.1: Schematic representation of the RAD 7 instrument for measuring radon in water [9].

The radon concentration of drinking water is an important issue from the dosimeter aspect, because more attention is paid to the control of public natural radiation exposure. The radiation dose due to radon can be divided into two parts, the dose from ingestion and the dose from inhalation.

Radon is soluble in water and this route of exposure is important if high concentrations are found in drinking water[10]. On some occasions, water is consumed immediately after leaving the faucet before its radon is released into the air. This water goes directly to the stomach. Before the ingested water leaves the stomach, some of the dissolved radon can diffuse into and through the stomach wall. During that process, the radon passes next to stem or progenitor cells that are radiosensitive. These cells can receive a radiation dose from alpha particles emitted by radon and radon decay products that are created in the stomach wall. After passing through the wall, radon and decay products are absorbed in blood and transported throughout the body, where they can deliver a dose to other organs[11].

The annual effective dose in oranges body in ($mS.y^{-1)}$ due to the ingestion and inhalation of radon, resulting from the radon concentration in domestic water, was calculated according to the following expression[12-14]:

$$\text{Annual effective Dose } (Sv.y^{-1}) = A\ (Bq/l) \times V(l/y) \times CF\ (Sv/Bq) \quad (1)$$

where :

A (Bq/L): is the concentration of ^{222}Rn in the ingested drinking water.

V(L/y): is the annual intake of drinking water.

CF (Sv/Bq): is the ingested dose conversion factor for ^{222}Rn.

Annual effective dose due to intake of ^{222}Rn from drinking water is calculated considering that an adult (age 18 year), on average, takes 730 L water annually [12]. Following ingestion of ^{222}Rn dissolved in drinking water, a dose conversion factor for all body, lung and stomach were 110, 38 and 73 mSv/Bq respectively [14].

Results and Discussion

Table1 shows the results of concentrations of radon ($Bq.m^{-3}$) and the rate annual effective dose ($\mu Sv.y^{-1}$) in healthy drink water samples. Table 1 and Fig.2 show that the sample Al-Naqawa has highest radon concentration 142±0.38 $Bq.m^{-3}$, and sample Al-Tour has lowest radon concentration 1.2±0.42 $Bq.m^{-3}$. Also Table 1 and Fig.3 shows the value of the annual effective dose in all body, lung and stomach for all samples. From the spectra that shown in Figs. 4 and 5 for higher and lower radon concentrations in samples of this study, can be noted the relation between the count rate and the energy which consist of Radon daughters in A(^{218P}Po), B(^{214}Po) and Thoron daughters D(^{216}Po), E(^{212}Po) where

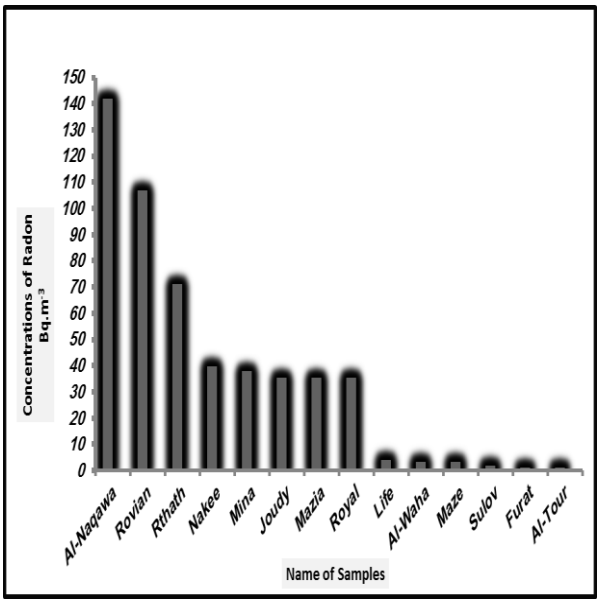

Fig. (2) Concentration of radon in healthy drinking water samples.

Table 1: The concentration of (^{222}Rn) in ($Bq.m^{-3}$) and the rate annual effective dose of ^{222}Rn in $\mu Sv.y^{-1}$ in healthy drinking water samples.

No.	Name of Samples	Made of samples	Concentrations of Radon $Bq.m^{-3}$	The rates of annual effective dose in (μSvy^{-1})		
				All Body	Lung	Stomach
1	Al-Naqawa	Iraq(Mosel)	142±10.38	11.4026	3.93908	7.56718
2	Rovian	Iraq(Dhok)	107±10.324	8.5921	2.96818	5.70203
3	Rthath	Iraq(Najaf)	71.2±7.56	5.71736	1.975088	3.794248
4	Nakee	Iraq(Babylon)	39.8±3.987	3.19594	1.104052	2.120942
5	Mina	Iraq(Kirkuk)	38.3±2.71	3.07549	1.062442	2.041007
6	Joudy	Iraq(Najaf)	35.6±4.456	2.85868	0.987544	1.897124
7	Mazia	Iraq(Najaf)	35.6±4.456	2.85868	0.987544	1.897124
8	Royal	Iraq(Najaf)	35.6±4.456	2.8105	0.9709	1.86515
9	Life	Iraq(Babylon)	4.12±1.6	0.330836	0.1142888	0.2195548
10	Al-Waha	Iraq(Babylon)	3.6±1.55	0.28908	0.099864	0.191844
11	Maze	Iraq(Dhok)	3.4±1.2	0.27302	0.094316	0.181186
12	Sulov	Iraq(Zako)	1.9±0.4	0.15257	0.052706	0.101251
13	Furat	Iraq(Baghdad)	1.5±0.23	0.09636	0.033288	0.063948
14	Al-Tour	Iraq(Karbala)	1.2±0.42	0.09636	0.033288	0.063948

these spectra determined by MCA in RAD system. All results of the annual dc effective for ^{222}Rn of healthy drinking wa were smaller than the normal limits of wo 1mSv.y^{-1} [15].Results of the average activ concentration ^{222}Rn of healthy drinki water were smaller than the accordable lir as reported in USEPA [16]. The allow maximum concentrations level for ^{222}Rn water for human conception is 500 Bq.m The reason for vibration in rad concentration could be a function geological structure of the area, water source and differences in the climate. Others have reported that the geological structure of an area is a predominant factor for high radon concentration and climate is also an important factor[17].

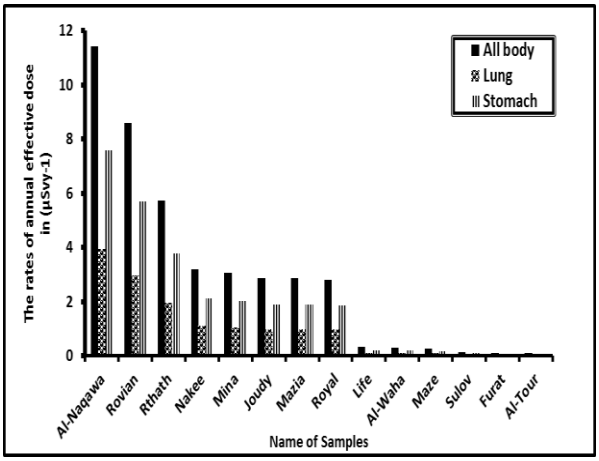

***Fig.3: The rates of annual effective dose of radon concentration in healthy drinking water samples*.**

Conclusions

In this paper the results of the ^{222}Rn measurements in 14 bottled drinking waters are presented. The measurements were performed by RAD-7 radon detector manufactured by DURRIDGE company Inc. From the results for the bottled drinking water, it can be concluded that the majority of bottled drinking water is safe to use from the standpoint of concentration of radon in them.

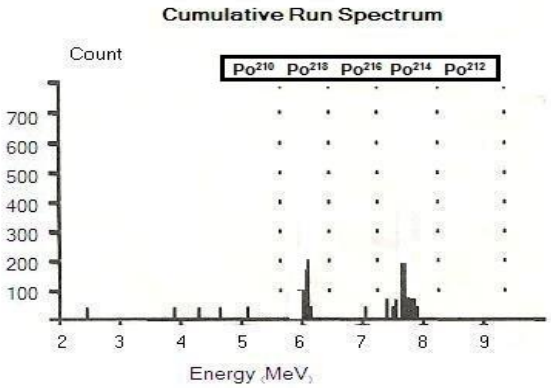

Fig. 4: Spectrum of Sample(Al-Naqawa)

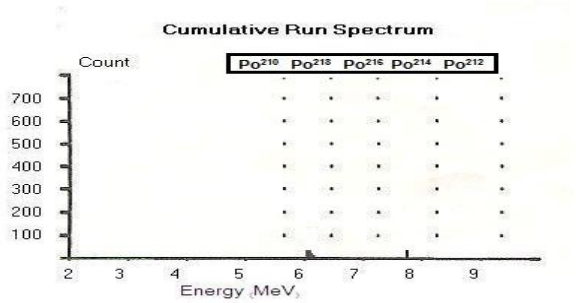

Fig. 5: Spectrum of location Sample(Al-Tour)

References

[1] A.V. Nero, "Radon and its decay products in indoor air", An overview. Editors W. Nazaroff and A. Nero, John Wiley and Sons, Inc., P. 1 – 53, (1988).

[2] C.Samuelsson, H.Petterson, Radiation Protection Dosimetry, 7, 1 – 4 (1984) 95 – 100.

[3] C.Lubin, Radiat. Res, 163 (2005) 571-579.

[4] D.Krewski, Epidemiology, 6 (2005) 137-145.

[5] S.Darby, BMJ, 330 (2005) 223-227.

[6] R. K Somashekar and P. Ravikumar, J. of Radioanalytical and Nuclear Chemistry, 285 ,2 (2010) 343-351.

[7] A.R.Subber, M.Ali and T.Al-Asadi, Advances in Applied Science Research, 2,6 (2011) 336-346.

[8]H. Al Zabadi, S.Musmar, S.Issa, N.Dwaikat and G,Saffarini, *BMC Research* Notes,5 (2012) 29.
[9] Durridge Company Inc., Manual version 6.0.1, RAD-7™ Electronic Radon Detector, (2010).
[10] UNSCEAR (B), Sources and Effects of Ionizing Radiation, Annex B: Exposures from Natural Radiation Sources. United Nation Scientific Committee on the Effect of Atomic Radiation, UNSCEAR 2000, New York, USA.
[11] G.M. Kendall, T.J.Smith, J. Radiol. Prot., 22 (2002) 389–406.
[12] WORLD HEALTH ORGANISATION (WHO), third ed. Guidelines for Drinking Water Quality, vol. 1. World Health Organisation, Geneva (2004).
[13] "Guide to Radioactivity in Drinking Water" N.1. Department of Environmental Protection. Bureau of Save Drinking Water, (1998).
[14] K.M.Hady, N.F.Taofeek and L.M.Hauder, J. of Al-Nahrain University - Science, 15,2 (2012) 6-9. (Arabic Language)
[15] UNSCEAR, Sources, effects and risks of ionizing radiation. United Nations, New York, pp 1–35, (2000)
[16] Connecticut Department of Public Health Environmental Health Section Radon Program, Report, (2010).
[17]J.Vaupotic, I.Kobal and J.Planinic, J.Radioanalyt Nucl. Chem., 238 (1998) 61.