
Research Article

Investigation of Nitrate Concentration in Drinking Water of Different Regions of Mashhad

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ABSTRACT

Water is the most vital component of nature on which the life of all creatures, including humans, depends. But in recent decades, with the growing trend of the human population as well as industrialization, the entry of pollutants into running and groundwater has made it difficult to achieve optimal drinking water. One of the most important pollutants is nitrate and nitrite ions, which can have side effects when they enter the body. In this study, nitrate ion concentrations in different areas of Mashhad metropolis are compared and compared with the standard amount of the World Health Organization (WHO), and at the end, solutions to prevent it from entering the water are presented.

Keywords: Water; Drinking water; Water pollution; Nitrate; Mashhad.

1. Introduction

In recent decades, many human activities have had irreversible consequences for the environment, threatening and destroying it. A consequence that not only threatens other creatures of the planet Earth but also man himself has not escaped from it. If in the past, the effects of these environmental threats affected most of the human habitation, but today it

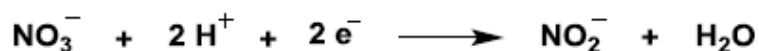
encompasses the entire ecosystem. The most important threat is soil pollution, climate. However, due to the fluidity of the climate, unfortunately, the transfer of pollutants in these two systems is easier. The Constitution of the Islamic Republic of Iran explicitly states the duty of every citizen to protect the ecosystem: "In the Islamic Republic, environmental protection, in which today's and future generations should have a growing social life, is considered a public duty. Therefore, economic activities other than those associated with environmental pollution or irreparable damage are prohibited" [1].

According to the definition, any natural or artificial activity that causes materials to enter the water and cause changes in its appearance, physical or chemical, will cause water pollution. The increase in population led to the need for more food, and as a result, the expansion of agricultural lands and the increasing use of pesticides such as insecticides and herbicides. Of course, the increase in population has caused an increase in human wastewater and also the creation of more leachate from landfills. Industrialization also led to an increase in factories, resulting in more pollutants. These are the factors that caused more pollutants to enter surface water as well as groundwater year by year; contaminants such as nitrates, nitrites, phosphates, potash, heavy metals as well as organic compounds in plant effluents or pesticides [2].

One of the most important pollutants in surface and groundwater is nitrate ion (NO_3^-). An important part of nitrate enters the water from agricultural lands. It has long been thought that the main cause of nitrate entering water is unabsorbed ammonium nitrate from oxidized animal waste (natural fertilizers) and other nitrogen-containing chemical fertilizers. But today it is known that due to the expansion of agricultural lands, the reduction of reduced nitrogen in organic matter decomposed in the soil to nitrate ions also plays an important role in the entry of this ion into the water. Other cases of nitrate contamination of water include human wastewater and effluents of some industries.

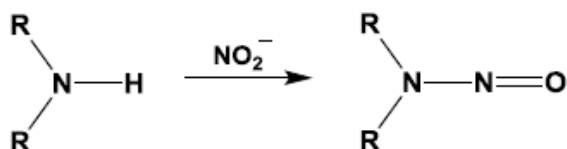
Nitrate in surface water can be absorbed by plants and algae, reducing its concentration. For this reason, high concentrations of nitrate are generally observed in groundwater more than in surface water. This point should be more important when we know that the drinking water of the inhabitants of many cities of the world, including Iran, is supplied more than underground aquifers [3].

One of the most important side effects of nitrogen in drinking water is the possibility of converting blood hemoglobin to methemoglobin. Some nitrate is reduced to nitrite ions (NO_2^-) in the stomach.



Nitrite causes the oxidation of Fe^{2+} hemoglobin in the blood to Fe^{3+} and converts it to methemoglobin. The oxygen uptake and transport capacity of methemoglobin are much lower than that of hemoglobin. As a result, the transport of oxygen in the blood is greatly reduced. This complication, known as Methemoglobinemia, causes irreversible complications, especially in infants, of which Blue Bay Syndrome is the most well-known.

Also, studies have shown that the presence of nitrate in water can cause stomach cancer. As mentioned, part of the nitrate in the stomach is converted to nitrite. Nitrite ions can convert amines in food to N-nitrosamines. These compounds are carcinogenic [4].



Although there is no strong evidence that nitrate ions can be carcinogenic in the absence of amine-containing substances, many studies have confirmed a link between the amount of nitrate in drinking water and the incidence of various cancers in humans. Medical studies have also shown an increased risk of miscarriage due to high concentrations of nitrate in water [3].

Generally, in environmental chemistry, the concentration of NO_3^- is measured and expressed in milligrams per liter. According to the recommendation of the World Health Organization (WHO), the permissible limits of nitrate ion and nitrate ion in drinking water are 50 and 0.1 mg/l, respectively [5]. These concentrations have also been referenced by the National Standards Organization of Iran as the source of drinking water health [6].

Studies have shown that in urban and suburban areas, the most common cause of water pollution with nitrate is the high level of groundwater aquifers in these areas, and as a result, the leakage of domestic sewage into groundwater [7]. In recent years, there has also been concern about rising levels of nitrate ions in drinking water from wells, which are generally the result of drainage water entering agricultural aquifers from agricultural land [8,9].

According to what has been said, pollution of groundwater and surface water with nitrate in many countries of the world as well as in some parts of Iran has been considered as a problem. The purpose of this study is to determine the concentration of nitrate in drinking water in some areas of Mashhad and compare it with the standard amount of the World Health Organization. The importance of Mashhad as the second-largest city in Iran becomes clearer when we know that the population of this city in the last census of 1395 was more than three million people, and more than thirty million passengers enter the city annually [10].

2. Experimental

In this study, the concentration of nitrate in samples of drinking water from eleven different areas of Mashhad was studied and measured (the names and specifications of the areas are reserved and can be provided by the authors, but due to the possibility of sensitivity, its publication is avoided).

All samplings were performed in the fall of 1400 and to ensure and reduce the error coefficient, sampling was done 3 times from each region and reported on average. One-liter polyethylene bottles with polypropylene caps were used to collect the samples, and the containers were washed with the same sample of water before filling. After recording the specifications (sampling location and time), the samples were sent to the laboratory to determine the nitrate concentration in the minimum time (between 4 to 6 hours). Nitrate concentrations in the samples were measured by HATCH spectrophotometer model DR 5000 using a standard nitrate solution reagent (1000 mg/l) from Sigma-Aldrich. All experiments were performed according to the methods described in the book "Standard Method for Water and Wastewater Testing" [11].

Table 1: Concentrated nitrate ion concentrations in eleven urban areas of Mashhad

sample number ¹	average nitrate concentration (mg/l)
1	18.0
2	30.8
3	9.2
4	27.0
5	13.0
6	23.0
7	55.6
8	97.2
9	56.1
10	71.7
11	69.7

3. Results and discussion

In this study, nitrate concentration in drinking water samples prepared from different areas of Mashhad metropolis ranged from 9.2 mg/l (in sample 3) to 97.2 mg/l (in sample 8). The permissible amount of nitrate according to the standards of the World Health Organization and also the national number of Iran, standard number 2441, is 50 mg per liter.

According to the results, the amount of nitrate in the samples from six urban areas was lower than the standard; it was only slightly higher than the standard in two areas and higher in three areas. Also, the average total nitrate concentration in all eleven urban areas was 42.8, which is an acceptable value considering the standard concentration.

Higher than nitrate ion concentrations in some areas (especially suburban areas) can be related to reasons such as exposure of water source to industrial effluents and exposure of water source to agricultural land effluents that are excessive, have used nitrate fertilizers.

Although according to this research, the overall average concentration of nitrate ion in Mashhad drinking water (42.8 mg/l) is less than the allowable limit and is not currently an acute problem, by observing the following, we can go to safe water. More for drinking for the citizens of Mashhad:

- Livestock wastewater is one of the important sources of nitrate entering groundwater and groundwater. If the distance of livestock farms from the city is reasonably increased, and if it is possible to treat the wastewater of industrial livestock farms, the amount of this ion in urban drinking water can be reduced.
- The use of the urban ego-system is a good solution to prevent the leakage of sewage and domestic effluents into groundwater and thus reduce pollution of urban drinking water.

- Proper management of industrial and workshop effluents is a very appropriate and important method to prevent the penetration of pollutants such as nitrate ions into surface and groundwater. The concentration of workshops and industrial units in industrial towns and the treatment of effluent of all industries in the town in the treatment plant of that industrial town is a principled solution for this purpose.
- As a precaution, using home water purifiers that work with the reverse osmosis process can be a good way to access nitrate-free water.

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