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Nitrate and Nitrite Concentration in the Drinking Water of Some Universities in Iran

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ABSTRACT

Introduction: Water is vital for life, and its poor quality causes significant adverse effects on the health of individuals and the community. Groundwater is an important source of nitrate, and higher nitrate levels than the standard limits may lead to several health complications, such as hemoglobin metabolism and formation of nitro amino compounds. The present study aimed to determine the concentration of nitrate and nitrite in the drinking water of some universities in Iran.

Methods: This descriptive, cross-sectional study was conducted during the 2016-2017 to measure the concentration of nitrate and nitrite in the drinking water of some universities in Iran, including Ferdowsi University of Mashhad, Guilan University, Kerman University, Hamedan University, Chamran University of Ahvaz, Shiraz University, Qom University, Isfahan University, Sabzevar University, and Tehran University. In total, 156 samples were collected, and nitrate and nitrite concentrations were assessed using a HACH DR-5000 spectrophotometer (Germany).

Results: The nitrate content in all the samples was below the standard limits. The highest level of nitrate was observed in the drinking water samples collected from Sabzevar University, and the lowest level was observed in the samples obtained from Guilan and Kerman universities. However, nitrite content was not detected in any of the samples.

Conclusion: The World Health Organization standards for nitrate and nitrite levels in drinking water are less than 50 and 3 mg/l, respectively. Drinking water with lower levels of nitrate and nitrite than 50 and 3 mg/l is considered to be safe for public use. However, comprehensive studies are required for the monitoring of the chemical quality of water supplies and providing practical applications for the avoidance of the increased levels of these ions.

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Introduction

Today, water scarcity and drinking water health are considered to be major health challenges. Large portions of freshwater are consumed for agricultural activities, and excessive consumption along with the intensification of the water crisis have led to the leaching process of nitrate from the root zone.[1] On the other hand, nitrate is able to enter drinking water through human sources. The most important sources of nitrate in the environment and drinking water are agricultural and non-agricultural sources.

The increased concentration of nitrate in soil, water, and plants is due to the excessive consumption of nitrogen fertilizers, animal fertilizers, and herbicides.[2, 3] In this regard, some of the non-agricultural sources include leakage from sewage farms, contaminated land around waste landfills, multiple industrial activities, entry of raw or refined sewage into rivers, septic tanks, absorbent wells, pollution due to various industries (e.g., household detergent industries, metal and plastic industries), raw materials of the textile and pharmaceutical industries, and leaks and atmospheric drops.[4]

Nitrates are toxic to humans through the increased levels of methemoglobin. Due to the health importance of nitrate, several studies have been conducted in this regard across the world, as well as Iran.[5] Therefore, proper investigations are required to measure the levels of these ions. The present study aimed to determine the concentration of nitrate and nitrite in the drinking water of some universities in Iran.

Materials and Methods

This descriptive, cross-sectional study was conducted to determine the concentrations of

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nitrate and nitrite in drinking water in some universities in Iran. In total, 156 samples of drinking water were collected using the sampling method of the Institute of Standards and Industrial Research of Iran. Afterwards, the samples were sent to the laboratory to determine the concentrations of nitrate and nitrite using the HACH DR-5000 spectrophotometer (Germany).[6] Data analysis was performed in Excel software, and the mean values were compared based on the national standards.

Results

The findings of the experiments and analysis of the collected water samples from the studied areas confirmed that the concentration of nitrate was lower than the recommended national standards in all the samples. However, nitrite was not detected in any of the samples.

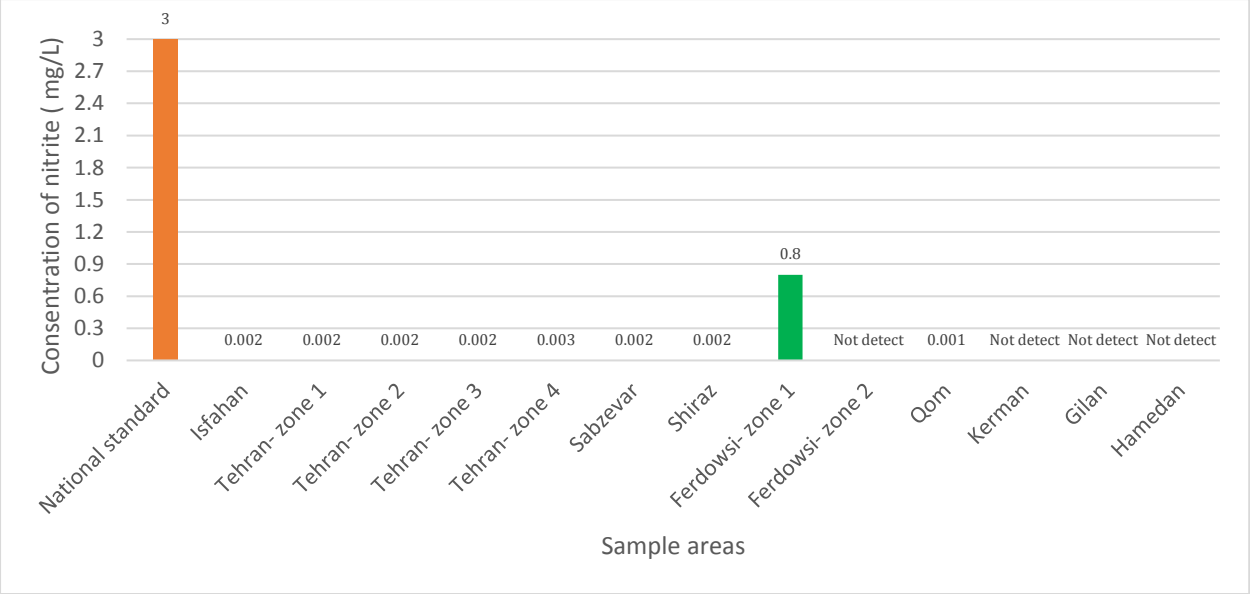

Figure 1. Nitrate Concentration in Selected Areas (mg/l)

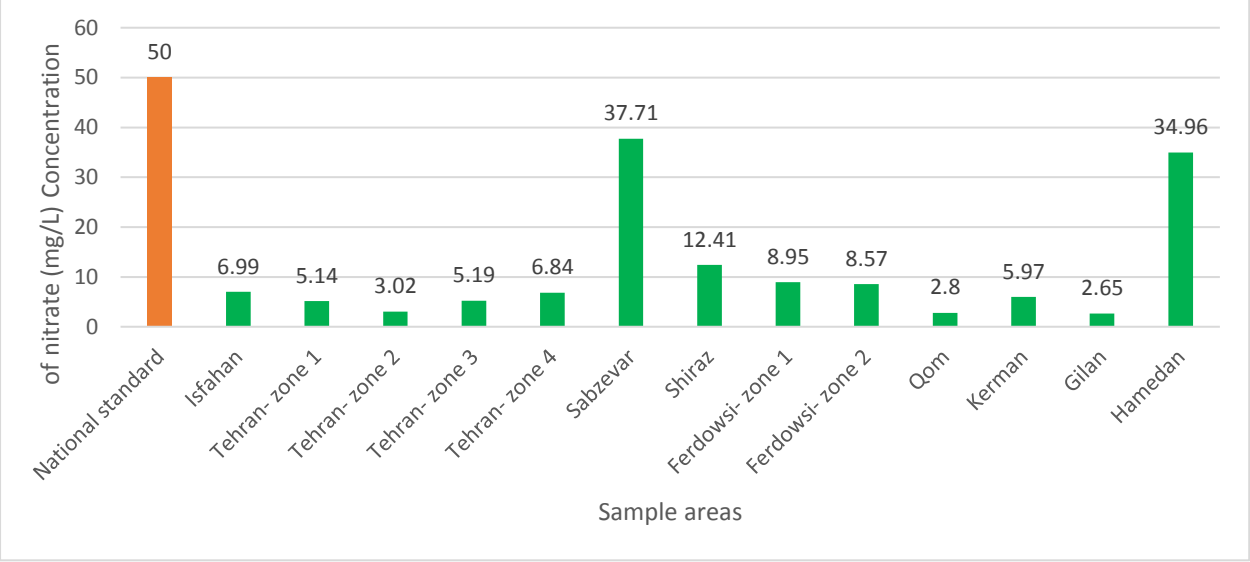

Figure 2. Nitrite Concentration in Selected Areas (mg/l)

Discussion

Several studies have been focused on the concentrations of nitrate and nitrite in some regions in Iran, as well as other countries across the world. According to the literature, nitrogen compounds enter the human body via two main routes of food and drinking water. Since it is virtually impossible to control these compounds

through food, controlling their concentration through drinking water is considered to be the optimal approach to the prevention of diseases and their complications.

Nitrate concentrations have been reported to be on the rise in global water resources due to population growth, increased use of nitrogen fertilizers, and increased agricultural activities. Considering the vitality of water for human health, the monitoring of water resources is of paramount importance.[7] Iran's National Water Health Standard recommends the levels of nitrate and nitrite in drinking water at 50 and 3 mg/l, respectively.[8] According to the results of the present study, nitrate and nitrite concentrations were lower than the standard levels in all the controlled areas. As is shown in Figure 1, the highest concentration of nitrate was observed in the samples collected from Sabzevar University and Hamadan University although these levels were below the standard limit.

The disposal of urban and rural raw sewage is considered to be the primary source of increased nitrate and nitrite ions in water resources.[4] In a study conducted by Latif et al. (2001) in Mashhad (Iran), nitrate concentration was measured in 40 water wells, and the results indicated that the mean concentration of nitrate was within the range of 3.5-74.4 mg/l.[17] The results of the present study demonstrated that in the drinking water samples of Ferdowsi University of Mashhad, the nitrate content was below the permissible limit (mean: 8.76 mg/l), which is within the range of the values obtained from the study. However, no nitrite was detected in these samples. In the research performed by Farshad et al. (1998), the mean nitrate concentration was reported to be 51.6 mg/l.[9]

According to the current research, the highest nitrate concentration was observed in the drinking water samples of Sabzevar University although the level was below the recommended values. In another study, Babaei et al. (2013) reported that with the exception of one case, nitrite and nitrate contents in all the samples were below the guidance value.[10] On the other hand, Badiynejad et al. (2012) claimed that the nitrate concentration in groundwater drinking water sources was within the range of 4-72 mg /l.

According to the results of the present study, the mean concentration of nitrate in the drinking water samples was 12.41 mg/l, which is within the range reported in similar studies.[11] In another study, Falah et al. (2008-2009) stated that the highest nitrite content was 11 mg/l in a region near an urban area with the cultivation of vegetables and corn.[12] On the same note, Asadi et al. investigated 45 samples of drinking water in Qom Hospital (Iran), reporting that the samples were free of nitrate and nitrite contamination.[13] The results of the mentioned study regarding the drinking water samples of the University of Qom also indicated that the nitrate content was 2.8 mg/l, and the nitrite content was 0.0001 mg/l.

Table 1: Amount of Nitrite and nitrate in drinking water samples (mg / l)

Universities	Nitrate	Nitrite	Number of sample	**Universities**	Nitrate	Nitrite	Number of samples
Isfahan	6.99 ± 0.035	0.002	12	Ferdowsi – zone 1	8.95 ± 0.006	0.8	12
Tehran – zone 1	5.14 ± 0.008	0.002	12	Ferdowsi – zone 2	8.57 ± 0.011	Not detect	12
Tehran – zone 2	3.02 ± 0.012	0.002	12	Qom	2.8 ± 0.010	0.001	12
Tehran – zone 3	5.19 ± 0.008	0.002	12	Kerman	5.97 ± 0.011	Not detect	12
Tehran – zone4	6.84 ± 0.008	0.003	12	Gilan	2.65 ± 0.02	Not detect	12
Sabzevar	37.71 ± 0.01	0.002	12	Hamedan	34.96 ±0.023	Not detect	12
Shiraz	12.41 ± 0.01	0.002	12				

*Maximum desirable and maximum allowable nitrate are 0 and 50 mg respectively.
** Maximum desirable and maximum allowable nitrite are 0 and 3 respectively.

In the study by Malakootian et al. (2009-2010), no contamination was reported.[14] According to the findings of the current research, the nitrate concentration in the drinking water samples of Guilan University was 2.65 mg/l. In this regard, Nasseri et al. (2004) reported that the drinking water in Yakon Abad was contaminated.[15] The results of the present study indicated that the concentration of nitrate in the drinking water samples of Hamadan University was 37.96 mg/l. Due to the close proximity of the nitrate ion to the standard value, more extensive investigations are required in order to achieve accurate results.

Conclusion

According to the extensive studies on the concentration of nitrate in drinking water, nitrate pollution in the water resources of Iran is at a moderate level. Therefore, qualitative water resource studies are essential to obtaining qualitative data on water resources. In order to prevent the pollution of groundwater and surface water, extensive and comprehensive studies are required to monitor their chemical quality and provide practical solutions in this regard, such as accelerating the implementation of sewage collection and treatment networks and determining the health protection level of water wells.

Authors' Contributions

Amir Salari, Saeid Khanzadi, and Zeinab Rezaei designed the study; Amir Salari and Zeinab Rezaei conducted the study, analyzed the data, and drafted the manuscript. All the authors read, revised, and approved the final manuscript.

Conflicts of Interest

None declared.

Acknowledgments

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