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CONCENTRATION OF NITRATE/ NITRITE IN GROUNDWATER WELLS IN BAGHDAD CITY, IRAQ

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ABSTRACT

Both Nitrate and Nitrite are naturally occurring in the environment, products by oxidation of nitrogen by microorganism in plants, soil and water. The objective of this study was to investigate and determine the nitrate/ nitrite compounds in groundwater wells of Baghdad city/ Iraq. During a period of three months (January, April and August 2014), 26 samples of water were examined. The results showed that mean Nitrate concentration in water samples were 52.66 ppm, 15.03 ppm, 8.53 ppm, 12.30 ppm, 13.36 ppm, 50.56 ppm for three Months (January, April and August) and Nitrite concentration were 4.05 ppm, 072 ppm, 0.85 ppm, 0.88 ppm, 1.05 ppm, 3.11 ppm at Dyala Ridge, Salikh, Doura, Al-Jadria, Ghazalyia – Ammiria, and Abu-Ghreeb locations, respectively. Both Nitrate, Nitrite in Two area (Abu-Ghreeb, Dyala) had been more than the others locations due to increasing use of artificial fertilizers, the disposal of wastes and changes in land use are the main factors responsible for the progressive increase in nitrate/ Nitrite levels in both locations. One of the important issue that protection these area by apply many actions to reduce or remove nitrate concentration from groundwater.

Keywords: Nitrate, Nitrite, Groundwater, Human activities, Baghdad

INTRODUCTION

Groundwater can be found at various depths at any location on the earth's surface. It is the water that fills the natural open spaces (e.g., fractures or pore spaces between grains) in soil and rocks (Stephin, 2001). With increased use of chemicals in the 20th century, contamination of groundwater has become a growing concern. When rainwater comes in contact with any source of contamination at the surface or in the soil, it

dissolves some of that contaminant and carries it to the aquifer. Groundwater moves from areas where the water table is high to where the water table is low. (Williams, 1996 and Nelson, 2007).

Nitrates occur naturally in plants, for which it is a key nutrient. The nitrate concentration level in groundwater for human consumption is one of the most important problems related with the quality of the groundwater in many countries and also in Iraq. Nitrate can reach both surface water and groundwater as a consequence of agricultural activity (including excess application of inorganic nitrogenous fertilizers and manures) (Gatsevaa and Argirova, 2008), and from wastewater treatment and from oxidation of nitrogenous waste products in human and animal excreta, including septic tanks. Nitrite can also be formed chemically in distribution pipes by Nitr-osomonas bacteria during stagnation of nitrate-containing and oxygen-poor drinking-water in galvanized steel pipes. (WHO, 1974; Hem, 1991; Brentice, 1997, and Nolen *et al*., 2002).

Concentrations of nitrate in rainwater of up to 5 mg/l have been observed in industrial areas (Van Duijvenboden and Matthijsen, 1989; Dubrovsky and Hamilton, 2010). In rural areas, concentrations are lower. The nitrate concentration in surface water is normally low (0 – 18 mg/l) but can reach high levels as a result of agricultural runoff, refuse dump runoff or contamination by human or animal wastes. (Young and Morgan, 1980).

The natural nitrate concentration in groundwater under aerobic conditions is a few milligrams per liter and depends strongly on soil type and on the geological situation. In the United States of America (USA), naturally occurring levels do not exceed 4 – 9 mg/l for nitrate and 0.3 mg/l for nitrite (USEPA, 1987; Harter, 2003; Jacks and Sharma, 1983). In the USA, nitrates are present in most surface water and groundwater supplies at levels below 4 mg/l, with levels exceeding 20 mg/l in about 3% of surface waters and 6% of groundwater. In 1986, a nitrate concentration of 44 mg/l (10 mg of nitrate nitrogen per liter) was exceeded in 40 surface water and 568 groundwater supplies. Nitrite levels were not surveyed but are expected to be much lower than 3.3 mg/l (USEPA, 1987).

The health effects of nitrate are generally a consequence of its ready conversion to nitrite in the body. The WHO legislation established a maximum allowed concentration of 50 mg- NO_3- ppm and 3 ppm NO_2 in drinking water (WHO, 2011) and the same standard is prescribed in Iraq (IQS, 2009). Nitrites can cause problems in young children and farm animals, as they bind very strongly to hemoglobin, and can affect the blood's ability to carry and release oxygen (Amouha *et al*., 2001; Ward and Brender, 2011). Nitrates are ingested-through water, or food- and nitrate reducing bacteria in an infant's digestive tract convert these nitrates to nitrites.

Baghdad is one of the important city in Iraq, which located in center of Iraq, covers area of 5159 Km^2 and it has approximately 6.5 million people (Al-Maliky, 2005). Most of drinking water is supplied from surface water but some regions use groundwater well for multi-purpose. The study area has changed lithology formation with variable thicknesses of clay, sand and silt in both sides of Karkh and Rasafa. The fluctuation of water table ranged from (0.4 – 1.95) meter, (0.7 – 2.03) meter at Karkh and Rasafa sides, respectively. Many previous studies concerning Nitrate/ Nitrite concentrations in water (Al-Hiti, 1985; Al-Maliky, 2005 and Ali, 2013).

MATERIAL AND METHODS

1. Sampling Collection

Twenty six of groundwater samples were collected from six areas in Baghdad city during three month (January, April and August) in 2014. The major area are Dyala ridge (7 wells), Doura (3 wells), Salikh (4 wells), Ghazalyia – Ammiria (3 wells), Al-Jadria (3 wells) and Abu-Ghreeb (6 wells) (Fig. 1). The maximum depth was 18 m whereas the minimum depth 8 m. All samples were collected in one liter polythene bottles and stored at 4 °C and carried to the laboratory for analysis.

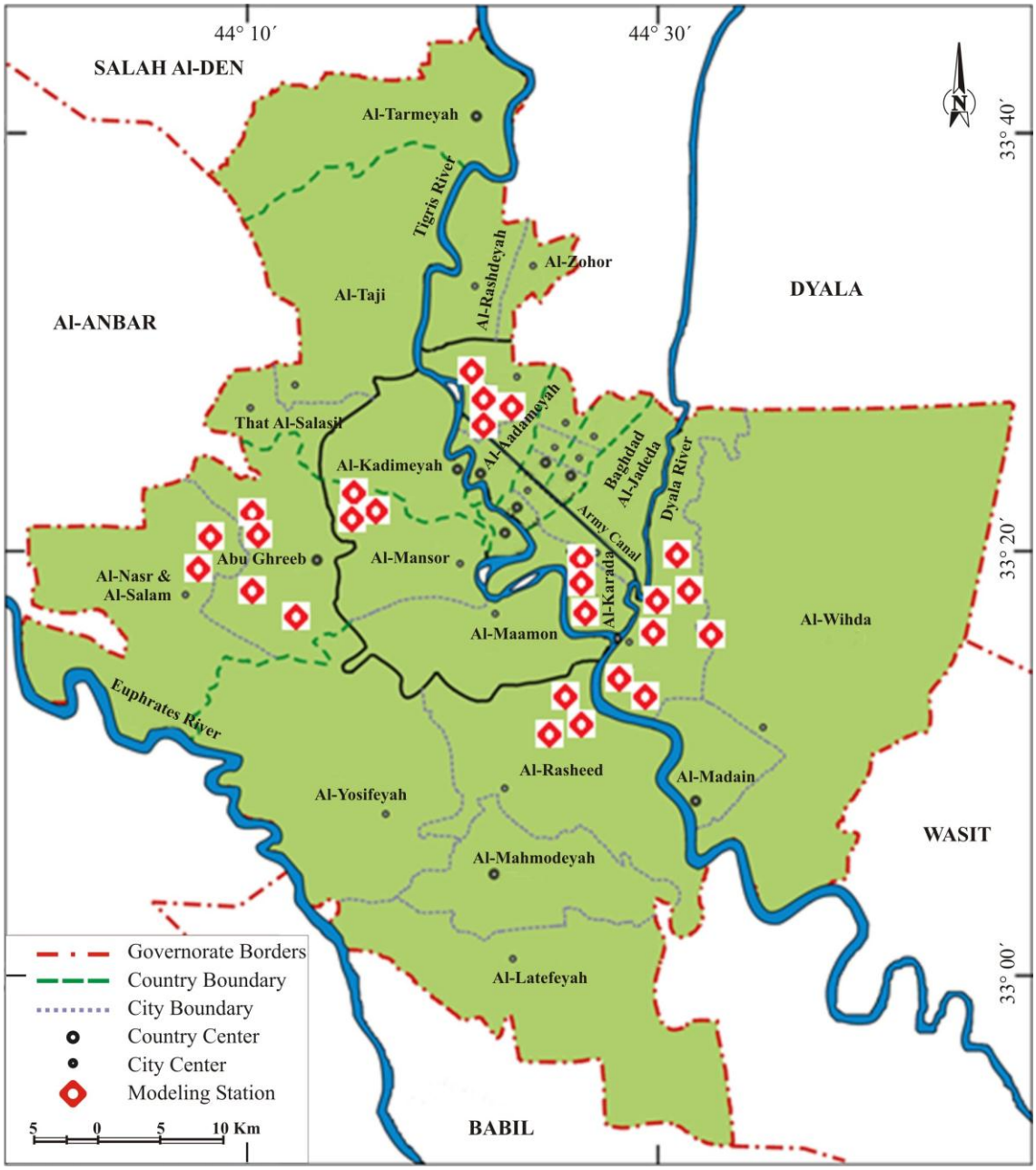

Fig. 1: Map of the study area (Maliky, 2005)

2. Analysis Methods

Nitrate and Nitrite ions were analyzed by a UV-spectrophotometer, at 549 and 410 nm according to the standard methods for the examination of water and wastewater (APHA, 1975). At the first a square samples cells was filled with 10 ml of water samples and pull to the cell holder for determination the Nitrate concentration and same procedure use to determination of Nitrite concentration. The concentration of Nitrate and Nitrite are expressed in mg/l NO_3-N and NO_2-N, respectively.

Nitrite and nitrate concentration obtained from study area are summarized in Tables 1 and 2. The concentration of nitrate in water samples ranged between (24 – 80 ppm), (1 – 27 ppm), (2 – 18 ppm), (1.9 – 33 ppm), (1 – 22 ppm), (18 – 79 ppm) with average values of 52.66 ppm, 15.03 ppm, 8.53 ppm, 12.30 ppm, 13.36 ppm, 50.56 ppm for three months (January, April and August) at Dyala Ridge, Doura, Salikh, Ghazalyia – Ammiria, Al-Jadria and Abu-Ghreeb locations, respectively. While The concentration of nitrite in water samples ranged between (0.2 – 8) ppm, (0.08 – 1.6) ppm, (0.01 – 2.40 ppm), (0.01 – 2.2 ppm), (0.09 – 2.4 ppm), (0.29 – 6.12 ppm) with average values of 4.05 ppm, 0.72 ppm, 0.88 ppm, 1.05 ppm, 3.11 ppm for three months (January, April and August) at Dyala Ridge, Doura, Salikh, Ghazalyia – Ammiria, Al-Jadria and Abu-Ghreeb locations, respectively (Fig. 2 and 3).

Table 1: Range and average concentration of Nitrate in groundwater wells of some area in Baghdad city during three months (January, April and August) in 2014

Area	January			April			August		
	Range	Average		Range	Average		Range	Average	
Dyala Ridge	27 – 79	53		24 – 77	50.5		29 – 80	54.5	
Doura	1.2 – 22	11.6		1.0 – 19	10		2 – 27	23.5	
Salikh	2.2 – 14	8.1	ppm	2 – 12	7	ppm	3 – 18	10.5	ppm
Ghazalyia – Ammiria	4.01 – 16	10.005		1.9 – 14	7.9		5 – 33	19	
Al-Jadria	1 – 16	8.5		1.2 – 14	7.7		1.9 – 22	23.9	
Abu-Ghreeb	23 – 78	50.5		18 – 75	46.5		23 – 79	51	

Table 2: Range, average concentration of Nitrite in groundwater wells of some area in Baghdad city during three months (January, April and August) in 2014

Area	January			April			August		
	Range	Average		Range	Average		Range	Average	
Dyala Ridge	0.4 – 7.9	4.15		0.2 – 7.2	3.7		0.6 – 8	4.3	
Doura	0.09 – 1.2	0.645		0.08 – 1.1	0.62		0.2 – 1.6	0.9	
Salikh	0.02 – 1.4	0.71	ppm	0.01 – 1.23	0.625	ppm	0.05 – 2.4	1.225	ppm
Ghazalyia – Ammiria	0.02 – 1.5	0.77		0.01 – 1.43	0.72		0.05 – 2.2	1.15	
Al-Jadria	0.1 – 2.1	1.1		0.09 – 1.2	0.645		0.23 – 2.4	1.43	
Abu-Ghreeb	0.3 – 5.8	3.05		0.29 – 5.7	2.995		0.45 – 6.12	3.285	

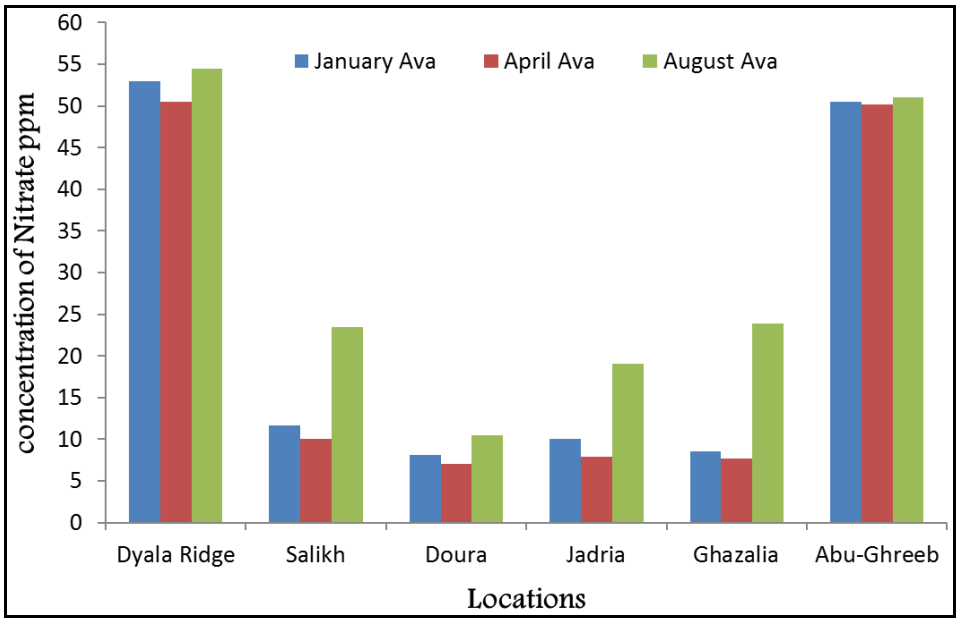

Fig. 2: Average concentration of NO_3 for three months at some area in Baghdad city

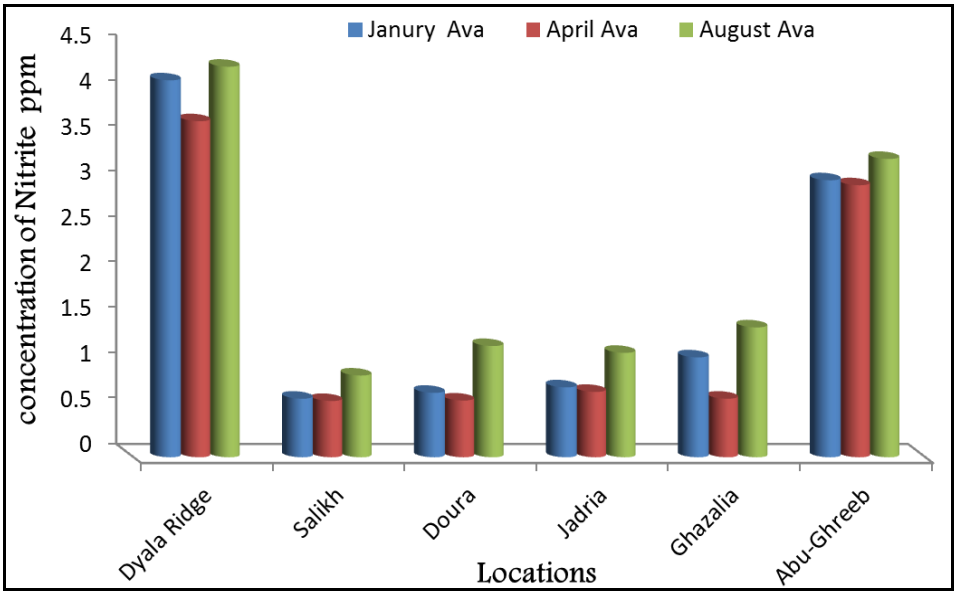

Fig. 3: Average concentration of NO_2 for three months at some area in Baghdad city

The highest concentration of NO_3 was showed 80 ppm, 79 ppm in the areas of Dyala Ridge and Abu-Ghreeb during three months for studied periods. While the lowest concentration was showed 1.0 ppm in the area of Al-Jadiria. The same trend can be see with concentration of NO_2. As shown in Figure 4. The results showed that the nitrate content in Dyala Ridge can be higher than other area. The major source of pollution in

this area due to domestic and industrial effluents from Al-Rystmia plant. On the other hand the high concentration of NO_3, NO_2 in the wells close Dyala River during studied periods, assure that continues recharge from the river.

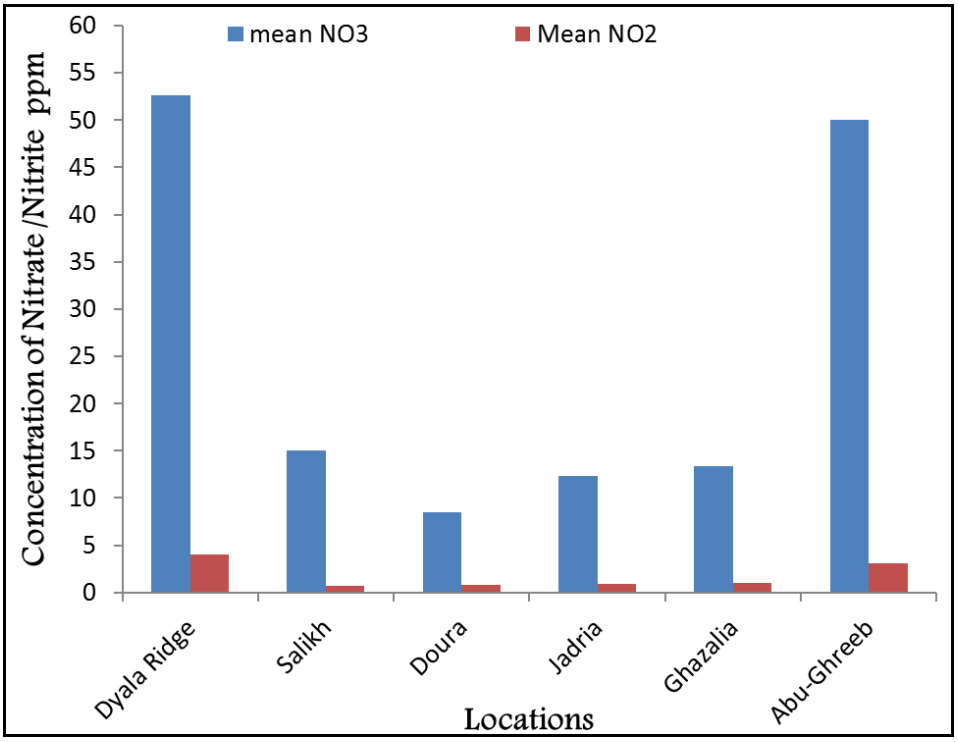

Fig. 4: Average concentration of NO_3 and NO_2 during studied periods in some area at Baghdad city

Increase in nitrate ion concentration was noticed in well water in January, April and August at Abu-Ghreeb region. This observation is supported by the claim that agricultural practices, with the usual attendant excessive use of fertilizers. While the effects of main drain is mentioned, is only of small extends due to relatively low discharge.

For well water in the studied areas, percolation of water occurs during rainy season. Consequently, a kind of galloping value of nitrite is observed but in the dry season it may be increase, since normally the nitrite ion is unstable. The presence of nitrites indicates partially decomposed organic wastes in the water being tested.

During rainy season, nitrate level decreases while during dry season increases due to the transport time to the aquifer.

The variation of Nitrate/ Nitrite ions concentration is significantly lower in the Doura, Salikh, Ghazalyia and Al-Jadria regions than in the wells at Abu-Ghreeb and Dyala Ridge, indicate there are different sources of NO_3-N during studied periods. High concentration of NO_3, NO_2 in some area (Ghazalyia, Doura) during August, assure the effect of septic tanks effluent as well as the possible contribution of human activity related by sewage and the other source of NO_3.

In this current study, All values of NO_3 during three periods in 2014 within acceptable limits except at (Dyala Ridge and Abu-Ghreeb) locations which are characterized by high values of nitrate (24 – 80 ppm) and nitrite (0.2 – 8 ppm), respectively, and nitrate pollution is associated with septic systems and agricultural activity.

CONCLUTION

In present study, nitrite and nitrate levels in well water of six areas at Baghdad city are generally less than standard levels (3 and 50 mg/L) except two area (Dyala and Abu-Ghreeb). Wastewater disposal is other source of groundwater pollution. The high occur in nitrite concentration due to application of nitrogen-fertilizers (ammonium-nitrate). Normally, nitrate pollution is associated with septic systems and agricultural activity. The concentration often fluctuates with the season and may increase when the Dyala, main drain rives is fed by nitrate-rich aquifers.

It is suggested that agricultural best management practices such as water-saving irrigation and split application of N fertilizer should be adopted to protect the groundwater quality from N-Pollution.

All groundwater wells should be checked at least every three months to assure that increase in nitrate and nitrite was not occurred. Current technology suggests that several techniques may be used for removing nitrate from drinking water including chemical reduction, ion exchange, reverse osmosis, electro dialysis, and distillation at the present time.

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