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INVESTIGATION OF RADON CONCENTRATION IN DRINKING WATER SAMPLES

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Abstract: This study was dedicated to the study of the concentration of Radon-222 in water samples collected at 17 different points along the Kura and Aras rivers. A portable radon detector RAD-7 was used to measure the concentration of radon. In all studied water samples, the isotope Rn-222 was observed, the activity of which varies in the range of 0.11-11.6 Bq/l. It was found that the activity of Rn-222 for well water from the Yevlakh region is 11.6 Bq/l, which easily increases the maximum level of radon contamination in drinking water proposed by the EPA, but below the action level of 100 Bq/l recommended by the World Health Organization (WHO).

Key words: River water, well water, Radon-222, RAD-7.

1. Introduction

Radiation is a natural part of the environment in which we live. All people receive exposure from naturally occurring radioactivity in soil, water, air, and food. The largest fraction of the natural radiation exposure we receive comes from a radioactive gas, radon. Radon is emitted from uranium, a naturally occurring mineral in rocks and soil; thus, radon is present virtually everywhere on the earth, but particularly over land. Thus, low levels of radon are present in all the air we breathe [1]. Radon (the element) is the heaviest known noble gas. Radon has only radioactive nuclides. In total, some 40 isotopes of radon are known up today. The three most common and naturally abundant isotopes of radon are ^{222}Rn, ^{220}Rn, and ^{219}Rn, originating from the decay series of ^{238}U, ^{232}Th, and ^{235}U, respectively. According to the health effects the long-lived radon isotope ^{222}Rn, which is a decay product of ^{238}U, is radiobiologically the most important one. It is present in subsoil and groundwater and permeates to the surface, where it may become health risk during the long-term inhalation. Proper testing of drinking water and building materials is also required to monitor radon concentrations below legal limits [2-3].

Most of the radon that enters a building comes directly from the soil that is in contact with or beneath the basement or foundation [4]. Radon is also found in well water and will enter a home whenever this water is used. In many situations such as showering, washing clothes, and flushing toilets, radon is released from the water and mixes with the indoor air. Thus, radon from water contributes to the total inhalation risk associated with radon in indoor air. In addition to this, drinking water contains dissolved radon, and the radiation emitted by radon and its radioactive decay products expose sensitive cells in the stomach as well as other organs once it is absorbed into the bloodstream.

Drinking water is the most important food. Therefore, its availability, quality, and regulation are delicate and important topics. In 1991, EPA proposed an MCL for radon of 11 Becquerel's per liter (about 300 pCi per liter) for radon in drinking water. [1,5]. The European Commission recommends for ^{222}Rn, that a reference level should be appointed above an activity concentration of 100 Bq/l [6].

Because of the above facts, the measurement of ^{222}Rn concentration in water has attracted many researchers in various parts of the world. The primary aim of the present study is to

measure the ^{222}Rn concentration in various water sources, which are a large used in Azerbaijan as drinking water sources. The work is also aimed to know its variations and assessment of the radiation dose to the public consuming this water and to assess that, whether the ^{222}Rn concentration in water is within the permissible limit. This type of study has not been reported so far in Azerbaijan and is first of its kind. Various methods are adopted to measure the ^{222}Rn concentration in water in different parts of the world [7-9]. In the present study, RAD – 7, Portable Radon Detector is used.

2. Sampling and measurements

Sample collection and analysis. The present study was conducted to investigate Radon contents in water samples. We collected samples from 17 different points along rivers Kura and Aras during the 2017 year (Table 1). During the sample collection, handling, and preservation, the standard procedures recommended by the EPA and ASTM were followed to ensure data quality and consistency. All water samples were analysed for water parameters (PH, Conductivity, Salinity, TDS, and DO.) by portative equipment in sampling points.

Table 1. Sampling points Coordinates

№	Sampling point ID	Sampling point ID	**Source Coordinates**	
			Longitude	latitude
1	Az 1	Chrami	41.313224	45.128063
2	Az 2	Kur-Shixli	41.32969	45.080844
3	Az 3	Agstafa Chay	41.051914	45.271659
4	Az 4	Iori	41.175515	46.247589
5	Az 6	Kur-Yenikand	40,765222	47.035845
6	Az 7	Kur-Mingachevir	40,765222	47.035845
7	Az 7a	Min.Dam.Cent.-Surf	40,765222	47.035845
8	Az 8	Min.Dam.Cent.-Bot	40,765222	47.035845
9	Az 9	Min.Dam.Alaz.Side-Surf	40,765222	47.035845
10	Az 10	Min.Dam.Alaz.Side-Bot	40,765222	47.035845
11	Az 20	Min.Dam.Yen.Side-Surf	40,765222	47.035845
12	Az 11	Min.Dam.Yen.Side-Bot	40,765222	47.035845
13	Az 12	Yevlakh dist. Ashagi Garkhun, well water	40,035167	47.685209
14	Az13	Kur after Sugov.	40.030302	48.472882
15	Az 14	Kur till Sugov.	40.018546	48.435182
16	Az 15	Aras	40.007217	48.439422
17	Az 16	Kur-Banka	39.413493	49.242462

Radon measurement system

In this research to determine the concentration of radon in water the RAD – 7. Portable Radon Detector by DURRIDGE Company has been used. This system has suitable features to measure the concentration of radon gas in the water and weather. The most important characteristics of this system are of high sensitivity and short-time response [10].

The detection system has used the Electrostatic collection of alpha-emitters with spectral analysis. All radon instruments detect the radon atoms that decay inside the instrument. After the initial decay, to Polonium-218, there is a chain of further radioactive decays, all of which occur inside the instrument.

In the generally, aliquot in water volume, 40 mL (or 250 mL) of the sample place in glass special beaker then should choose the protocol for measurement "Wat-40" or "Wat-250" by the RAD – 7. The protocol has cycle (5 minutes), recycle (4 runs). After four runs have on the display at equipment specific report (RAD7 Owner's manual, 2001).

3. Results and discussions

All water samples were analyzed for Rn-222. In all investigated water samples Rn-222 isotope was observed, which changes in range 0.11-11.6 Bq/l.

The results of the analysis of Radon in water samples collected from different points along rivers Kura and Aras shown in Table 2.

Table 2. Radon concentration in water samples taken from Kura and Aras rivers

N:	Name of place	Concentration Rn-222, pCi/L	Concentration Rn-222, Bq/L
1	Chrami	5.8	0.22
2	Kur-Shixli	14.5	0.54
3	Agstafa Chay	11.7	0.43
4	Iori	2.93	0.11
5	Kur-Yenikand	11.7	0.43
6	Kur-Mingachevir	20.4	0.76
7	Min.Dam.Cent.-Surf	23.4	0.87
8	Min.Dam.Cent.-Bot	8.78	0.33
9	Min.Dam.Alaz.Side-Surf	14.6	0.54
10	Min.Dam.Alaz.Side-Bot	14.6	0.54
11	Min.Dam.Yen.Side-Surf	14.6	0.54
12	Min.Dam.Yen.Side-Bot	8.77	0.33
13	Yevlakh. Ashagi Garkhun, well water	313.51	11.6
14	Kur after Sugov.	17.6	0.65
15	Kur till Sugov.	35.1	1.29
16	Aras	23.4	0.87
17	Kur-Banka	23.4	0.87

The observed Rn-222 concentrations in all water samples were below compared to the value proposed by EPA as an MCL for radon (11 becquerels per liter- about 300 pCi per liter) in

drinking water except well water. For well water from Yevlakh district was observed Rn-222 activity 11.6 Bq/l which slowly elevated MCL for radon in drinking water, proposed by EPA. It means that if people will use this water source for a long time as drinking water, so it is possible they may have lung and stomach cancer risks in the future.

4. Conclusion

This study investigated the human health risk from radon concentration in drinking and irrigated water collected from different locations of Azerbaijan. High radon concentrations were observed in well water sources with the highest observed value of 14.6 Bq/l and low radon concentrations were observed in river water sources with the highest value of 0.11 Bq/l. Values of radon concentration in well water exceed the EPA recommended level of 11 Bq/l, but are below the action level of 100 Bq/l recommended by WHO. However, it is recommended to boil the well water before use for drinking to decrease the level of radon concentration.

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ИССЛЕДОВАНИЕ КОНЦЕНТРАЦИИ РАДОНА В ОБРАЗЦАХ ПИТЬЕВОЙ ВОДЫ

Ф.Ю. Гумбатов

Резюме: Это исследование было проведено для изучения концентрации Radon-222 в пробах воды, собранных в 17 различных точках вдоль рек Кура и Араз. Для измерения концентрации радона использовался портативный радоновый детектор РАД-7. Во всех исследованных пробах воды

наблюдался изотоп Rn-222, активность которого колеблется в пределах 0,11–11,6 Бк/л. Было установлено, что активность Rn-222 для колодезной воды из Евлахского района составляет 11,6 Бк/л, что легко увеличивает максимальный уровень загрязнения радоном в питьевой воде, предложенный EPA, но ниже уровня действия 100 Бк /л, рекомендованного Всемирного организация здравоохранения ВОЗ.

Ключевые слова: Речная вода, колодезная вода, Радон-222, РАД-7.

İÇMƏLİ SU NUMUNƏLƏRİNDƏ RADONUN QATILIĞININ TƏDQİQİ

F.Y. Hümbətov

Xülasə: Hazırkı tədqiqat Kür və Araz çayları boyunca 17 fərqli nöqtədən toplanmış su nümunələrində Radon222 konsentrasiyasının araşdırılması məqsədilə aparılmışdır. Radon konsentrasiyasını ölçmək üçün Portativ Radon Detektoru RAD-7 istifadə edilmişdir. Bütün araşdırılmış su nümunələrində Rn-222 izotopunun 0.11-11.6 Bk/L aralığında dəyişməsi müşahidə edildi. Yevlax rayonundan götürülmüş quyu suyu üçün Rn-222 aktivliyinin 11,6 Bk/L təşkil etdiyi və EPA tərəfindən içməli suda radon konsentrasiyası üçün təklif olunan həddi bir qədər aşdığı, lakin Ümumdünya Səhiyyə Təşkilatı (ÜST) tərəfindən tövsiyə edilən 100 Bk/L səviyyəsindən aşağı olduğu müəyyən edilmişdir.

Açar sözlər: Çay suyu, quyu suyu, Radon-222, RAD-7.