

RESEARCH ARTICLE

DETERMINATION OF NITRATE AND NITRITE CONCENTRATION OF SOME BOTTLED DRINKING WATER BRANDS IN HAWLER CITY KURDISTAN REGION, IRAQ

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ARTICLE DETAILS

Article History:

Received 20 December 2023
Revised 15 January 2024
Accepted 01 February 2024
Available online 05 February 2024

ABSTRACT

This investigation was done to find out how much packaged natural spring and mineral water consumed in Hawler City contained nitrate (NO₃-) and nitrite (NO₂-). Between January and March of 2021, a total of sixty water samples with four replications from fifteen different companies (Life, Mazi, Reni, Lava, Kani, Rovian, Rawan, Hayat, Vauban, Grand Barbier, Evian, Bakoor, Shexy balak, Mira, and Tiyan) were tested for nitrate and nitrite. Using the spectrophotometric method, the levels of nitrate and nitrite were determined. Based on the findings, every water sample contained both nitrate and nitrite. The findings indicated that the average concentrations of nitrate and nitrite in the water sample ranged from 1.6 mg/l to 28.48 mg/l and 0.044 mg/l to 0.69 mg/l, respectively. Ultimately, the levels of nitrate and nitrite in a total of 60 water samples from Hawler City were deemed safe for consumption and in compliance with relevant international and national regulations.

KEYWORDS

Water, Nitrate, Nitrite and Bottled water.

1. INTRODUCTION

The most prevalent material in the human body is water, which can account for up to 60% of an adult's weight and 80% of an infant's weight. (Gad, 2018). The choice for bottled water is expanding at the fastest rate in the world. Some people drink it to replace other beverages, while others do so because they like the taste or believe it to be safer than tap water. (Oyelude and Ahenkorah, 2012) (Taiwo et al., 2010). Because of the facts of climate change, rapid population growth, and industrialization, there is an increasing daily demand for water. (Atasoy et al., 2011). Water is essential to life and a vital resource for all living things, including humans. Not just for drinking, but for everyone. The availability of a clean water source is crucial for preserving human health and wellbeing since everyone on the planet depends on it for survival.

The most significant factor influencing the decline in mortality and morbidity in developing nations is the production of sufficient and safe drinking water. In naturally occurring ground water, nitrate (NO₃) and nitrite (NO₂) ions are dangerous substances (Theroux et al., 1943). In the surroundings, they are commonplace. When nitrate is converted to nitrite in the digestive system, drinking water containing nitrate-nitrogen poses the greatest health risk (Abouleish, 2012). Red blood cell hemoglobin contains iron that is oxidized by nitrite to create methemoglobin, which is incapable of carrying oxygen like hemoglobin does. In the blood, absorbed nitrite quickly oxidizes to nitrate. The oxidation of haemoglobin (Hb) to methaemoglobin (methHb) in the bloodstream is facilitated by nitrite: the oxidized haem group's Fe²⁺ is converted to Fe³⁺, and the leftover nitrite forms a strong bond with this oxidized haem. Because of the strong oxygen bonding in the Fe³⁺ form, oxygen cannot be transported, and methaemoglobinemia can result in cyanosis. (Zatar et al., 1999). Since nitrates can be endogenously reduced to nitrite and then nitrosated to

form N-nitroso compounds, which are powerful carcinogens, drinking water contamination by nitrates is a growing public health concern. N-nitroso compounds have a well-established carcinogenicity. (Addiscott and Benjamin, 2004). Nitrites can cause methemoglobinemia, also known as "blue baby syndrome," in infants. Nitrate concentration and other illnesses, including recurrent diarrhea, are strongly correlated. The compound hemoglobin, which carries oxygen from the blood to the body's tissues, binds to nitrate and changes chemically to become methemoglobin, which hinders the delivery of oxygen to tissues and gives the skin its blue hue.

In the early stages of blue baby syndrome, the lips, nose, and ears exhibit blue coloring. In more severe cases, the blue coloration extends to peripheral tissues. Lower tissue oxygenation can have a variety of harmful effects on the child, the most serious of which are death and coma. (Nemade and Attarde, 2014). In adults, exposure to higher levels of nitrates or nitrites has been linked to an increased risk of cancer; in children, some studies have suggested an increased risk of brain tumors, leukemia, and nasopharyngeal (speech and throat) tumors (Gupta et al., 2001). Growth retardation, a higher incidence of SIDS, cardiac abnormalities, and a higher risk of nervous system defects were among the additional health effects that resulted from fetal exposure to high levels of nitrates in drinking water (Addiscott and Benjamin, 2004).

The WHO guideline for nitrates in drinking water was developed to prevent methaemoglobinemia, also known as "blue babies," a condition that is fatal in infants and can be dangerous for large populations of people due to nitrate conversion to nitrite, and acquire an unusual blue-grey complexion. Depending on the severity of their ailment, they may also become agitated or lethargic (Gupta et al., 2001). High nitrate consumption is linked to pathologic alterations in the lung parenchyma

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DOI:
[10.26480/jcleanwas.01.2024.06.10](http://doi.org/10.26480/jcleanwas.01.2024.06.10)

and bronchi. Additional health effects that may be linked to nitrate exposure in children include a higher risk of childhood diabetes, recurrent diarrhea, and recurrent respiratory tract infections, according to a few studies. Chronic exposure in adults has also been linked to recurrent bleeding in the spleen and frequent urination. Acute high dose ingestion exposure to nitrates can cause abdominal pain, muscle weakness, blood in stools and urine, fainting, and death (Addiscott and Benjamin, 2004; Nemade and Attarde, 2014).

A rise in nitrates in water is frequently linked to improper use of pesticides, fertilizers, or hygiene practices in agriculture. Generally, agricultural runoff, refuse dump runoff, or contamination with human or animal waste are the main causes of high nitrate concentrations in our water samples. Several of our ground water samples had nitrate levels higher than 10 mg/liter, in contrast to surface waters. (Edition, 2011). Fertilizers, rodenticides (which kill rodents), and food preservatives all contain nitrates and nitrites. Additionally naturally occurring, nitrate (NO₃-) and nitrite (NO₂-) are metabolic byproducts of microbial digestion of nitrogen-containing wastes, such as animal feces or fertilizers based on nitrogen. It has also been found that fruits and vegetables contain nitrates. In aerobic conditions, the naturally occurring nitrate concentration in groundwater is a few milligrams per liter. This concentration is highly dependent on the type of soil and the geological conditions, where drinking water quality may be affected by nitrate-contaminated groundwater (Nemade and Attarde, 2014).

Nitrate concentrations in drinking water made from surface water do not go above 10 mg/l in the majority of nations. Still, in certain places, concentrations are greater due to runoff, sewage effluent discharge, and certain industrial wastes (Edition, 2011). Water used to prepare drinking water is treated at drinking water treatment plants using a variety of technologies, such as ion exchange, reverse osmosis, biological processes, and others, to reduce or remove nitrate. However, because of human error and infrequent monitoring (testing), high nitrate levels in drinking water can occasionally occur. (Nemade and Attarde, 2014).

2. MATERIALS AND METHODS

The study was carried out in Hawler city. The studied area (Hawler city) covers about 70Km² between latitude 36° 09' to 36° 14' N and between longitude 43° 58' to 44° 03' E (Toma et al., 2013). The fifteen distinct bottled waters were gathered from Hawler City's various shops, with four duplicates in (January-march/2021). In this study, a broad range of people from Hawler City consumed fifteen different types of commonly available bottled water. The sources of these bottled waters are Turkey, Duhok, France, and Hawler. Table (1) shows the type of water and its source for each.

Table 1: Type and source of bottled water

Bottle water brands	Water type	Source of water
Life	Natural spring water	Duhok-Iraq
Mazi	Natural spring water	Duhok-Iraq
Reni	Natural spring water	Hawler -Iraq
Lava	Natural spring water	Zakho-Iraq
Kani	Natural spring water	Hawler -Iraq
Rovian	Natural spring water	Duhok-Iraq
Rawan	Purified drinking water	Hawler -Iraq
Hayat	Natural mineral water	Adana-Turkey
Vauban	Natural mineral water	Vauban-France
Grand barbier	Natural spring water	Ovarnei-France
Evian	Natural mineral water	Cachet- France
Bakoor	Natural spring water	Hawler -Iraq
Shexy balak	Natural spring water	Hawler -Iraq
Mira	Natural mineral water	Hawler -Iraq
Tiyan	Natural spring water	Duhok/Zakho-Iraq

Life, Mazi, Reni, Lava, Kani, Rovian, Rawan, Hayat, Vauban, Grand Barbier, Evian, Bakoor, Shexy Balak, Mira, and Tiyan were among the fifteen brands of drinking bottled water that were randomly gathered from Hawler City's local markets and supermarkets with four replications between January and March 20. The amount of nitrate and nitrite in each sample was determined by analysis. In accordance with (APHA) Standard Procedures for the Examination of Water and Waste Water, the nitrate content of

bottled water samples was ascertained by colorimetric method using digital ultraviolet spectrophotometric screening method. (Ndabigengesere and Narasiah, 1998) and (WHO) guidelines for drinking water quality after acidification with 2 milliliters of HCL(1N), using quartz 1 cm-cuvette cell spectrophotometer (model JENWAY 6305 Spectrophotometer) with wave lengths of 220 and 275 nm (Galal-Gorchev and Ozolins, 1993; Miyazaki et al., 2008). The results were expressed in mg NO₃ -NL-1. Using a 543 nm wavelength and the turbidity metric approach as outlined by the American Public Health Association, the nitrite concentration was measured spectrophotometrically (model JENWAY 6305 Spectrophotometer). The outcome was given in milligrams of NO₂-NL-1.

2.1 Experimental Design and Statistical Analysis

Complementary Randomized Design was used in the experiment, with four replications and the least significant difference. Water sample means were compared using LSD, and statistical significance was defined as a probability level of P<0.05. The mean of the results was displayed.

3. RESULT AND DISCUSSION

One substitute source for supplying daily needs for potable water is bottled water. In Kurdistan, as in the rest of the world, the production of bottled water has advanced quickly. Among the most pervasive chemical pollutants found in aquifers worldwide is nitrate. Drinking water nitrates have a positive correlation with colorectal cancer and non-Hodgkin lymphoma (Kazmi and Khan, 2005). The results of the examination of fifteen bottled water samples that were gathered from different Hawler City stores in order to measure the nitrate and nitrite contents are displayed in Table 2. The stable form of combined nitrogen for oxygenated systems is the nitrate ion (NO₃-2), which can be reduced by microorganisms. Significant nutrient sources include fertilizers, industrial and municipal waste, and NO₂-1 gases found in the atmosphere, as well as the oxidation of organic matter (Ma, 2005). Nitrogen found in wastewater typically takes the following forms: ammonia, nitrate, nitrite, organic, and gaseous (Hammer, 1986). An unstable intermediate stage in the nitrogen cycle is nitrite. It is created in water by the reduction or oxidation of ammonia and enters surface water from various sources. In clean surface waters, they are found in small amounts, but in ground water, they are more prevalent. It is regarded as a sign of the amount of organic matter and pollution in water (Bartram and Ballance, 1996; Rump, 1999)

The current nitrate concentration results showed significant differences at the P<0.05 level between the majority (table 2) of the imported and local bottled brands, including four brands: Lava (28.48 mg/l), Rovian (27.15 mg/l), Rawan (23.03 mg/l), and Life (10.57 mg/l) that displayed significant differences when compared to the other brands (Figure, 1). While most (table 2) of the domestic and imported bottled brands, such as Bakoor (0.695 mg/l) and Evian (0.695 mg/l), show significant differences at the (P<0.05) level when it comes to nitrite concentration, When compared to the other brands, Shexybalak (0.595 mg/l), Reni (0.5875 mg/l), and Grand Barber (0.48 mg/l) displayed noteworthy variations (Figure 2). The study's observed values of nitrate mean concentration ranged from the lowest (1.6) mg/l for Shexy Balak brands to the highest (28.48) mg/l for Lava brands; nevertheless, these values remained within the WHO's permissible limit for drinking water. (WHO, 1985; Arbuckle et al., 1988). The mean concentrations of nitrite in all the water samples under investigation varied from 0.69 mg/l-1 to 0.044 mg/l-1. The Tiyan bottled water had the lowest nitrate reading. Conversely, the brands of bottled water that had the highest nitrate value were Bakoor. These suggest that all brand samples are fit for consumption. The nitrate content of some of the bottled waters from local markets (Mazi, Reni, Hayat, Kani, Bakoor, and Tiyan) in the current study was largely consistent with that of earlier research while in contrast to (Toma, 2009; Madison and Brunett, 1985; Kazmi and Khan, 2005).

While the nitrite content of bottled waters sold from local markets was generally in agreement with previous study (Arbuckle et al., 1988). Only one out of fifteen brands, according to our analysis, agreed with the nitrate concentration on the labels in relation to the nitrate content. In drinking water, the maximum concentration limit for nitrites is 1 mg/L and for nitrates, it is 10 mg/L. "Infants below the age of six months who drink water containing nitrate in excess of the Maximum Concentration Limit could become seriously ill and, if untreated, may die," according to the U.S. Environmental Protection Agency, citing potential health effects. The same claim is made by the US EPA regarding nitrite in water. The majority of the bottled water brands had nitrate and nitrite levels that were generally low and within the WHO-approved drinking water standard of 50 mg/L (WHO, 1985). For nitrate in drinking water, a maximum acceptable concentration (MAC) of 45 mg/L is suggested. This corresponds to a nitrate-nitrogen

measurement of 10 mg/L. The recommended limit of nitrite in drinking water is 3 mg/L. This translates to 1 mg/L of nitrite-nitrogen (Organization, 2008; Water and Organization, 2006). Nitrate and nitrite content information would enable consumers to know if their drinking water contains these substances or not. This information would be

included on the labels of Kurdistan bottled water. The customer would be able to make an informed decision about their choice of drinking water by knowing the amount of nitrate and nitrite they are consuming thanks to this.

Table 2: Nitrate (NO₃) and Nitrite (NO₂) values (mg NO_n/L) with mean of different bottled water brands analyzed in Hawler city are compared with WHO standards.

parameters	N03	N02	WHO	WHO	Labeled N03	Labeled N02
Bottle water brands	mg/L	mg/L	Standards for (N03) mg/L	Standards for (N02) mg/L	Concentration	Concentration
Life	10.575	0.1225	50	3	0.5	NP
Mazi	6.435	0.235	50	3	NP	NP
Reni	5.5575	0.5875	50	3	5.61	NP
Lava	28.48	0.14	50	3	0.5	NP
Kani	2.725	0.1275	50	3	10.5	NP
Rovian	27.15	0.128	50	3	NP	NP
Rawan	23.035	0.11	50	3	6.5	NP
Hayat	3.53	0.10075	50	3	1.64	NP
Vauban	4.6375	0.21	50	3	1	NP
Grand barbier	4.65	0.48	50	3	0.8	NP
Evian	2.2025	0.69	50	3	3.7	NP
Bakoor	2.8925	0.695	50	3	NP	NP
Shexy balak	1.06	0.595	50	3	11.4	NP
Mira	2.9075	0.155	50	3	10	NP
Tiyan	4.095	0.04425	50	3	NP	0.2

NP: Not

provided

LSD (0.05) for Nitrate (N03) = 2.96

LSD (0.05) for Nitrite (N02) = 0.171

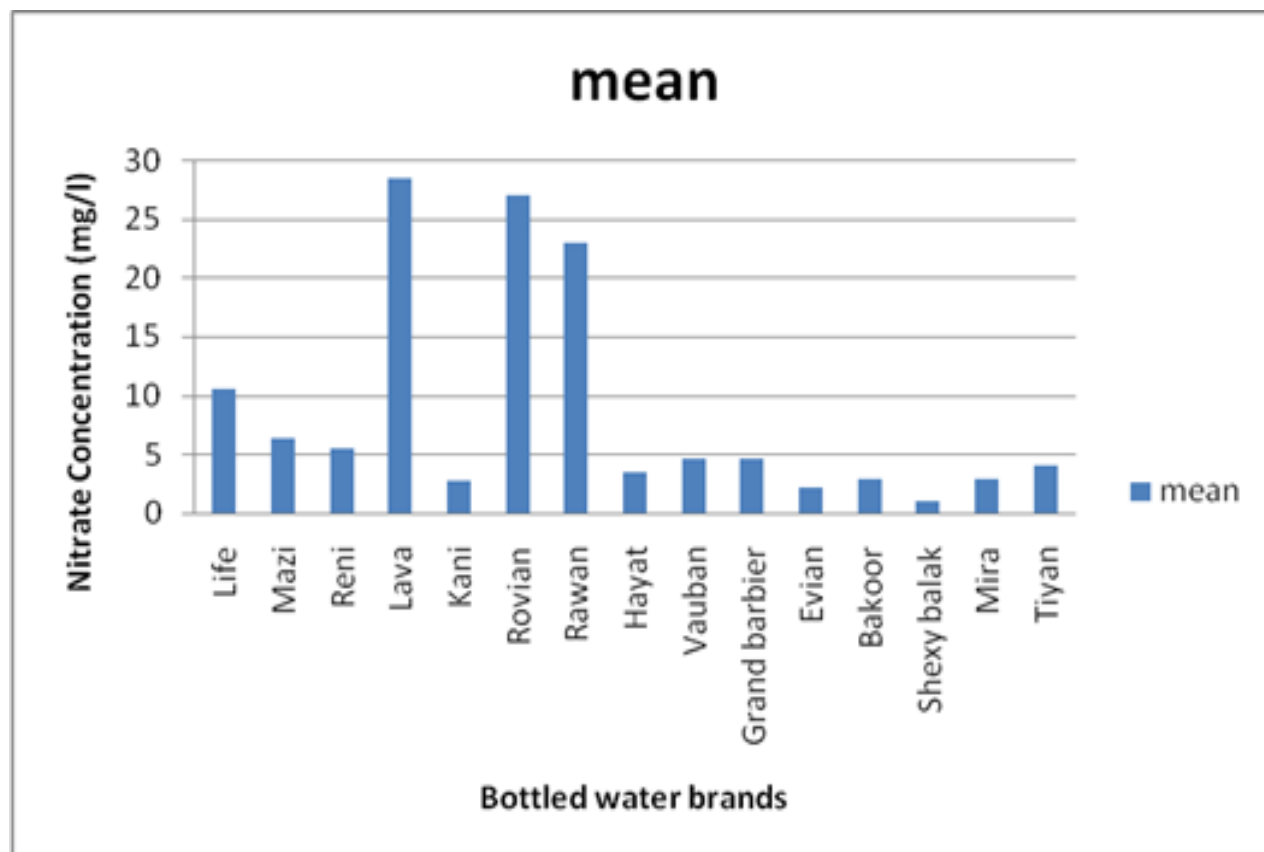


Figure 1: Nitrate content of bottled drinking water brands in Hawler markets.

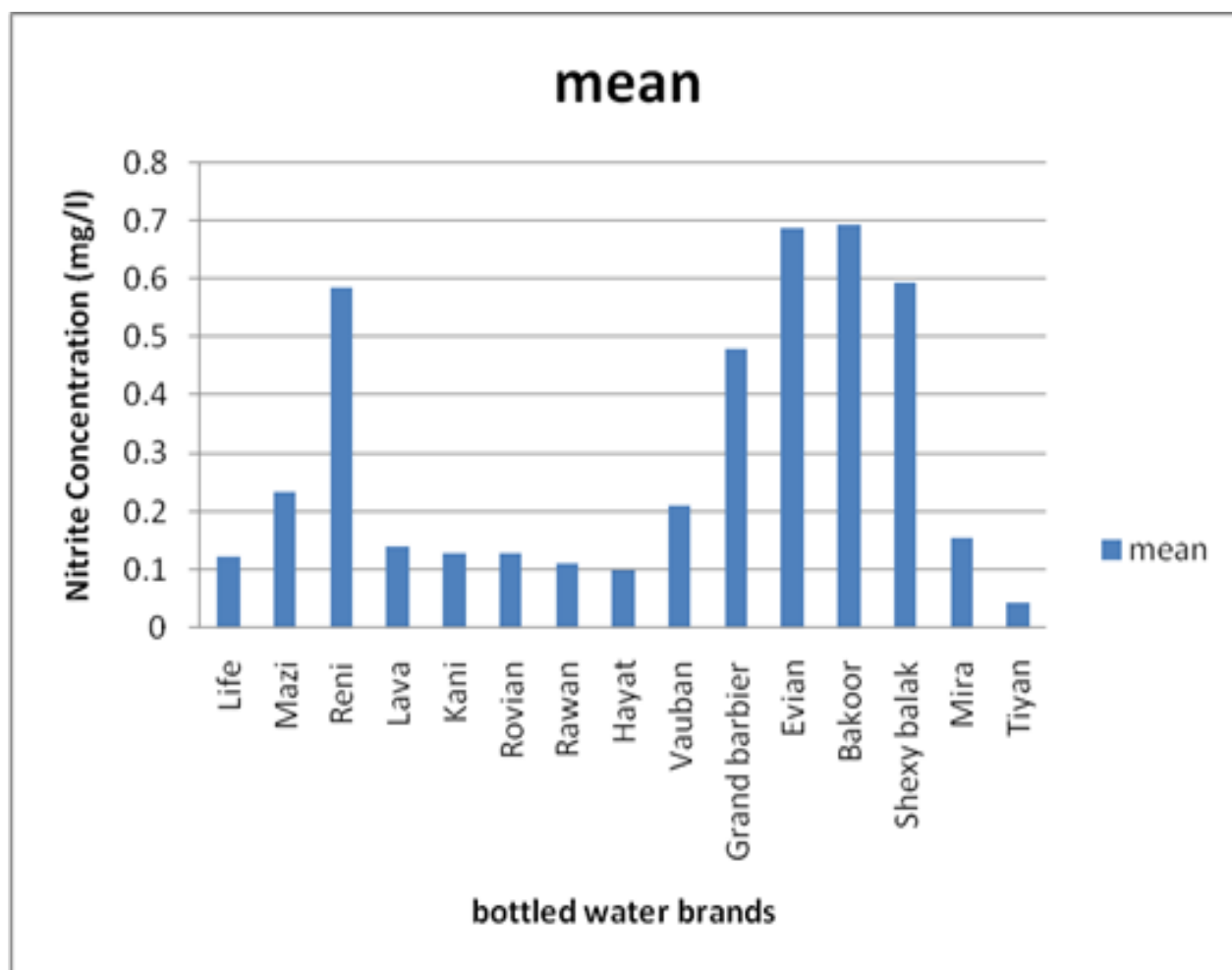


Figure 2: Nitrite content of bottled drinking water brands in Hawler markets.

4. CONCLUSION

After all 60 bottled water samples were collected from various local markets and supermarkets in Hawler Province, their nitrate and nitrite concentrations were analyzed. The results showed that the values were within the WHO's permissible limits and were not exceeded. When comparing the majority of the bottled water samples statistically, the measured obtained mean values of Nitrate values showed significant differences at the ($p < 0.05$) level. The results showed that the total (60) bottled water samples for the drinking water supply in Hawle province had lower-than-standard levels of nitrate and nitrite, which remained within safe bounds and were deemed suitable for consumption.

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