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Survey on difference concentration of radon 222 in the tap drinking water between Bandar Abbas and Minab Cities

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Abstract: *Radon 222 is a colorless and odorless radioactive element that is available in the water, soil and air. It can endanger human health by alpha-ray emissions. Existing radon 222 in drinking water supplies in the long run can cause stomach and lung cancer. In this review study, concentration of Radon 222 tap drinking in Minab and Bandar Abbas cities was measured in past studies and compared by Independent Samples Test. The mean concentration of radon 222 tap water of Minab city at 5 and 15 ˚C was 0.78±0.06 and 0.46±0.04 Bq/l, respectively. Also the mean radon 222 of tap water in Bandar Abbas city was 0.082±0.028 Bq/l. Statistical analysis showed that the mean concentration of radon 222 Minab city's tap water at temperatures between 5 and 15 ˚C is significantly higher than the city of Bandar Abbas (p value<0.05). Hence, the dangers of radon 222 of tap drinking water in the city of Minab is higher.*

Keywords: *different concentrations of radon 222, tap drinking water, Bandar Abbas and Minab cities*

I. Introduction

Radon 222 is natural radioactive element with a half-life of 3.8 days, which is colorless and odorless in uranium-238 chain which can cause lungs, blood and stomach cancer in the long term in humans with the release of alpha radiation [3-1]. Radon has high solubility in water (moles refractive index; 1.25×10^{-5} at 37°C), and also has solubility ninety times more than the neon and helium [4]. Radon 222 can be emitted from various sources such as surface water and groundwater, soil, igneous and sedimentary rocks (granites) [6 ,5]. Humans are constantly exposed internally or externally with radioactive materials, especially radon 222 via inhalation of air and ingestion of drinking water [9-7]. It is estimated that 89% and 11% of cancer related to radon 222 gas inhalation and ingestion of water containing radon water 222, respectively [10]. WHO guidelines for radon 222 Europe Committee for Radon 222 drinking water is 100 Bq/l [11]. The EPA standard for drinking water Radon 222 has proposed 11 Bq/l [12]. Due to more contact of groundwater with igneous rocks (granites) and sedimentary beds, the concentration of radioactive substances in the water can be more than surface waters ,3] [15-13. Radon 222 concentrations in ground and water resources is 2 to 3 times higher than other radioactive materials [16 ,3]. Cities of Bandar Abbas and Minab and located less than 100 km from each other. The two cities are the most populous city in the province. Source of tap drinking water in Minab city is wells (groundwater) [17]and Bandar Abbas city (Minab and Shamil wells, 50%) and Minab Esteghlal Dam, 50%) [18]. In a study conducted by Fakhri et al, concentration of radon 222 tap drinking water in the two cities was measured. In this study, it is tried that concentrations of radon 222 of water in the two cities are compared and evaluated.

II. Materialsand Methods

In Minab city, 250 water samples were collected from 10 districts of the city and was measured at 5 and 15 °C in the sampling place. In the city of Bandar Abbas, 48 water samples were collected from 8 regions and finally according to EPA guidelines, it was transferred for measurement to the Laboratory School of Public Health, Tehran Medical Sciences at 4 to 6 °C[19]. In both studies, measurements of radon 222 in both cities was conducted by radon detector RTM1688-2 model.

To compare concentrations of radon 222 tap water at Minab city at 5 and 15 °C with Bandar Abbas city, Independent Samples Test was used in SPSS16. P value <0.05 was considered as significant level.

III. Results

Geometric mean and range of concentration of ^{222}Rn in drinking water was measured 0.78±0.06 Bq/l and 0.19-1.7 Bq/l at 5ºC and 0.46±0.04 Bq/l and 0.16-1.45 Bq/l at 15 ºC, respectively (p value<0.05) (Tables 1 and 2)[17].

Table 1. Geometric mean (GM±SE), Middle, maximum and minimum concentration of radon 222 tap water samples in the temperature of 5 ºC (Bq/l ×10^3)

Regions	Minimum	Maximum	Middle	Geometric mean
1	0.96	1.8	0.24	1.17±0.1
2	0.77	1.71	0.5	1.14±0.1
3	0.68	1.08	0.98	0.93±0.08
4	0.78	1.15	0.9	0.92±0.08
5	0.48	0.96	0.87	0.77±0.06
6	0.65	0.89	0.76	0.72±0.06
7	0.42	0.69	0.56	0.57±0.5
8	0.43	0.85	0.72	0.65±0.5
9	0.26	0.65	0.46	0.47±0.4
10	0.2	0.65	0.54	0.49±0.4
mean				0.78±0.06

Geometric mean and range of concentration of radon 222 in drinking water was measured 0.78±0.06 Bq/l and 0.19-1.7 Bq/l at 5 ºC and 0.46±0.04 Bq/l and 0.16-1.45 Bq/l at 15 ºC, respectively (p value<0.05). (Tables 1 and 2) [17].

Table 2. Geometric mean (GM±SE), Middle, maximum and minimum concentration of ^{222}Rn drinking water samples in the temperature of 15ºC (Bq/l)

Regions	Min	Max	Middle	Geometric mean
1	0.6	1.14	0.78	0.81±0.6
2	0.54	1.45	0.76	0.86±0.7
3	0.26	0.82	0.59	0.53±0.4
4	0.48	0.88	0.62	0.62±0.5
5	0.17	0.75	0.53	0.48±0.4
6	0.19	0.75	0.47	0.43±0.3
7	0.18	0.49	0.32	0.33±0.2
8	0.16	0.49	0.39	0.37±0.3
9	0.17	0.54	0.29	0.27±0.2
10	0.2	0.42	0.26	0.27±0.2
Mean				0.46±0.04

Range and mean concentrations of radon 222 tap drinking water is 0.51-0.153 Bq/l and 0.082 ± 0.028 Bq/l, respectively [18].

Table 3. Geometric mean concentrations of radon 222 drinking water in 16 Location of Bandar Abbas cities (Bq/l)

Region	Location Sampling	Concentration of radon 222
1	1	0.153
	2	0.059
2	3	0.083
	4	0.096
3	5	0.11
	6	0.104
4	7	0.06
	8	0.109
5	9	0.086
	10	0.103
6	11	0.095
	12	0.096
7	13	0.051
	14	0.058
8	15	0.055
	16	0.059
	Geomean	0.082
	Standard deviation	0.028

IV. Discussion

The mean radon 222 concentration of tap drinking water in Minab at 5 °C is more than 15 °C temperature of Bandar Abbas cites. As can be seen in Tables 4, Statistical analysis Independent Samples Test t shows significant difference between the concentrations of these two cities at 5 and 15 °C (p value <0.05).

Table 4. Statistical analysis Independent Samples Test of Radon 222 of tap water at Minab city with in Bandar Abbas cites

	p value	Mean Difference	95% Confidence Interval of the Difference	
			Lower	Upper
5˚C	<0.000	0.693	0.654	0.733
10˚C	<0.000	0.374	0.334	0.413

Groundwater has more concentrations of radon 222 than surface water [20 ,16]. Though the two cities are not far away from each other (less than 100 km), it is all Minab city water source of groundwater (wells), but half the water of Bandar Abbas cites from surface water supplies (Minab Esteghlal Dam) and the other half is provided from groundwater sources (Minab and Shamil wells). Hence, low concentrations of radon 222 can be caused by mixing of surface and groundwater. In the study done by Alirezazadeh, despite Tehran's water source is surface [21], the mean radon concentration of 222 water supply in this city is much more than Bandar Abbas and Minab cities. This difference in the concentrations of radon 222 may be due to higher radioactive substances in catchment area bedrock water of the dams supplying Tehran city water [15 ,14]. The mean concentration of radon 222 tap water at Kulachi city in Pakistan in the study done by Nasir et.al (0.602 Bq/l) is also higher than the city of Minab (5˚C) and Bandar Abbas cites [22]. In the study conducted by Yalcin et al, mean concentrations of radon 222 in tap water in the city of Kastamonu (Turkey) is 3.24 ± 0.27 Bq/l is much more than the mean water in Bandar Abbas and Minab cities [23].

V. Conclusion

The mean concentration of radon 222 tap water Minab city at a temperature of 5 ˚C (9.5 times) and 15 ˚C (5.75 times) is more than of Bandar Abbas city (p value <0.05). Hence, the health risks of radon 222 of tap drinking water at Minab city is more than Bandar Abbas city.

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