

Determination Concentration of Nitrate in 8 high consumed marks of bottled water in Bandar Abbas, Iran

Yadolah Fakhri¹, Leila rasouli amirhajloo², Ghazaleh langarizadeh³, Mahboobeh Moradi⁴, Bigard Moradi⁵, Yahya Zandsalimi⁶, Maryam Mirzaei^{7,*}

¹Social Determinants in Health Promotion Research Center, Hormozgan University of Medical Sciences, Bandar Abbas, Iran.

²Department of Environmental Health Engineering, School of Public Health, Qom University of Medical Sciences, Qom, Iran.

³Food and Drugs Research Center, Bam University of Medical Sciences, Bam, Iran

⁴Student's research committee, Shahid Beheshti University of Medical sciences, Tehran, Iran

⁵Department of health public, Kermanshah University of Medical Sciences, Kermanshah, Iran

⁶Environmental Health Research Center, Kurdistan University of Medical Science, Sanandaj, Iran

⁷Research Center for non-communicable disease, Msc of critical care nursing, Jahrom University of Medical Sciences, Jahrom, Iran

*Corresponding author, Email: Maryamirzaei32@yahoo.com

Abstract

Bottled water is the main beverage in developed and developing countries, particularly Iran. Bottled water can also be contaminated by chemical agents. Today, the consumption of bottled water is widespread among the population; therefore, becoming aware of biological and chemical quality for each consumer is mandatory. Nitrate is a chemical contaminants that could endanger human health. This study aims to determine concentration of Nitrate in 8 highly-consumed marks of bottled water in Bandar Abbas, Iran. This cross-sectional and descriptive study measured concentration of Nitrate in 144 specimens of 8 marks of high consumption bottled water in Bandar Abbas during the summer and winter of 2013. It was measured by ferrous sulfate 8153 using spectrophotometry device model 28000 DR (Hack Company). The highest and lowest concentration of nitrate of bottled water was related to BW7 (18.9 mg/l) and (BW3 less than 2 mg/l). The mean and range of concentration of nitrate in bottled water are 9.2±4.6 and ND-26 mg/l, respectively. Also, the mean concentration of nitrate in the summer and spring are 10.3±4.3 and mg/l 8.1±4.9, respectively. Mean nitrate concentrations at 8 marks of bottled waters of Bandar Abbas is lower than the WHO and EPA standard limits.

Keywords: bottled water, concentration of nitrate, Bandar Abbas city

1. Introduction

In the last 30 years, the consumption of bottled water as a source of safe water is increasing in many communities [3-1]. The main reasons for the increased use of bottled water include the reduced quality of other resources, packaging attractiveness and their availability [4]. Packaged water is classified into mineral water and bottled water [6 ,5]. In packaged water, various additives such as scarce elements, etc. is added to the water, but in mineral water, the bottle is filled with fountain water without additives [7]. Regardless of chemical and biological parameters of bottled water, it cannot be sure it is sanitary. One of these toxic chemical parameters is nitrate [9 ,8]. Nitrate ion is part of inorganic nitrogen compounds that is produced in the last step of ammonia oxidation [11 ,10]. Water pollution by organic substances, municipal and industrial waste, animal manure and municipal sewage and industrial chemicals cause nitrate insertion into the resources [13 ,12]. Since nitrate has a high solubility in water it can be extended into the water resources [15 ,14]. Studies have shown that consumption of drinking water with high concentration of nitrate cause Methemoglobin in infants, diabetes in children and stomach, bladder and liver cancer [18-16]. Several studies in the field of chemical and microbiological quality of bottled water in the country have been carried out [20 ,19]. According to the guidelines of World Health Organization and America Environmental Protection Agency, maximum permissible nitrate ions in bottled drinking water by nitrate is 45 mg/l [22 ,21]. This

study was an attempt to measure concentration of nitrate in some high-consumed bottled water in Bandar Abbas city and compared it with the standard limits.

2. Materials and methods

1.2 Study area

The coastal city of Bandar Abbas (the capital of Hormozgan province) has been located in southern Iran (53° 27'11"53"N and 54°22'7" E) and at an elevation of 9 meters above sea level (Figure 1) [23]. The climate of this city is hot and humid and its population is increasing day by day due to business growth.

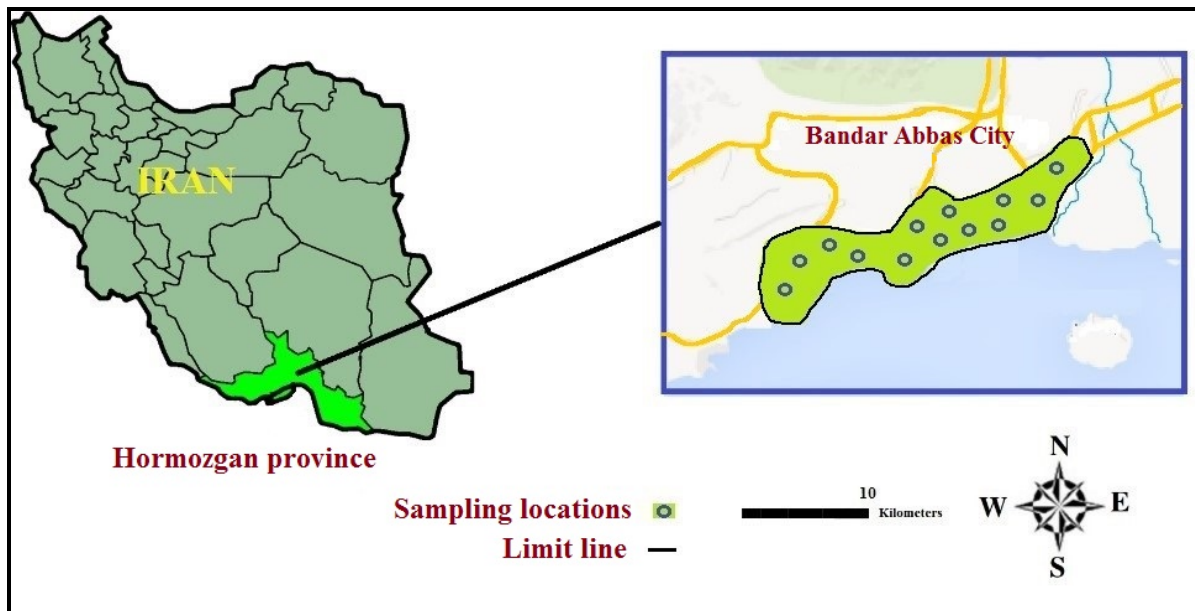


Figure 1. Location of collecting samples of bottled water in the city of Bandar Abbas in southern Iran

2.2 Sample collection

This cross-sectional and descriptive study was conducted in the summer and winter seasons of 2013. Samples collection was performed from 8 high-consumed bottled water in Bandar Abbas from 13 locations (Figure 1). 3 bottles of 1.5 liters were collected at random from each mark per month. 72 water samples collected in summer and 72 ones were collected in winter (a total of 144 samples of bottled water). According to the chemical sampling guideline, samples were transferred to the Chemistry Faculty of Hormozgan University of Medical Sciences at 4°C to measure the concentration of nitrate [24].

3.2 Measurement concentration of nitrate

Concentration of Nitrate in the samples was measured by spectrophotometry model 28000 DR (Hack Company). Ferrous sulphate 8153 measurement method to determine the concentration of nitrate was used. According to this method, the measurement range is 2-250mg/l NO_2^- in the 585 nm wavelength [25].

4.2 Statistical Analysis

The mean concentration of nitrate in summer and winter, as well as in the standard limits by using T test and SPSS16 software with statistical error of 5% ($\alpha=5$) as significant level was performed.

2. Results

Mean concentration of nitrate of bottled water in summer for BW1, BW2, BW3, BW4, BW5, BW6, BW7, BW8 is 9.4, 7.3, ND¹, 9.5, 8.9, 8, 18.8, ND and for winter is 5.3, 8, ND, 7.6, 6.4, 5.7, 18.9, 4.7 mg/l, respectively. The total mean concentration of nitrate for bottled water BW1, BW2, BW3, BW4, BW5, BW6, BW7, BW8 is 7.3, 7.7, ND, 8.6, 7.6, 6.9, 18.9 and 4.7 mg/l, respectively. Mean and range of bottled water concentration of nitrate is 9.2 ± 4.6 and ND-26 mg/l. The mean concentration of nitrate in the summer and spring is 10.3 ± 4.3 and 8.1 ± 4.9 mg/l, respectively.

Table 1. Concentration of nitrate of 8 high consumed marks of bottled water in Bandar Abbas

	Summer		Mean			Winter		Mean	Mean annually
BW1	ND	13.3 ²	5.4	9.4	6.0	ND	4.6	5.3	7.3
BW2	5.0	11.6	5.4	7.3	4.0	14.5	5.4	8.0	7.7
BW3	ND	ND	ND	ND	ND	ND	ND	ND	ND
BW4	14.0	5.0	ND	9.5	14.0	2.2	6.6	7.6	8.6
BW5	2.6	17.4	6.6	8.9	ND	5.4	7.3	6.4	7.6
BW6	8.0	ND	ND	8.0	4.5	6.9	ND	5.7	6.9
BW7	19.5	22.6	14.4	18.8	13.4	26.0	17.2	18.9	18.9
BW8	ND	ND	ND	ND	3.6	ND	5.8	4.7	4.7
Mean	9.8	14.0	8.0	10.3	7.6	11.0	7.8	8.1	9.2
SD	6.9	6.6	4.3	4.3	4.8	9.5	4.7	4.9	4.6

4. Discussion

The order of bottled water in terms concentration of nitrate is BW3 < BW8 < BW6 < BW1 < BW5 < BW2 < BW4 < BW7. The mean concentration of nitrate to the standard limits in summer and winter and the total mean is 31.1%, 18% and 20.4%, respectively.

¹ Not detected (less than 2 mg/l)

² Mean of 3 samples

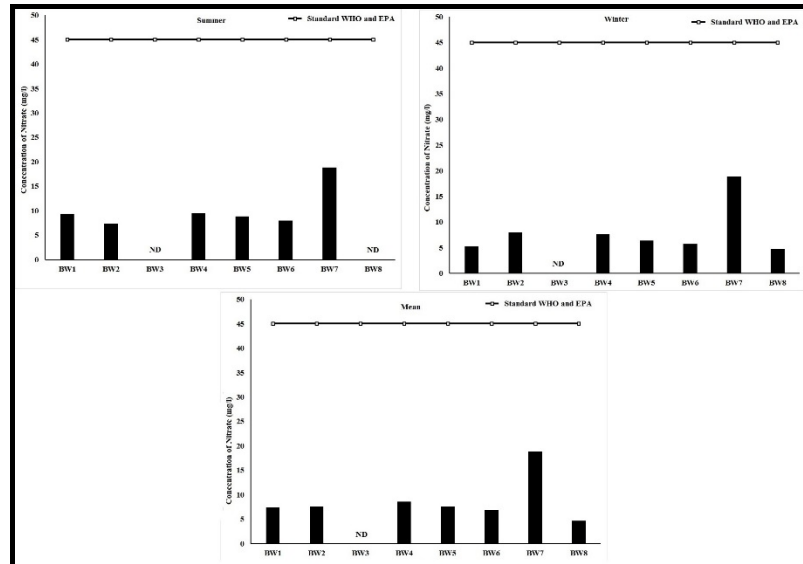


Figure 2. Comparing the nitrate concentration of 8 marks of bottled waters with WHO and EPA standard limits in the summer and winter and annually

Concentration of Nitrate in all samples of bottled water (n=144) is less than the standard limits. As can be seen in Figure 2, the lowest and highest concentration of nitrate is related to BW3 and BW7. This difference in concentration may be due to differences in the type of bottled water or purification process [26 ,5]. Mean concentration of nitrate in summer, winter and the total mean is lower than the standard limits (Figure 3)

[22 ,21]. Statistical analysis showed that there is no significant difference between the concentration of nitrate in bottled waters in summer and winter. (p value>0.05). Also, there is a significant difference between bottled water concentration of nitrate and standard limits (p value <0.05).

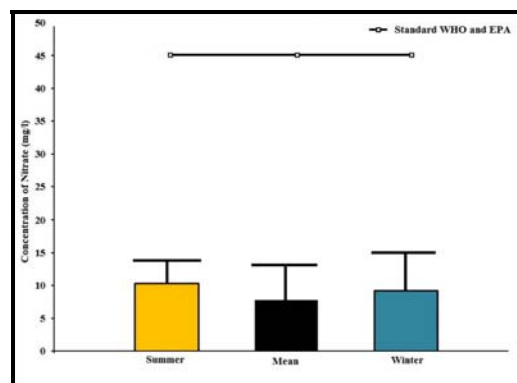


Figure 3. Comparison of bottled water concentration of nitrate in summer, winter and annually with the standard limits

Mean concentration of nitrate in our study was very close to the study done by Khaniki et al (9.02 mg/l) done in China. Also, the mean concentration nitrate in our study is was observed more than bottled water concentration nitrate in Turkey, Japan, Malaysia and Iran (Qom) (Table 2).

Table 2. Comparison of concentration of nitrate in bottled water in Bandar Abbas city with some cities of Iran and the world

Countries	Concentration of Nitrate (mg/l)	References
Turkey	1.7	[27]
Japan	1.06	[27]
Malaysia	4.5	[27]
China	9.07	[27]
Iran (Tehran)	9.02	[28]
Iran (Qom)	2.1	[29]
Iran (Bandar Abbas)	9.2	This study

5. Conclusion

Concentration of Nitrate in all samples (n=144) is lower than the standard limits. Mean concentration of nitrate in bottled water in Bandar Abbas city is lower than the WHO and EPA standard limits. There is no significant difference between bottled water concentration of nitrate in summer and winter seasons.

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