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Determination concentration of Radon222 in Tap drinking water; Bandar Abbas City, Iran

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Abstract: *Isotope radon222 is one of radioactive elements that is colorless, odorless with a half-life of 3.825 days that can endanger the human health by alpha-ray emissions into air, water and food. The consumption of water containing Radon 222 can cause stomach cancer in the humans in the long term. In this descriptive cross sectional study, 48 water samples were collected from 8 regions of Bandar Abbas city during June 2015.Then, the concentration of Radon222 was measured by the portable Radon-meter model RTM1688-2.The range and mean concentration of Radon222 in tap drinking water is, 15-153 Bq/m^3 and 82±28 Bq/m^3, respectively.Also, the highest and lowest concentration of Radon222 was related to regions 3 and 7, respectively. Theconcentration of Radon222 in tapdrinking water of Bandar Abbas cityis lower than WHO and EPA standard limits.*

Keywords: *Concentration of Radon222, tap water, Bandar AbbasCity*

I. Introduction

Radon222 and its daughters Polonium 214 and Polonium 218 are the main and final products in decay chains of uranium 235that can be spread from various sources such as surface waters and groundwater, soil, igneous (granites) and sedimentary rocks]2 ,1[.Also, Radon222 is a radioactive isotope with a half-life of 3.825 days, which is colorless and odorless and can cause lung, blood and stomach cancer in individuals at long term by Alpha-ray release during decay]4 ,3[.Alpha ray,in terms ofinternal radiation, is in the first degree of danger than the other rays due to the high ionization power]5[.Many studies have shown that when a person consumes water containing Radon222, the emitted Alpha ray will cause damage to DNA cells of inside the stomach during its decay.On the other hand, through penetration into the stomach wall, it can enter the bloodstream and spread throughout the body]9-6[.The International Research Committee has estimated that about 30% of Radon222 radioactivity is absorbed through the stomach wall]10[.Although people who exposure toRadon222 through drinking water is much less than inhalation, but many international organizations have determined limits for existed Radionuclides in drinking water, especially Radon 222]11[. The WHO[1]and the Europe committee standard limits for radon 222in drinking water is 11000Bq/m^3]12[.Also, the EPA[2]standard limits has proposed 11000Bq/m^3 for radon 222 in drinking water]13[.As it was said before, due to more physical contact of groundwater with igneous (granites) and sedimentary rocks (containing radium), in these waters, the concentration of radioactive substances can be more than surface waters]16-14 ,2[. Also, in groundwater resources, the concentration of radon 222 is 2 to 3 times higher than other radioactive materials]17[.In the world, numerous studies have been done in the field of measuring the concentration of Radon222 in drinking water]19 ,18[. Since approximately 50% of the water of distribution network in Bandar Abbas city, comes from groundwater resources (groundwater wells and Shamil and Minab), hence, the concentration of Radon222 was measured in drinking water and was compared with standard limits.

[1] World Health Organization
[2] Environmental Protection Agency

II. Materials and Methods

2.1 Study area

The coastal city of Bandar Abbas (the provincial capital of Hormozgan) is located in the south of Iran (27°11´53" Nand 54°22´7" E) and at an elevation of 9 meters above sea level (Figure 1)]20[.The climate of this city is hot and humid and its population is rising day by day due to business growth]21[.

2.2 Sample collection

In the descriptive cross sectional study, based on similar studies in June 2015 from 8 regions of Bandar Abbas city which includes: region 33 (Chahestany neighborhood), region 29 (Shah-Hosseini neighborhood), region 17 (Shahid Jafari street), region 8 (Islamabad), region 9 (Jahanbar), region 37 (khajeh Ata), region 64 (ShahrakTohid) and region 41 (ZibaShahr), 48 tap water samples were collected, each of them 1.5liter (each region 6 samples in different places]23 ,22[. Finally, for measuring according to the instruction, EPA, at 4 to 6C°, was transferred to the laboratory of School of Public Health Tehran University of Medical Sciences,]24[.

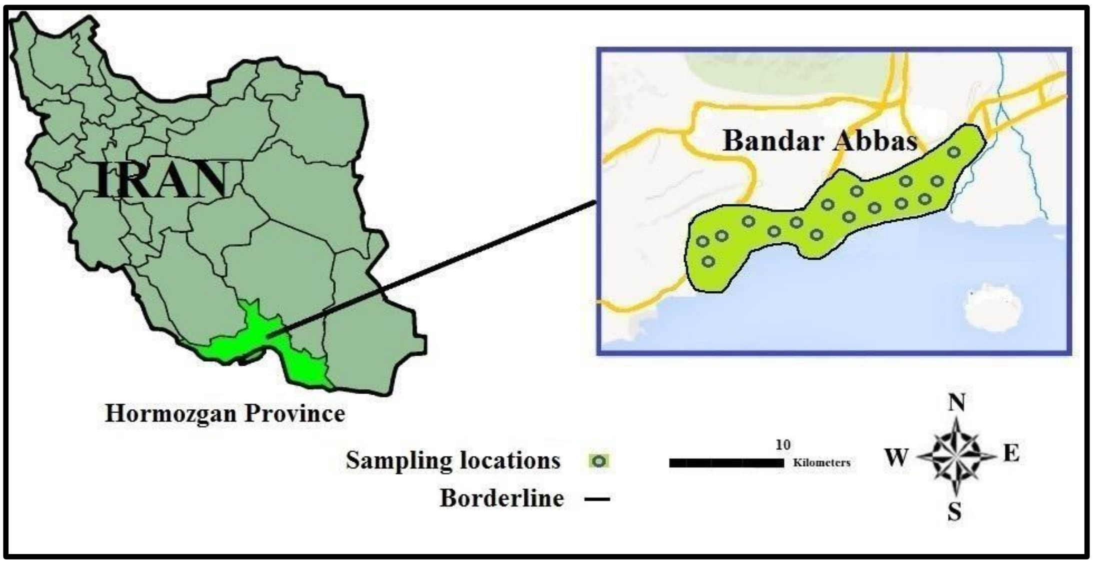

Figure1. Regions to collect samplesof water indistribution network of Bandar Abbas City

2.3 Measurement concentration of Radon 222

Regarding the effect of temperature on the concentration of Radon 222 emission from water before measuring, all samples have the same temperature and were brought to 12°C]26 ,25[. The concentration of Radon 222 wasmeasured by radon-meter model RTM166-2 manufactured by Sarad company in Germany (Figure 2). The sensitivity of this device in 150 minutes of continuous measurement is 5.6 Counts/(min×KBq/m^3)]27[. High sensitivity along with alpha spectrometric analyzes leads to short response time, even in low concentrations.Measuring the concentration of Radon 222 intap water samples was done in accordance with the measuring instruction provided by the Sarad Company. Also, 2hours mean concentration of Radon 222were recorded and analyzed for all samples]28[.

Figure2. Measuring the concentration of Radon 222 by radonmeter model RTM1688-2

III. Results

The mean concentration of Radon222 of tap water for regions of 33, 29, 17, 8, 9, 37, 64 and 41, is106, 89.5, 107, 84.5, 94.5, 95.5, 54.5 and 57 Bq/m^3, respectively. The range and the mean (Geometric mean ±SD) concentration of Radon 222 in drinking water of distribution network is 51-153Bq/m^3 and 82±28 Bq/m^{3}respectively (Figure 2). Also, the highest and lowest concentration Radon222 is related to regions 3 and 7, respectively (Table 1).

Table1. Geometric mean (median) of radon-222 concentration of drinking water in 16 regions of Bandar Abbas (Bq/m3)

Region	Location Sampling	Concentration of radon 222	Mean of Region
1	1	153[3]	106
	2	59	
2	3	83	89.5
	4	96	
3	5	110	107
	6	104	
4	7	60	84.5
	8	109	
5	9	86	94.5
	10	103	
6	11	95	95.5
	12	96	
7	13	51	54.5
	14	58	
8	15	55	57
	16	59	
	Geomean	82	
	Standard deviation	28	

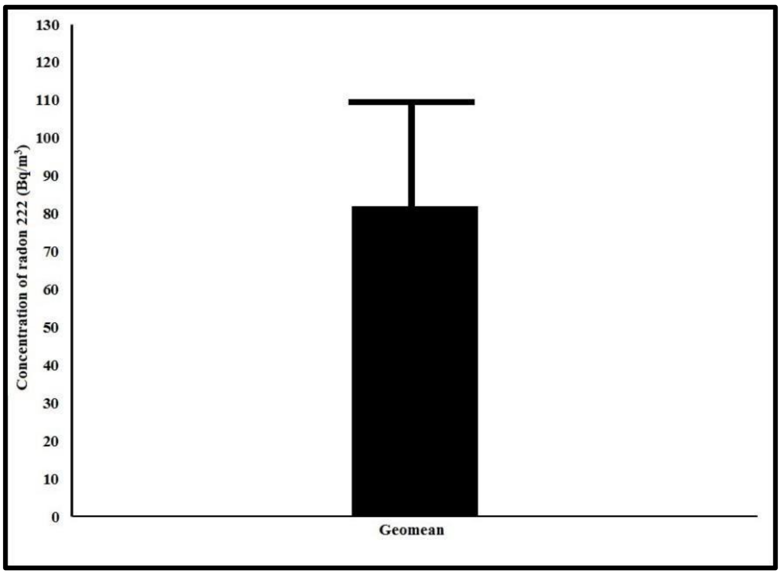

Figure2.Geometric mean and standard deviation concentration of Radon 222 in tap drinking water of distribution network in Bandar Abbas City

IV. Discussion

The order of studied regions, based on concentration of Radon 222 of tap water is 3>6>5>2>4>8>7. This difference concentration of Radon 222 between different regions of the city is caused by the retention time difference of water in distribution network]29[. The mean ratios of concentration ofRadon 222 to WHO and

[3]Mean of 3 samples

EPA standard limitsis 0.08% and 0.74% respectively. The mean concentration of Radon222 in 16 points (in the 8 regions) of Bandar Abbas city is much less than the level of WHO and EPA standard limits (Figure 3).

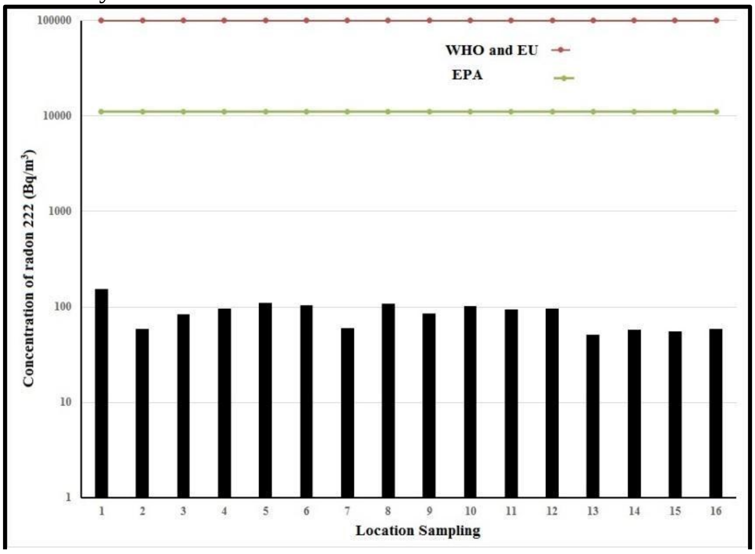

Figure3. Themean concentration of Radon222 of tap drinking water in distribution network in 16 points of 8 regions in Bandar Abbas city

Table2. The comparison concentration of Radon 222 of tap water in Bandar Abbascity with rest of the world and Iran

Kind Water	Countries'	Concentration of radon 222 (Bq/l)	References
tap water	Turkey	12.58-0.91	]30[
tap water	Iran (Tehran)	3.70	]31[
tap water	Iran (Nishapur)	17.99	]31[
tap water	Iran (Mashhad)	16.23	]31[
tap water	Iran (Ramsar)	3.40	]31[
tap water	Iran (Bandar Abbas)	0.08	This study

The mean concentration of Radon222 in tap drinking water of Bandar Abbas city is much less than cities of Ramsar, Mashhad, Nishapur, Tehran and the country of Turkey (Table 2).concentration of Radon 222 in groundwater is more than surface waters]17[. Since half of the tap water of Bandar Abbas comes from surface water supplies (Minab Esteghlal Dam) and the other half comes from groundwater sources (wells of Shamil and Minab), hence, low levels of concentration of Radon 222, can be due to the combination of surface and groundwater water. Although surface waters are the sourceof water supply in Tehran, but the mean concentration of Radon222 of tap water in this city is much more than the city of Bandar Abbas city (Table 2).This discrepancy may be due to higher concentration of radioactive substances in the bedrock of catchment area of water supply dams of Tehran city]15 ,14[. The mean concentration of Radon222 in tap water of the city of Kulachi in Pakistan in the study of Nasir et al (602 Bq/m^3) is also higher than our study]10[.

V. Conclusions

Since the geometric mean concentration of radon222 of tap water in Bandar Abbas city is much lower than the standard limits of WHO and EPA, Hence, it can be said that in terms of the risk of radioactivity of Radon222 in tap drinking water, the population of Bandar Abbas are in the safe range.

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