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A REVIEW ON DIFFERENCE CONCENTRATION OF RADON 222 IN THE TAP DRINKING WATER BETWEEN MINAB AND JASK CITES, IRAN

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Abstract

Radon 222 is a colorless and odorless radioactive element with a half-life of 3.83 days which is emitted by different sources such as igneous (granites) and sedimentary rocks. Humans are constantly exposed to radon 222 through inhalation of air and water drinking. In this study, based on previous studies, concentration of radon 222 in tap drinking water of Minab and Jask were compared.

The concentration of radon 222 in tap drinking water of Minab was 870±251 Bq/m^3 (Minab5˚C) >464±210 Bq/m^3 (Minab15˚C)>198.8±61.39 Bq/m^3 (Jask 12˚C), respectively. Concentration of radon 222 in the tap drinking water of Minab at temperatures of 15 °C and 5°C was significantly more than the city of Jask at 12˚C (P value<0.001).

The concentration mean of radon 222 at 5˚C and 15˚C in Minab, and Jask (12˚C) ratio to EPA standard limit was 7.9%, 4.2% and 1.8% and relative to WHO guideline was 0.87%, 0.46% and 0.19%, respectively. The mean concentration of radon 222 in tap drinking water of Minab and Jask cites was much lower than EPA standard limit and guideline of WHO. Hence, health risks of radon 222 in tap drinking water does not threaten the inhabitants Minab and Jask cites.

Keywords:

Radon 222, concentration difference, review , tap drinking water, Minab, Jask.

1. Introduction

Water is one of the important natural resources for most life on the planet, and as such the water quality of drinking water is an important parameter for a person's health and for environmental studies because it is consumed and can transport pollutants in the environment [1]. Radon 222 is a colorless and odorless radioactive element with a half-life of 3.83 days which is at the end of the uranium 238 chain.

It can be emitted by various sources such as surface and groundwater, igneous (granites) and sedimentary rocks [2, 3]. Radon 222 has high solubility in water (mole refractive index; 1.25×10^{-5} at 37 °C), which is 90 times greater than neon and helium [4,5]. Humans are constantly exposed to radioactive materials, especially radon 222 via inhalation of air and drinking water [6,7]. The alpha radiation, due to high ionization power, is primarily at risk in terms of internal exposure compared to other types of radiations[8].

Therefore, the long-term exposure to this radiation causes lung, stomach and blood cancer [9,10]. When a person consumes water containing radon 222, alpha radiation emitted during its decay, causes DNA damage of the cell in the stomach. On the one hand, it can penetrate through the stomach into the blood stream and spread throughout the body [3,11]. It is estimated that 89% and 11% of the risk of cancer is related to inhalation of radon 222 and drinking water containing radon 222, respectively [3].

The due to more contact of groundwater with the igneous rock substrates (granites) and sedimentary substrates, the concentration of radioactive substances of groundwater is more than surface waters [12-15]. Additionally, concentration of radon 222 in groundwater and surface water resources is 2 to 3 times higher than other radioactive materials [16]. Studies have shown that consumption of waters containing high concentration of radon 222 increases the effective dose and subsequently increase in stomach and lung cancers in humans [17,18].

Although the amount of subjects' exposure to radon 222 by drinking water is much less than inhalation, many international organizations have determined limits for the radio-nucleoside in drinking water especially radon 222 [19]. The guideline of WHO and Europe Committee for radon 222 of drinking water is 100 Bq/l [20]. EPA standard has also proposed 11 Bq/l for radon 222 of drinking water [21].

The Minab and Jask cities are at 220 kilometers away from each other in a hot and humid climate (Figure 1) [22]. tap drinking water source for both cites is wells (groundwater). In the study conducted by Fakhri et al, concentration of radon 222 in tap drinking water was measured in the two cities [23,24]. Therefore, in this study, it was attempted to compare and evaluate concentration of radon 222 in tap drinking water of these two cities.

Figure-1: The Minab and Jask cities in the southeastern of Hormozgan province, Iran.

2. Materials and Methods

2.1. Samples collection

In these two descriptive cross sectional studies, 250 water samples were collected from 10 locations in Minab since January 2013 to March 2013. Also in June 2013 in Jask, 8 regions of Jask city which includes Yakbeni, Louran, Sarrig, Maghsa, Kampa, Zolm abbad, Sarkalleh and Gharib abbad, 24 water samples with 1.5 liter volume were collected (each zone 3 samples in two different places).

2.2 Measurement concentration of radon 222

The measurement concentration of radon 222 in the tap drinking water was carried out at two temperatures of 5˚C and 15˚C in Minab city and temperature of 12˚C in Jask city. Before the start of the measurement, two 300 ml samples were extracted from a 1.5 liter volume sample; then, temperature of water sample was reached to the desired temperature. The concentration of radon 222 were measured by radon 222 detector, RT1688 2[1] model manufactured in Sarad Co. of Germany (figure 2) [25]. The high sensitivity along with alpha spectroscopy analysis leads to a short response time even in low concentration. The 2-hour mean of radon 222 concentration was recorded for all samples and were analyzed [26].

Figure-2: The measurement concentration of radon 222 by radon meter device model RTM1688-2.

2.3. Statistical analysis

The Kolmogorov-Smirnov test was used to determine the normality of the data in Minab and Jask cites and subsequently type of statistical analysis to compare data. To compare concentration of radon 222 in Minab and Jask cites, independent sample t test was used.

Also, one sample t test was conducted in SPSS16 for the comparison of radon 222 concentration with standard limits. P value<0.05 was selected as the significance level (α=5%).

3. Results

The mean concentration of radon 222 in tap drinking water in the regions Yakbeni, Louran, Sarrig, Maghsa, Kampa, Zolm abbad, Sarkaleh and Gharib abbad were 180, 161, 115, 200, 212.5, 302, 199 and 286.5 Bq/m^3, respectively. The range and mean concentration of radon 222 was 105-304 Bq/m^3 and 198.8±61.9 Bq/m^3, respectively.

The highest and lowest concentration of radon 222 was related to Zolm abbad and Sarrig regions, respectively[24] . The range and mean concentration of radon 222 in Minab at temperature of 5 ˚C was 200-1800 Bq/m^3 and 870±251 Bq/m^3 and 15 ˚C was 200-1450 Bq/m^3 and 464±210 Bq/m^3[24].

In the Kolmogorov-Smirnov test, p value> 0.05 concentration of radon 222 in tap drinking water of Minab and Jask cites showed that the data are normally distributed. Therefore, T Test used to determine a significant difference.

Table-1: Kolmogorov-Smirnov test of radon 222 concentration in tap drinking water of Jask, Minab (5 °C) and Minab (15 °C).

	Kolmogorov-Smirnov test		
	Jask (12˚C)	Minab (5˚C)	Minab (15˚C)
P value	0.534	0.998	0.989

Table-2: Independent Samples Test between concentration of radon 222 in drinking tap water of Minab and Jask at temperature of 12 ˚C.

	p value	Mean difference	Standard error	95%Confidence Interval	
				low	high
Minab (5 ˚C) and Jask	<0.001	578	64	442	710
Minab (15 ˚C) and Jask	<0.001	289	55	176	404
Minab (5 ˚C) and Minab (15 ˚C)	0.013	286	104	68	504

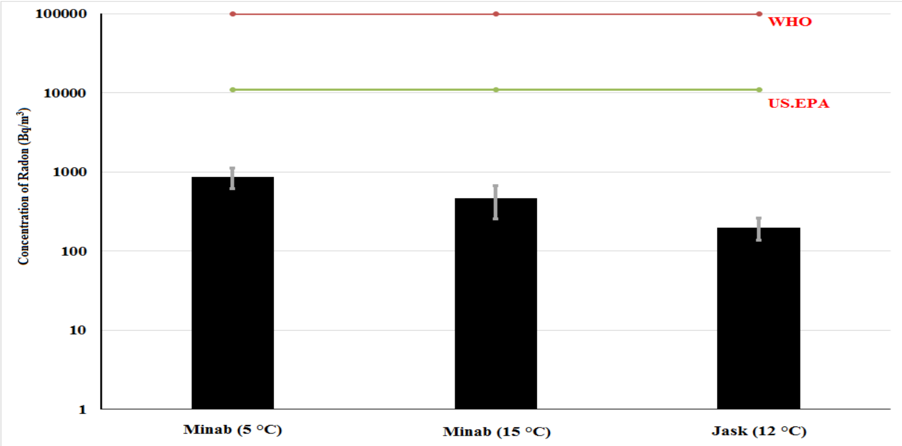

Figure-3: The mean and standard deviation of radon 222 concentration in tap drinking water of Minab 15 °C and Minab at temperatures of 5 ˚C and 12 ˚C compare to standard EPA and guideline WHO.

4. Discussion

We conducted that concentration ratio of radon 222 at 5 ˚C and 15 °C in Minab and Jask cites to EPA standard was 7.9%, 4.2% and 1.8% and relative to guideline WHO was % 0.87, 0.46 % and 0.19 % respectively. One-Sample test showed that concentration of radon 222 in drinking water of Minab and Jask is much lower than standard EPA and guideline WHO (p value<0.001).

Whenever most radon-related deaths are due to radon 222 aggregated in houses, 30 to 1,800 deaths per year are related to radon 222 from domestic or tap water. High dissolved radons 222 are found in the groundwater in some areas flowing through granite or granitic sand and gravel formations [27]. If you live in an area with high radon in groundwater it can get into your private well. Showering, washing dishes, and laundering can disturb the water and emission radon 222 into the air our breathe [13].

Table-3: The comparison of concentration of radon 222 in the tap drinking water of Minab and Jask Cites with other countries and Iran (Bq/m^3).

Type of water	Concentration of radon 222	Countries	Sources
Tap water	910-125800	Turkey	[28]
Tap water	12000	China	[29]
Tap water	3700	Iran (Tehran)	[30]
Tap water	3240±270	Turkey (Kastamonu)	[28]
Tap water	179000	Iran (Neyshabour)	[28]
Tap water	16230	Iran (Mashhad)	[28]

Tap water	3400	Iran (Ramsar)	[28]
Tap water	187-14800	Iran (Yazd)	[31]
Tap water	602	Pakistan (Kulachi)	[32]
Tap water	198±61	Iran (Jask)	[24]
Tap water	870±251	Iran (Minab, 5˚C)	[23]
Tap water	464±210	Iran (Minab, 15˚C)	[23]

Concentration of radon 222 in tap drinking water of Minab and Jask has been compared with some cities in Iran and the other countries (Table 3). The mean concentration of radon 222 in Jask and Minab cites was less than Ramsar, Mashhad, Tehran, Neyshabour, Kastamonu as well as Turkey and China. The mean concentration of radon 222 in Kulachi was less than Minab at 5 ˚C temperature. This difference in concentration of radon 222 in drinking water may be due to type of water sources (groundwater or surface water)[33,34] , retention time of water [35], geological texture, [36] and water temperature [37]. Thabayneh et al, concentration of radon 222 in drinking water was measured in 96 samples in different parts of southern Palestine that an mean of 660 Bq/m^3 was obtained which was approximately similar to the results of this study [38]. Malakootian et al, concentration of radon 222 in water of villages adjoining Lalehzar fault in Kerman province (distance of 150 to 200 kilo meters Minab and Jask cites) was measured by RAD7. The concentration range of radon 222 in this study (26880-74000 Bq/m^3) was much higher than our study [39]. Erdogan et al study was measured concentration of radon 222 in tap drinking water of some houses in Konya by Alpha GUARD radon gas analyzer, concentration range of radon 222 (3150-10200 Bq/m3) was higher than our study [40]. But in the study of Asadi et al, concentration range of radon 222 in 18 sources in the city of Rafsanjan (13900-320 Bq/ m3) was close to our study [41]. The mean concentration of radon 222 in our study was also close to mean concentration of radon 222 in the study carried out by Sahin et al (40Bq / m3 ± 610) in Kutahya in Turkey [42].Ahmed et al, concentration of radon 222 in tap drinking water of Sungai Petani in Malaysia was 5370 Bq/m^3 that has been reported much more than cities of Minab and Jask [4]. The order of concentration of radon 222 in tap drinking water of is Minab, 5 ˚C > Minab, 15 C˚ > Jask, 12 ˚C. Since the temperature is a very influencing variable on the emission rate of radon 222 gas from water [37], radon 222 emission in different temperatures will be different. Although the measurement temperature in Jask city (12˚C) is less than measurement temperature in Minab city (15 ˚C), concentration of radon 222 in drinking water of Minab was greater than it. Since there was a short period between time of sampling and measurement, the impact of retention time on concentration of radon 222 can be ignored. Thus, the significant variation was different geological textures of aquifer between the two cities [36]. On the other hand, some studies have shown that the measurement concentration of radon meter devices such as RAD7, RTM1688-2 etc. can be different [43].

5. Conclusions

The mean concentration of radon 222 in the tap drinking water in Minab and Jask cites was less than EPA standard limit and WHO guidelines (P value <0.001). Hence health risks of radon 222 in tap drinking water does not threaten the inhabitants. The concentration of radon 222 in tap drinking water of Minab, was significantly higher than Jask city.

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