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RESEARCH ARTICLE

EVALUATION OF NITRATE AND NITRITE IN DRINKING WATER OF SOME RURAL AREAS OF SHAHREKORD, IRAN

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ABSTRACT

Pollution of ground and surface waters by nitrates is a widespread and serious global problem. The objective of this study was to evaluate of nitrate and nitrite in drinking water of some rural areas of Shahrekord, Iran. We collected 490 drinking water samples from 49 villages in the rural areas of Shahrekord, Iran and analyzed them for NO₃-N and NO₂-N. Nitrate and nitrite ions were analyzed by Spectrophotometer 2100 UV-Vis, at 220 and 543nm. The highest (29.94±4.2 mg/L) and lowest (9.82±2.6 mg/L) concentrations of nitrate in duration 5 years were belonged to Sartashnez and Qaraqush, respectively. The highest (0.069±0.004mg/L) and lowest (0.005±0.001mg/L) concentrations of nitrite in duration 5 years were belonged to Shurab-eShagir and Salm, respectively. The results obtained for the nitrate and nitrite indicated that the 49 areas are below the limits allowed by Iran and WHO Standards.

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INTRODUCTION

Nitrate is one of the main contaminations of drinking water worldwide. Nitrate (NO₃⁻) and nitrite (NO₂⁻) are the main forms of N in groundwater which are usually seen as agricultural pollutants that often arises from the use of large amounts of nitrogenous fertilizers or septic systems and leaking municipal sewers, are generally less significant regionally but may affect groundwater locally (Dubrovsky *et al.*, 2010, Majumder *et al.*, 2006), seepage from landfills, the spreading of sewage sludge to land, atmospheric deposition, industrial pollution, and animal waste and manure (Capella *et al.*, 2014). The exposure of humans to high doses of nitrate in drinking water causes severe health effects, e.g., methaemoglobinaemia or blue baby syndrome, stomach cancer (Pastén-Zapata *et al.*, 2014; Fadaei and Sadeghi 2014). Toxicological problems associated with nitrates and nitrites are related to the formation of endogenous N-nitroso compounds (nitrosamines and nitrosamides); the carcinogenic activity of these species is well known (da Silva *et al.*, 2013) and nitrate poisoning in animals e.g. gastrointestinal cancer, Alzheimer disease, vascular dementia, absorptive, secretive functional disorders of the intestinal mucosa, multiple sclerosis, Non-Hodgkin's lymphoma, hypertrophy of thyroid, etc. (Stadler, 2012, Suthar *et al.*, 2009). Nitrates are nutrients that normally promote excessive growth of algae. As the algae die and decay, high levels of organic matter and the decomposing organisms

deplete the water of available oxygen, causing the death of other organisms, such as fish (Ben Hamouda *et al.*, 2012). According to the World Health Organization (WHO), Iranian guideline and the European Community (EC), the maximum contaminant level (MCL) of nitrate is given to be 50 mg/L whereas European Community (EC) describe the guide level (GL) of nitrate as 25mg/L (WHO, 2011), while the US Environmental Protection Agency has stipulated 44 mg NO₃⁻/L (EPA, 2009).

MATERIALS AND METHODS

Study Area

Shahrekord is the biggest county in Charharmahal and Bakhtiari province of Iran located in the southwest area. The Shahrekord county covers an area of 3,004 km² and it has a population of approximately 380,312 people. The major rurals of are Heydari, Yan Cheshmeh, Azadegan, Pahna, Jamalvi-ye, Bardeh, SheykhShaban, Larak, Vardanjan, Tumanak, Shurab-eKabir, Shurab-eShagir, KahKesh, Cham-eZin, Cham-eNaz, Mohammadabad-eTabatabayi, Cham-eKhorram, Chelvan, Markadeh, Quchan, Garmdarreh, YasehChah, Sadegabad, Qaraqush, Hureh, Dashti, Cham-eAli, Cham-eJangel, ChamKhalifeh, SavadJan, ChamKaka, Cham Chang, Ilbegi, Jafarabad, Zavardajan, GhlahMamaka, Hajieabad, Dastania, Salm, Khraji, GhalahTak, Tashnez, Amirabad, Slamabad, Sartashnez, Museabad, Kharabad, Dehzak and Gashnizjan.

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Sampling

A total of 490 water samples from drinking water of Shahrekord county were randomly collected from 49 areas over a period of five years during 2 seasons. The most population rural's of the Shahrekord county was located in these 49 areas. In this study, several samples were taken from the water resources (wells) and the rural's drinking water distribution network system (tap water) in 2 seasons. All samples were collected in 500 ml polythene bottles and carried to the laboratory. Water samples were then stored in 500 ml polythene bottles for up to 24 hours at 4°C. Acidification with 1N HCl is designed to prevent interference from hydroxide or carbonate concentrations up to 1000mgCaCO₃/L.

Analytical Measurements

Nitrate and nitrite were measured using a Spectrophotometer 2100 UV-Vis, at 220 and 543 nm according to the standard methods for the examination of water and wastewater (APHA., 2005). Data was analyzed, using one-way ANOVA test and Friedman test.

RESULTS AND DISCUSSION

Nitrate concentration in water rurals

Nitrate concentration obtained from this study are summarized in Table 1 and 2. Water samples from Cham Jangel rural had the highest content of nitrate. The highest content of nitrate was 70.5 mg L⁻¹ in three samples in 2012 year. Also,

Table 1. Nitrate concentration in water drinking some rural areas of Shahrekord (mg /L)

Rural	No. of Sample	Nitrate(Mean± SD)					Sum(5 years) (Mean± SD)
		2009	2010	2011	2012	2013	
Heydari	10	5±2.4	6±3.1	18±5.5	19±4.5	32±3.5	16±5.5
Yan Cheshmeh	10	7±2.6	16±2.1	12±4.5	17±5.5	30±3.1	16.4±6.5
Azadegan	10	9±3.6	11±5.1	23±6.5	27±2.5	29±5.1	19.4±4.5
Pahna	10	10±4.6	11±5.1	13±4.5	17±3.5	20±3.1	14.2±6.5
Jamalvi-ye	10	11±2.6	13±4.1	14.7±4	17±3.5	19.7±6.1	15.08±4.5
Bardeh	10	6.2±2.5	8±4.9	13.7±3.5	17±3.2	18.7±2.1	12.72±3.5
Sheykh Shaban	10	14.2±3.5	16±2.9	19.7±4.5	25±3.9	26.7±5.1	20.32±4.5
Larak	10	12.5±5.5	17±2.8	20.5±4.2	23±2.8	28.7±5.9	20.34±3.5
VardanJan	10	22.5±2.5	15±2.8	22.5±2.2	23.7±3.8	26.7±3.9	22.08±5.5
Tumanak	10	17.5±2.5	16±1.8	27.5±3.2	20.7±2.8	28.1±4.9	21.96±3.5
Shurab-eKabir	10	10.5±1.5	16±1.7	20.5±3.5	22.7±3.8	30.1±4.4	19.96±2.5
Shurab-eShagir	10	8.5±1.9	16±1.9	17.5±2.5	22.5±3.2	31.1±2.4	19.12±5.1
Kah Kesh	10	12.2±2.9	14.5±2.9	19.5±3.5	21.5±2.2	28.1±3.4	19.16±3.1
Cham-eZin	10	3.2±2.3	8.5±1.9	15.5±3.2	16.7.5±2.2	20.2±3.4	12.82±4.5
Cham-eNaz	10	12.8±3.3	18.5±2.9	15.5±3.1	29.7.5±4.2	32.2±6.4	21.74±5.5
Mohammadabad-e-Tabatabayi	10	17.8±4.3	18.9±3.9	15.3±2.1	20.7 ±3.2	29.2±5.4	20.38±4.5
Cham-e Khorram	10	6.5±2.3	8.9±2.9	15.3±3.1	12.7 ±4.2	20.2±3.4	12.72±5.5
Chelvan	10	7.5±3.3	9.9±2.1	18.3±2.1	24.5 ±3.2	25.2±2.4	17.08±3.5
Markadeh	10	6.5±3.1	10±2.2	15.3±2.1	22.5 ±2.2	24.2±2.8	15.7±3.3
Quchan	10	4.5±3.5	11±1.2	18.3±2.9	21.5 ±2.2	29.2±1.8	16.9±3.2
Garmdarreh	10	14.5±3	11±1.2	14.3±2	24.5 ±2.4	28.2±1.9	18.5±2.2
Yaseh Chah	10	22.5±3.5	24.6±1.6	14.3±2.4	22.5 ±2.4	29.2±1.3	22.62±2.6
Sadeqabad	10	9.5±3	7.6±1.2	20.3±2	21.5 ±2.1	25.2±1.8	16.82±3.6
Qaraqush	10	3.5±1.1	6.6±1.1	11.3±1.1	15.5 ±2.7	12.2±1.3	9.82±2.6

Table 2. Nitrate concentration in water drinking some rural areas of Shahrekord (mg /L)

Rural	No. of Sample	Nitrate(Mean± SD)					Sum(5 years) (Mean± SD)
		2009	2010	2011	2012	2013	
Hureh	10	7.5±1.9	11.6±2.1	16.3±1.1	15.5 ±2.7	19.2±1.9	14.02±2.3
Dashii	10	5.5±2.9	9.6±2.2	12.3±1.6	21.5 ±2.7	20.2±1.8	13.82±4.3
Cham-eAli	10	10.5±2.5	15.6±2.2	20.3±1.8	21.5 ±3.7	27.2±1.7	19.02±3.3
Cham Jangel	10	9.5±2.5	12.6±2.1	18.3±1.7	23.5 ±2.2	31.2±1.8	19.02±2.3
Cham Khalifeh	10	7.5±2.9	10.6±2.6	19.3±3.7	25.5 ±2.6	31.2±2.2	18.82±4.3
Savad Jan	10	6.5±2.3	11.6±2.5	13.3±3.1	25.5 ±2.3	18.2±2.1	15.02±2.3
Cham Kaka	10	5.5±2.1	12.6±2.5	13.3±2.1	25.5 ±2.3	19.2±4.1	15.22±2.9
Cham Chang	10	12.5±2.7	17.6±2.9	13.9±2.8	21.5 ±2.3	22.2±4.8	17.54±2.8
Ilbegi	10	11.5±2.1	13.6±2.3	15.9±2.2	22.5 ±4.3	30.2±2.8	18.74±1.8
Jafarabad	10	10.5±1.1	12.6±3.3	17.9±2.1	20.5 ±2.3	28.6.2±1.8	18.02±2.8
ZavardaJan	10	7.5±2.1	10.6±3.8	12.9±3.1	17.5 ±3.3	19.6±1.9	13.62±3.8
Ghlah Mamaka	10	12.5±2.5	10.6±3.6	18.9±2.1	22.5 ±4.3	19.6±1.9	16.82±1.8
Hajieabad	10	15.5±2.2	18.6±2.6	19.9±2.4	21.5 ±2.3	26.6±1.6	20.42±2.8
Dastania	10	7.5±3.2	11.6±3.6	13.9±2.9	17.5 ±4.3	20.6±1.5	14.22±2.9
Salm	10	4.5±3.3	7.6±1.6	12.9±2.9	13.5 ±3.3	15.6±2.5	10.82±2.5
Khraji	10	14.5±3.9	18.6±1.9	12.9±2.7	23.5 ±5.3	25.6±2.3	19.02±4.5
Ghalahtak	10	16.5±2.9	13.6±1.9	14.9±3.9	31.5 ±3.3	25.6±2.1	20.42±2.5
Tashnez	10	14.5±3.9	15.6±2.9	17.4±2.4	18.5 ±1.3	25.6±2.9	18.32±2.5
Amirabad	10	19.5±6.9	21.6±1.9	27.4±3.2	28.5 ±2.3	25.6±3.9	25.62±3.5
Slamabad	10	17.5±2.9	22.6±1.4	27.4±2.9	28.5 ±3.3	29.6±1.9	25.12±3.2
Sartashnez	10	19.5±2.3	27.6±1.4	19.4±2.2	28.5 ±4.3	29.6±2.9	29.94±4.2
Museabad	10	15.5±3.3	17.6±1.8	20.4±2.9	33.5 ±2.3	29.6±2.9	23.32±3.2
Kharabad	10	14.5±2.3	20.6±1.9	15.4±2.2	22.5 ±3.9	30.6±3.9	20.72±4.2
Dehzak	10	15.5±2.3	12.6±1.9	15.4±2.6	17.5 ±1.9	23.6±2.9	16.92±3.2
Gashnizjan	10	15.5±2.3	16.6±2.9	20.4±2.6	17.5 ±3.9	23.6±2.7	18.72±2.2

Water samples from Qaraqush rural had the lowest content of nitrate. The lowest content of nitrate was 1 mg L⁻¹ in two samples in 2009 year. The mean and standard deviation(5years) of nitrate content in drinking water samples were:

16±5.5, 16.4±6.5, 19.4±4.5, 14.2±6.5, 15.08±4.5, 12.72±3.5, 20.32±4.5, 20.34±3.5, 22.08±5.5, 21.96±3.5, 19.96±2.5, 19.12±5.1, 19.16±3.1, 12.82±4.5, 21.74±5.5, 20.38±4.5, 12.72±5.5, 17.08±3.5, 15.7±3.3, 16.9±3.2, 18.5±2.2, 22.62±2.6, 16.82±3.6, 9.82±2.6, 14.02±2.3, 13.82±4.3, 19.02±3.3, 19.02±2.3, 18.82±4.3, 15.02±2.3, 15.22±2.9, 17.54±2.8, 18.74±1.8, 18.02±2.8, 13.62±3.8, 16.82±1.8, 20.42±2.8, 14.22±2.9, 10.82±2.5, 19.02±4.5, 20.42±2.5, 18.32±2.5, 24.52±3.5, 25.12±3.2, 29.94±4.2, 23.32±3.2, 20.72±4.2, 16.92±3.2, 18.72±2.2 mg/L for Heydari, Yan Cheshmeh, Azadegan, Pahna, Jamalvi-ye, Bardeh, SheykhShaban, Larak, Vardanjan, Tumanak, Shurab-eKabir, Shurab-eShagir, KahKesh, Cham-eZin, Cham-eNaz, Mohammadabad-eTabatabayi, Cham-eKhorram, Chelvan, Markadeh, Quchan, Garmdarreh,

YasehChah, Sadegabad, Qaraqush, Hureh, Dashti, Cham-eAli, Cham-eJangel, ChamKhalifeh, SavadJan, ChamKaka, Cham Chang, Ilbegi, Jafarabad, Zavardajan, GhlahMamaka, Hajieabad, Dastania, Salm, Khraji, GhalahTak, Tashnez, Amirabad, Slamabad, Sartashnez, Museabad, Kharabad, Dehzak and Gashnizjan, respectively. The highest (29.94±4.2 4mg/L) and lowest (9.82±2.6 mg/L) concentrations of nitrate in duration 5years were belonged to Sartashnez and Qaraqush, respectively. In all of the areas there was significant association between the value of nitrate and various years (p<0.05). In general, there was no significant association between the value of nitrate in areas and various years (p>0.05).

Nitrite concentration in water rurals

Nitrite concentration obtained from this study are summarized in Table 3 and 4. Water samples from Shurab-eShagir rural had the highest content of nitrite. The highest content of nitrite was

Table 3. Nitrite concentration in water drinking some rural areas of Shahrekord (mg /L)

Rural	No. of Sample	Nitrite(Mean± SD)					Sum(5 years) (Mean± SD)
		2009	2010	2011	2012	2013	
Heydari	10	0.01±0.001	0.02±0.002	0.03±0.001	0.03±0.002	0.05±0.033	0.028±0.001
Yan Cheshmeh	10	0.001±0.002	0.002±0.001	0.02±0.002	0.03±0.001	0.04±0.003	0.018±0.002
Azadegan	10	0.003±0.001	0.009±0.005	0.01±0.003	0.02±0.004	0.03±0.006	0.014±0.005
Pahna	10	0.001±0.001	0.005±0.001	0.01±0.002	0.013±0.005	0.026±0.004	0.011±0.002
Jamalvi-ye	10	0.005±0.003	0.015±0.002	0.018±0.001	0.019±0.003	0.02±0.002	0.015±0.003
Bardeh	10	0.009±0.002	0.010±0.001	0.07±0.002	0.05±0.002	0.02±0.001	0.031±0.003
Sheykh Shaban	10	0.006±0.001	0.018±0.002	0.05±0.003	0.09±0.005	0.03±0.003	0.038±0.003
Larak	10	0.007±0.002	0.008±0.003	0.07±0.002	0.06±0.004	0.04±0.005	0.037±0.006
VardanJan	10	0.008±0.002	0.01±0.003	0.03±0.002	0.08±0.004	0.09±0.005	0.043±0.004
Tumanak	10	0.002±0.003	0.06±0.001	0.07±0.001	0.09±0.005	0.09±0.003	0.062±0.006
Shurab-eKabir	10	0.005±0.003	0.07±0.001	0.08±0.001	0.05±0.005	0.09±0.003	0.059±0.002
Shurab-eShagir	10	0.002±0.003	0.08±0.001	0.09±0.001	0.08±0.005	0.095±0.003	0.069±0.004
Kah Kesh	10	0.001±0.002	0.03±0.003	0.04±0.002	0.06±0.002	0.01±0.003	0.028±0.002
Cham-eZin	10	0.005±0.001	0.05±0.003	0.07±0.002	0.08±0.002	0.09±0.003	0.059±0.003
Cham-eNaz	10	0.002±0.001	0.005±0.002	0.009±0.003	0.08±0.002	0.01±0.003	0.021±0.003
Mohammadabad-eTabatabayi	10	0.001±0.001	0.003±0.002	0.02±0.003	0.05±0.002	0.09±0.003	0.032±0.007
Cham-e Khorram	10	0.002±0.001	0.004±0.002	0.002±0.003	0.005±0.002	0.09±0.003	0.020±0.001
Chelvan	10	0.01±0.001	0.004±0.002	0.02±0.003	0.05±0.002	0.08±0.003	0.032±0.003
Markadeh	10	0.004±0.001	0.006±0.002	0.02±0.003	0.05±0.002	0.09±0.003	0.034±0.006
Quchan	10	0.003±0.001	0.006±0.002	0.02±0.001	0.03±0.001	0.07±0.004	0.025±0.003
Garmdarreh	10	0.001±0.001	0.004±0.003	0.07±0.002	0.03±0.002	0.07±0.001	0.035±0.005
Yaseh Chah	10	0.03±0.001	0.06±0.002	0.06±0.001	0.03±0.001	0.07±0.004	0.05±0.003
Sadeqabad	10	0.04±0.002	0.01±0.002	0.02±0.001	0.03±0.001	0.05±0.004	0.03±0.002
Qaraqush	10	0.004±0.002	0.01±0.001	0.002±0.004	0.03±0.003	0.01±0.001	0.011±0.003

Table 4. Nitrite concentration in water drinking some rural areas of Shahrekord (mg /L)

Rural	No. of Sample	Nitrite(Mean± SD)					Sum(5 years) (Mean± SD)
		2009	2010	2011	2012	2013	
Hureh	10	0.001±0.001	0.002±0.002	0.003±0.001	0.03±0.002	0.05±0.033	0.017±0.002
Dashti	10	0.002±0.001	0.003±0.003	0.005±0.002	0.02±0.001	0.04±0.033	0.014±0.003
Cham-eAli	10	0.005±0.001	0.004±0.004	0.005±0.001	0.01±0.002	0.09±0.003	0.022±0.004
Cham Jangel	10	0.001±0.002	0.007±0.002	0.008±0.007	0.04±0.001	0.08±0.002	0.027±0.005
Cham Khalifeh	10	0.003±0.003	0.006±0.001	0.009±0.002	0.03±0.003	0.07±0.001	0.023±0.002
Savad Jan	10	0.002±0.002	0.006±0.003	0.005±0.001	0.003±0.002	0.07±0.003	0.017±0.004
Cham Kaka	10	0.001±0.002	0.005±0.001	0.007±0.005	0.007±0.002	0.07±0.005	0.018±0.003
Cham Chang	10	0.006±0.001	0.007±0.003	0.005±0.001	0.008±0.003	0.04±0.002	0.013±0.002
Ilbegi	10	0.005±0.001	0.006±0.003	0.004±0.001	0.008±0.005	0.03±0.001	0.053±0.003
Jafarabad	10	0.003±0.001	0.006±0.003	0.007±0.003	0.008±0.002	0.05±0.001	0.014±0.005
ZavardaJan	10	0.002±0.001	0.007±0.003	0.009±0.003	0.009±0.002	0.07±0.001	0.019±0.002
Ghlah Mamaka	10	0.004±0.002	0.008±0.002	0.009±0.002	0.007±0.001	0.06±0.003	0.017±0.005
Hajieabad	10	0.006±0.001	0.008±0.002	0.02±0.002	0.07±0.001	0.06±0.003	0.032±0.004
Dastania	10	0.002±0.001	0.009±0.002	0.01±0.002	0.02±0.001	0.02±0.001	0.012±0.002
Salm	10	0.002±0.001	0.003±0.003	0.005±0.001	0.008±0.002	0.01±0.002	0.005±0.001
Khraji	10	0.002±0.001	0.009±0.003	0.01±0.004	0.02±0.002	0.01±0.002	0.010±0.005
GhalahTak	10	0.004±0.002	0.09±0.003	0.003±0.001	0.02±0.002	0.04±0.002	0.031±0.003
Tashnez	10	0.003±0.001	0.009±0.003	0.003±0.001	0.02±0.001	0.04±0.003	0.015±0.002
Amirabad	10	0.02±0.001	0.05±0.002	0.02±0.003	0.03±0.001	0.07±0.003	0.038±0.001
Slamabad	10	0.03±0.002	0.005±0.002	0.005±0.001	0.009±0.001	0.07±0.003	0.023±0.002
Sartashnez	10	0.003±0.001	0.005±0.002	0.03±0.003	0.04±0.002	0.04±0.001	0.023±0.005
Museabad	10	0.01±0.001	0.02±0.001	0.03±0.002	0.04±0.001	0.08±0.002	0.036±0.002
Kharabad	10	0.009±0.001	0.01±0.001	0.02±0.004	0.04±0.002	0.07±0.003	0.029±0.003
Dehzak	10	0.004±0.001	0.02±0.002	0.01±0.003	0.06±0.001	0.08±0.002	0.034±0.004
Gashnizjan	10	0.008±0.001	0.03±0.001	0.04±0.004	0.04±0.002	0.06±0.002	0.035±0.003

1 mg L⁻¹ in two samples in 2013 year. Also, water samples from Salm rural had the lowest content of nitrite. The lowest content of nitrite was 0.0001 mg L⁻¹ in two samples in 2009 year. The mean and standard deviation(5years) of nitrite content in drinking water samples

0.028±0.001,0.018±0.002,0.014±0.005,0.011±0.002,0.015±0.003,0.031±0.003,0.038±0.003,0.037±0.006,0.043±0.004,0.062±0.006,0.059±0.002,0.069±0.004,0.028±0.002,0.059±0.003,0.021±0.003,0.032±0.007,0.020±0.001,0.032±0.003,0.034±0.006,0.025±0.003,0.035±0.005,0.05±0.003,0.03±0.002,0.011±0.003,0.017±0.002,0.014±0.003,0.022±0.004,0.027±0.005,0.023±0.002,0.017±0.004,0.018±0.003,0.013±0.002,0.053±0.003,0.014±0.005,0.019±0.002,0.017±0.005,0.032±0.004,0.012±0.002,0.005±0.001,0.010±0.005,0.031±0.003,0.015±0.002,0.038±0.001,0.023±0.002,0.023±0.005,0.036±0.002,0.029±0.003,0.034±0.004,0.035±0.003, mg/L for Heydari, Yan Cheshmeh, Azadegan, Pahn, Jamalvi-ye, Bardeh, SheykhShaban, Larak, Vardanjan, Tumanak, Shurab-eKabir, Shurab-eShagir, KahKesh, Cham-eZin, Cham-eNaz, Mohammadabad-eTabatabayi, Cham-eKhorram, Chelvan, Markadeh, Quchan, Garmdarreh, YasehChah, Sadegabad, Qaraqush, Hureh, Dashti, Cham-eAli, Cham-eJangel, ChamKhalifeh, SavadJan, ChamKaka, Cham Chang, Ilbegi, Jafarabad, Zavaradjan, GhlahMamaka, Hajieabad, Dastania, Salm, Khraji, GhalahTak, Tashnez, Amirabad, Slamabad, Sartashnez, Museabad, Kharabad, Dehzak and Gashnizjan, respectively. The highest (0.069±0.004mg/L) and lowest (0.005±0.001mg/L) concentrations of nitrite in duration 5years were belonged to Shurab-eShagir and Salm, respectively.

In all of the areas there was significant association between the value of nitrite and various years (p<0.05). In general, there was no significant association between the value of nitrite in areas and various years (p>0.05).

The results obtained for the nitrate and nitrite indicated that the 49 areas are below the limits allowed by Iran and WHO Standards. In a survey of groundwater supplies in some rural areas of Rajasthan, India, the mean and standard deviation nitrate concentration 60.6±33.6 mg/L (Suthara *et al.*, 2009). Reddy and colleagues reported that about 65% samples of groundwater unfit for drinking purposes from Anantapur district of Andhra Pradesh are due to very high NO₃⁻ contents (Reddy *et al.*, 2009). 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/L and nitrate from 10.4±2.41 to 21.8±9.8 mg/L (Gordon and Enyinyay, 2012). In a survey nitrate concentration was measured in 78 wells and ranged from 15.39 to 246.90 mg/l as NO₃ (Sadeq *et al.*, 2008). Nitrate and nitrite enter the subsurface system through several pathways: directly through the nitrogen oxides in precipitation, leaching from nitrous fertilizers, agricultural activities, domestic wastewaters, recharge via river water contaminated with nitrate (Ghadermazia *et al.*, 2011; Fadaei and Najafi 2014).

Conclusion

The nitrate concentration in water rural areas was below 50 mg/l as NO₃⁻ and nitrite concentration was below 3 mg/l as NO₂⁻. Results indicate nitrate contamination in drinking water

was relatively low and stable. It is suggested that suitable agricultural management practices such as water-saving irrigation and cut application of N fertilizer should be adopted to protect the ground and surface waters quality from NO₃-N contamination.

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