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Short Communication

Nitrite and Nitrate in the Municipal Drinking Water Distribution System

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ABSTRACT

In this cross-sectional descriptive study, 188 samples were examined for nitrate and nitrite from Zanjan (Iran) drinking water municipal distribution system and other reservoirs like wells. Amongst 82% of samples, the concentration of nitrate was less than 45 mg L^{-1} as NO_3^-, which was less than the standard level (i.e. 50 mg L^{-1} as nitrate) as recommended by national standard and WHO guideline values. This study showed that none of samples had extra concentrations of nitrite based on national standards and WHO guidelines. Majority of the polluted samples were found in the regions, which received water from polluted wells in Zanjan area. Therefore, it was recommended that water extracted from wells should be first transmitted to reservoirs and after mixing in reservoirs to be distributed in the system.

Key words: Nitrate; Nitrite; Drinking water; Iran; Zanjan

INTRODUCTION

Ground-water contamination by nitrate is a worldwide problem mainly related to excessive use of fertilizers in intensive agriculture, however, non-agricultural sources of nitrogen such as septic systems, cesspools and leaking municipal sewers also affect ground-water. Therefore, high concentrations of these ions can indicate contamination of water by agricultural run-off, refuse dump leachate, and human or animal wastes (Anonymous, 1993 & 2001; Hudak, 1999; Lake *et al.,* 2003; Fytianos & Christophridis, 2004). Regarding the health effect, nitrite and nitrate ions cause acute but reversible illness called methaemoglubinemia for infants. Besides, a relationship between these ions and stomach cancer, because of nitrosamine compounds formation, has also been reported (Bitton, 1999).

This paper describes nitrate and nitrite pollution in drinking water of Zanjan (Iran).

MATERIALS AND METHODS

This study was was done in Zanjan City of Iran in 2003. In this cross-sectional study, 188 samples were collected from Zanjan drinking water distribution system, all operating wells and reservoirs. Samples are collected in glass containers and rapidly moved to laboratory and immediately analyzed. Sampling methods and analytical procedures were according to standard methods for the examination of water and wastewater (4500 - NO_2 B & 4500 - NO_3 B) (Anonymous, 2001). Data were analyzed by statistical methods (SPSS) and concentrations compared to national standards, WHO guidelines and US EPA primary standards for nitrite and nitrate (WHO, 2003). The maximum permissible levels of these ions in drinking water as given by above agencies are as follows:

	National	WHO	US-EPA
NO_2	3 mg.L^{-1} as NO_2	3 mg.L^{-1} as NO_2	1 mg.L^{-1} as N
NO_3	50 mg.L^{-1} as NO_3	50 mg.L^{-1} as NO_3	10 mg.L^{-1} as N

RESULTS AND DISCUSSION

Average nitrite concentrations for different city regions are given in Table I. All samples had nitrite concentrations less than 3 mg L^{-1}. Results showed nitrate concentrations are less than 45 mg L^{-1} as NO_3 for 82% of samples, between 45 to 50 mg L^{-1} for 3% of samples and more than 50 mg L^{-1} for 15% of samples (Table I). Average nitrate concentration for wells that are located in internal city regions was 39.2±17.3 mg L^{-1}, for external city regions, it was 20.5±3.7 mg L^{-1} and for reservoirs it was 24.2±3.47 mg L^{-1} (Table II & III). Maximum nitrate concentration for internal city wells was found as 69.1 mg L^{-1} and minimum as 17.4 mg L^{-1}. For external city wells, maximum concentration was found as 28.2 mg L^{-1} and minimum as 17.4 mg L^{-1}. According to cross-calvarias assumption, different between nitrate concentrations in internal city region wells and external city region wells were significantly accepted ($p < 0.01$). Maximum and minimum nitrate concentrations for reservoirs were determined as 29.8 and 20.6 mg L^{-1}.

This study showed that none of samples had extra

concentrations of nitrite based on national standards and WHO guidelines. However, 15% (n=29/188) samples had nitrate concentrations higher than levels recommended by national standards and WHO guideline values (Anonymous, 1997; WHO, 2003). If these data are compared to EPA standards, 18% samples were to be defined as polluted. Furthermore, study indicated four polluted water resources (wells) based on nitrate concentrations. Comparison of these results with the earlier study (Mohammadian & Sadeghi, 2001), revealed that water contamination has increased especially in some wells that are located in city area.

In the west region of Tehran, average nitrate concentrations were determined as 51.6±20.16 mg L^{-1} that showed pollution of ground water resources in this area (Farshad & Imandel, 2002). Other study in Hamadan established average nitrate concentration equal to 17.72 mg L^{-1} and seasonal fluctuations in concentrations. This study showed maximum level occurred in summer and minimum level in winter (Sadri & Karimpour, 1999).

A study, in Tenerife Island (Spain), was indicated the highest concentrations found in the public water supply coincided with the areas of the island that have traditionally been the site of more intense farming activities. In general, the public water supply for the island of Tenerife is of sanitarily optimum quality for consumption as far as nitrates are concerned, although concentrations should be closely monitored in certain municipal areas. Study on 96.8% of municipalities in Tenerife present NO_3^- concentration means below the guideline level of 25 mg L^{-1} established by legislation (Mesa *et al.,* 2003). To sum up, this study showed that some people consumed water with high concentration of nitrate in some regions. It is occurred by feeding water distribution system with polluted wells (Wells Nos. 8, 12, 13 & 46). Maximum concentrations were determined in the regions that have direct feeding in the water distribution system with well No. 8.

It was concluded that the drinking water sources should be regularly monitored for the pollutants in order. For this purpose, the responsible agencies should play a proactive role for ensuring healthy water supply to the communities.

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Table I. Average of nitrite and nitrate levels in the regions of Zanjan (mg L^{-1})

No.	Region	Nitrite	Nitrate
1	Eslam abad	0.006±0.006	51.8±8.8
2	Kou-e-farhang	0.007±0.006	27.6±14.7
3	Rajaai shahr	0.007±0.017	40.0±16.98
4	Amir kabir	0.001±0.001	21.5±0.5
5	Baharestan	0.001±0.001	23.6±0.1
6	Ziba shahr	0.004±0.001	21.9±0.1
7	Paeen kokh	0.002±0.002	21.5±0.9
8	Kou-e-ghaem	0.001±0.002	21.4±0.3
9	Karmandan	0.000	19.1±0.3
10	Azadegan	0.000	19.6±1.1
11	Ansarieh	0.009±0.015	32.4±11.2
12	Khoramshahr	0.003±0.003	22.9±8.3
13	Bisim	0.000	25.6±3.6
14	Saadi-e-shomali	0.008±0.013	38.3±19.7
15	Sabzeh meydan	0.003±0.007	21.2±2.04

Table II. Nitrate levels in wells inside and outside of Zanjan (mg L^{-1})

	Well No.	Nitrate	Well No.	Nitrate
	3	21.7	22	44.3
	4	19.1	25	31.5
	6	28.4	26	49.8
Inside	8	59.9	44	17.4
	12	69.1	45	37.1
	13	65.7	46	62.1
	14	35.4	47	49.7
	15	30.6	48	26.5
	21	29.8	49	24.2
	Mean = 39.2	Max. = 69.1	Min. = 17.4	SD = 17.3
	Well No.	**Nitrate**	**Well No.**	**Nitrate**
	29	17.4	36	18.3
outside	30	18.7	38	23.1
	32	20.3	41	24.8
	34	19.3	42	17.5
	35	17.2	43	28.2
	Mean = 20.5	Max. = 28.2	Min. = 17.2	SD = 3.7

Table III. Nitrate levels in the reservoirs

No.	Reservoir	Nitrate
1	Ghaem	29.8
2	Ziba shahr	23.2
3	Kouy-e-ghaem	20.6
4	Amir-kabir	23.6

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