Print ISSN: 2321-6379
Online ISSN: 2321-595X
DOI: 10.17354/ijssl/2017/98

Original Article

Investigation of Nitrate Concentration and Its Correlation with Water pH in Drinking Water Distribution Network of the City of Tabriz

Parisa Dadgar[1]*, Parna Eskandari Payandeh[2]

[1]MSc of Health, Safety and Environmental Management, Department of Environmental Engineering, Central Tehran Branch, Islamic Azad University, Tehran, Iran, [2]MSc of civil and Environmental, Department of Environment, University of Tehran, Aras International Campus, Jolfa, Iran

Abstract

Nitrate is one of the most common and primary decentralized contaminants of water. Its excess concentration in drinking water is an indicator that the water is contaminated by urban, agriculture, and industrial wastewater. Consuming water containing high concentration of nitrate (exceeding EPA standards) has negative impacts on human health. The aim of this research is to evaluate nitrate and pH levels in drinking water distributed in the city of Tabriz, and to compare them with common standards. This cross-sectional study was conducted to determine the concentration of nitrate and pH values in drinking water of the city of Tabriz. In this research, 120 residential areas of the city of Tabriz were randomly selected, and the concentrations of nitrate and pH values of the water were examined using spectrophotometry method and pH meter, respectively, and the results were analyzed in SPSS. The findings indicate that the maximum levels of nitrate reach 7.86 mg/l in the region of Eel Goli, while the minimum levels reach 3.23 mg/l in the region of Baghmisheh, with the concentration averaging 5.14 mg/l. Further to this, the maximum and minimum values of pH were 8.44, and 7.18 in Baghmisheh, and Elgoli regions, respectively. It was interpreted that there was a reverse linear correlation between the concentration of nitrate and pH value in drinking water, meaning with increasing levels of nitrate in water, the pH levels decline. According to the results from the most recent studies, the concentration of nitrate is less than 10 mg/l (as N) in the entire drinkingwater network of the city of Tabriz. Based on EPA standards, this indicates that the water is safe to drink. Nevertheless, constant control of these water sources is deemed to be necessary, and proper treatment of wastewater needs to be taken into consideration as well.

Key words: Drinking water, Nitrate, pH, Tabriz, Water pollution

INTRODUCTION

Population growth and industrial development in recent decades has led to wide water resources pollution. The pollution caused by the inappropriate discharge and disposal of municipal, industrial and agricultural wastewater to absorbent wells and infiltration of these wells into aquifers. (Eamhart, 2013) (Baghvand&Etal., 2016).

Nitrate (NO_3^{-1}) is a chemical and one of the most soluble anionsthat widely pollute surface and ground water resources.

Access this article online

www.ijss-sn.com

Month of Submission : 05-2017
Month of Peer Review : 06-2017
Month of Acceptance : 07-2017
Month of Publishing : 07-2017

Nitrate, is the most common decentralizedpollutant in groundwater resources that is often attributed to the agricultural management (Turkeltaub&Etal, 2016). The possibility of nitrate entry into water resources depends on the depth of wells and soil conditions. The nitrate pollution in shallow wells is more likely rather than deep wells(Badeenezhad&Etal, 2012). One of the influencing factors on the concentrations of nitrate in groundwater resources is soil texture. The coarse and sandy grain texture of the soilincrease the nitrate leaching(Abdesselam&Etal, 2013).

Anion concentration in water can result from improper disposal of municipal and industrial wastewater, and alsoexcessive use of nitrogenous fertilizers in farmlands or even nitrogen pollutants in the air. Today, farmers use fertilizers to increase their crop that leaching rapidly out of reach and pollute the soil and water resources as the main source of nitrate pollution (Ansari Etal,2016).They also

Corresponding Author: Parisa Dadgar, MSc of Health, Safety and Environmental Management, Department of Environmental Engineering, Central Tehran Branch, Islamic Azad University, Tehran, Iran.

concluded that nitrate enters the body about 94%though urban plumbing drinking water and 6%through eating food (Brender&Etal, 2013). In the USA and Europe, 1-2 Mol nitrate consumption is estimated per individual daily. If the concentration of nitrate in drinking water exceeds 45 mg/l, then water is the most important source of nitrate absorption. However, if the nitrate concentration in drinking wateris within the acceptable limits,the total nitrate absorption in the human body is 70% for fruits and vegetables, 21% for drinking water and 9% for meat products and other food(Miranzadeh&Etal, 2010).

When nitrate enters the human body thougheating food and drinking water, it is convertedinto Nitrite in the intestine and combined with blood hemoglobin and greatly reduces the ability to transfer oxygen to the bloodstream. Excess nitrate in drinking water can cause disturbances such as heart pain, shortness of breath, andalso results in the formation of nitroso carcinogenic compounds.Also, nitrate is a major threat to the health of babiesbecause it causes Blue Baby Syndrome or Methemoglobinemiathat negatively affects the growth of the baby and if not promptly treated, it will lead to the death of the baby. According to some research, the more the consumption of nitrate by pregnant women, the high the risk of abortion (the increase in nitrate consumption in pregnant mothers increases the risk of abortion)(Russell, 2016). According to World Health Organization guidelines and national standards, maximum acceptable concentration of nitrate in drinking water is 50 mg/l, as nitrate.Based on this, a prescriptive guide for nitrite at 3 mg/L is Proposed.World Health Organization conditional guidelines recommended 0.2 mg/l because of chronic effects of nitrite. Due to the possibility of simultaneous nitrate and nitrite ions in drinking water, the total ratio of the measured values of each of these factors to their suggested guidance values should be less than 1(World Health Organization, 2011).

Similar studies have been done on measuring the concentration of nitrate. Hereby,someof them are mentioned. (Mohammadi&Etal, 2011) carried out a study to measure the concentration of nitrate in drinking water ofShahidBeheshti University in Tehran. They stated that the concentration of nitrate in most samples was less than 50 mg/l, which is in accordance with theWorld Health Organization standards andnational standards (Mohammadi&Etal, 2011). In another study, nitrate concentration in all samples, which were taken from the supply sources and distribution network for drinking water in the city of Ardebil (except an area of water supply system), is less than the maximum permitted value (determined by Iranian standards) in drinking water(Alighadri&Etal, 2011). Also, a study of the concentration of nitrate in drinking water during pregnancy has shown that there was a direct correlation between increased nitrate in drinking water and congenital defects (Brander et al (2013).(Harter and Lund (2012), also, investigated the concentration of nitrate in drinking water of 4 counties (cities) of California. In these areas, 6.2 million people use groundwater resources, 40% of which is threatened by nitrate Contamination.In order to control nitrate in drinking water, it should be prevented from entering water resources. In case of excessive increase of this substance in drinking water, advanced methods such as membrane processes, ion exchange and Denitrification should be used to remove it.If possible, the source of water supplycan be replaced(Miranzadeh&Etal,2010). The highest nitrate reduction occurs when septic tanks are removed (Jacobson, 2010).By choosing the proper location of the wells,creating proper distances between the wells and possible contaminating sources, the development of a new well, connecting to adjacent systems,combining with a source with less nitrate and fertilizing at a radius of three kilometers from the well can reduce the nitrate concentration of drinking water(Alighadri&Etal,2011). Proper management of chemical fertilizers and other nitrogen sources reduces the pollution of drinking water reservoirs(Self&Waskom,2013). The highest nitrate pollution in Iran was reported in Isfahan province (318 mg/l), and the city of Zahedanlocated in Sistan and Baluchestan province (295 mg/l). Based on the reported results of all cities in Iran, the status of nitrate pollution in the country's water resources is Moderate(Akhavanand&Etal, 2014). Understanding the nitrate pollution levels and its sources, control the input of nitrogen and promote are very critical, and sustainable management in these areasshould be implemented (XueEtal.,2016).Water testing is the only way to determine the concentration of nitrate and based on its results, acceptable or unacceptable standard can be determined(Gheysari&Etal, 2007). Several methods are available to measure nitrate concentrations in water specimens.Determination the concentration of nitrate in ultraviolet UV) wavelength is a fully optimized method and is preferable to other methods (Causse&Etal, 2017). This study is the firstresearchon the importance of nitrate compounds in drinking water and its relation to water pH in the city of Tabriz, which is compared with international standards and the amount of nitrate in accordance with international standards in 120 regions of Tabriz city has been reviewed and presented.

MATERIALS AND METHODS

This study is descriptive-cross sectional. So that in the summer of 2016, in 15 regions and 120 districts of the city sampling was done fromprivate branch taps. Samples (volume of each sample of 1000 ml) were immediately transferred to the laboratory and tested. In

this research, nitrate concentration was measured using Spectrophotometric method at a wavelength of 220-275 nm(using aHachDr 5000spectrophotometer) and pHvalueswere measured by the Metrohm744 pHMeter. Spectrophotometric method is very fast so that measuring the concentration of nitrate in a sample of water takes up to 45 seconds. Finally, the results were analyzed by SPSS.

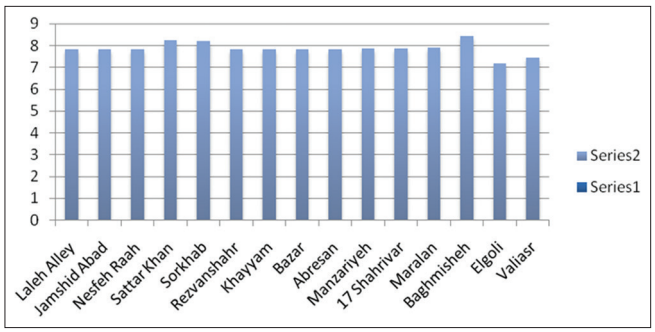

Figure 1: Evaluation of nitrate amounts segregated for each region

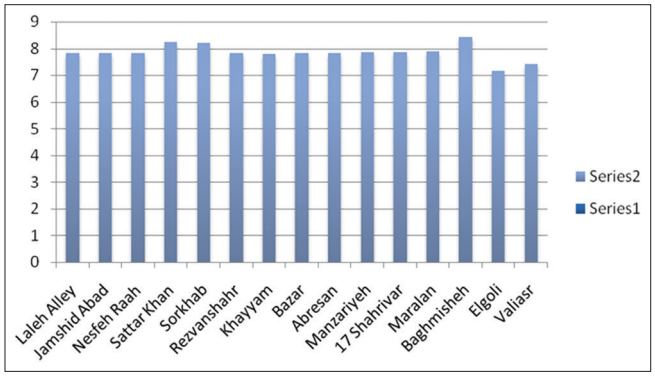

Figure 2: Check the water PH in drinking water of Tabriz City

RESULTS

The results showed that the maximum and minimum concentration of nitrate was 7.86 and 3.23 mg/l in Elgoli and Baghmisheh regions, respectively, and the mean concentration was 5.14 mg/L. The maximum and minimumamount of Ph,was obtained inBaghmisheh (8.44) and Elgoli (7.18). The correlation between the nitrate and water pH is inverse linear. It means that by increasing the amount of nitrate, water pH decreases.According to the results of statistical analysis, nitrate concentration in each area of Tabriz showed a significant difference at the level of $P<1$. This means a very significant conflict with international standards for nitrate concentrations in drinking water (10 mg/l) as nitrogen. Based on the results of water quality, nitrate was in the acceptable Range. According to Figures 1 and 2, it is shown that the average nitrate and PH in water in the west of the city is higher. Based on the amount of variance, it is demonstrated that data dispersion in the North and West is more than other parts of the city. The highest nitrate concentration is in

Table 1: National and international standard of nitrate concentration in drinking water. (Drinking Water Quality Standards, 2012)

Standard title	The maximum permissible nitrate (mg/l)
Iranian standard (The standard of industrial research in Iran)	50 (Based on nitrate)
The World Health Organization (WHO)	45 (Based on nitrate)
The United States Environmental Protection Agency (USEPA)	45 based on nitrate (or) 10 based on nitrogen
The Europe Environment Agency (EEA)	50 (Based on nitrate)

Table 2: Overview of nitrate and pH of drinking water of Tabriz Province

Location	Resource	Average Nitrate	District Name	Average PH
East	Zarrineh River	5. 32	Laleh Alley	7. 84
East	Zarrineh River	5. 36	Jamshid Abad	7. 82
East	Zarrineh River	5. 28	Nesfe-e-Raah	7. 83
North	Elgoli reservoir	3. 91	Sattar Khan	8.23
North	Elgoli reservoir	3. 85	Sorkhab	8.22
North	Zarrineh River	5. 33	Rezvanshahr	7. 84
Central	Zarrineh River	5. 33	Khayyam	7. 81
Central	Zarrineh River	5. 30	Bazar	7. 83
Central	Zarrineh River	5. 31	Abresan	7. 82
South	Highruth reservoir	4/41	Manzariyeh	7. 85
South	Highrugh reservoir	4/38	Sharestanpour	7.87
South	High Ruth reservoir	4/46	Maralan	7. 90
West	NahandReservoir	3/23	Baghmisheh	8.44
West	High reservoir	7/86	Elgoli	7. 18
West	High reservoir	7/79	Valiasr	7.43

Elgoli and Valiasrwith 7.86 and 7.79mg/l and the lowest nitrate was reported in Baghmisheh and Sorkhab with 3.23 and 3.85mg/l, respectively.

Table 2 shows 15 studied districts in 5 geographic locations from 6 separated tanks throughout Tabriz City. Results of nitrate and pH of drinking water was achieved and analyzed. According to Table 3 and the p-value, it is determined that the data have a normal distribution and parametric tests can be used for data analysis.

Table 3: data normalization nitrate Kolmogorov-Smirnov test

One-Sample Kolmogorov-Smirnov Test		
		Nitrate concentration
N		120
Normal Parameters	Mean	5.14507
	Std. Deviation	1.245276
Most Extreme Differences	Absolute	0.286
	Positive	0.286
	Negative	-0.135
Kolmogorov-Smirnov Z		3.135
Asymp. Sig. (2-tailed)		0.000
Test distribution is	Normal	

Analysis of variance (ANOVA)

Since the aim of the study is to investigate the amount of nitrate in 5 different parts of the city (north, south, west, east and center), ANOVA is used to check the following assumptions that assumes zero equal to the amount of nitrate in the water in five direction of the city and the premise of the inequality is the amount of nitrate.

H_0: $\mu_1=\mu_2=\mu_3=\mu_4=\mu_5$

H_1: $\mu_1\neq\mu_2\neq\mu_3\neq\mu_4\neq\mu_5$

ANOVA

According to Table 4 and the SIG that is less than 5 percent, H0 hypothesis is rejected and a significant difference between the amounts of nitrate in the water in different parts of the city is determined by sampling from different directions (North, South, West, East, Central). On this basis, there is a need to review the differences of specified

Table 4: Evaluation of nitrate using ANOVA analysis of variance

Nitrate levels	Sum of squares	ANOVA			
		DF	Mean square	F	Sig
Between Group (Combined)	60.544	4	15.136	14.038	000
Liner Team Contrast	18.957	1	18.957	17.583	000
Deviation	41.586	3	13.862	12.857	000
Within Group	123.991	115	1.078		
Total	184.535	119			

Table 5: multiple nitrate comparisons using the Tukey test

Multiple Comparisons Tukey HSD						
(I) Direction	(J) Direction	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
north	south	-0.055042	0.299747	1.000	-0.88580	0.77572
	west	-1.931667*	0.299747	0.000	-2.76243	-1.10091
	east	-0.960542*	0.299747	0.015	-1.79130	-0.12978
	central	-0.952500*	0.299747	0.016	-1.78326	-0.12174
south	north	0.055042	0.299747	1.000	-0.77572	0.88580
	west	-1.876625*	0.299747	0.000	-2.70739	-1.04586
	east	-0.905500*	0.299747	0.025	-1.73626	-0.07474
	central	-0.897458*	0.299747	0.027	-1.72822	-0.06670
west	north	1.931667*	0.299747	0.000	1.10091	2.76243
	south	1.876625*	0.299747	0.000	1.04586	2.70739
	east	0.971125*	0.299747	0.013	0.14036	1.80189
	central	0.979167*	0.299747	0.012	0.14841	1.80993
east	north	0.960542*	0.299747	0.015	0.12978	1.79130
	south	0.905500*	0.299747	0.025	0.07474	1.73626
	west	-0.971125*	0.299747	0.013	-1.80189	-0.14036
	central	0.008042	0.299747	1.000	-0.82272	0.83880
central	north	0.952500*	0.299747	0.016	0.12174	1.78326
	south	0.897458*	0.299747	0.027	0.06670	1.72822
	west	-0.979167*	0.299747	0.012	-1.80993	-0.14841
	east	-0.008042	0.299747	1.000	-0.83880	0.82272

*. The mean difference is significant at the 0.05 level.

areas using Tukey test. The provincial breakdown is divided into three parts based on nitrate concentration:
Section 1: The north and south of province
Section 2: The Central and Eastern part province
Section 3: The Western part of the province

According to the results of Tukey test in Table 5, there isa significant difference between the mean concentration of nitrate in water in different parts of the city that were highlighted and showsa significant difference in west of the city.

Assessment of the Correlation between Nitrate Concentration and pH of Water

In order to investigate the correlation between nitrate and pH of Water, correlation coefficient is used. According toTable6,there is a very strong reverse correlation at 99 % between nitrate and pH of water. This Connectionis of the linear reverse kind meaning that with the increase of nitrate concentration, the pH value decreases.

According to Table 7, the correlation between the independent and dependent variables is 94% and the coefficient of determination is 88% which shows that88% of the changes in the concentration of nitrate is related to PH.

According to Table 8, the average concentration of nitrate in the West of Tabriz was measured that 95% confidencelevel assure that the estimated number is between upper and lower limit.

According to table 8 and 9, there is a significant difference between the nitrate content in each of the three neighborhoods. The Baghmisheh area has a very low level of Nitrate, however, Elgoli and Valiasr districts have high levels of nitrate.

DISCUSSION AND CONCLUSION

Evaluation of this study indicated that nitrate concentration in drinking water was in the range of 3.23 to 7.86mg per liter that these values are less than the maximum permitted concentration of nitrate in drinking water according to WHO and the Department of Energy of Iran.

Currently, at the time of sampling for water quality, nitrate concentration is within acceptable level. The concentration of nitrate in the examined areas was compared with each other and the results of ANOVA and Tukey tests indicated

Table 6: Final analysis of nitrate content using Tukey test

TUKEY HSD				
Geographical Direction	N	Subset for Alpha		
		3	2	1
North	24	4.36512		
South	24	4.42.17		
Central	24	5.31762		
East	24	5.32567		
West	24	6.29679		
Sig.		1.000	1.000	1.000

Table 7: Evaluation of the adequacy of the correlation between nitrate and pH of water

Model Summary					
model	Correlation coefficient	Determination coefficient	Adjusted determination coefficient	Standard Deviation	Durbin-Watson
1	0.941a	0.886	0.885	0.09878	0.296

Nitrate concentration
a. Predictors: (Constant)
b. Dependent Variable: PH

Table 8: Determination of nitrate in the western part of the city

Descriptions								
Nitrate concentration								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lowest Bound	Upper Bound		
Valiasr	8	7.79350	0.022058	0.007799	7.77506	7.81194	7.765	7.830
Elgoli	8	7.86325	0.043282	0.015303	7.82707	7.89943	7.798	7.912
Baghmisheh	8	3.23362	0.029189	0.010320	3.20922	3.25803	3.198	3.280
Total	24	6.29679	2.212984	0.451723	5.36233	7.23125	3.198	7.912

Table 9: Nitrate analysis in west of Tabriz using Tukey test

	Dist9ricts	N	Subset for alpha=0.05		
			1	2	3
TukeyHSDa	Baghmisheh	8	3.2336		
	Valiasr	8		7.7935	
	Elgoli	8			7.86325
	Sig.		1.000	1.000	1.000

a difference in water qualityin the areas. According to the results, maximum and minimum nitrate concentration was 7.86 and 3.23 mg/L,respectively, in Elgoli and Baghmisheh districts, and the mean concentration was 5.14 mg/L. The results indicated that water samples taken in terms of nitrate concentration in comparison with the recommended standard (maximum nitrogen concentration of 10 mg/L) as nitrogen, is approximately free from contamination, and at this time, there is not a serious risk. However,But the nitrate concentration in 12 of the 15 sampled areas is above 4 mg/L, which is extremely harmful for pregnant and lactating women, infants and the elderly. Therefore, appropriate strategies are needed to be offered for nitrate reduction.

REFERENCES

1. Badeenezhad, A., Gholami, M., JonidiJafari, A. and Ameri, A., 2012. Factors Affecting nitrate Concentrations in Shiraz Groundwater Using Geographical Information System) GIS. Toloo-e-behdasht, 11(2), pp.47-56.
2. Alighadri, M., Hazrati, S., Sakhaiezadeh, A. and Soleymanpoor, M., 2011. Measurement of Nitrate Concentrations in Drinking Water Supply Sources and Distribution Network of Ardabil City.
3. Harter, T. and Lund, J., 2012. Addressing Nitrate in California's Drinking Water: Executive Summary. Addressing Nitrates in California's Drinking Water.
4. Jacobson, J., 2010. Distribution and transport of nitrate in an unconfined alluvial aquifer, Carson Valley, Douglas County, Nevada, 2009.University of Nevada, Reno.
5. Brender, J.D., Weyer, P.J., Romitti, P.A., Mohanty, B.P., Shinde, M.U., Vuong, A.M., Sharkey, J.R., Dwivedi, D., Horel, S.A., Kantamneni, J. and Huber Jr, J.C., 2013. Prenatal nitrate intake from drinking water and selected birth defects in offspring of participants in the National Birth Defects Prevention Study. Environmental health perspectives, 121(9), p.1083.
6. ANSARI, S., Heidarpour, M. and Mousavi, S.F., 2016.Application of barley straw to remove nitrate from drainage water. Iran Agricultural Research.
7. Baghvand, A., Vosoogh, A., Givehghi, S. and Daryabeigi, Z.A., 2016. Ground Water Modeling To Estimate Nitrate Dispersion In Critical Aquifers (A Case Study: Mashhad City).
8. Abdesselam, S., Halitim, A., Jan, A., Trolard, F. and Bourrié, G., 2013. Anthropogenic contamination of groundwater with nitrate in arid region: case study of southern Hodna (Algeria). Environmental Earth Sciences, 70(5), pp.2129-2141.
9. Zhang, X., Xu, Z., Sun, X., Dong, W. and Ballantine, D., 2013. Nitrate in shallow groundwater in typical agricultural and forest ecosystems in China, 2004–2010. Journal of Environmental Sciences, 25(5), pp.1007-1014.
10. Turkeltaub, T., Kurtzman, D. and Dahan, O., 2016. Real-time monitoring of nitrate transport in the deep vadose zone under a crop field–implications for groundwater protection. Hydrology and Earth System Sciences, 20(8), pp.3099-3108.
11. Xue, Y., Song, J., Zhang, Y., Kong, F., Wen, M. and Zhang, G., 2016. Nitrate pollution and preliminary source identification of surface water in a semi-arid river basin, using isotopic and hydrochemical approaches. Water, 8(8), p.328.
12. Akhavan, S., ZareAbyaneh, H. and BayatVarkeshi, M., 2014. A systematic review on nitrate concentration in water resources of Iran. Iranian Journal of Health and Environment, 7(2), pp.205-228.
13. Self J.R and Waskom R.M. (2013). Nitrate in Dinking water. Colorado: Colorado State University, U.S. Department of Agriculture and Colorado counties cooperating.
14. Gheysari, M.M., Houdaji, M. and Najafi, P., 2007. Assessment of nitrate pollution of groundwater in south-east of Isfahan region.
15. Earnhart, D. (2013). "Water pollution from industrial sources." Encyc. Energ. Nat. Res. Environ. Econ., 3,PP 114-120
16. Russell, C.S. ed., 2016. Safe drinking water: current and future problems. Routledge.
17. Standard and Industrial Researches Organization, Drinking Water Quality Standards, Iran 2012
18. World Health Organization, 2011. Guidelines for Drinking Water Quality. Eng. sanit. ambient, 16(4), pp.4-5.
19. Mohammadi, H., Yazdanbakhsh, A., SheykhMohammadi, A., Bonyadinejad, G. and Alinejad, A., 2011. ghanbari G. Investigation of Nitrite and Nitrate in Drinking Water of Regions under Surveillance of ShahidBeheshti University of Medical Sciences in Tehran Province, Iran. Health System Research, 7(6), pp.782-8.
20. Miranzadeh, M.B., Heidari, M., Dehghan, S. and Hasanzadeh, M., 2010. An Overview Of Nitrate In Drinking Water And Its Health Effect With Emphasis On Its Carcinogenic Risk In Human.
21. Causse, J., Thomas, O., Jung, A.V. and Thomas, M.F., 2017. Direct DOC and nitrate determination in water using dual pathlength and second derivative UV spectrophotometry. Water Research, 108, pp.312-319.

How to cite this article: Parisa Dadgar P, Payandeh PE. Investigation of Nitrate Concentration and Its Correlation with Water pH in Drinking Water Distribution Network of the City of Tabriz. Int J Sci Stud 2017;5(4):726-731.

Source of Support: Nil, **Conflict of Interest:** None declared.