Nitrate Content in Drinking Water in Gilan and Mazandaran Provinces, Iran

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Abstract

Water pollution issue has become one of the most important public awareness issues. The excessive use of the fertilizers and pesticides in agriculture with the threat of the chemicals in water and crops especially in the two north provinces of Iran is a major concern of Iranian environmental scientists. This project is a trial to find out the status of nitrate content in drinking water of two great provinces in the north of Iran. The objectives of the present research: Determination the level of nitrate (mg/L) in drinking water of some agricultural and industrial cities and comparing of the probable effects of different industrial factories on the level of nitrate in drinking water of them. The tap water samples of 60 different sites from Rasht, Bandar Anzali and Talesh in Gilan province and Sari, Behshar and Amol in Mazandaran province in three consequent months in summer season (July, August and September) in 2013, were collected and by spectroscopy method were determined. There are no wastewater collection, treatment and disposal system in these cities. Sampling was replicated twice within each month at intervals of two weeks and the mean value considered as a result of one sample. To evaluate variability of nitrate content within sub-samples, five sub-samples (900 sub-samples) on the whole were analyzed separately. The mean concentrations of NO3- (mg/L) in most examined water samples were lower than acceptable ranges (NO3- ≤ 50 mg/L) and only 11% of all samples were higher than it. A highly significant, positive correlation was found between nitrate contents of the August and September drinking water samples, compared to July ones. Results shows a significant difference between locations (p<0.03) and in the different sites as nitrate content in drinking water in industrial locations were obviously higher than other locations in the cities.

Keywords: Nitrate content; Drinking water; Gilan; Mazandaran

Introduction

Fresh water shortage is becoming an increasingly acute problem facing many nations in the world. In the Near East Region, some 16 countries out of 29 member states are classified as water-deficient, with less than 500 m³ per capita of the annual renewable fresh water resources [1,2]. Although the Near East Region occupies about 14 percent of the world area and embraces almost 10 percent of the world population, it only receives 3.5 percent of total precipitation and only 2.2 percent of the annual internal renewable water resources (IRWR). Ground water provides drinking water for most of the Nation’s population and it is sole source of drinking water for many rural communities and some large cities in Iran. Nitrate and nitrite and other chemicals can pass through the soil and contaminate ground water [3,4]. Knowing where, what type of contaminants and risks to ground water exist can alert water- resource managers and users of the need to protect water supplies. The risk of ground-water contamination by nitrate depends both on the nitrogen input to land surface and the degree to which an aquifer is vulnerable to nitrate leaching and accumulation. Beneath agriculture lands, nitrate is primary form of nitrogen. It is soluble in water and can easily pass through soil to the ground water table. Nitrate can persist in ground water for decades and accumulate to high levels as more nitrogen is applied to the land surface every year. Most drinking water in Iran generally is supplied through modern infrastructure such as dams, reservoirs, long-distance transmission pipelines, and deep wells [5]. Alireza Marandi, the former Health Minister of the Islamic Republic, also confirms that the water increasingly contains unsafe levels of nitrates and heavy metals due to population overgrowth [5,6]. Dangerous contents of Cadmium and Lead could be found in recent years in Mazandaran and Gilan agricultural products due to contaminated source targeted to address population and over fertilization with chemical fertilizers and high rain falling [3,7-9]. The consumption of risk nitrate diet increased the risk of formation of carcinogenic nitroamine [4,10-12]. High levels of nitrate intake were linked with the Non-Hodgkin’s lymphoma [13], bladder cancer [13], pancreatic cancer [14] and stomach cancer [3,15-18]. The US National Research Council found an association between high nitrate intake and gastric and esophageal cancer [13,19].

Even water from a tap or a well may contain toxins from human activity or those that are simply present in the ground. Although low levels of nitrate may occur naturally in water, higher levels are potentially dangerous to infants. It is often difficult to pinpoint sources of nitrates because there are so many possible sources of nitrogen and nitrates may include runoff or seepage from fertilized agricultural land, municipal and industrial waste water, refuse dumps, animal feedlots, septic tanks and private sewage disposal system, urban drainage and decaying plant debris [2]. Geologic formations and direction of ground water flow also may influence nitrate concentration. Shallow wells, poorly sealed or poorly constructed wells and wells that draw from shallow aquifers are at greatest risk of nitrate contamination. Increased nitrate concentrations can occur from: Rainfall, Erosion, Human pollution, Upwelling, Decomposition, Animal excretions, Natural breakdown of minerals [20-23]. There are many factors that

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affect the nitrate level in drinking water; among these factors are the rainfall amounts in different months (The average rainfall of the study area for example in Talesh has been reported as 1250 mm in summer, water- resources, the high sunlight intensity and direction of ground water flow also may influence nitrate concentration.

Aside from the difficulties with nitrates in drinking water, there are a very few published studies evaluating the nitrate levels in the various provinces and cities. A 2007 investigation was undertaken in Hamedan Province to determine the concentration of nitrate and nitrite in ground water sources in the province and to compare the nitrate and nitrite contents with the standard levels. Results indicate that few of samples had nitrate greater than 45 mg/L [24,25]. A documentary review of Iran’s experiences with Wastewater Management in Urban and Rural Areas reveals that the nitrate content in groundwater resources in the cities of Mashhad and Arak is many times over the allowable limits [26,27].

This project is a trial to find out the status of nitrate content in drinking water of two great provinces in the north of Iran as there are no wastewater collection, treatment and disposal system in these cities and in Mazandaran and Gilan agricultural products due to contaminated source tapped to address population and over fertilization with chemical fertilizers and high rain falling, risk of high nitrate content in the tap water is likely possible. The objectives of the present research:

1-Determination the level of nitrate (mg/L) in drinking water of some main agricultural and industrial cities in the north of Iran

2-Comparing of the probable effects of different industrial factories on the level of nitrate in drinking water in these two important provinces

3-Comparison of nitrate content in different parts and location of studied cities

Materials and Methods

Study area

Northern Iran includes the Southern Caspian regions representing provinces of Gilan, Mazandaran, and Golestan. Gilan and Mazandaran Provinces are two of the 31 provinces of Iran. They lie along the Caspian Sea, Gilan in the west of the province of Mazandaran, east of the province of Ardabil, north of the provinces of Zanjan and Qazvin and Mazandaran. The northern part of the province is part of territory of South (Iranian) Talesh. At the center of the province is the main city of Rasht. Other towns in the province include Talesh, and Bandar Anzali. Mazandaran is one of the most densely populated provinces in Iran and has diverse natural resources, especially large reservoirs of oil and natural gas. The province’s four largest counties are Sari, Babol, Amol and Qaemshahr. The name and description of all the sites in two studied provinces in this research are provided in Figure 1. The Caspian Sea constitutes the southern limit of the study area. The regional climate is humid and very humid with cool winter according to Emberger climate classification. Gilan has a humid subtropical climate with by a large margin the heaviest rainfall in Iran reaching as high as 1,900 millimeters in the southwestern coast and generally around 1,400 millimeters. Rainfall is heaviest between September and December because the onshore winds from the Siberian High are strongest, but it occurs throughout the year though least abundantly from April to July [28].

There are no wastewater collection, treatment and disposal system in these cities such as Sari. The common practice for wastewater disposal is through percolation pits. These wells have 1 to 1.2 mm diameter and 8 to 10 m depth and normally require one time cleaning in about 1 to 2 year period. The wastewater is almost entirely of domestic origin. Some industries that produce an effluent are located in the project area such as dairy factories and soft drink factories. These factories have activated sludge wastewater pre-treatment plants, which produce effluent compliant with Iranian standards for industrial effluent discharge to the sewer network [29].

Sampling method

The tap water samples of 60 different sites from Rasht, Bandar Anzali and Talesh in Gilan province and Sari, Behshar and Amol in Mazandaran province in three consequent months in summer season (July, August and September) in 2013, were collected according to standard methods: 2347 and 1053 [30] and nitrate concentration, were studied by spectroscopy method [31-41]. The results were compared to Iranian standards and World Health Organization [19,23,24,30].

Nitrate determination

Nitrate levels can be expressed differently, but provide for the same standard. The World Health Organization [23, 24] standard is expressed on the basis of nitrates itself as 50 mg/liter, while the nitrate- nitrogen value of 10 mg/liter. This standard is essentially the same. The 1993 Guidelines concluded that extensive epidemiological data support the current guideline value should be expressed not on the basis of nitrate-nitrogen but on the basis of nitrate itself, which is chemical entity of concern to health. The guideline value for nitrate is therefore 50 mg/liter” [23,24]. The EU directive standard is set at 50 mg/L expressed on the basis of nitrate itself, or 10 mg/L expressed as the nitrate/nitrogen value [23-25].
In this study 900 sub-samples on the whole were analyzed separately. The results were compared to Iranian standards and World Health Organization [13,23,24,29,30]. The World Health Organization (WHO) and the European Community (EC), maximum contaminant level (MCL) of nitrate is given to be 50 mg/L.

Samples were collected and stored in clean acid-washed polyethylene bottles, following the sampling routines set for water quality studies [21]. After collection and delivery to the Pharmaceutical Research laboratory in Azad University, the water samples were acidified to a pH <2. Prior to the chemical analysis, water samples were filtered through a Whatman glass microfiber filter (GF/C). 400 mL of distilled water was added to a 500-mL Kjeldahl flask with previously treated boiling chips to avoid bumping. Steam distilled until it showed no positive reaction with Nessler reagent (100 g mercuric iodide and 70 g of potassium iodide in small amount of water). Dechlorinating agent (sodium thiosulfate (1/35 mol/L) was added in order to equivalent to the chlorine residue in the sample. In this step, pH of each sample to 9.5 with 1 mol/L sodium hydroxide solution was adjusted. 50 mL of samples (drinking water) in Kjeldahl flask was taken and 2.5 mL of borate buffer was added. Distilled 15.0 mL of the sample into 2.5 mL boric acid solution in 250 mL Erlenmeyer flask. The distilled solution to 100 mL with deionized water was diluted; 1 mL Nessler reagent was added and mixed thoroughly to allow the solutions to sit for 20 minutes for color development. Background correction with blank solution was performed and followed by sample analyses [30-42]. The absorbance was performed at 425.0 nm against a reagent blank using perkin Elmer UV/Vis spectrophotometer with single beam sample compartment.

Statistical method

Seasonal differences on the basis of the sites of drinking water were determined by student t-test. Seasonal changes were calculated by one way ANOVA and for analysis of the role of multiple factors univariate analysis was used by SPSS 17. Probability values of <0.05 were considered significant.

Results

The results were determined as mean ± SD of three replications in each test. Results indicate that only in 20 samples (100 subsamples) had nitrate above standard levels. Few of samples which were taken from the cities from Bandar Anzali, Talesh, Sari, Behshahr had nitrate above standard levels. Few of samples which were taken from the cities from Bandar Anzali, Talesh, Sari, Behshahr had nitrate above standard levels. Few of samples which were taken from the cities from Bandar Anzali, Talesh, Sari, Behshahr had nitrate above standard levels. Few of samples which were taken from the cities from Bandar Anzali, Talesh, Sari, Behshahr had nitrate above standard levels. Few of samples which were taken from the cities from Bandar Anzali, Talesh, Sari, Behshahr had nitrate above standard levels. Few of samples which were taken from the cities from Bandar Anzali, Talesh, Sari, Behshahr had nitrate above standard levels. 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In Figure 3 the mean level of nitrate concentration in different sites are compared. Results shows a significant difference between locations (<p>0.03) and in the east sites nitrate content in drinking water were obviously higher than other locations in the city, which could be related to industrial wastewater of some factories and most of them have not wastewater treatment facilities and control equipment [45].

It is reported that every year large volumes of wastewater and industrial waste flow into eastern parts of Anzali wetland from the cities of Rasht and Khomam [45]. During recent years, the expansion of the industrial areas and the accompanying increase in population density has impacted the heavy metal content in the river pollution [46]. Results show Shows a significant difference between locations (<p>0.03) and in the east sites nitrate content in drinking water were obviously higher than other locations in the city, which could be related to industrial wastewater of some factories and most of them have not wastewater treatment facilities and control equipment again.

In Figure 5, in order to find the procedure of nitrate fluctuation, the mean level of nitrate contents were compared during different months.
The best way to reduce nitrate in the drinking water is to identify any potential sources of nitrate because there are so many possibilities. It is often difficult to pinpoint sources of nitrates because there are so many possibilities.

We suggest that some projects should be done to improve the operational efficiency and financial sustainability of two provincial water and wastewater companies, due to improve water distribution systems, including metering, sanitary sewers and a wastewater treatment plant in Gilan and Mazandaran provinces.

**Acknowledgment**

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**References**


**Table:**

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean Nitrate Content (mg/L)</th>
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<tr>
<td>Bandar Anzali</td>
<td>15.74</td>
</tr>
<tr>
<td>Rasht</td>
<td>20.58</td>
</tr>
<tr>
<td>Talesh</td>
<td>17.04</td>
</tr>
<tr>
<td>Behshahr</td>
<td>16.96</td>
</tr>
<tr>
<td>Sari</td>
<td>13.22</td>
</tr>
<tr>
<td>Amol</td>
<td>14.47</td>
</tr>
</tbody>
</table>

**Figure 4:** The mean level of nitrate concentration (mg/Liter) in different locations of Rasht drinking water in summer 2013.

**Figure 5:** Monthly fluctuations of mean level nitrate contents in drinking water samples in summer 2013.

The Figure shows the same trend for all cities, as the NO3- contents in september were the lowest while in July were highest. The most of samples in Amol had highest level especially in July collected samples while sari had the lowest level of nitrate in drinking water samples. The results in our study is the same as other environmental studies by Sheikhry Narany and her co-authors in 2014 [47]. They represented that the slope of the land surface was created using digital elevation model (DEM) maps of the Amol-Babol Plain. In low slope areas there is increased infiltration from runoff, which shows greater potential for groundwater contamination, while high slope areas, cannot retain runoff for a long time reducing infiltration to the groundwater. Their results showed that Amol City was having a high probability of nitrate contamination and high probability risk.

Results indicated that samples examined in July contained significantly higher nitrate levels than other months (p<0.01) and months of study had the meaningfully proportion in nitrate concentration.

**Conclusion**

It is clear that the result of our study shows a variation in the nitrate levels in the different drinking water of cities. It is often difficult to pinpoint sources of nitrates because there are so many possibilities. The best way to reduce nitrate in the drinking water is to identify any potential sources of nitrate on the water sources and find ways to manage those sources. A high nitrate level may signal the presence of other contaminants including pesticides, and disease causing bacteria, therefore examine the tap water from all cities and the surrounding area for sources of other contaminants are recommended.
34. 40-CFR Appendix B to Part 136 - Definition and Procedure for the Determination of the Method Detection Limit-Revision 1.11
38. Environmental Protection Agency (EPA’s) or the American Society for Testing and Materials (ASTM’s) approved and published methods are used to determine nitrate concentrations in water.