Survey of Nitrate and Nitrite in Ground Water Sources of Shahre-kord, Iran

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Abstract   The aim of this study is survey of nitrate and nitrite in ground water sources of Shahre-kord, Iran. 529 water samples from ground water of Shahre-kord small province were randomly collected from 15 areas over a period of five years during all of the seasons. Nitrate and nitrite ions were analyzed by Spectrophotometer 2100 UV-Vis, at 549 and 410 nm. The mean and standard deviation (5 years) of nitrite and nitrate content in groundwater samples were 0.016 ± 0.015 to 0.048 ± 0.030 mg/L and 9.78 ± 4.1 to 46.12 ± 13.63 mg/L, respectively. It was concluded that nitrate contents in ground water sources for drinking water supply in Shahre-kord small province can be higher than standard level in some areas. The monitoring of water quality is one of the important tools for water resources control management.

Keywords   Ground Water, Nitrate, Nitrite

1. Introduction

Nitrate and nitrite are the most common chemical contaminant in the world's groundwater aquifers. Nitrate is a colorless, odorless, and tasteless compound that is present in some groundwater in Iran. Nitrate is present widespread in the environment and the major sources of nitrate pollution in both developed and developing countries is crop fertilization (Gatseva *et al., 2008*).

Common sources of nitrate include: Fertilizers and manure, animal feedlots, wastewater-disposal, industrial waste, and food processing waste, septic systems, and N-fixation from atmosphere by legumes, bacteria and lightning (Smith *et al., 2005*). Nitrate and nitrite have some hazards for human. Most important environmental problems caused by nitrate are eutrophication in water supplies and infectious disease (Loganathan *et al., 2013*) Toxic nitrate has a negative effect on the human's health, which could result in many diseases, such as birth defects, spontaneous abortion, increased infant mortality, diarrhea, abdominal pain, vomiting, diabetes, hypertension, respiratory tract infections, changes in the immune system, and methemoglobinemia (Azizullah *et al., 2011*; Ward *et al ., 2011*).

The aim of the present study was thus to determine the concentrations of nitrate and nitrite in ground water sources of Shahre-kord small province, Iran and to compare the nitrate and nitrite contents with standards levels because

there is no whole information available on nitrate and nitrate in ground water sources.

2. Materials and Methods

2.1. Study Area

Charharmahal and Bakhtiari is one of the 30 provinces of Iran in the west south. The province of Charharmahal and Bakhtiari covers an area of 16,403 km² and it has a population of approximately 857,910 people. The Province Charharmahal and Bakhtiari has 6 small provinces. The major cities of Shahre-kord small province are Shahre-kord, Saman, Ben, Sureshjan, Hafshejan, Shahrekian, Shalamzar, Farrokhshahr, Gahru, Taqanak, Nafch, Sudejan, Chaleshtar, Mahdieh and Eshkaftak.

2.2. Sampling

A total of 529 water samples from ground water of Shahre-kord small province were randomly collected from 15 areas (Shahre-kord, Saman, Ben, Sureshjan, Hafshejan, Shahrekian, Shalamzar, Farrokhshahr, Gahru, Taqanak, Nafch, Sudejan, Chaleshtar, Mahdieh and Eshkaftak) over a period of five years during all of the seasons. In this study, several samples were taken from the water resources (wells) and the city's drinking water distribution network system (tap water) and in different months. All samples were collected in 500 ml polythene bottles and carried to the laboratory. Water samples were stored in 500 ml polythene bottles for up to 24 hours at 4ºC. Acidification with 1N HCl is designed to prevent interference from hydroxide or carbonate concentrations up to 1000mg $CaCO_3$/L.

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2.3. Analytical Measurements

Nitrate and nitrite were measured using a Spectrophotometer 2100 UV-Vis, at 549 and 410 nm according to the standard methods for the examination of water and wastewater (APHA, AWWA, WPCF 1992). The SPSS software was used for statistical analysis with a significance determined at p<0.05.

3. Results and Discussion

3.1. Nitrate Concentration in Water Sources

Nitrate and nitrite concentrations obtained from this study are summarized in table 1 and 2. Water samples from Hafshejan city had high content of nitrate and nitrite. The highest content of nitrate was showed 80.5 mg L^{-1} in two samples in 2009 year. Also, nitrate content was low in water samples of Gahru city. Among the most collected water samples, Hafshejan city contained more nitrite about 0.071 mg/L, whereas the Shalamzar city contained lower nitrite about 0.001 mg/L. The mean and standard deviation (5 years) of nitrate content in groundwater samples were 28.6±7.5, 16.3±8.5, 23.02±8.2, 20.4±10.6, 46.12±13.63, 21.18±8.91, 14.5±6.6, 24.4±10.6, 9.78±4.1, 24.32±11.05, 15.5±6.43, 13.72±5.43, 16.78±8.1, 17.54±7.1, 17.28±8.9 mg/L for Shahre-kord, Saman, Ben, Sureshjan, Hafshejan, Shahrekian, Shalamzar, Farrokhshahr, Gahru, Taqanak, Nafch, Sudejan, Chaleshtar, Mahdieh and Eshkaftak, respectively.

Table 1. Nitrate concentration in water sources of Shahre-kord small province (mg /L)

City	No. of Sample	Nitrate(Mean± SD)					Sum(5 years) (Mean± SD)
		2009	2010	2011	2012	2013	
Shahrekord	60	10.6±2.2	25.6±4.5	6.8±2.2	52±7.6	48±15.5	28.6±7.5
Saman	45	7.5±3.5	12.4±6.5	24.4±9.5	20.6±11	16.6±5.1	16.3±8.5
Ben	34	14.8±3.5	17.8±3.5	10±5.5	55±17.5	17.5±6.1	23.02±8.2
Sureshjan	35	19±11.5	22±9.5	18±4.5	20±9.5	23±13.5	20.4±10.6
Hafshejan	37	54±18.5	44±10.5	52±12.5	32.6±6.5	48±14.6	46.12±13.63
Shahre-kian	32	26.4±8.5	18±6.5	22±11.5	17.5±3.5	22±9.7	21.18±8.91
Shalamzar	32	24.2±4.5	18.8±9.5	4±2.5	9.5±3.5	16±8.5	14.5±6.6
Farrokhshahr	43	10.4±4.7	12.5±7.5	17.5±5.5	33.6±12.5	48±18.5	24.4±10.6
Gahru	31	2.6±1.2	13.8±3.6	5±2.5	10±3.5	17.5±7.5	9.78±4.1
Taqanak	30	10.2±6.5	24±11.5	25.8±8.5	36±11.5	25.6±8.5	24.32±11.05
Nafch	30	13±1.5	7±4.5	18±6.5	16.5±5.5	23±9.5	15.5±6.43
Sudejan	30	10.2±6.5	13.2±11.5	6.8±3.5	24.2±2.5	14.2±3.5	13.72±5.43
Chaleshtar	30	15.2±6.5	14±9.5	16±8.5	12.5±4.5	26.2±10.5	16.78±8.1
Mahdieh	30	8.5±3.5	7±4.5	30±11.5	19±10.5	23.2±8.5	17.54±7.1
Eshkaftak	30	23.4±16.5	11.6±5.5	24±6.5	6.4±3.5	21±10.5	17.28±8.9
Total	529	15.96±6.9	17.44±8.5	18.68±6.9	21.55±8.2	25.98±10	-

Table 2. Nitrite concentration in water sources of Shahre-kord small province (mg /L)

City	No. of Sample	Nitrite(Mean± SD)					Sum(5 years) (Mean± SD)
		2009	2010	2011	2012	2013	
Shahrekord	60	0.035±0.011	0.078±0.014	0.045±0.019	0.030±0.021	0.045±0.016	0.046±0.018
Saman	45	0.011±0.010	0.033±0.014	0.055±0.050	0.045±0.001	0.065±0.051	0.041±0.026
Ben	34	0.015±0.010	0.019±0.013	0.041±0.011	0.023±0.020	0.055±0.030	0.030±0.019
Sureshjan	35	0.021±0.013	0.025±0.010	0.024±0.015	0.030±0.020	0.041±0.023	0.028±0.023
Hafshejan	37	0.053±0.021	0.041±0.019	0.071±0.024	0.033±0.018	0.044±0.030	0.048±0.030
Shahre-kian	32	0.033±0.014	0.025±0.014	0.020±0.010	0.043±0.021	0.033±0.021	0.030±0.019
Shalamzar	32	0.014±0.010	0.021±0.011	0.011±0.001	0.019±0.011	0.017±0.040	0.016±0.015
Farrokhshahr	43	0.011±0.010	0.024±0.018	0.028±0.010	0.029±0.013	0.037±0.021	0.025±0.017
Gahru	31	0.011±0.010	0.021±0.020	0.032±0.031	0.028±0.030	0.039±0.024	0.026±0.025
Taqanak	30	0.023±0.021	0.041±0.014	0.034±0.021	0.035±0.031	0.023±0.013	0.031±0.020
Nafch	30	0.033±0.010	0.021±0.010	0.024±0.021	0.028±0.021	0.055±0.031	0.032±0.018
Sudejan	30	0.023±0.011	0.026±0.021	0.022±0.011	0.025±0.013	0.025±0.010	0.024±0.017
Chaleshtar	30	0.023±0.013	0.025±0.016	0.033±0.017	0.029±0.015	0.044±0.019	0.030±0.019
Mahdieh	30	0.023±0.011	0.021±0.012	0.021±0.014	0.055±0.015	0.044±0.019	0.032±0.016
Eshkaftak	30	0.029±0.012	0.011±0.010	0.036±0.018	0.026±0.011	0.021±0.011	0.028±0.019
Total	529	0.024±0.012	0.028±0.015	0.028±0.016	0.031±0.017	0.042±0.026	-

3.2. Nitrite Concentration in Water Sources

The mean and standard deviation (5 years) of nitrite content in groundwater samples were 0.046±0.018, 0.041±0.026, 0.030±0.019, 0.028±0.023, 0.048±0.030, 0.030±0.019, 0.016±0.015, 0.025±0.017, 0.026±0.025, 0.031±0.020, 0.032±0.018, 0.024±0.017, 0.030±0.019, 0.032±0.016, 0.028±0.019 mg/L for Shahre-kord, Saman, Ben, Sureshjan, Hafshejan, Shahrekian, Shalamzar, Farrokhshahr, Gahru, Taqanak, Nafch, Sudejan, Chaleshtar, Mahdieh and Eshkaftak, respectively. In general, the results obtained for the nitrate and nitrite indicate that the 15 areas are within the limits allowed by Iran and WHO Standard, It was concluded that nitrate contents in ground water sources for drinking water supply in Shahre-kord small province can be higher than standard level in some areas. The major sources of nitrate pollution in this research include: Application of nitrogen-rich fertilizers (ammonium- or nitrate-based) on farms is the main source of nitrate pollution and wells located in these areas are highly susceptible to nitrate contamination. Natural decomposition of organic compound an also result in the release of nitrate in soils, animal matter, domestic and industrial effluents. Irrigation activities can also increase leaching rates of nitrates (Agwu *et al., 2013*).

In a survey of groundwater supplies in British Columbia Of over 12,000 samples analysed for nitrate-nitrogen concentration, 186or 1.5% had nitrate-nitrogen levels above the WHO drinking water guideline of 50 mg/L, and 7% of samples had concentrations of nitrate-nitrogen greater than or equal to 3 mg/L (Tredoux et al., 2009). In another survey in China concentrations of nitrate (NO_3^-) in groundwater in the study area varied from 50 to 130 mg/L (Tang et al., 2004). Also, in a survey of groundwater supplies in Osona, NE Spain, mean nitrate concentration ranged from 8 to 391 mg/L (Boy-Roura et al., 2013). In a survey of groundwater supplies in Nigeria nitrate recorded a mean value of 0.307mg/l. Min 0.004mg/l and Max is 1mg/L. The standard deviation is 0.433 these values are within the acceptable limits for drinking water. Normally, nitrate pollution is associated with septic systems and agricultural activity (Gordon et al., 2012). In a survey of drinking water in Golestan province, Iran concentrations of mean nitrite from 0.013±0.003 to 0.021±0.01 mg/Land nitrate from10.4±2.41 to 21.8±9.8 mg/L (**Semnani et al., 2009**). Jalali (2011) reported that nitrate in 95 groundwater samples of Toyserkan city, Hamedan Province, Iran have minimum, maximum and average 1 mg/L and 162 mg/L and 30 mg/L, respectively (Jalali, 2011).

4. Conclusions

In present study, nitrite and nitrate levels in municipal water supplies of Shahre-kord small province are generally less than standard levels (3, 50 mg/L).It is suggested that agricultural best management practices such as water-saving irrigation and split application of N fertilizer should be adopted to protect the groundwater quality from N pollution. Avoid the spreading of waste on the surface of the ground; Make periodic analyzes of the level of nitrate and nitrite of the site. All drinking water sources should be tested at least every one or two years to assure that considerable growth in nitrate and nitrite are not occurring. Increasing public awareness about nitrite and nitrate contamination can help to improve public participation in water resources protection activity. Wastewater disposal is other source of groundwater pollution. Current septic system needs to be replaced with a sewer system to collect municipal and industrial wastewaters. Four methods such as ion exchange, reverse osmosis, chemical precipitation, and electrocoagulation are can be applied for removing nitrate from drinking water.

ACKNOWLEDGEMENTS

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