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A Survey of Nitrate and Fluoride in Water Distribution Networks of Tabas, Iran

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Abstract: Fluoride and nitrate are important in term of public health. Long-term uptake of excess amounts of fluoride can contribute to chronic adverse effects. Nitrate, especially in babies and high risk groups, can cause dangerous Met Hb. Recent study reviews the concentration of nitrate and fluoride in distribution networks of Tabas country and comparing with national and international standards. Sampling from different drinking and sanitary water distribution systems was done in two stages in June trough march and July trough September of 2009. Measuring of fluoride was performed using spectrophotometer DR/5000 (HACH Company, USA) by standard SPADNS method. Nitrate measured in the same way using the DR 2000, after carrying samples that take on from different parts of the distribution networks. The study show that average fluoride concentration in June trough march and July trough September 2009 in drinking water networks was 0.51 and 0.71 respectively. The average concentration of nitrate in drinking water networks, According to this study was 3.25 mg /l in July trough September and 2.9 mg/l in June trough march. Average concentration of fluoride in potable and sanitary distribution networks of Tabas city was 0.53 and 0.81 mg/l in July trough September and 0.62 and 0.64 in June trough march. This study showed that concentration of fluoride and nitrate of all distribution networks and cisterns was in national and international standard limit. Review also showed that average concentration of fluoride and nitrate is higher in July through September.

Key words: Fluoride · Nitrate · Water distribution network · Drinking water

INTRODUCTION

Nitrate and fluoride are important in terms of public health. Human activities beside different natural resources of dissolution of minerals containing these salts are contributed in increasing of these anions in water resource.

Nitrate and Nitrite are formed part of the nitrogen cycle in nature. Nitrate is established form of nitrogen that has highly soluble salts which used widely in mineral fertilizers production plants. Nitrate is also the final product of organic nitrogen stabilization in Sewage.

Nitrate concentration in surface waters is low (0-18 mg/l) and can increase to several mg/l in agricultural and contaminated soil runoffs and studies was done by investigator proof its influence [1]. In groundwater, depending on geological and climate conditions concentration of nitrate rarely exceed a few mg/l, but human activities can increase the concentrations up to several hundred mg/l [2]. For example, concentrations higher than 1500 mg/l reported in groundwater of some agricultural areas in India [3]. Nitrate and phosphorus are contributed to eutrification of lakes and rivers. This phenomenon caused severe loss of water quality.

Part of Nitrate in digestive system revive to nitrite by normal flora and absorbed into bloodstream which oxidize quickly to nitrate in combination with Hb while oxide it to Met Hb. This reaction leads to disability of hemoglobin carrying the oxygen to tissues and in severe cases can lead to cyanosis of body and tissue bruising. Presence of high concentration of nitrate, particularly for at risk groups include, children under 3 years and those with the enzyme MetHb deficiency can be very dangerous [4]. Considering of epidemiological

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evidence related to Met Hb, World Health Organization Guideline of 50 mg/l nitrate in drinking water for the prevention of this complication, particularly contemptible to infants is considered.

Fluoride is the other natural anion in waters, especially in groundwater contacted with minerals such as fluorapatite, fluorspar and cryolite. Fluoride in particular concentration can have beneficial effects [5,6]. The ossify of body tissues required some amounts of this anion, but long-term uptake of high quantities of this anion from different source, especially of water, can lead to chronic complications such as teeth and bone fluorosis, infertility, neurological problems, Alzheimer and thyroid problems [8,9].

Industrial and agricultural activities are effectively contributed in the entrance of these anions to water resources. Glass and ceramic industries, semiconductor materials industries, electroplating, coal power plants, Beryllium extraction plants and iron and aluminum extraction factories can release waste water with hundreds mg/l fluoride to water resource [10,11]. Many studies also investigated the fluoride contents of groundwater, bottled water and black tea and air [12-14]. Regarding dental fluorosis World Health Organization considered 1.5 mg/l as a guideline for fluoride. In regions with high concentrations fluoride , treatment of water and removal of fluoride with appropriate technology is recommended [15].

Present study reviews the concentration of nitrate and fluoride in Tabas County water distribution networks and cisterns comparing with national and international standards.

MATERIALS AND METHODS

Tabas is located in central Iran, 950 kilometers southeast of Tehran, in the province of Yazd, in 56,57 Longitude and 33,36 Latitude with 735 meters Altitude. located the city in the south east and north west of LUT Desert, low sea level and low latitude, contributed to warm and dry climate with 82 mm mean annual precipitation and minimum, average and maximum annual daily temperature of respectively 12.5, 20.7 and 29°C and the minimum and maximum relative humidity of 27 and 58 percent, respectively.

On 2007, Tabas had 66245 Population with Total 219 villages and 33910 rural populations. climatic condition, country development and population growth, high per capita water consumption, reduction of groundwater supply, inappropriability of many surface waters for potable use, no major and permanent surface flow and high costs of water transfer, in order to optimizing existing resources usage and providing high water quality, experts design two network distribution system. According to this plan, a distribution network provide sanitary water supply and another one provide drinking water. Higher quality Water allocated to drinking water and lower ones injected to sanitary distribution network. Appropriate option in terms of economic, technical and executive was design of potable water stations and allocation of existing water distribution network to sanitary water. Water stations constructed after primary studying according to population density and ease of accessibility to this Case.

Measuring of fluoride was performed using spectrophotometer DR5000 (HACH Company, USA) by SPADNS standard method in 580 nm. Nitrate ion measured in the same way using the DR 2000 in 530 nm according to "Standard Methods for the Examination of Water and Wastewater" [16]. Finally, data was analyzed using SPSS, version 11.5.

RESULTS

Present study show that average concentration of fluoride in drinking water network, in summer and winter was 0.71 and 0.58 mg/l respectively. Tables 1 and 2 show means, minimum and maximum fluoride concentration of each water supply. study also show average fluoride concentration in June trough march and July trough September 2009 in drinking water networks was 0.51 and 0.71 respectively.

Figure 1 and 2 show rural drinking water distribution systems, cisterns, drinking and sanitary water distribution networks based on fluoride concentrations in winter and summer.

The average concentration of nitrate in drinking water networks of TABAS According to present study was 3.25 mg /l in July trough September and 2.9 mg/l in June trough march. Table 3 and 4 shows concentration of nitrate in urban and rural distribution networks and cistern in two period of study.

Figure 1 and 2 Show rural drinking water distribution systems, cisterns, drinking and sanitary water distribution networks based on fluoride concentrations in winter and summer.

Table 1: Fluoride concentration of distribution network in urban, rural and cisterns in June trough march of 2009

Water supply	Average concentration	Maximum concentration	Minimum concentration	Standard deviation
Rural distribution Network	0.57	1.1	0.3	0.3231
Drinking distribution network	0.62	.77	0.42	0.1292
Sanitary distribution network	0.64	1	0.4	0.2578
Cisterns	0.51	0.7	0.26	0.1884

Table 2: Fluoride concentration of distribution network in urban, rural and cisterns in July trough September of 2009

Water supply	Average concentration	Maximum concentration	Minimum concentration	Standard deviation
Rural distribution network	0.75	1.39	0.12	0.4277
Drinking distribution network	0.53	0.61	0.46	0.07
Sanitary distribution network	0.81	0.97	0.59	0.1986
Cisterns	0.78	1.04	0.37	0.2060

Table 3: Nitrate concentrations in distribution networks of urban, rural and cisterns in July trough September of 2009

Water supply	Average concentration	Maximum concentration	Minimum concentration	Standard deviation
Rural distribution network	2.29	9.1	0	2.48
Drinking distribution network	2.92	6.5	0	3.21
Sanitary distribution network	3.7	7	1	2.33
Cisterns	2.7	8.7	0	2.83

Table 4: Nitrate concentrations in distribution networks of urban, rural and cisterns in July trough September of 2009

Water supply	Average concentration	Maximum concentration	Minimum concentration	Standard deviation
Rural distribution network	3.48	11	0	3.52
Drinking distribution network	3.22	6.4	0.6	2.45
Sanitary distribution network	4.1	6.4	2.3	2.02
Cisterns	2.2	6	0	2.3

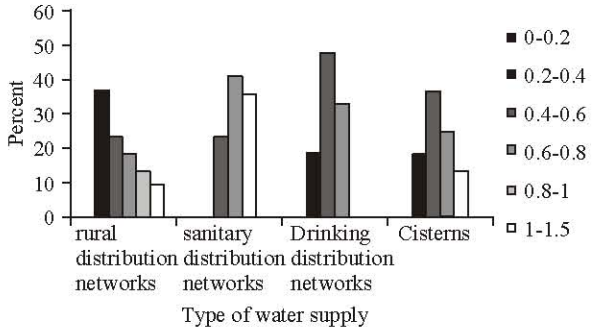

Fig. 1: Percent of water supply distribution network of TABAS County based on fluoride concentration in June trough march of 2009

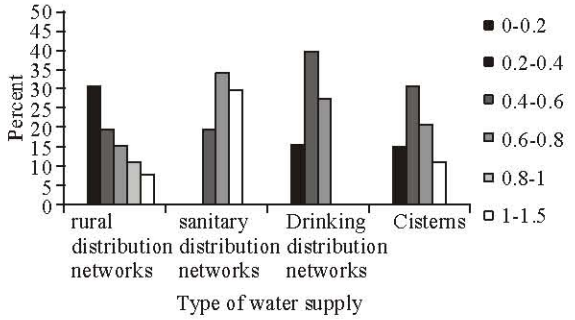

Fig. 2: Percent of water supply distribution network of TABAS County based on fluoride concentration in July trough September of 2009

DISCUSSIONS

Evaluation of the concentration in different water resources and searching ways to reduce the concentration in polluted water was investigated by several scientists [17]. Nuralh Mir Ghafari et al carry a survey on fluoride concentrations in Mohammadian Fazli *et al.* showed that 11 percent of water resources in Zanjan have nitrate concentration beyond the standards during April 2000-2001 [18] A study in evaluation of nitrate in wells and water distribution network of Kashan in 2004-2005 was conducted by Mohammad Bagher Zadeh and colleagues, in this study average nitrate concentration in distribution networks in summer

and winter, was 4.14 and 2.13 mg/l respectively [19]. In another study on Bahar's groundwater, Hamedan province, the mean concentration of nitrate in these water supplies was 40 mg /l [20]. The average concentration of nitrate and nitrite in potable water wells of Uromie was determine to be 17 mg/l [21]. Dr Ali Akbar Azimi and colleagues conducted a study on the concentration of fluoride in Karaj and Jajrud rivers which are the major surface drinking water supply in Tehran, the average concentration of fluoride in this research was, in the range of 0.15-0.35 and 0.28-0.52 respectively groundwater, agricultural soil and some vegetables in Isfahan, in this study the average concentrations of fluoride in spring and summer was 0.3 and 0.05 mg/l, respectively [22]. In a study carried by Jahed Khaniki Gh.R et al the mean and standard deviation of nitrate and nitrite contents in water samples were 16.39±14.05 mgL^{-1} and 0.038±0.056 mgL^{-1}, respectively [23].

In present study the difference of fluoride and nitrate concentrations in water distribution networks viewed in two seasons can be explained by water injection of lower water quality well source to the networks which being in-active and entering networks during summer month due to lack of water resources. In 1971, international standards set maximum fluoride concentration based on the annual average of daily maximum temperature. According to this standard, concentration of fluoride in drinking water of areas with annual average maximum daily temperature of 10-12 and 26.3-32.6°C, allowed to be in the range of 0.9-1.7 and 0.6-0.8 mg/l respectively. In first edition of guidelines of drinking water quality by the World Health Organization published in 1984, the value of 1.5 mg/l was considered for this ion, however, weather conditions, volume of water intake and daily intake of fluoride received from other resources was considerably emphasized.

As said, TABAS is located in warm and dry region with 29°C annual average maximum daily temperature. Per capita water consumption is 330 liters. Although present study show that the fluoride concentration in all water distribution systems of county was less than 1.5 mg/l, considering the weather conditions and per capita drinking water consumption, concentrations of fluoride in the existing cases can create Fluorosis, as is evident in city. Chart 1 and 2 shows percentile of rural drinking water distribution systems, cistern and sampling of various part of drinking and sanitary networks based on fluoride concentration in study periods. Chart shows 17.7 percent of distribution systems in winter and 30.75 percent in summer have fluoride concentration beyond international standard of 0.8 mg/l in 1974 for areas with noted temperature.

Average concentration of fluoride in drinking and sanitary network was 0.53 and 0.81 mg/l in summer and 0.62 and 0.64 mg/l in winter respectively. It must consider that although the sanitary distribution system allocated to non potable applications, but because of un accessibility to potable stations, many consumer used it for their drinking water consumption. So water quality of sanitary network is very important.

Cisterns in urban and rural areas which have own local consumers, has average fluoride concentration of 0.78 and 0.51 mg/l in summer and winter, respectively. Lower fluoride concentration in these resources is due to surface waters feed it.

Review water distribution systems in County showed that nitrate concentrations in all water distribution networks is lower than limitations.

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