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Research Article

Nitrate and Nitrite Levels of Potable Water in Mardin, Turkey

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Abstract

In this study, it was aimed to investigate the presence and levels of nitrate and nitrite in potable water in Mardin. A total of 118 water samples, collected from 64 taps, 41 wells and 13 water tanks within the city center and districts of Mardin, were used in this study. The nitrate and nitrite analyses were performed by spectrophotometric method. The mean value of nitrate levels was found as 2.55±3.58 ppm in 31 (26.27%) and nitrite as 0.032±0.091 ppm in 91 of 118 water samples. The mean values of nitrate and nitrite were 2.49±3.65 ppm and 0.033±0.072 ppm in taps; 2.00±3.09 ppm and 0.035±0.125 ppm in wells; 3.93±4.71 ppm and 0.018±0.017 ppm in tank water respectively. One (0.85%) of analyzed water samples had nitrite level (0.72 ppm) higher than maximum legal limit. There was no statistically significant difference between the samples taken from taps, wells and water tanks for presence of nitrate and nitrite.According to the results of the study, although a general risk was not determined in terms of nitrate and nitrite levels in the water in Mardin, it is thought that monitoring is important for the detection of individual contaminations.

Key words: Mardin, Nitrate, Nitrite, Water, Water Quality

Mardin'deki İçme Sularında Nitrat ve Nitrit Düzeyleri, Türkiye

Öz

Bu çalışmada Mardin'deki içme sularındaki nitrat ve nitrit varlığı ve düzeylerinin araştırılması amaçlanmıştır. Çalışmada Mardin merkez ve ilçelerinden toplanan 64 şebeke, 41 kuyu, ve 13 depo suyu olmak üzere 118 su örneği kullanılmıştır. Örneklerdeki nitrat ve nitrit varlığı ve düzeyini belirlemeye yönelik analizler spektrofotometrik yöntemle gerçekleştirilmiştir. İncelenen 118 su örneğinin 31 (%26.27)'inde ortalama 2.55±3.58 ppm nitrat, 91(%77.11)'inde ortalama 0.032±0.091 ppm nitrit tespit edilmiştir. Nitrat ve nitrit tespit edilen su örneklerinin ortalama değerleri sırası ile şebeke sularında 2.49±3.65 ppm ve 0.033±0.072 ppm; kuyu sularında 2.00±3.09 ppm ve 0.035±0.125 ppm; depo sularında 3.93±4.71 ppm ve 0.018±0.017 ppm olarak bulunmuştur. İncelenen su örneklerinin 1 (%0.85)'inde yasal olarak belirlenen maksimum limitin üzerinde (0.72 ppm) nitrit tespit edilmiştir. Şebeke, kuyu ve depo suyu örneklerinde nitrat ve nitrit varlığı açısından istatistiki olarak anlamlı bir fark bulunmamıştır. Araştırma sonuçlarına göre Mardin'deki sulardaki nitrat ve nitrit seviyesi açısından genel bir risk tespit edilmemekle birlikte münferit kontaminasyon durumlarının tespiti açısından izlemelerin sıklıkla yapılmasının önemli olduğu düşünülmektedir.

Anahtar kelimeler: Mardin, Nitrat, Nitrit, Su, Su Kalitesi

Introduction

Water is an indispensable need for the continuity of human life. Contamination of water with nitrate and nitrite may pose a health risk (Harrison et al., 2000; WHO, 2011a). Both underground and surface waters can be contaminated with nitrate due to fertilizers that are used widely in agricultural activities, human and animal wastes, and industrial wastes (Mourabit et al., 2002; Sönmez et al., 2008; IARC, 2010; WHO, 2011b). Nitrate is reduced to nitrite by microorganisms available in the soil and water. In

addition, in water distribution channels, nitrite is formed by the reduction of nitrate by bacteria in drinking waters containing nitrate and low oxygen level during stagnation of water in galvanized steel pipes (WHO, 2011b). Although the nitrate level in surface waters is generally low, an increase in nitrate level can be seen depending on the intensity of agricultural activities and wastes. However, nitrate contamination is usually higher in underground waters (Mourabit et al., 2002; Koukal et al., 2004; WHO, 2011a; WHO, 2011b). The toxic effect of nitrate in humans is associated with the formation of methemoglobin. Nitrate taken into the body with water and food is reduced to nitrite by bacteria. The resulting nitrite is involved in the oxidation of hemoglobin in the blood to methemoglobin. The decrease in the oxygen carrying capacity of the blood, which occurs as a result of the methemoglobin concentration reaching 10% and above the normal hemoglobin concentration, is called methemoglobinemia. This condition causes cyanosis and high concentrations of asphyxia. Since the stomach of babies is less acidic, compared to adults, this creates a more suitable environment for the growth of some bacteria that reduce nitrate to nitrite and therefore, infants are more sensitive to the formation of methemoglobin. The formation of methemoglobin in infants is called “blue baby syndrome” (Harrison et al., 2000; Santamaria, 2006; WHO, 2011b). It is also reported that there are doubts about the existence of a relationship between high concentration of methemoglobin and miscarriage during the pregnancy, intrauterine growth restrictions, birth defects and diabetes during the childhood, thyroid hypertrophy, high blood pressure and recurrent diseases (IARC, 2010). Nitrate is reduced to nitrite in foods or after it is taken into the body and nitrite reacts with secondary amines and other nitrogenous substances to form N-nitroso compounds. Some of these N-nitroso compounds are considered to be at risk for health because of their potential for cancer (Shephard and Lutz, 1989; Harrison at al., 2000; IARC, 2010). In a report prepared by International Agency for Research on Cancer (IARC); it is stated that the ingested nitrate and nitrite are classified as Group 2A since they may be carcinogenic to humans under the conditions that cause formation of N-nitroso coumponds (IARC, 2010). In this study, it was aimed to investigate the presence and levels of nitrate and nitrite in potable waters in Mardin and to determine the risk status in terms of public health

Material and Method

In this study, a total of 118 water samples (64 from taps, 41 from wells and 13 from water tanks), which were taken from the districts of Mardin province (Artuklu=49, Dar Geçit=4, Derik=4, Kızıltepe=25, Mazıdağı=5, Midyat=5, Nusaybin=19, Savur=3, Yeşilli=4), located in Southeastern Anatolia Region of Turkey, were used as the study materials. These samples were collected between January 2017 and August 2018. The analyses to determine the presence and level of nitrate and nitrite in the samples have been performed through spectrophotometric method (DR3900). The nitrite levels in water samples, which were taken with 500 ml capped glass bottles, were analyzed by using LCK 341 (Hach Lange GMBH, Germany) kits and nitrate was analyzed by LCK 339 (Hach Lange GMBH, Germany) kits.

The statistical analyses of the data were performed with SPSS ver. 21 software for Windows. One-way ANOVA was used to determine the statistical difference in terms of nitrate and nitrite presence between water samples collected from taps, wells and tanks as well as water samples collected from districts. In the analyses, $p < 0.05$ was considered statistically significant.

Results and Discussion

Findings of this study on the presence and level of nitrate and nitrite detected in the analyzed water from taps, wells and tanks are given in Table 1 and Table 2 respectively. There was no statistically significant difference between the water samples collected from taps, wells and tanks as well as between the disctricts where the water samples were collected ($p>0.05$) (Table 1, 2).

The level of nitrate and nitrite in water is an important indicator of the quality of water since the nitrate consumed through water may cause health problems due to its reduction to nitrite. Potable water can be contaminated with nitrate and nitrite due to various reasons, such as environmental effects, changes in the utilization of land and climatic changes (Harrison et al., 2000). Maximum level of nitrate that can be allowable in potable water was determined as 50 ppm by the Turkish Regulation on Water Intended for Human Consumption, European Union (EU) legislation and World Health Organization (WHO) whereas maximum level of nitrite was determined as 0.50 ppm by aforementioned regulation and EU legislation and 3 ppm by WHO (Council Directive, 1998; Anonim, 2005; WHO, 2011a).

The mean value of nitrate was determined as 2.55±3.58 ppm between the range of 0.01-12.20 ppm in 31 of 118 water samples analyzed in this

study. The mean of nitrate level in 19 of 64 taps was 2.49±3.65 ppm, in 8 of 41well water was 2.00±3.09 ppm and in 4 of 13 water tanks was 3.93±4.71 ppm.

Table 1. Levels of nitrate detected in water samples (ppm)

Type of water sample	Number of samples	Mean±std.	Number of samples with detectable nitrate (%)	Mean±std (Min-Max)	P value
Tap	64	0.74±0.26	19 (29.69)	2.49±3.65 (0.02-12.20)	0.848
Well	41	0.39±1.52	8 (19.51)	2.00±3.09 (0.01-9.36)	
Tank	13	1.21 ±3.02	4 (30.77)	3.93±4.71 (0.1-3.93)	
Total	118	0.67±2.13	31 (26.27)	2.55±3.58 (0.01-12.20)	

*Legal Limit: 50 ppm

The highest levels of nitrate found in the samples analyzed in this study were 12.20 ppm, 9.36 ppm, 3.93 ppm in water taken respectively from taps, wells and water tanks. These values were similar to the nitrate values of 2.08-12.52 ppm, which were found in 98 well waters in Kayseri by Ertaş et al. (2013). However, they are lower than 0.63-46.61 ppm, found in the water samples taken from 83 wells in Şanlıurfa and the surrounding area by Durmaz et al. (2007); 10.37-874.08 ppm, found in the water samples taken from 142 wells in Afyon by Özdemir et al. (2004), and 1.1-492.5 ppm, found in the water samples taken from 631 wells in pig farms of United State of America by Bruning -Fann et al. (1994).

None of the water samples analyzed in this study was found to exceed the maximum legal limit specified by the Turkish Regulation on Water Intended for Human Consumption. However it was reported that the level of nitrate found in 65% of samples, taken from private drinking water sources in United Kingdom for a study conducted by Harrison et al. (2000), and 4.3% of samples taken in a study of Bruning –Fann et al. (1994) were higher than the maximum allowable limit. Although a detectable level of nitrate was found in all analyzed samples in the studies conducted by some other researchers (Durmaz et al., 2007; Ertaş et al., 2013), we found a detectable level of nitrate only in 26.27% of the samples.

In this study, the mean value of nitrite was found as 0.032±0.091 ppm in 91 of 118 water samples (Table 2). The mean values of nitrite level found in 50 of 64 analyzed tap water samples was 0.033±0.072 ppm, in 32 of 41 analyzed well water samples was 0.035±0.125 ppm, and in 9 of 13 analyzed tank samples was 0.018±0.017 ppm. The level of nitrite, which was found as 0.72 ppm, in 1 (0.85%) of water samples analyzed in this study, was higher than the allowed maximum limit.

The level of nitrite found in the water samples taken from wells in this study was lower than the level of nitrite found as 0.00 - 4.83 ppm by Özdemir et al. (2004) in Afyon, as 0.12-5.00 ppm by Harrison et al. (2000), and as 0.5-26.0 ppm by Bruning –Fann et al. (1994). However it was higher than 0.14 ppm, which was the highest value found by Durmaz et al. (2007) and 0.001 ppm, which was found in 2 wells by Ertaş et al. (2013). The nitrite value determined in the present study was partially similar to the values of 0.325 ppm, 0.121 ppm and 0.700 ppm, in the samples taken from 1 well and 2 springs in the study conducted by Ağaoğlu et al. (2007) in Van.

Table 2. Levels of nitrite detected in water samples (ppm)

Type of water sample	Number of samples	Mean±std.	Number of samples with detectable nitrite (%)	Mean±std (Min-Max)	P value
Tap	64	0.03±0.07	50 (78.13)	0.033±0.072 (0.001-0.500)	0.453
Wells	41	0.027±0111	32 (78.04)	0.035±0.125 (0.001-0.72)	
Tank	13	0.013±0.017	9 (69.23)	0.018±0.017 (0.003-0.059)	
Total	118	0.025±0.081	91 (77.11)	0.032±0.091 (0.001-0.72)	

* Legal Limit: 0.5 ppm

The different results reported by other researchers on the presence and level of nitrate and nitrite in waters might be related to various factors, such as geographical region difference, the way to use the land around the source of water,

the level of agricultural practices, proximity to industrial, household and animal wastes, and the condition of distribution channels of water.

Conclusion

As a result of this study, higher nitrite level than legally allowed limit was found only in one sample, taken from a well, whereas other samples were found to meet the criteria specified by the Turkish Regulation on Water Intended for Human Consumption. Although no general risk was found in terms of level of nitrate and nitrite in the analyzed water samples in Mardin, it can be suggested that water sources should be monitored frequently in order to find any individual contamination.

Disclosure: This study was presented as a summary at the 2. International Congress on Food of Animal Origin which took place on November 8–11, 2018, in Northern Cyprus.

Conflict of Interest Statement: The manuscript's authors declare that, they do not have any conflict of interest.

Researchers' Contribution Rate Statement Summary: The first author contributed to the design and laboratory analysis of this study, the writing of the article, the second author contributed to the statistical analysis of the data and the writing of the article.

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